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GEOTECHNICAL ENGINEERING STUDY AND PAVEMENT THICKNESS DESIGN EVERHOME SUITES HOTEL EAST OF THE INTERSECTION OF MARSHALL ROAD & MCCASLIN BOULEVARD SUPERIOR, COLORADO

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TABLE OF CONTENTS

SUMMARY

1. The borings encountered a relatively thin layer of topsoil underlain by existing fill extending to naturally deposited (native) granular soils at depths ranging from about 4 feet to 6 feet in Borings 1 through 4 and to the maximum explored depth of about 5 feet in Borings P-1 and P-2. The native granular soils extended to claystone bedrock at depths ranging from about 14 feet to 21 feet below existing grades at the time of drilling. The claystone continued to the maximum explored depths of about 25 feet or 30 feet.

   Groundwater was encountered in Borings 1 and 2 at depths of about 19 feet and 14 feet, respectively, during drilling. Stabilized groundwater was measured in Borings 1, 3, and 4 at depth of about 16.5, 22.5, and 22 feet, respectively when measured 7 days subsequent to drilling.

2. Spread footings foundations are recommended for the proposed building. Footings should be supported on structural fill extending to undisturbed native overburden soils. Footings supported as recommended should be designed for an allowable bearing pressure of 3,000 psf.

3. Slab-on-grade floor slabs should be supported on structural fill extending to undisturbed native overburden soils.

4. Pavement thickness and subgrade preparation recommendations for private site pavement areas are presented herein and summarized in the table below:

Pavement Type	**Composite HMA/ABC Pavement Section (in)**	**Full-depth HMA Pavement Section (in)**	**Rigid PCCP Thickness (in)**
Light-duty	4.0/6.0	5.5	6.0
Medium-duty	4.5/6.0	6.0	6.0

HMA = Hot Mix Asphalt; ABC = Aggregate Base Course, PCCP = Portland Cement Concrete Pavement

PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study performed for the proposed Everhome Suites Hotel to be located east of the intersection of Marshall Road and McCaslin Boulevard in the Town of Superior, Colorado. The project site is shown on Fig. 1. The study was conducted in general accordance with the scope of work in our Proposal No. P-23-783 to Entitlement and Engineering Solutions, Inc., dated September 29, 2023 (revised).

A field exploration program consisting of exploratory borings was conducted to obtain information on subsurface conditions. Samples of soils and bedrock obtained during the field exploration program were tested in the laboratory to determine their classification and engineering characteristics. The results of the field exploration and laboratory testing programs were analyzed to develop geotechnical engineering recommendations for use in design and construction.

This report has been prepared to summarize the data obtained during our services and to present our conclusions and recommendations based on our understanding of the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations pertaining to the proposed construction are included in the report.

PROPOSED DEVELOPMENT

Based on the information provided to us, we understand site development will consist of the construction of a 4-story hotel building with approximate dimensions of 84 feet wide by 239 feet long resulting in a footprint area of about 20,000 square feet. The building is planned to have minimal landscaping surrounding the structure with private drive lanes and parking areas to the east and south of the proposed building. A patio/amenity area is to be located to the northwest corner of the building.

We anticipate building foundation loads will be light to moderate and that construction will likely consist of wood framing supported on reinforced concrete foundations. Based on existing site topography, we assume project site grading will consist of cuts and fills on the order of 5 feet or less to achieve finished grades.

If the proposed construction varies significantly from that described above or depicted in this report, we should be notified to reevaluate the recommendations provided in this report.

SITE CONDITIONS

The project site currently consists of a 1.97-acre, undeveloped property bounded on the north and east by United States Highway 36 (US 36), on the south by a concrete pedestrian trail and Coal Creek, and on the west by an existing hotel facility. Based on available topographic information and site observations, site topography is generally gently sloping down from northwest to southeast, towards Coal Creek.

Based on historical aerial photographs after 1999, the site appears to have been generally undeveloped/unutilized except from between 2015 and 2016 when it was used as a storage yard.

SUBSURFACE CONDITIONS

The field exploration program for the project was performed on October 16, 2023. Six (6) exploratory borings were drilled for this study to explore subsurface conditions and to obtain samples for laboratory testing. The approximate locations of the exploratory borings are shown on Fig. 1. Logs of the exploratory borings are presented on Fig. 2. An associated legend and explanatory notes is presented on Fig. 3.

The borings were advanced with 4-inch-diameter, continuous-flight augers and were logged by a representative of K+A. Samples of the soils and bedrock, where encountered, were obtained with a either a 1-3/8-inch I.D split-spoon sampler or a 2-inch I.D. California-liner sampler driven into the various strata with blows from a 140-pound hammer falling 30 inches. Sampling with the split-spoon sampler is the standard penetration test (STP) described by the ASTM International (ASTM) Method D1586 procedure. Samling with the California-liner sampler is similar to the SPT. Sampler penetration resistance values (blow counts), when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples were obtained and the penetration resistance values are shown adjacent to the boring logs on Fig. 2.

<u>Subsurface Soil Conditions</u>: The borings encountered a relatively thin layer of topsoil underlain by existing fill extending to naturally deposited (native) granular soils at depths ranging from about 4 feet to 6 feet in Borings 1 through 4 and to the maximum explored depth of about 5 feet in Borings P-1 and P-2. The native granular soils extended to claystone bedrock at depths ranging from about 14 feet to 21 feet below existing grades at the time of drilling. The claystone continued to the maximum explored depths of about 25 feet or 30 feet.

The existing fill materials consisted of clayey sand, lean clay, and isolated lenses of well-graded gravel with silt and sand. The fill was generally fine to coarse-grained with variable gravel content, slightly moist to moist, and brown to dark brown to dark gray. The horizontal and vertical limits, along with the consistency of the fill, were not determined during this study. However, the fill soils appear to be reworked onsite or locally sourced soils.

The native granular soils varied between clayey sand and silty sand, contained occasional lean clay lenses, and were generally fine- to coarse-grained with variable gravel content, moist to wet (below groundwater), and brown to gray with occasional iron oxidation staining. Based on blow counts, the native granular soils ranged from loose to very dense.

The claystone bedrock was generally moist, dark brown to gray to dark gray with occasional iron oxidation staining, and contained a fine- to medium-grained sand fraction. Based on blow counts, the bedrock ranged from hard to very hard, in consistency.

Groundwater was encountered in Borings 1 and 2 at depth of about 19 feet and 14 feet, respectively, during drilling. The remaining borings were found to be dry. Borings 1 through 4 were left open to allow for a follow-up groundwater level measurement with Borings P-1 and P-2 backfilled subsequent to drilling. Stabilized groundwater was measured in Borings 1, 3, and 4 at depth of about 16.5, 22.5, and 22 feet, respectively when measured 7 days subsequent to drilling. Groundwater was not present in Boring 2 at the time of the follow-up measurement. The open borings were backfilled upon completion of the follow-up measurements.

LABORATORY TESTING

Samples obtained from the exploratory borings were visually classified in the laboratory by the project engineer. Laboratory testing was performed on representative samples, including evaluation of in-situ moisture content and dry unit weight, grain size distribution, liquid and plastic limits, and swell-consolidation behavior. The above tests were performed in accordance with the corresponding ASTM standard test procedures. The percentage of water-soluble sulfates was determined in general accordance with the Colorado Department of Transportation (CDOT) CP-L2103 test procedure. The results of the laboratory tests are shown to the right of the logs on Fig. 2, plotted graphically on Figs. 4 through 6, and summarized in Table I.

Swell-Consolidation: Swell-consolidation testing was performed on two samples of the claystone bedrock in order to determine the compressibility and swell characteristics under loading and when submerged in water. The sample was prepared and placed in a confining ring between porous discs, subjected to a surcharge pressure of 1,000 psf, and allowed to consolidate before being submerged in water. The sample was then inundated with water, and the change in sample height was measured with a dial gauge. The sample was loaded incrementally to a maximum surcharge pressure of either 3,000 psf or 10,000 psf. The sample height was monitored until deformation practically ceased under each load increment.

