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ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

SUBSURFACE SOIL INVESTIGATION AND PRELIMINARY PAVEMENT DESIGN REPORT

Allison Park Townhomes
5219 Allison Street
Arvada, Colorado

PREPARED FOR:

Allison Park LLC
5690 Webster St.
Arvada, CO 80002

JOB NO. 166729

October 31, 2018

Respectfully Submitted,

RMG – Rocky Mountain Group

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Reviewed by,

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GENERAL SITE AND PROJECT DESCRIPTION

Project Description

The site is located in the southeastern portion of Arvada, Colorado, northwest of the intersection of West 52nd Avenue and Allison Street. It is noteworthy that the Jefferson County interactive ASPIN map lists the site address as 5690 Webster Street. The approximate location of the site is shown on the Site Vicinity Map, Figure 1.

Rocky Mountain Group (RMG) understands the project is to consist of multi-family residential construction across approximately 2.96 acres at the proposed development of Allison Park Townhomes. The proposed construction is to consist of 35 townhome units within 10 buildings along with the construction of residential roadways and parking areas across the site. The structures are anticipated to be two to three stories in height with multi-car garages and are to consist of relatively light-weight wood-frame construction. Based on conversations with the client the townhomes are to bear upon shallow foundations with stiffened slabs.

Final grades for the structures and roadways have not been provided to RMG prior to the issuance of this report. RMG assumes that the existing surface during explorations is within 5 feet of final grades for the proposed construction. At this time final grading is not complete and subgrades have not been rough cut. It is assumed that the roadways will be maintained by the City of Arvada and that the total length of roadway along centerline will not exceed 500 feet. RMG was retained to explore the subsurface conditions at the site and develop geotechnical engineering recommendations for design and construction.

Existing Site Conditions

Most recent historical aerial imagery of the site reveals that several unknown structures along with a paved parking areas existed across portions of the site prior to 2017. A drainage ditch trending southwest-northeast bisected the property prior to being diverted along the southern and eastern edges of the site after approximately May 2018. RMG has not been provided construction documents as to the depth or extent of fill placed within the area of the drainage ditch to bring it up to current grade. The site can be described as vacant land and is presently in the beginning stages of development. Excavation of a storm water basin has begun on the east-central portion of the site. Significant vegetation was generally not present due to overlot grading. Vegetation on the edges of the property consisted of native grasses and weeds along with occasional deciduous trees. Topography across the site was relatively flat aside from the excavation of the detention basin to the east.

Previous Studies and Field Investigation

Reports of previous geotechnical engineering/geologic investigations for this site were available for our review and are listed below:

1. *Preliminary Geotechnical Study, 5219 Allison Street, City of Arvada, Jefferson County, Colorado,* CRE Design Engineering Inc., Project No. 15-6235, March 23, 2015.

The findings, conclusions and recommendations contained in this reports were not considered during the preparation of this report.

FIELD INVESTIGATION AND LABORATORY TESTING

Drilling

The subsurface conditions on the site were investigated by drilling twelve exploratory test borings. The approximate locations of the test borings are presented in the Test Boring Location Plan, Figure 1.

The test borings were advanced with a power-driven, continuous-flight solid and hollow stem auger drill rig to depths of approximately 5 to 30 feet below the existing ground surface (bgs). Samples were obtained in general accordance with ASTM D-1586 utilizing a 2-inch OD split-barrel sampler or in general accordance with ASTM D-3550 utilizing a 2½-inch OD modified California sampler. Representative bulk samples of subsurface materials were obtained from selected borings. An Explanation of Test Boring Logs is presented in Figure 2. The Test Boring Logs are presented in Figures 3 through 8.

Laboratory Testing

The moisture content for the recovered samples was obtained in the laboratory. Natural Dry Unit Weight/Density, Grain-size analysis, Atterberg Limits, Denver Swell/Consolidation, Water Soluble Sulfates, and Standard Proctor tests were performed on selected samples for purposes of classification and to develop pertinent engineering properties. A Summary of Laboratory Test Results is presented in Figures 9 and 10. Soil Classification Data are presented in Figures 11 through 16. Swell/Consolidation Test Results are presented in Figures 17 through 19. Standard Proctor Test results are presented in Figure 20.

GEOLOGY, FAULTING, AND SUBSURFACE CONDITIONS

Geologic Setting

The project site is located approximately 8.5 miles east of the southern Rocky Mountains, within the Colorado Piedmont section of the Great Plains Physiographic Province. The City of Arvada is located within a large north-south trending structural basin called the Denver Basin which consists of an asymmetric syncline of Paleozoic, Mesozoic, and Cenozoic sedimentary rock layers. The Denver Basin formed during the Laramide Orogeny that uplifted the Rocky Mountains during the late Cretaceous and early Tertiary (Trimble, 1980). The surficial geology of the site is mapped by Lindvall (1979) as Holocene-age Post-Piney Creek Alluvium. A review of a Colorado Geological Survey map delineating areas based on their relative potential for swelling in the Denver area by Hart (1973-4) indicates soil and bedrock materials in the project vicinity have low swell potential.

Faulting

Historically, several minor earthquakes have been recorded around the Denver metropolitan area. Based on our field observations and our review of readily available published geological maps and literature there are no known active faults underlying or adjacent to the subject site. Therefore, the probability of damage at the site from seismically induced ground surface rupture is considered to be low.

Seismicity

In accordance with the International Building Code, 2012/2015, seismic design parameters have been determined for this site. The Seismic Site Class has been interpreted from the results of the soil test borings drilled within the project site. The USGS seismic design tool has been used to determine the seismic response acceleration parameters. The soil on this site is not considered susceptible to liquefaction.