The results of the swell-consolidation testing are presented on Fig. 4 as plots of the curve of the final strain at each increment of pressure against the log of the pressure. Based on the results of the laboratory swell-consolidation testing, the samples of claystone bedrock exhibited low (0.5%) to moderate (2.7%) swell potential when wetted under a constant surcharge pressure of 1,000 psf.

Index Properties: Samples were classified into categories of similar engineering properties in general accordance with the Unified Soil Classification System. This system is based on index properties, including liquid limit and plasticity index and grain size distribution. Values for moisture content and dry unit weight, liquid limit and plasticity index, and the percent of soil retained on the U.S. No. 4 sieve and passing the No. 200 sieve are presented in Table I and adjacent to the corresponding sample on the boring logs. The results of gradation testing performed on samples of the existing fills and native granular soils are presented on Figs. 5 and 6.

GEOTECHNICAL ENGINEERING CONSIDERATIONS

Existing Fills: As previously stated, up to about 6 feet of existing fill materials were encountered in the exploratory borings. Deeper fills not encountered by our subsurface exploration program may also be present. The existing fills appear to be reworked onsite soils that were disturbed during previous site grading activities. Without documentation of placement conditions, the existing fill materials are considered non-engineered and expected to exhibit variable and unpredictable settlement behavior under structural loading. Accordingly, they are generally considered unsuitable for support of foundations, soil-supported slabs, and movement sensitive exterior flatwork.

However, with proper site preparation, shallow foundations and slab-on-grade construction should be feasible. Ideally, proper subgrade preparation should include complete removal of existing fill materials from beneath the structure footprint and settlement-sensitive flatwork areas, with the material replaced in a properly compacted, moisture-treated state.

It is our opinion a partial fill removal and replacement option beneath new pavement, such as the proposed parking lot, should be feasible provided the owner accepts the risk that post-construction compression of existing fill left in place may result in settlement in excess of normally accepted tolerances and associated distress. While we believe that risk is relatively low, it should be carefully considered.

SITE GRADING AND EARTHWORK

Site and Building Subgrade Preparation: Based on our understanding of the proposed construction and observed site topography, grading over most of the site is expected to consist of cuts for removal of the existing fills. Existing fill should be removed from beneath foundations and soil-supported slabs, movement-sensitive exterior flatwork, and pavements consistent with the recommendations for fill removal presented in specific sections of this report, and replaced with structural fill. Structural fill should meet the material and placement requirements presented herein. The indicated fill thicknesses are relative to the bottom of the foundation, slab, and pavement. Overexcavation, where necessary, should extend laterally beyond the perimeter of structures a distance equal to the thickness of the engineered fill zone underlying the foundations, or beyond the limits of any exterior flatwork or pavements where reduction of settlement potential is considered critical.

Subgrade preparation recommendations below pavements are presented in the "Pavement Thickness Design" Section of this report.

Based on the subsurface conditions encountered and the standard penetration testing performed in the exploratory borings, we anticipate the overburden soils can be excavated using conventional, large hydraulic excavators.

Temporary Excavations: We assume temporary excavations will be constructed by over-excavating the slopes to a stable configuration. All excavations should be constructed in accordance with OSHA requirements, as well as state, local and other applicable requirements. Site excavations are anticipated to encounter primarily granular overburden soils with occasional zones and lenses of clay soils. The existing fills and native granular soils will classify as OSHA Type C soils and the native cohesive soils will classify as OSHA Type B soils.

Although not anticipated, excavations encountering perched groundwater could require much flatter side slopes than those allowed by OSHA or the use of temporary shoring, and areas where insufficient lateral space exists may require temporary shoring.

Surface water runoff into the excavations can act to erode and potentially destabilize the excavation side slopes and/or result in soft or excessively loose ground conditions at the base of the excavation and should not be allowed. Diversion berms and other measures should be used to prevent surface water runoff into the excavations from occurring. If significant runoff into the excavations does occur, further excavation to remove and replace soft or loose subgrade materials, or stabilize the slopes, may be required.

Dewatering Considerations: Groundwater will likely not be encountered in excavations in the upper 12 to 15 feet at the site. If local perched groundwater is encountered and dewatering is necessary, we believe construction dewatering can be accomplished with trenches sloping to sumps where the water can be pumped out of the excavation. Excavations close to Coal Creek could encounter water seeping through the banks of the Creek into the excavation.

Selection of a dewatering system is the responsibility of the contractor. Dewatering systems should also be properly designed to prevent piping and removal of soil particles which could have damaging effects.

Fill Material: Unless specifically modified in the other sections of this report, the following recommended material and compaction requirements are presented for engineered fill materials on the project site. A representative of the geotechnical engineer should evaluate the suitability of all proposed fill materials for the project prior to placement.

1. *General Site Grading Fill*: Fill used for site grading and beneath exterior flatwork and pavements that are not movement-sensitive may consist of moisture-conditioned, on-site materials provided the materials meet the low-swelling criteria presented in Item 5 below.

2. *Structural Fill*: Structural fill placed beneath the building and movement-sensitive exterior flatwork and pavements should consist of moisture-conditioned on-site materials, including reworked existing fills, or imported, low permeability, non-expansive to low-swelling materials meeting the swell criteria presented in Item 5 below. Imported materials,

if necessary, should have a maximum of 60% soil passing the U.S. No 200 sieve, a maximum Liquid Limit of 30, and a maximum Plasticity Index of 15.

3. *Pipe Bedding/Pipe Zone Material*: Material used for pipe bedding beneath the pipe, and as pipe zone material placed around and above the pipe and below the trench backfill material, should be a free draining, coarse-grained sand and/or fine gravel. The specific gradation of pipe backfill material should also conform to the type and diameter of pipe used and the manufacturer's requirements. Some of the native granular soils may be suitable.

4. *Utility Trench Backfill*: Materials excavated from the utility trenches may be used for trench backfill above the pipe zone fill provided they do not contain unsuitable material or particles larger than 4 inches and can be placed and compacted as recommended herein.

5. *Material Suitability*: Unless otherwise defined herein, all fill material should be non-expansive; free of claystone, vegetation, brush, sod, trash and debris, and other deleterious substances; and should not contain rocks or lumps having a diameter of more than 3 inches. Unless otherwise defined herein, a material generally should be considered low-swelling if the swell potential does not exceed 1% when the materials are remolded to 95% of the standard Proctor (ASTM D698) maximum dry density at optimum moisture content and wetted under a 200 psf surcharge pressure.

   Based on the results of laboratory testing completed for this study, the majority of the on-site overburden soils should meet the requirements presented above. Evaluation and acceptance of imported fill sources should include determination of laboratory moisture-density relationships and swell-consolidation tests on remolded samples.

<u>Compaction Requirements</u>: We recommend the following compaction criteria be used on the project:

1. *Moisture Content*: Fill materials should be compacted at moisture contents within 2 percentage points of optimum for predominately granular materials and between optimum moisture content and 3 percentage points above optimum for predominantly clay materials and. The contractor should be aware clay materials, including on-site and imported

materials, may become somewhat unstable and deform under wheel loads if placed near the upper end of the moisture range.

2. *Placement and Degree of Compaction*: Site grading fill and structural fill should be placed in maximum 8-inch-thick loose lifts. The following compaction criteria should be followed during construction:

Fill Location	Percentage of Maximum Standard Proctor Density (ASTM D698)
Beneath and Adjacent to Foundations	98%
Beneath Floor Slabs, Exterior Flatwork, and Pavements	
Fill less than 8 feet deep	95%
Fill placed deeper than 8 feet	98%
Wall Backfill	95%
Utility Trenches	
Fill less than 8 feet deep	95%
Fill placed deeper than 8 feet	98%
Landscape and Other Areas	95%

3. *Subgrade Preparation*: Prior to placing engineered fill, the upper 12 inches of the subgrade soils at the base of the fill zone should be scarified and well-mixed, moisture conditioned, and recompacted to at least 95% of the standard Proctor (ASTM D698) maximum dry density. All other areas to receive new fill not specifically addressed herein should be scarified to a depth of at least 8 inches and recompacted to at least 95% of the standard Proctor (ASTM D698) maximum dry density. The moisture conditioning should be to the moisture contents recommended herein.

   Excessive wetting and drying of excavations and prepared subgrade areas should be avoided during construction.

FOUNDATION CONSIDERATIONS

Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend the proposed structures are founded on a shallow foundation system. As previously stated, subgrade preparation below shallow foundations should be performed as recommended herein to reduce the risk of post-construction settlement of existing fills and/or loose soils.

<u>Spread Footing Foundations</u>: The design and construction criteria presented below should be observed for a spread footing foundation system. The construction details should be considered when preparing project documents.

1. Spread footings should be placed on structural fill extending to undisturbed native soils. This will result in excavation extending to depths ranging from about 4 to 6 feet below existing grades. Structural fill should satisfy the material and placement requirements presented in the “Site Grading and Earthwork” section of this report and extend down and away from the edges of the footings at a 1 horizontal to 1 vertical projection.

   Areas of existing fill, excessively loose or soft material, and/or deleterious substances encountered within the foundation excavation should be removed to firm native soils and replaced with structural fill.

2. Spread footings supported as recommended should be designed for a net allowable soil bearing pressure of 3,000 psf. The allowable bearing pressure may be increased by one-third for transient loads.

3. Based on experience, we estimate total settlement for footings designed and constructed as discussed in this section will be less than 1 inch. Differential settlements across the building are estimated to be approximately ½ to ¾ of the total settlement.

4. Spread footings should have a minimum footing width of 16 inches for continuous footings and of 24 inches for isolated pads, and a minimum embedment of 24 inches below lowest adjacent grade.

5. 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 36 inches below the lowest adjacent grade is typically used in this area.

6. The lateral resistance of a spread footing 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 may be calculated based on a coefficient of friction of 0.35. Passive pressure against the sides of the footings may be

calculated using an equivalent fluid unit weight of 200 pcf. These values are working values.

Compacted fill placed against the sides of the footings to resist lateral loads should consist of structural fill meeting the material and placement requirements presented in the “Site Grading and Earthwork” section of this report.

7. Continuous foundation walls should be reinforced top and bottom to span an unsupported length of at least 10 feet.

8. A representative of the geotechnical engineer should observe all footing excavations prior to fill and concrete placement.

FLOOR SLABS

The following measures should be taken to reduce damage which could result from movement should the subslab materials be subjected to moisture changes.

1. Floor slabs should be placed on structural fill extending to undisturbed native soils. Structural fill should meet the material and placement requirements presented in the “Site Grading and Earthwork” section of this report.

2. A modulus of vertical subgrade reaction of 125 pci is recommended for a subgrade consisting of structural fill. The modulus of vertical subgrade reaction of 125 pci was correlated based on material classification and blow count values from several engineering resources including Joseph E. Bowles *Foundation Analysis and Design*.

3. Floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. This recommendation is intended to reduce the risk of structural distress due to potential settlement-related differential movement between foundations and soil-supported floor slabs. If the owner understands and accepts the risk of potential damage resulting from stresses induced by differential movement of the foundations and floor slabs, the design team may consider forgoing the use of slabs supported independently of the foundations. While we believe risk of significant differential movements is low if the subgrade preparation recommendations in this report are

followed, elimination of the separation of floor slabs and foundations as recommendations should be carefully considered.

4. Interior non-bearing partitions resting on floor slabs should be provided with slip joints at the bottoms so, if the slabs move, the movement cannot be transmitted to the upper structure. This detail is also important for wallboards, stairways and door frames. Slip joints that will allow at least 2 inches of vertical movement are recommended.

   If wood or metal stud partition walls are used, the slip joints should preferably be placed at the bottoms of the walls so differential slab movement will not damage the partition wall. If slab-bearing masonry block partitions are constructed, the slip joints will have to be placed at the tops of the walls. If slip joints are provided at the tops of walls and the floors move, it is likely the partition walls will show signs of distress, such as cracking. An alternative, if masonry block walls or other walls without slip joints at the bottoms are required, is to found them on shallow foundations and to construct the slabs independently of the wall foundation. If slab-bearing partition walls are required, distress may be reduced by connecting the partition walls to the exterior walls using slip channels.

   Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction.

5. Floor slab control joints should be used to reduce damage due to shrinkage cracking. Joint spacing is dependent on slab thickness, concrete aggregate size, and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) or American Concrete Institute (ACI). We suggest joints be provided on the order of 12 to 15 feet apart in both directions. The joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use.

6. If moisture-sensitive floor coverings will be used, additional mitigation of moisture penetration into the slabs, such as by use of a vapor retarder may be required. If an impervious vapor barrier membrane is used, special precautions will be required to prevent differential curing problems which could cause the slabs to warp. American Concrete Institute (ACI) 302.1R-16 addresses this topic.

7. All plumbing lines should be tested before operation. Where plumbing lines enter through the floor, a positive bond break should be provided. Flexible connections should be provided for slab-bearing mechanical equipment.

The precautions and recommendations itemized above will not prevent the movement of floor slabs if the underlying materials are subjected to alternate wetting and drying cycles. However, the precautions should reduce the damage if such movement occurs.

EXTERIOR FLATWORK

To limit potential movement due to settlement of overlot fills, movement-sensitive exterior flatwork and exterior flatwork immediately adjacent to the buildings, including entries, patios, and sidewalks where reduction of potential movement is considered critical, should be underlain to the same depth as in the “Floor Slab” section of this report.

Where reduction of potential movement is less of a concern, such as for sidewalks located more than 10 feet from building, the flatwork should be prepared as recommended in the “Pavement Thickness Design” section of this report. The owner should be aware these subgrade preparation measures will reduce but not eliminate potential movement should moisture levels increase within the overlot fills soils.

Proper surface drainage measures and irrigation practices as recommended in following sections of this report are also critical to limiting moisture-related, post-construction movement.

LATERAL EARTH PRESSURES

Earth retaining structures such as elevator pits, etc. should be designed for the lateral earth pressure based on the degree of rigidity of the retaining structure and the type of backfill material used. Retaining structures that are laterally supported and can be expected to undergo only a moderate amount of deflection should be designed for earth pressures based on the following equivalent fluid unit weights:

Imported free-draining granular backfill (< 5% passing No. 200 sieve)...................... 45 pcf
CDOT Class 1 (<20% passing No. 200 Sieve).. 50 pcf
On-site, moisture-conditioned granular backfill .... 55 pcf

Cantilevered retaining structures that can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for the following equivalent fluid unit weights:

Imported free-draining granular backfill (< 5% passing No. 200 sieve)...................... 35 pcf
CDOT Class 1 (<20% passing No. 200 Sieve)... 40 pcf
On-site, moisture-conditioned granular backfill .... 45 pcf

The equivalent fluid weights recommended above assume drained conditions behind the wall or retaining structures and a horizontal backfill surface. The buildup of water behind a wall or retaining structure, or an upward sloping backfill surface, will increase the lateral pressure imposed on the wall or retaining structure. Care should be taken not to over compact the backfill since this could cause excessive lateral pressure on the structure. Hand compaction procedures, if necessary, should be used to prevent lateral pressures from exceeding the design values. We recommend calculating design lateral pressures due to surcharge loads using a lateral earth pressure coefficient of 0.6.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the site building and movement-sensitive flatwork and pavements during construction and after construction has been completed. Drainage recommendations provided by local, state and national entities should be followed based on the intended use of the facility. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying of the exposed subgrade soils should be avoided during construction.