The following recommended Seismic Design Parameters are based upon Seismic Site Class D, and a 2 percent probability of exceedance in 50 years. The Seismic Design Category is "B".

Table 1: Seismic Design Parameters

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	Ss	0.189	Fa	1.6	Sms	0.302	Sds	0.201
1.0	S1	0.060	Fv	2.4	Sm1	0.143	Sd1	0.095

Notes: MCE = Maximum Considered Earthquake
g = acceleration due to gravity

SUBSURFACE CONDITIONS

Subsurface Materials

The subsurface materials encountered in the test borings were classified using the Unified Soils Classification System (USCS) and American Association of State Highway and Transportation Officials (AASHTO) classification system.

Topsoil

Topsoil was not encountered in at the boring locations but could be encountered outside of the areas of investigation. Topsoil is generally defined as a surficial layer of soil which contains a higher percentage of organic matter of decayed plant roots, stems, and leaves. Topsoil is not considered suitable for construction. Topsoil was visually described as dark brown and moist.

Fill Material

From the surface, fill material was encountered in all of the test borings except B-09 to depths ranging from approximately 1 to 6 feet bgs. Unless appropriate documentation can be provided, it will be assumed that this fill was not moisture conditioned and compacted in a manner consistent with the *Structural Fill* recommendations contained within this report. If such fill is encountered, it is not considered suitable for support of shallow foundations or pavement sections. Fill material was generally classified as stiff to very stiff sandy clay and medium dense clayey sand. Fill material was visually described as light brown to dark brown, black, olive with oxidation staining and relatively dry to moist.

Native Soils

From the surface in test boring B-09 and underlying the fill material in the remaining borings, native soils were encountered to the termination depths. Native soils were generally classified as loose to very denes silty sand with layers of gravel and intermediate cobbles, medium dense to very dense silty sand, very dense silty sand with gravel, medium dense to very dense gravel with sand, medium stiff to stiff sandy clay and medium dense clayey sand. Native soils were visually classified as gray, brown with white mineral deposits and relatively dry to wet.

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs. The classifications shown on the logs are based upon the engineer's classification of the samples at the depths indicated. Stratification lines shown on the logs represent the approximate boundaries between material types and the actual transitions may be gradual and vary with location.

Groundwater

Groundwater was encountered in all of the test borings except P-2 to depths ranging from approximately 5 to 9 feet bgs at the time of field explorations. However, when checked ten days subsequent to drilling, groundwater was not encountered in the test borings. Additionally, the test borings had caved to depths near or shallower than groundwater levels originally encountered bgs. Fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Development of the property and adjacent properties may also affect groundwater levels.

FOUNDATION CONCLUSIONS AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the test borings and on the project characteristics previously described. If conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and adjust them, if necessary.

Geotechnical Considerations

The primary geotechnical concern at this site is fill material encountered at anticipated foundation bearing levels. Fill soils were encountered during our explorations to depths ranging from approximately 1 to 6 feet bgs. Due to the variability in selection, placement, and compaction of fill soils, unsuitable fill soils may be encountered beneath building, pavement, or flatwork areas to greater depths than indicated on the test boring logs. Specifically, areas of greater fill are anticipated within the area of the previous drainage ditch that was in place prior to current site grading at the site. It is recommended that the new foundation extend down through the fill materials to bear on the native soils below. Fill soils are not considered suitable for support of foundations or reinforced slabs. Unless documentation is provided showing fill soils were placed in a controlled and engineered manner, fill soils should be completely removed, replaced, and recompated in accordance with *Structural Fill* section of this report.

Native loose soils and oversized material not suitable for construction were encountered in the test borings. Loose soils and oversized material may be encountered at foundation bearing levels during

excavation. Therefore, RMG recommends the removal (overexcavation) and replacement with on-site structural fill to a depth which results in at least 2 feet of compacted, suitable structural fill below all foundation components and floors slabs. Suitable structural fill may consist of the on-site sand and gravel. However, the sand and gravel should be in accordance to the specifications and be processed per the *Structural Fill* section of this report. The zone of overexcavation and replacement should extend that same distance beyond the building perimeter, including beyond the perimeter of counterforts and "T" wall footings. The structural fill should be observed and tested during placement as indicated under *Structural Fill* section of this report, to ensure proper compaction.

Groundwater was encountered in all of the test borings except P-2 to depths ranging from approximately 5 to 9 feet bgs. Groundwater was not encountered ten days subsequent to drilling possibly due to hole cave. The potential for fluctuations in groundwater at the site are anticipated to have an impact on construction. Due to the recommended depths of overexcavation and depending on the conditions encountered in the excavation, additional drainage/dewatering systems and/or foundation stabilization may be recommended.

Recommendations based on the field investigation and laboratory testing, are presented below.

SITE DEVELOPMENT AND EARTHWORK

The following sections present our preliminary recommendations for site development and earthwork.

Site Preparation

Prior to construction, the ground surface in the proposed addition and improvement areas should be stripped of existing vegetation, pavements, flatwork, debris, topsoil, undocumented existing fill, soft, loose, or disturbed native soils, and other deleterious material. Materials generated during clearing operations should be removed from the project site for disposal. Soft, loose, or yielding subgrade should be removed to a depth that exposes firm subgrade and replaced with engineered fill. In areas to receive engineered fill, the exposed subgrade should be scarified, moisture conditioned, and compacted per the recommendations set forth herein.

Overexcavation and Replacement

The native sand and gravel and fill materials are not suitable for direct bearing of shallow foundations or floor slabs their present condition. Fill materials should be removed, replaced, and recompacted as *Structural Fill*. We recommend the overexcavation of native soils beneath all foundations and floor slabs, moisture conditioning, and replacement as Structural fill to depths which result in as much as 2-feet of compacted structural fill beneath all foundation components and floor slabs. The zone of overexcavation and replacement should extend that same distance beyond the building perimeter, including beyond the perimeter of counterforts and "T" wall footings. The structural fill should be observed and tested during placement as indicated under the *Structural Fill* section of this report, to ensure proper compaction.