2. The upper 1 to 2 feet of exterior backfill adjacent to the building should be relatively impervious materials compacted as recommended above to promote runoff and limit infiltration of surface runoff. Unless otherwise recommended herein, exterior backfill should be compacted to at least 95% of the standard Proctor (ASTM D698) maximum dry density at moisture contents within 2 percentage points of the optimum moisture content.

3. The ground surface surrounding the exterior of the building and movement-sensitive flatwork and pavement areas should be sloped to drain away in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas and a

minimum slope of 6 inches in the first 10 feet in paved areas. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce infiltration. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act.

4. Ponding of water should not be allowed within 20 feet of structures and movement-sensitive flatwork and pavement areas.

5. Roof downspouts and drains should discharge directly to site surface drainage systems.

6. Excessive landscape irrigation should be eliminated within 20 feet of the building and movement-sensitive flatwork and pavement areas. Irrigation schemes are available which allow placement of lightly irrigated landscape near foundation walls in moisture sensitive soil areas. Drip irrigation heads with main lines located at least 10 feet from the foundation walls are acceptable provided irrigation quantities are limited.

WATER-SOLUBLE SULFATES

The concentration of water-soluble sulfates measured in a sample of the granular fill soils was 0.03%. This concentration of water-soluble sulfates represents a Class S0 severity of exposure to sulfate attack on concrete exposed to these materials. The degree of attack is based on a range of Class S0 (not applicable), Class S1 (moderate), Class S2 (severe), and Class S3 (very severe) severity of exposure as presented in ACI 201.2R. Based on our experience, we believe the existing fill soils will have similar concentrations of water-soluble sulfates as the native overburden soils.

Based on the laboratory test results and our experience at the site, we do not believe special sulfate resistant cement will be required for concrete exposed to the onsite existing fill and native overburden soils.

PAVEMENT THICKNESS DESIGN

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. Soils are represented for pavement design purposes by means of a soil support value for flexible pavements and a modulus of subgrade reaction for rigid pavements.

Subgrade Materials: Based on the results of the field exploration and laboratory testing programs, the predominant pavement subgrade materials at the site are anticipated to primarily classify as A-1-a, A-2-4, A-2-6 and occasionally A-6 soils with group index values ranging between 0 and 3 in accordance with the American Association of State Highway and Transportation Officials (AASHTO) soil classification system. Soils classifying as A-1-a, A-2-4 and A-2-6 would generally be considered to provide excellent to good subgrade support. Soils classifying as A-6 soils would generally be considered to provide poor subgrade support. Due to the somewhat varying soil types, a design resilient modulus value of 4,000 psi was selected for flexible pavements and a corrected modulus of subgrade reaction of 75 was selected for rigid pavements.

Design Parameters: We understand the project pavements will consist of private drive lanes and parking areas that are not owned or maintained by the City or County. Initial and terminal serviceability values of 4.5 and 2.0, respectively, and a reliability of 80 percent were selected. Material strength coefficients of 0.44 for hot bituminous asphalt (HMA) pavement, 0.11 for ABC, and 0.34 for concrete pavements were selected for design. If other design parameters are preferred, we should be contacted in order to reevaluate the recommendations presented herein.

Design Traffic: Since anticipated traffic loading information was not available at the time of report preparation, an equivalent 18-kip equivalent single axle loading (ESAL) value of 36,500 was assumed for combined automobile and light truck traffic areas, including parking areas, (light-duty pavement). An ESAL value of 73,000 was assumed for combined automobile and heavier truck traffic areas, including parking lot drive lanes and fire lanes (medium-duty pavement). The design team should verify which traffic loads are valid for the project. If higher EDLA values are anticipated, the pavement sections presented in this report will have to be reevaluated.

Pavement Sections: The pavement thicknesses were determined in accordance with the 1993 AASHTO pavement design procedures. If other design parameters than presented above are preferred, we should be contacted in order to reevaluate the recommendations presented herein. Site pavement sections should be constructed as presented in the following table.

Pavement Type	Composite HMA/ABC Pavement Section (in)	Full-depth HMA Pavement Section (in)	Rigid PCCP Thickness (in)
Light-duty	4.0/6.0	5.5	6.0
Medium-duty	4.5/6.0	6.0	6.0

HMA = Hot Mix Asphalt; ABC = Aggregate Base Course, PCCP = Portland Cement Concrete Pavement

The concrete sections presented above are assumed to be un-reinforced. Providing dowels at construction joints would help reduce the risk of differential movements between panel sections. Providing a grid mat of deformed rebar within the concrete pavement section would assist in mitigating corner breaks and differential panel movements. If a rebar mat is installed, we recommend the bars be placed in the lower half of the pavement section. On projects electing to install rebar mats, we have commonly seen No. 4 rebar placed at 24-inch centers in each direction, however we recommend a structural engineer evaluate the placement and spacing of rebar if needed.

<u>Pavement Materials</u>: The following are recommended material and placement requirements for pavement construction for this project site. We recommend that properties and mix designs for all materials proposed to be used for pavements be submitted for review to the geotechnical engineer prior to placement.

1. *Aggregate Base Course*: Aggregate base course (ABC) used beneath hot mixed asphalt (HMA) pavements should meet the material specifications for Class 6 ABC stated in the current Colorado Department of Transportation (CDOT) *"Standard Specifications for Road and Bridge Construction"*. The ABC should be placed and compacted as outlined in the Site Grading section of this report.

2. *Hot Mix Asphalt:* Hot mix asphalt (HMA) materials and mix designs should meet the applicable requirements indicated in the current CDOT *"Standard Specifications for Road and Bridge Construction"*. We recommend that the HMA used for this project is designed in accordance with the Super Pave gyratory mix design method. The mix should generally meet Grading S or SX specifications with a Super Pave gyratory design revolution (N_{DESIGN}) of 75. The mix design for the HMA should use a performance grade PG 58-28 asphalt binder. Placement and compaction of HMA should follow current CDOT standards and specifications.

3. *Portland Cement Concrete*: Portland cement concrete pavement (PCCP) should meet Class P specifications and requirements in the current CDOT *"Standard Specifications for Road and Bridge Construction"*. Rigid PCCP is more sensitive to distress due to movement resulting from settlement or heave of the underlying base layer and/or subgrade than flexible asphalt pavements.

Subgrade Preparation: We recommend new pavements be underlain by a minimum of 2 feet of general site grading fill meeting the material and placement recommendations presented in the "Site Grading and Earthwork" section of this report. Prior to placing new engineered fill, the upper 12 inches of the subgrade soils at the base of the fill zone should be scarified and well-mixed, moisture conditioned, and recompacted to at least 95% of the modified Proctor (ASTM D1557) maximum dry density.

Pavement design procedures assume a stable subgrade. The pavement subgrade should be proof-rolled with a heavily loaded pneumatic-tired vehicle with a tire pressure of at least 100 psi capable of applying a minimum load of 18-kips per axle. Areas which deform excessively under heavy wheel loads are not stable and should be removed and replaced to achieve a stable subgrade prior to paving. Areas of existing fill may also require deeper removal and replacement if they are unstable. Paving should be completed within 24 hours of completion of the subgrade preparation.

Drainage: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of pavement. Drainage design should provide for the removal of water from paved areas and prevent the wetting of the subgrade soils. Joints should be routinely inspected, and joints and cracks that develop after construction should be sealed to reduce the potential for water to migrate through the pavement.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

We recommend K+A be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies, if necessary, to accommodate possible changes in the proposed construction.

We recommend K+A be retained to provide construction observation and testing services to document the intent of this report and the requirements of the plans and specifications are being followed during construction. This will allow us to identify possible variations in subsurface conditions from those encountered during this study and to allow us to re-evaluate our recommendations, if needed. We will not be responsible for implementation of the recommendations presented in this report by others, if we are not retained to provide construction observation and testing services.

LIMITATIONS

The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Fig. 1, and the proposed type of construction. This report may not reflect subsurface variations that occur, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, bedrock or groundwater conditions appear to be different from those described herein, K+A should be advised at once so a re-evaluation of the recommendations presented in this report can be made. K+A is not responsible for liability associated with interpretation of subsurface data by others.

JDC/mm
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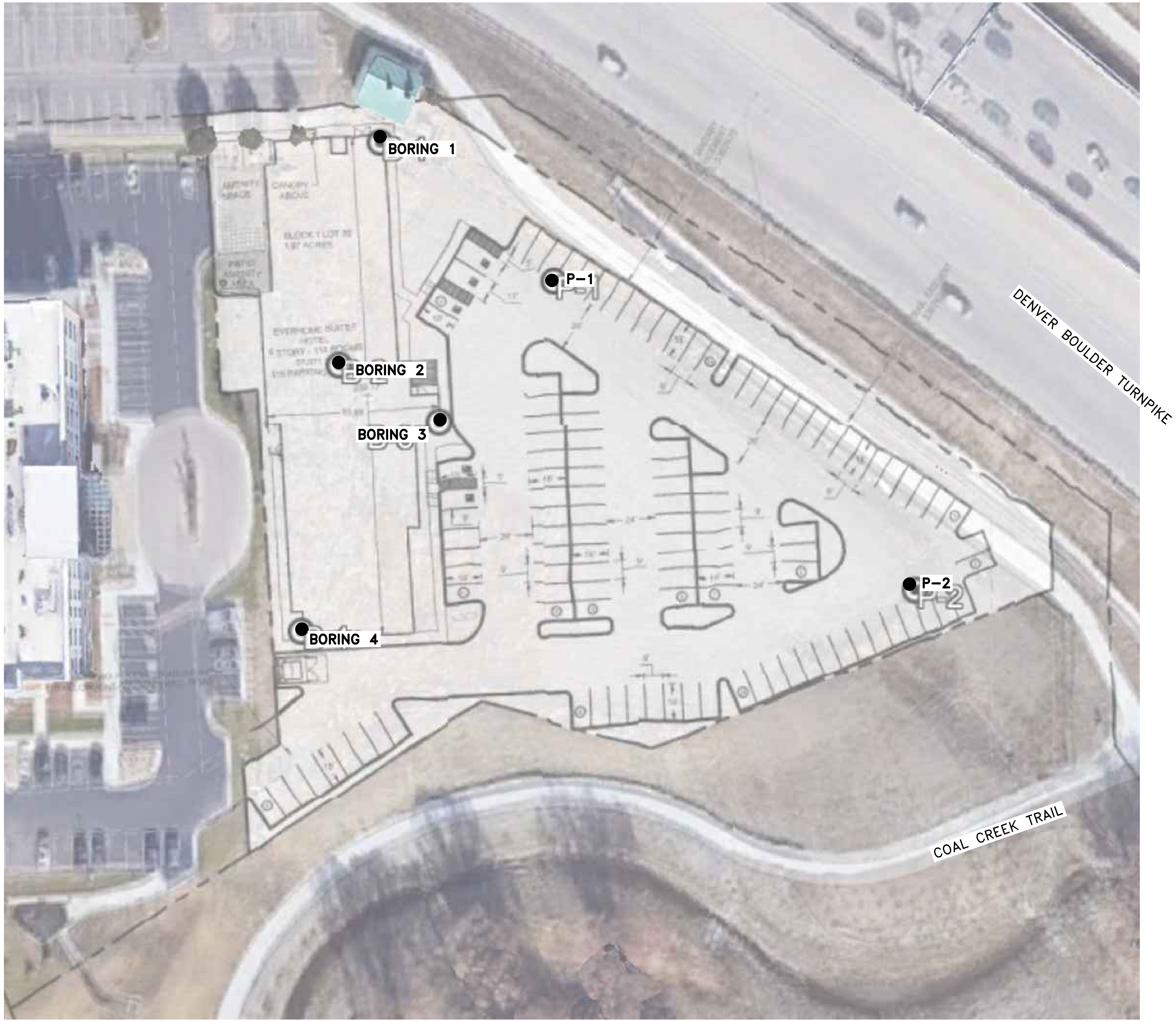

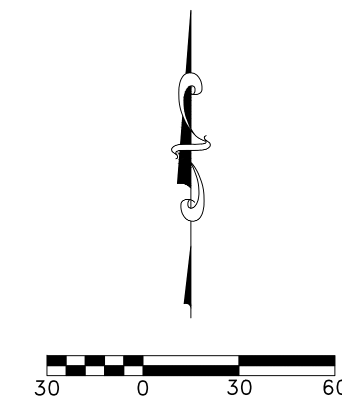

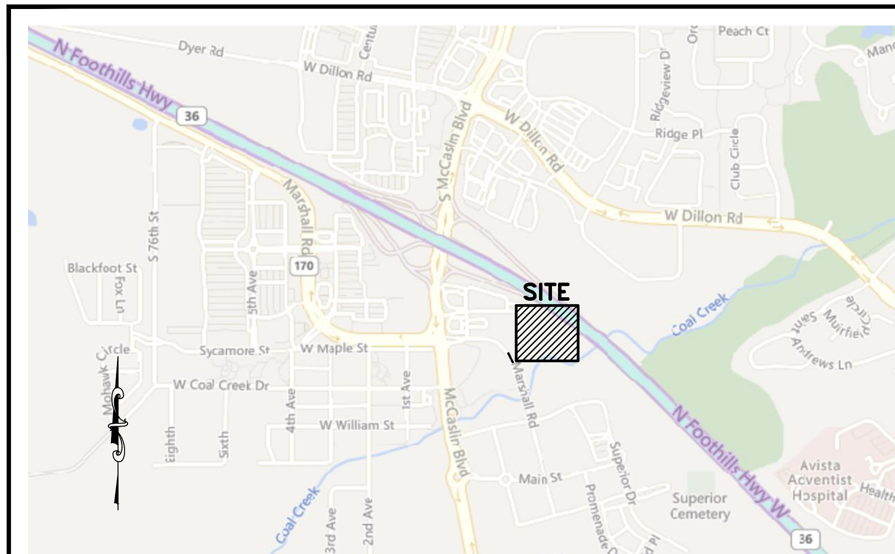

VICINITY MAP
NOT TO SCALE

23-1-644.1	Kumar & Associates	EVERHOME SUITES, EAST OF MARSHALL ROAD AND MCCASLINE BLVD, SUPERIOR, COLORADO	LOCATION OF EXPLORATORY BORINGS	Fig. 1