Excavations

Excavations for the project are expected to encounter native soils and fill materials. The native soils and fill materials will generally be excavatable with heavy-duty earth moving equipment. Extra precaution

should be taken during excavation due to the alluvium material and recommended overexcavation at the site.

The contractor should provide safely sloped excavations or an appropriately designed and constructed braced-shoring system, in compliance with Occupational Safety and Health Administration (OSHA, 2005) guidelines, for employees working in an excavation that may expose employees to the danger of moving ground. In our opinion, the native overburden soils should generally be considered a Type "C" soil when applying the OSHA guidelines. For these soil conditions, OSHA recommends a temporary slope inclination of 1.5H:1V or flatter for excavations 20 feet or less in depth. Some surface sloughing may occur on the slope face at these angles. Steeper cut slopes may be utilized for excavations less than 4 feet deep depending on the strength, moisture content, and homogeneity of the soils as observed in the field. Appropriate slope inclinations should be evaluated in the field by an OSHA-qualified "Competent Person" based on the actual conditions encountered.

Structural Fill

Areas to receive structural fill should have topsoil, organic material, or debris removed. The upper 6 inches of the exposed surface soils should be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) prior to placing structural fill.

Structural fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

Structural fill shall consist of the on-site sand and gravel. On-site material used as structural fill shall not contain particles greater than 6 inches in diameter. Structural fill material containing particles greater than 6 inches should be screened and evaluated by a representative of the geotechnical engineer prior to placement. It should be placed in loose lifts not exceeding 8 to 12 inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test, ASTM D-698. The materials should be compacted by mechanical means.

Materials used for structural fill should be approved by RMG prior to use. Structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement.

Earthwork operations should be observed and compaction of structural fill materials should be tested by the project's geotechnical consultant. It is the **responsibility of the builder or contractor to schedule with this office** to conduct compaction tests, retrieve or accept delivery of a fill sample, or certify the fill material. Early testing is recommended to demonstrate that placement and compaction methods are achieving the required compaction for the entire depth of fill. Without a strict quality assurance program, the fill may not be of sufficient quality to achieved required performance.

Exterior Backfill

Backfill should generally be free of topsoil, organics, particles greater than 5 inches in diameter, debris, or other deleterious material. Backfill should be placed in loose lifts not exceeding 8 to 10 inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to 90 percent of the maximum dry density as determined by the Standard Proctor test,

ASTM D-698 on exterior sides of walls in landscaped areas. In areas where backfill supports pavement and concrete flatwork, the materials should be compacted to 95 percent of the maximum dry density as determined by the Standard Proctor test, ASTM D-698.

Fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

The appropriate government/utility specifications should be used for fill placed in utility trenches. If material is imported for backfill, the material should be approved by the Geotechnical Engineer prior to hauling it to the site.

The backfill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement. Backfill should be compacted by mechanical means, and foundation walls should be braced during backfilling and compaction.

Utility Construction

The contractor should provide adequate mechanical compaction in the utility trench backfills. The contractor should take particular care in the lower portions of excavations and around manholes, valve risers and other vertical pipeline elements where settlements are commonly observed. Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials.

Soils in utility excavations are anticipated to encounter “Type C” or “Type A” soils according to OSHA regulations. Trench backfill should be compacted to City and/or County specifications and it is recommended that a representative of RMG provide full-time observation and compaction testing to ensure the backfill meets the required specifications.

Utility mains such as water and sanitary sewer lines are typically placed beneath paved roadways. The settlement of the utility trench backfill can have a detrimental effect on pavements and roadway surfaces. We recommend that utility trench backfill be placed in 5 inch loose lifts, moisture conditioned as required and compacted to 95 percent of the Standard Proctor test, ASTM D-698. The placement and compaction of utility trench backfill should be observed and tested by a representative of RMG during construction. If utility trenches are placed beneath existing or proposed foundation elements or loading bearing elements RMG recommends the use of flowable fill or controlled low strength material (CLSM).

Sandy pipe bedding materials can function as conduits for re-distribution of natural and applied waters in the subsurface. Development of site grading plans should consider the subsurface transfer of water in utility trenches and the pipe bedding in areas where the utility service trenches enter structures. If groundwater is encountered during excavation, cut-off walls in utility trenches or other water-stopping measures may be implemented to reduce the rates and volumes of water transmitted along utility alignments toward structures, where wetting of the underlying soils increases the potential for soil movements, material degradation, or structural distress.

FOUNDATION RECOMMENDATIONS

The foundation recommendations presented below are based on the subsurface soil findings documented in this report. Depending on the effectiveness of the overexcavation and replacement, the foundation may consist of a continuous bearing spread footing foundation with a minimum dead load.

A stiffened slab-on-grade foundation is suitable for the proposed structures. A maximum allowable bearing pressure of 2,000 psf may be used for design. A total movement of 1 inch with a differential movement of 1/2 inch over a horizontal distance of 10 feet has been estimated. The foundation design should be prepared by a qualified Colorado Registered Professional Engineer using the recommendations presented in this report. The bottoms of exterior foundation should be at least 36 inches below finished grade for frost protection.

LATERAL EARTH PRESSURES

Foundation walls should be designed to resist lateral earth pressures. For on-site backfill materials, we recommend an equivalent fluid pressure of 40 pcf for “Active” conditions and 60 pcf for “At-Rest” conditions be used for design of stem walls. The lateral earth pressures apply to level, drained backfill conditions. Equivalent Fluid Pressures for sloping/undrained conditions should be determined on an individual lot basis. These recommendations do not apply to design of structural elements other than stem walls (retaining walls, shoring piers, etc.) that may be proposed for the site.