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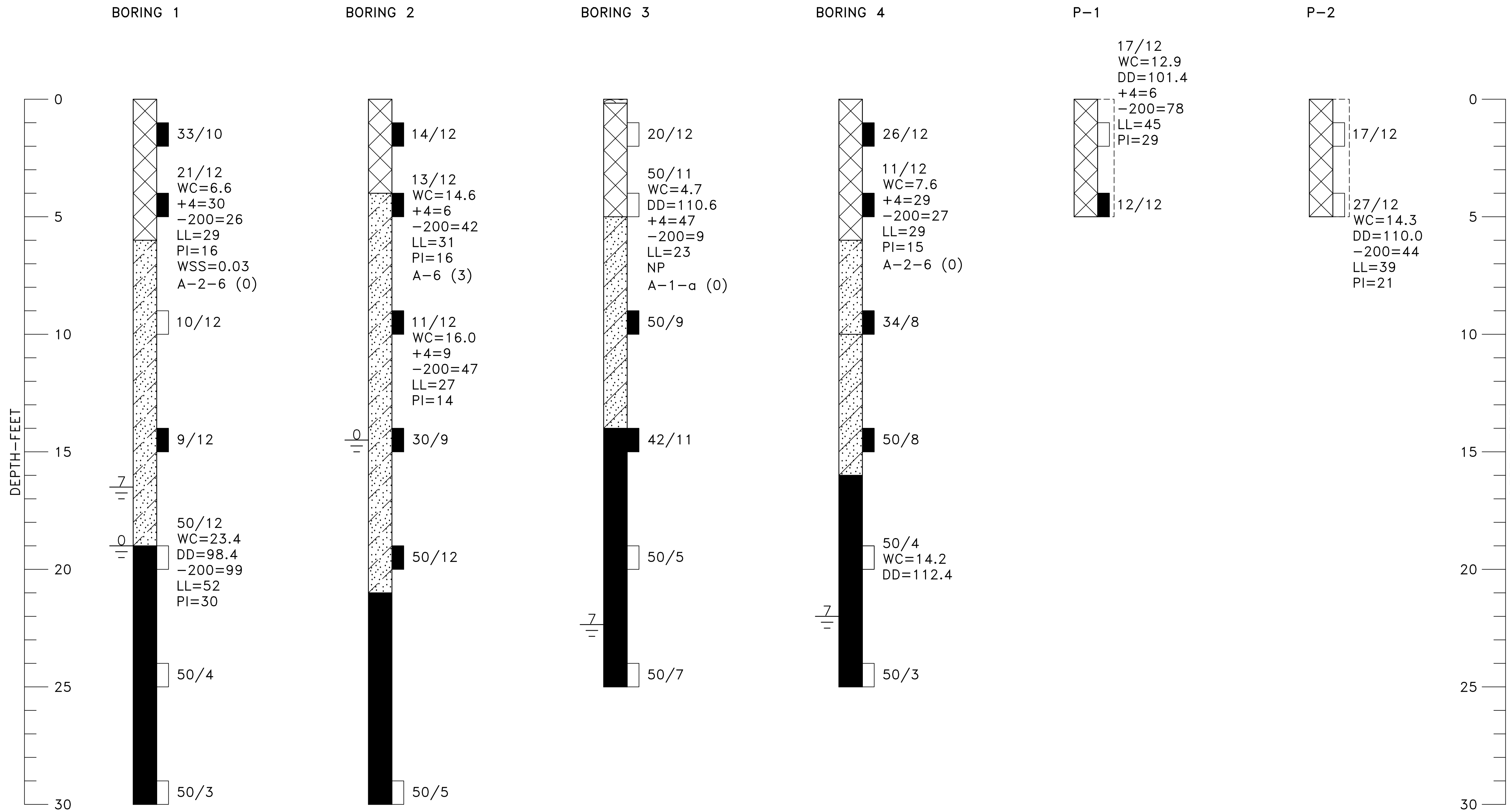

23-1-644.1	Kumar & Associates	EVERHOME SUITES, EAST OF MARSHALL ROAD AND MCCASLINE BLVD, SUPERIOR, COLORADO	LOGS OF EXPLORATORY BORINGS	Fig. 2

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LEGEND

TOPSOIL.

FILL: CLAYEY SAND (SC) TO LEAN CLAY (CL) WITH ISOLATED WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM) ZONES, FINE- TO COARSE-GRAINED WITH VARIABLE GRAVELS, SLIGHTLY MOIST TO MOIST, BROWN TO DARK BROWN TO DARK GRAY.

SILTY SAND (SM), FINE- TO COARSE-GRAINED WITH VARIABLE GRAVEL CONTENT, VERY DENSE, MOIST TO WET (BELOW GROUNDWATER), BROWN TO GRAY WITH OCCASIONAL IRON OXIDATION STAINING.

CLAYEY SAND (SC) WITH OCCASIONAL LEAN CLAY (CL) LENSES AND ZONES, LOOSE TO DENSE, MOIST TO WET (BELOW GROUNDWATER), BROWN.

CLAYSTONE BEDROCK, FINE- TO MEDIUM-GRAINED SAND FRACTION, HARD TO VERY HARD, MOIST, DARK BROWN TO GRAY TO DARK GRAY WITH OCCASIONAL IRON OXIDATION STAINING.

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

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

DISTURBED BULK SAMPLE.

33/10 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 33 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 10 INCHES.

7 DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED ON OCTOBER 16, 2023 WITH A 4-INCH-DIAMETER CONTINUOUS-FLIGHT POWER AUGER.

2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE LOCATED BY GPS COORDINATES OBTAINED FROM GOOGLE EARTH™ AND LOCATED IN THE FIELD WITH A HANDHELD GPS UNIT.

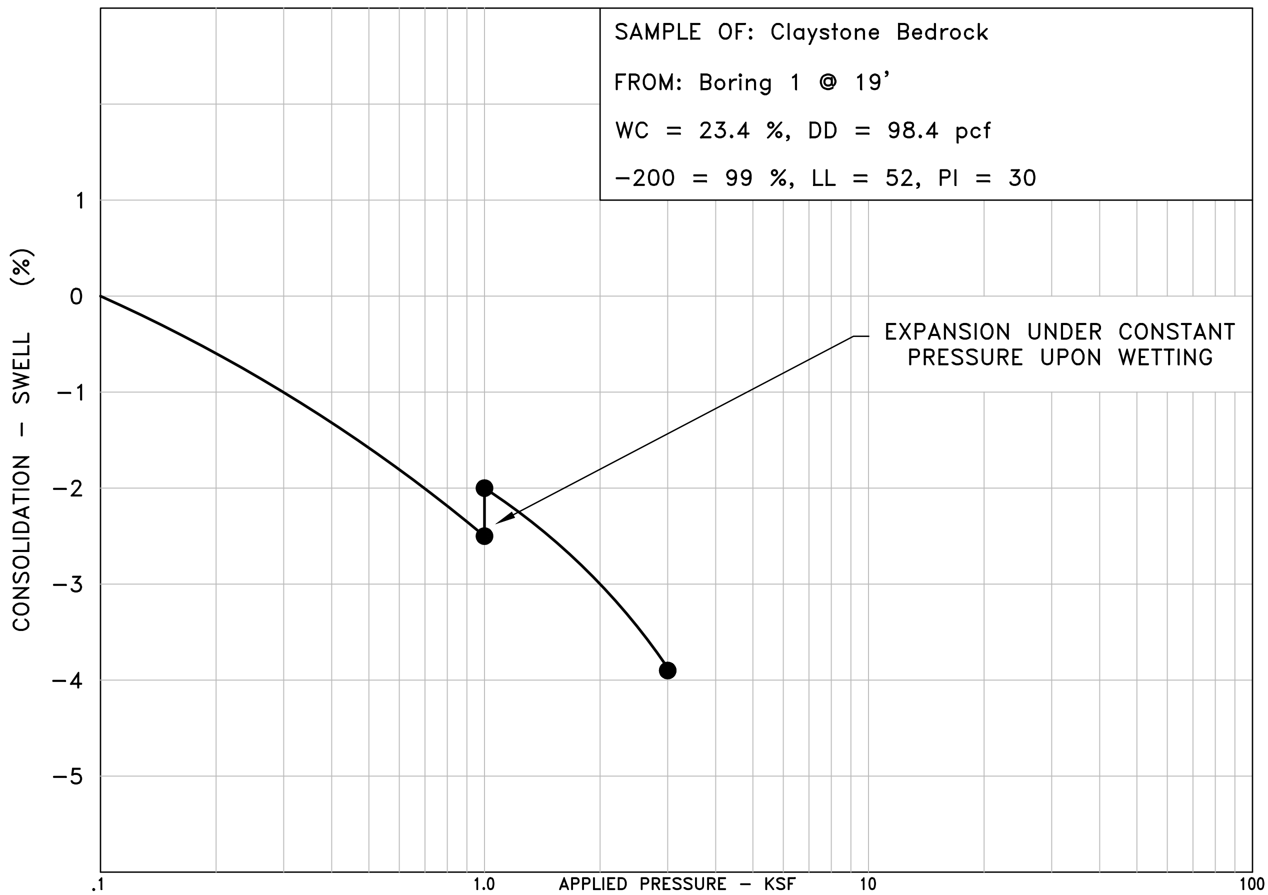
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.

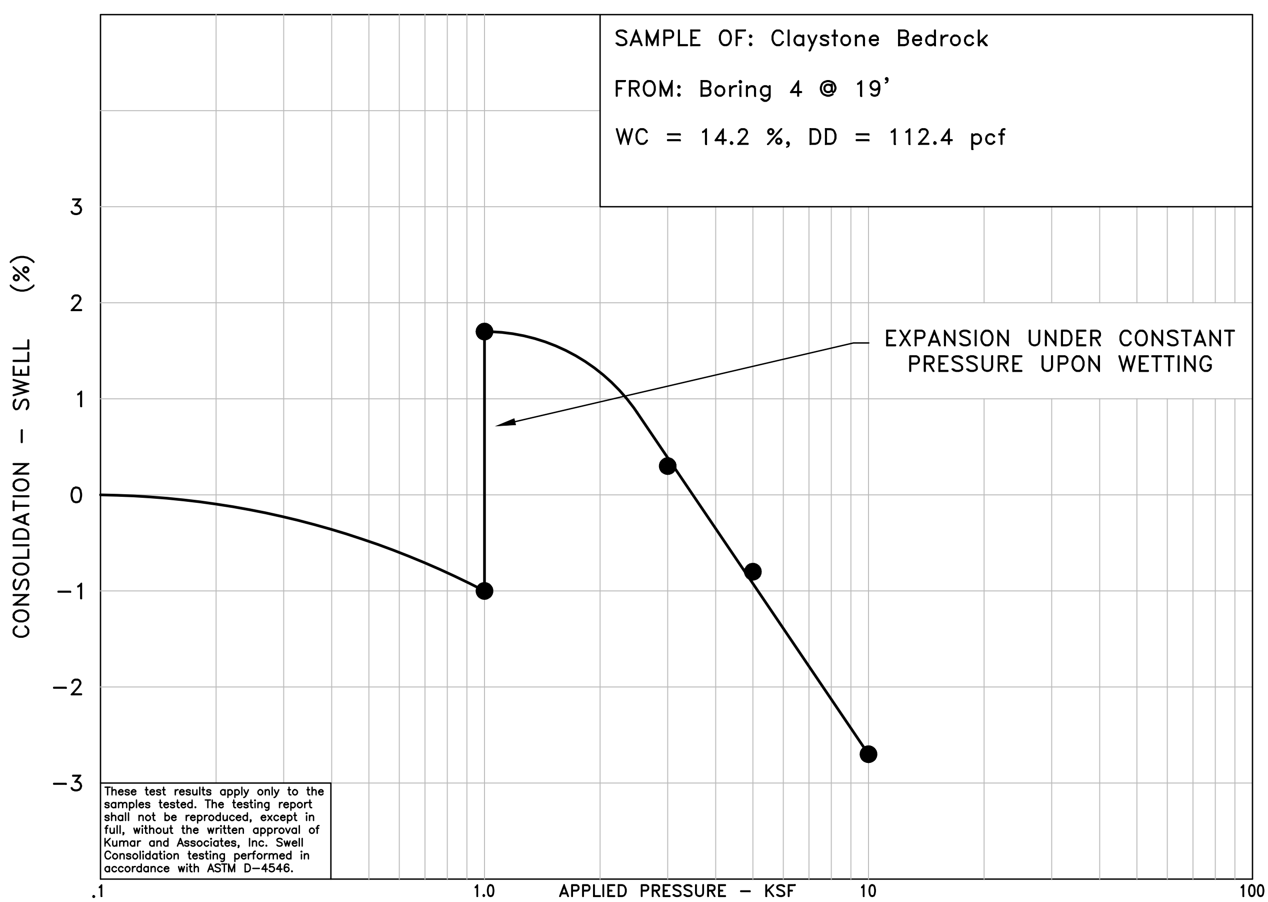
4. THE EXPLORATORY BORING LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

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 LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER 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);
   LL = LIQUID LIMIT (ASTM D4318);
   PI = PLASTICITY INDEX (ASTM D4318);
   NP = NON-PLASTIC (ASTM D4318);
   WSS = WATER SOLUBLE SULFATES (%) (CP-L 2103);
   A-2-6 (0) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M 145).





23-1-644.1	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 4

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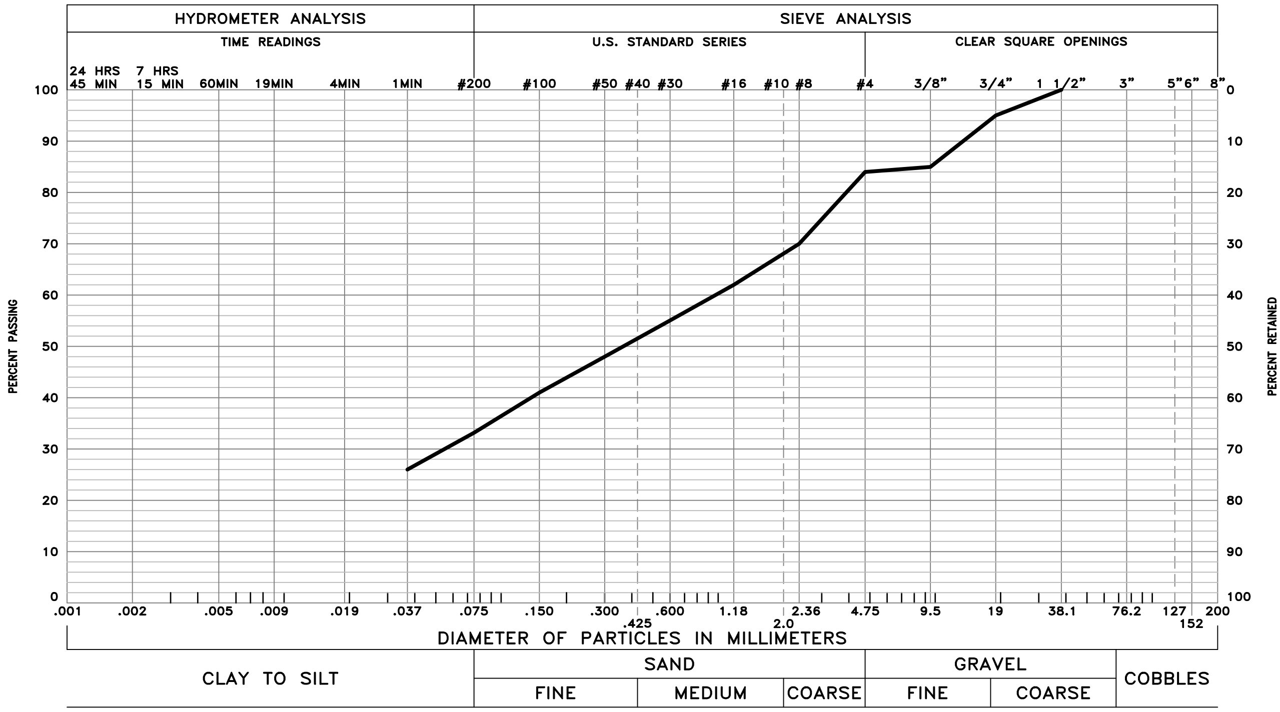
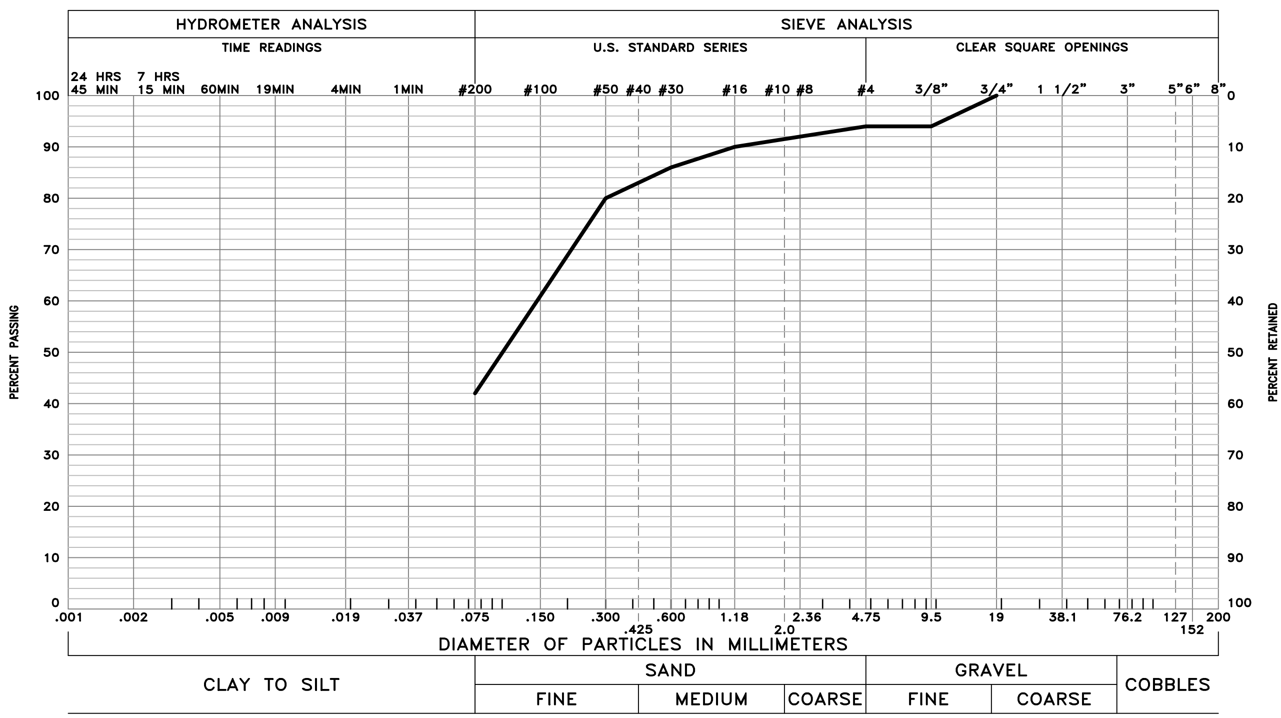