INTERIOR FLOOR SYSTEMS

RMG understands that the client would prefer to use a reinforced monolithic or structural floor system for the proposed structures.

Stiffened Slab Foundation Floor Slabs

For interior floor slabs not comprising an integral part of a stiffened slab foundation (such as garage or basement slabs), vertical slab movements on the order of one to three inches have been estimated for the subsurface conditions encountered. If movement and associated damage to floors and finishes cannot be tolerated, a structural floor system should be used. Floor slabs should be separated from structural components to allow for vertical movement.

Recommendations for exterior concrete slabs, such as patios, driveways, and sidewalks, are not included in this report.

Interior Partitions

Interior non-bearing partitions and other attached finishes do not require isolation from floor slabs that comprise an integral part of a stiffened slab-on-grade foundation. For interior slabs not comprising an integral part of a stiffened slab foundation (such as garage or basement floors), interior non-bearing partitions and attached furnishings (e.g., cabinets, shower stalls, etc.) on concrete slabs should be constructed with a void so that they do not transmit floor slab movement to the roof or overlying floor. A void of at least 1-1/2 inches is recommended beneath non-bearing partitions. The void may require reconstruction over the life of the structure to re-establish the void due to vertical slab movement.

SURFACE GRADING AND DRAINAGE

The ground surface should be sloped from the building with a minimum gradient of 10 percent for the first 10 feet. This is equivalent to 12 inches of fall across this 10-foot zone. If a 10-foot zone is not possible on the upslope side of the structure, then a well-defined swale should be created a minimum 5 feet from the foundation and sloped parallel with the wall with a minimum slope of 2 percent to intercept the surface water and transport it around and away from the structure. Roof drains should extend across backfill zones and landscaped areas to a region that is graded to direct flow away from the structure. Owners should maintain the surface grading and drainage recommended in this report to help prevent water from being directed toward and/or ponding near the foundations.

Landscaping should be selected to reduce irrigation requirements. Plants used close to foundation walls should be limited to those with low moisture requirements and irrigated grass should not be located within 5 feet of the foundation. To help control weed growth, geotextiles should be used below landscaped areas adjacent to foundations. Impervious plastic membranes are not recommended.

Irrigation devices should not be placed within 5 feet of the foundation. Irrigation should be limited to the amount sufficient to maintain vegetation. Application of more water will increase the likelihood of slab and foundation movements.

The recommendations listed in this report are intended to address normal surface drainage conditions, assuming the presence of groundcover (established vegetation, paved surfaces, and/or structures) throughout the regions upslope from this structure. However, groundcover may not be present due to a variety of factors (ongoing construction/development, wildfires, etc.). During periods when groundcover is not present in the "upslope" regions, higher than normal surface drainage conditions may occur, resulting in perched water tables, excess runoff, flash floods, etc. In these cases, the surface drainage recommendations presented herein (even if properly maintained) may not mitigate all groundwater problems or moisture intrusion into the structure. We recommend that the site plan be prepared with consideration of increased runoff during periods when groundcover is not present on the upslope areas.

SUBSURFACE DRAINAGE

RMG anticipates that the proposed structures will not have habitable or storage space located below the finished ground surface. Therefore, subsurface drainage is not anticipated to be necessary.

PRELIMINARY PAVEMENT RECOMMENDATIONS

At the time of our investigation site grading was not complete and the subgrade had not been rough cut per City of Arvada requirements for final design. RMG assumes the proposed roadways and parking areas at the Allison Park Townhomes Development will be maintained by the City of Arvada. Pavement design criteria in this report gives options for full depth and composite rigid and hot mix asphalt pavement sections. Final pavement grades have not been provided at this time. RMG assumes that the total length of roadways along centerline will not exceed 500 feet.

Preliminary pavement sections were developed in general accordance with the guidelines and procedures of the American Association of State Highway and Transportation Officials (AASHTO),

City of Arvada Pavement Design Criteria (APDC), and Colorado Department of Transportation (CDOT) methodology.

Subgrade Preparation

Section 100.15 of APDC requires mitigation measures for soils with swell test results equal to or more than 2.0 percent swell with a 400 psf surcharge. Clay will be prone to swelling and heaving upon wetting. Swell tests on selected samples indicated swell results of between -0.3 and -0.1 percent swell with a 200 psf surcharge. Therefore, subgrade mitigation measures are not required per City of Arvada Pavement Design Standards. However, we recommend that in areas of suitable subgrade soil the exposed material should be scarified to a depth of 12 inches, adjusted to within 2 percent of the optimum moisture content and recompacted to a firm and unyielding condition per City and/or project specifications, typically 95 percent of Standard Proctor test, (ASTM D-698). The subgrade should then be proof-rolled with a heavy, pneumatic tired vehicle. Areas which deform under wheel loads should be removed and replaced with select material.

Pavement Design

To accurately demonstrate that the pavement section will be adequate when a superior subgrade is installed, we provide pavement design calculations below based upon the moderately plastic sandy clay (A-6) soils existing on site. Pavement design parametric input data follows the guidelines presented in Section 100.16 of the APDC. The roadway is assumed to be classified as "Local-Residential". The pavement design parameters and design calculations for Rigid and Flexible Pavements are presented below:

Table 2: Preliminary Pavement Design Parameters

	Pavement	APDC
EDLA	8	Table 100.15
Serviceability Index	2.0	Table 100.16
Assumed CBR Value	3.0	--

Flexible Pavement Design

Table 100.17 of the APDC specifies a minimum full depth flexible pavement thickness of 6.0 inches and minimum composite flexible pavement sections of 5.0 inches of asphalt and 6.0 inches of treated subgrade or base for flexible pavements of "Local-Residential" sites. The flexible pavement design parameters are presented below. Design calculations are based on the general equation ($SN = a_1 D_{1+} a_2 D_2 + a_3 D_{3+} \ldots..$) as presented in Section 100.17 of the APDC.

Table 3: Flexible Pavement Strenth Coefficients

	Pavement	APDC
Asphalt (HMA)	0.40	Table 100.19
Aggregate Base Course (ABC)	0.12	Table 100.19
Granular Subbase Course	0.07	Table 100.19

The following Structural Number is recommended based on Standard Drawing ST-5 "Design Nomograph for Flexible Pavements Serviceability Index 2.0".

Table 4: Structural Number

	Pavement
Structural Number	2.6

Composite Hot Mix Asphalt Pavement Sections

Options for composite hot mix asphalt pavement section with aggregate base course, granular subbase course, and lime treated subgrade are as follows:

Calculated Minimum Hot Mix Asphalt Pavement thickness = D_1 = 5.0 inches
Calculated Minimum ABC thickness = D_2 = 6.0 inches
Calculated Minimum Granular Subbase Course thickness = D_2 = 9.0 inches

Required Minimum Hot Mix Asphalt Pavement thickness = 5.0 inches (Table 100.17)
Minimum Treated Subgrade or Base thickness = 6.0 inches (Table 100.17)

The following Composite Hot Mix Asphalt Pavement section is recommended.

Table 5: Recommended Composite Hot Mix Asphalt Pavement Sections

Section Type	HMA (in)	Base Layer (in)
Hot Mix Asphalt Pavement with Aggregate Base Course	5.0	6.0
Hot Mix Asphalt Pavement with Granular Subbase Course	5.0	9.0

Full Depth Hot Mix Asphalt

As an alternative to the Hot Mix Asphalt plus treated subgrade or base recommended above, a Full Depth Hot Mix Asphalt section is also suitable.

Full Depth Hot Mix Asphalt Pavement Section

Calculated Minimum Full Depth Hot Mix Asphalt Pavement thickness = D_1 = 6.5 inches
Required Minimum Full Depth Hot Mix Asphalt Pavement thickness = 6.0 inches (Table 100.17)

The following Full Depth Hot Mix Asphalt Pavement section is recommended.

Table 6: Recommended Full Depth Hot Mix Asphalt Pavement Section

Section Type	HMA (in)	SS (in)
Hot Mix Asphalt Pavement	6.5	--

Rigid Pavement Design

Table 100.17 of the APDC specifies a minimum rigid pavement thickness of 6.0 inches for Portland Cement concrete pavements of "Local-Residential" sites. The rigid pavement design parameters and design calculations are presented below.

Composite Rigid Pavement Section

Calculated Minimum Portland Cement thickness = D_1 = 5.0 inches
Required Minimum Portland Cement thickness = D_2 = 6.0 inches (Table 100.17)

The following rigid Pavement section is recommended based on Standard Drawing ST-7 "Design Nomograph for Rigid Pavements Serviceability Index 2.0" with a working stress (f_t) of the concrete assumed to be a minimum 28-day strength of 600 psi. To increase constructability of the rigid pavement section, RMG recommends the use of 6 inches of granular subbase.

Table 7: Recommended Rigid Pavement Section

Section Type	**Concrete (in)**	**Subbase (in) *(recommended)***
Rigid Concrete Pavement	6.0	6.0

Pavement Specifications

Flexible Pavement Materials

The asphalt pavement shall consist of a bituminous plant mix composed of a mixture of high quality aggregate and bituminous material meeting the requirements of a job-mix formula established by a qualified engineer. Grading C should be used for the lower lift(s) and grading CX should be used for the surface course. The surface coarse may be installed in 1-inch lifts.

Aggregate base material placed beneath pavements should meet the criteria of CDOT Class 6 aggregate base. Requirements for CDOT Class 6 aggregate base can be found in Section 703 of the current CDOT Standards and Specifications for Road and Bridge Construction. Aggregate base should be placed at moisture contents within 3 percent of optimum moisture content and compacted to a minimum of 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698).

Pavement Maintenance

The collection and diversion of surface drainage away from paved areas is vital to satisfactory performance of the pavements. Surface drainage should be carefully designed to facilitate removal of the water from paved areas and subgrade soils. Allowing surface waters to pond on pavements will cause premature pavement deterioration. Where topography, site constraints or other factors limit or preclude adequate surface drainage, pavements should be provided with edge drains to reduce loss of subgrade support.

Landscape irrigation in planters adjacent to pavements and in "island" planters within paved areas should be carefully monitored or differential heave and/or rutting of the nearby pavements will result.

Drip irrigation systems are recommended for such planters to reduce over-spray and water infiltration beyond the planters.

As noted above, the standard care of practice in pavement design describes the recommended rigid and flexible pavement section as a "20-year" design pavement; however, pavements in Colorado will not remain in satisfactory condition without routine, preventive maintenance and rehabilitation procedures performed during the life of the pavement. Preventive pavement treatments are surface rehabilitation and operations applied to improve or extend the functional life of a pavement. These treatments preserve, rather than improve, the structural capacity of the pavement structure.

CONCRETE

Sulfate testing was performed on selected samples based on ASTM C1580. Test results showed 0 percent by weight, indicating the soils present negligible sulfate exposure. Based on these results Type I/II cement is recommended for concrete in contact with the subsurface materials. Calcium chloride should not be used for the onsite soils. The concrete should not be placed on frozen ground. If placed during periods of cold temperatures, the concrete should be kept from freezing. This may require covering the concrete with insulated blankets and heating. Concrete work should be completed in accordance with the latest applicable guidelines and standards published by ACI.