GRAVEL 30 % SAND 44 % SILT AND CLAY 26 %

LIQUID LIMIT 29 PLASTICITY INDEX 16

SAMPLE OF: Fill: Clayey Sand with Gravel (SC) FROM: Boring 1 @ 4'



GRAVEL 6 % SAND 52 % SILT AND CLAY 42 %

LIQUID LIMIT 31 PLASTICITY INDEX 16

SAMPLE OF: Clayey Sand (SC) FROM: Boring 2 @ 4'

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.

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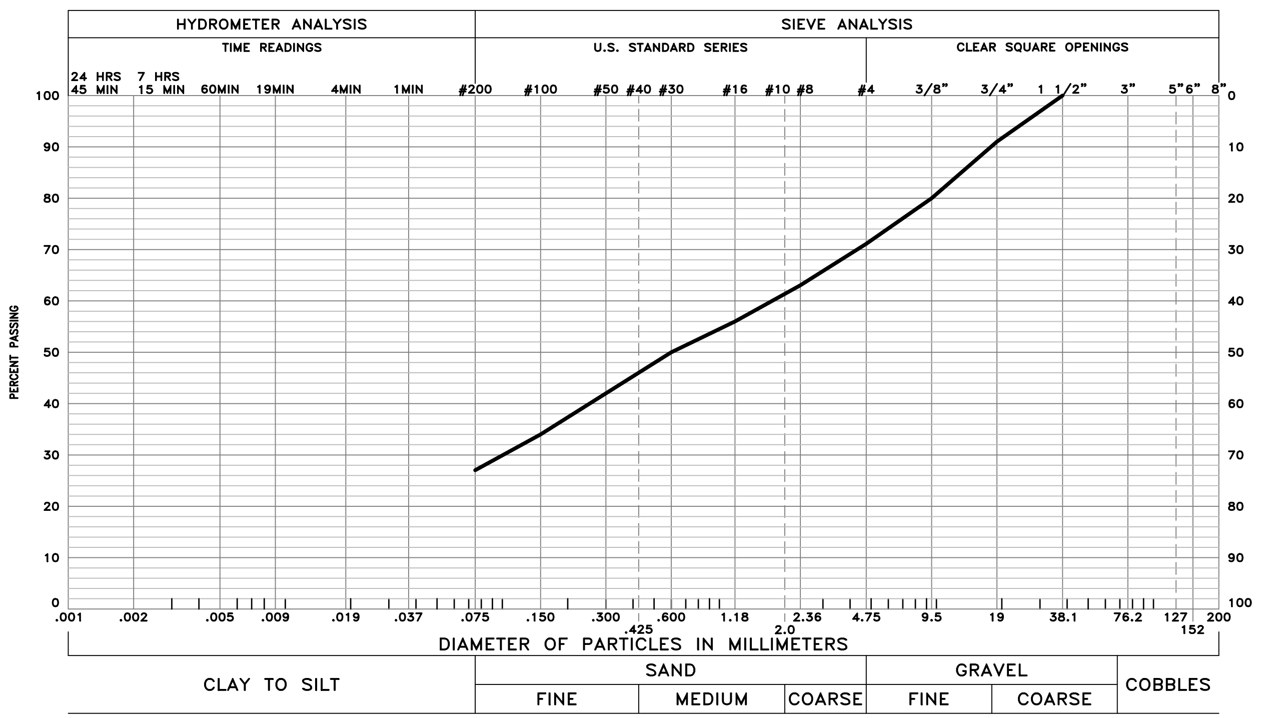
23–1–644.1	Kumar & Associates	GRADATION TEST RESULTS	Fig. 5

GRAVEL 47 % SAND 44 % SILT AND CLAY 9 %

LIQUID LIMIT 23 PLASTICITY INDEX NP

SAMPLE OF: Fill: Well-Graded Gravel with Silt and Sand (GW-GM) FROM: Boring 3 @ 4'



GRAVEL 29 % SAND 44 % SILT AND CLAY 27 %

LIQUID LIMIT 29 PLASTICITY INDEX 15

SAMPLE OF: Fill: Clayey Sand with Gravel (SC) FROM: Boring 4 @ 4'

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.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

PROJECT NO.: 23-1-644.1
PROJECT NAME: Everhomes - Superior
DATE SAMPLED: 10/16/2023
DATE RECEIVED: 10/17/2023

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE
BORING	DEPTH (feet)				GRAVEL (%)	SAND (%)		LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
1	4	10/19/23	6.6		30	44	26	29	16	0.03	A-2-6 (0)	Fill: Clayey Sand with Gravel (SC)
1	19	10/19/23	23.4	98.4			99	52	30			Claystone Bedrock
2	4	10/19/23	14.6		6	52	42	31	16		A-6 (3)	Clayey Sand (SC)
2	9	10/19/23	16.0		9	44	47	27	14			Clayey Sand (SC)
3	4	10/19/23	4.7	110.6	47	44	9	23	NP		A-1-a (0)	Fill: Well-Graded Gravel with Silt and Sand (GW-GM)
4	4	10/19/23	7.6		29	44	27	29	15		A-2-6 (0)	Fill: Clayey Sand with Gravel (SC)
4	19	10/19/23	14.2	112.4								Claystone Bedrock
P-1	1	10/19/23	12.9	101.4	6	16	78	45	29			Fill: Lean Clay with Sand (CL)
P-2	4	10/19/23	14.3	110.0			44	39	21			Fill: Clayey Sand (SC)