CLOSING

This report has been prepared for the exclusive purpose of providing geotechnical engineering information and recommendations for development described in this report. RMG should be retained to review the final construction documents prior to construction to verify our findings, conclusions and recommendations have been appropriately implemented.

This report has been prepared for the exclusive use by **Royal Oak LLC.** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon data obtained from test borings, site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG should be retained to review the recommendations presented in this report considering the varied condition, and either verify or modify them in writing.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

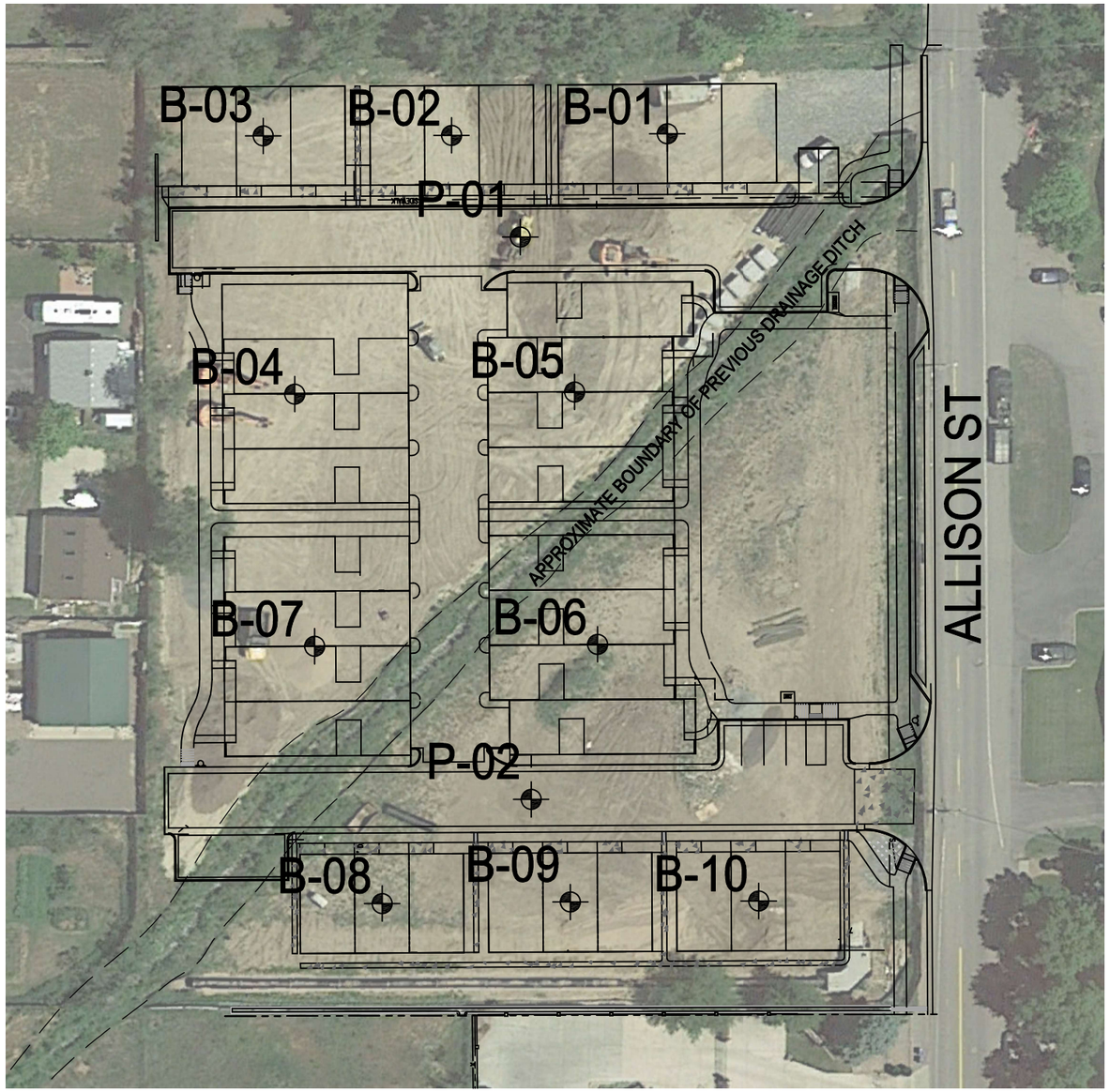
The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to biological or toxicological issues, are beyond the scope of this report. If the Client desires investigation into the potential for such contamination or conditions, other studies should be undertaken.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact us.

FIGURES

CITY OF ARVADA
ANY CHANGE OR DEVIATION FROM THESE PLANS MUST BE APPROVED BY ARVADA BUILDING DEPARTMENT

THIS SET OF PLANS TO STAY ON JOB AT ALL TIMES.
ON WORK SHALL COMPLY WITH
2020 NEC
2015 IRC



TEST BORING LOCATION PLAN

NOT TO SCALE

AERIAL IMAGE - 5/31/2018

N
W E
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VICINITY MAP

NOT TO SCALE

N
W E
S

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(719) 544-7750

ALLISON PARK TOWNHOMES
5219 ALLISON ST
ARVADA, COLORADO
ALLISON PARK LLC

ENGINEER:	FKW
DRAWN BY:	MAM
CHECKED BY:	FKW
	10.31.2018

REVISION:	DATE:

SITE VICINITY MAP AND BORING LOCATION PLAN

SHEET No.
FIG. 1

JOB No. 166729

SOILS DESCRIPTION


FILL: SAND, SILTY TO CLAYEY


FILL: CLAY, SANDY


USCS SILTY GRAVEL


SILTY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
RMG - ROCKY MOUNTAIN GROUP
14 INVERNESS DR. EAST, SUITE E-136
ENGLEWOOD, COLORADO

SYMBOLS AND NOTES


XX — STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-1586. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


XX — UNDISTURBED CALIFORNIA SAMPLE - MADE BY DRIVING A RING-LINED SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


FREE WATER TABLE


DEPTH AT WHICH BORING CAVED


BULK — DISTURBED BULK SAMPLE


AUG — AUGER "CUTTINGS"

4.5 — WATER CONTENT (%)

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EXPLANATION OF TEST BORING LOG

JOB No. 166729

FIGURE No. 2

DATE 10/30/18

TEST BORING: **B-01**
DATE DRILLED: 9/20/18
ELEVATION (FT):
NO GROUNDWATER ON 10/1/18

[FILL]: Clayey SAND with Gravel and Rootlets - light brown to black, medium dense, moist

Silty SAND with layers of Gravel and occasional Cobbles - brown to dark brown, dense, moist to wet

DEPTH (FT)	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5		38	11.8
10		39	--
15			11.2
20		43	--
25			--
30			--

TEST BORING: **B-02**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 10/1/18

[FILL]: Clayey SAND with Gravel - olive to brown, medium dense, moist

Silty SAND with layers of Gravel and occasional Cobbles - brown, medium dense to very dense, wet

DEPTH (FT)	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5		25	11.1
10		50/11"	--
15		50	--
		50/8"	--

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TEST BORING LOG

JOB No. 166729

FIGURE No. 3

DATE 10/30/18

TEST BORING: **B-03**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 10/1/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5			50/10"	--
10			50/5"	10.9
15			50/8"	13.7
			50/7"	9.9

[FILL]: Sandy CLAY with Gravel - brown to black, moist

Silty SAND with layers of Gravel and occasional Cobbles - brown, dense to very dense, moist to wet

TEST BORING: **B-04**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 10/1/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5			12	20.2
10			50/9"	11.0
15			50/9"	--
			50/8"	--

[FILL]: Sandy CLAY with Gravel - brown to black, olive with oxidation staining, stiff, moist

Silty SAND with layers of Gravel and occasional Cobbles - brown, medium dense, wet

Silty SAND - brown, very dense, wet

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TEST BORING LOG

JOB No. 166729

FIGURE No. 4

DATE 10/30/18

TEST BORING: **B-05**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 9/21/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5			50	--
			50/0"	7.0
10				
			50/9"	--
15				
			50/9"	--

[FILL]: Sandy CLAY - brown to black, moist

Wood debris @ 3'

GRAVEL with Sand - brown, medium dense to very dense, relatively dry to wet

Silty SAND with layers of Gravel and occasional Cobbles - light brown to brown, dense to very dense, wet

TEST BORING: **B-06**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 9/21/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5			27	4.2
			50/5"	14.9
10				
			50/0"	10.7
15				
			50/0"	13.8

[FILL]: Clayey SAND with Gravel - brown, relatively dry

Silty SAND with Gravel - brown, medium dense to very dense, relatively dry

GRAVEL with Sand - brown, very dense, moist

Silty SAND with layers of Gravel and occasional Cobbles - light brown, very dense, wet

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TEST BORING LOG

JOB No. 166729

FIGURE No. 5

DATE 10/30/18

TEST BORING: **B-07**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 9/21/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5			41	--
10			50/6"	--
15			50/8"	--
			50/7"	--

[FILL]: Sandy CLAY - brown to black, very stiff, moist

GRAVEL with Sand - brown, dense to very dense, relatively dry

Silty SAND with Gravel - light brown, very dense, wet

TEST BORING: **B-08**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 10/1/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
5			18	6.8
10			50/9"	--
15			50/7"	--
20			33	--

[FILL]: Sandy CLAY - light brown to brown, relatively dry

Silty SAND and layers of Gravel and occasional Cobbles - brown to dark brown, loose, relatively dry to wet

Silty SAND - light brown, medium dense to very dense, wet

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TEST BORING LOG

JOB No. 166729

FIGURE No. 6

DATE 10/30/18

TEST BORING: **B-09**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 10/1/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	
					GRAVEL with Sand - brown, dense, relatively dry to wet
5			50/11"	1.8	
			50/7"	11.9	Silty SAND with layers of Gravel and occasional Cobbles - light brown, very dense, wet
10					
			50/8"	17.5	
15					
			50/7"	15.2	

TEST BORING: **B-10**
DATE DRILLED: 9/21/18
ELEVATION (FT):
NO GROUNDWATER ON 10/1/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	
					[FILL]: Sandy CLAY - light brown to dark brown, relatively dry
					Silty SAND with layers of Gravel and occasional Cobbles - light brown to brown, medium dense to very dense, relatively dry to wet
5			50/11"	2.3	
			50/5"	--	
10					
			50/7"	--	
15					
			50/7"	--	

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TEST BORING LOG

JOB No. 166729

FIGURE No. 7

DATE 10/30/18

TEST BORING: **P-01**
DATE DRILLED: 9/20/18
ELEVATION (FT):
NO GROUNDWATER ON 9/20/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
			12	18.1
5			50/11"	5.6
10			12	23.8

[FILL]: Sandy CLAY ((A-6(10)) - brown to dark brown, stiff, moist

Silty SAND (A-2-6) with layers of Gravel and occasional Cobbles - brown, loose to medium dense, moist to wet

TEST BORING: **P-02**
DATE DRILLED: 9/20/18
ELEVATION (FT):
NO GROUNDWATER ON 9/20/18

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
			20	12.9
5			37	--

[FILL]: Sandy CLAY ((A-6(4)) - brown to black, very stiff, moist

Silty SAND (A-2-6) with layers of Gravel and occasional Cobbles - brown, medium dense, relatively dry

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TEST BORING LOG

JOB No. 166729

FIGURE No. 8

DATE 10/30/18

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	FHA Expansion Pressure (psf)	% Swell/ Collapse	USCS Classification
B-01	4.0	11.8	114.9	24	13		27.5		- 0.3	SC
B-01	14.0	11.2				21.8	18.0			
B-02	4.0	11.1	118.9				34.1		- 0.2	
B-03	9.0	10.9								
B-03	14.0	13.7								
B-03	19.0	9.9								
B-04	4.0	20.2	97.0				55.1		- 0.1	
B-04	9.0	11.0				36.3	5.6			
B-05	9.0	7.0				39.1	24.3			
B-06	4.0	4.2					10.4			
B-06	9.0	14.9								
B-06	14.0	10.7								
B-06	19.0	13.8								
B-08	4.0	6.8				29.2	7.4			
B-09	4.0	1.8					3.6			
B-09	9.0	11.9								
B-09	14.0	17.5					8.9			
B-09	19.0	15.2								
B-10	4.0	2.3				31.3	7.8			
C-1	1.0	11.1		30	19	24.0	35.0			SC

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SUMMARY OF LABORATORY TEST RESULTS

JOB No. 166729
FIGURE No. 9
PAGE 1 OF 1
DATE 10/30/18

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.10 Sieve	% Retained No.40 Sieve	% Passing No. 200 Sieve	% Swell @ 100 psf	AASHTO Classification
C-2	1.0	2.2		26	12	72.0	82.1	9.3		A-2-6 (0)
P-01	2.0	18.1	103.1	39	24			54.5	- 0.3	A-6 (10)
P-01	4.0	5.6								
P-01	9.0	23.8								
P-02	2.0	12.9	104.0	29	16			47.2	- 0.1	A-6 (4)

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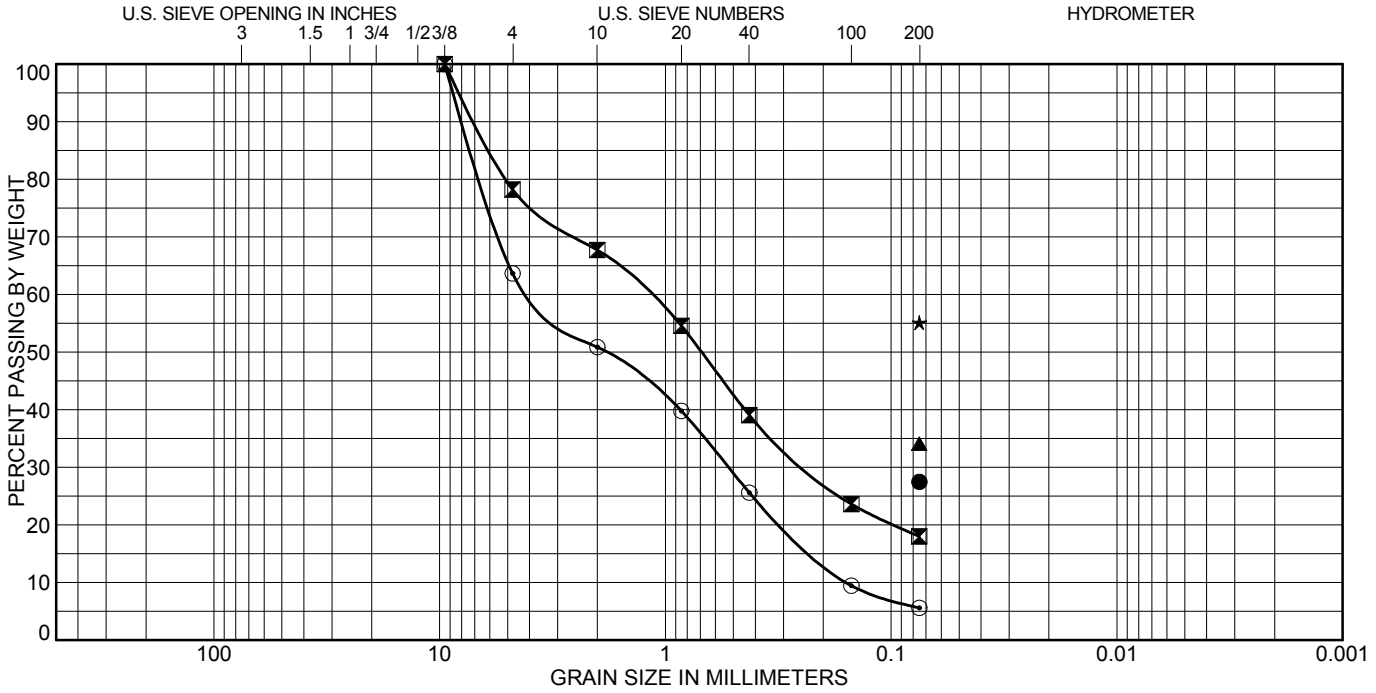
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 166729
FIGURE No. 10
PAGE 1 OF 1
DATE 10/30/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI
●	B-01	4.0	CLAYEY SAND(SC)	24	11	13
⧓	B-01	14.0				
▲	B-02	4.0				
★	B-04	4.0				
⊙	B-04	9.0				

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	B-01	4.0			27.5	
⧓	B-01	14.0	21.8	60.2	18.0	
▲	B-02	4.0			34.1	
★	B-04	4.0			55.1	
⊙	B-04	9.0	36.3	58.1	5.6	

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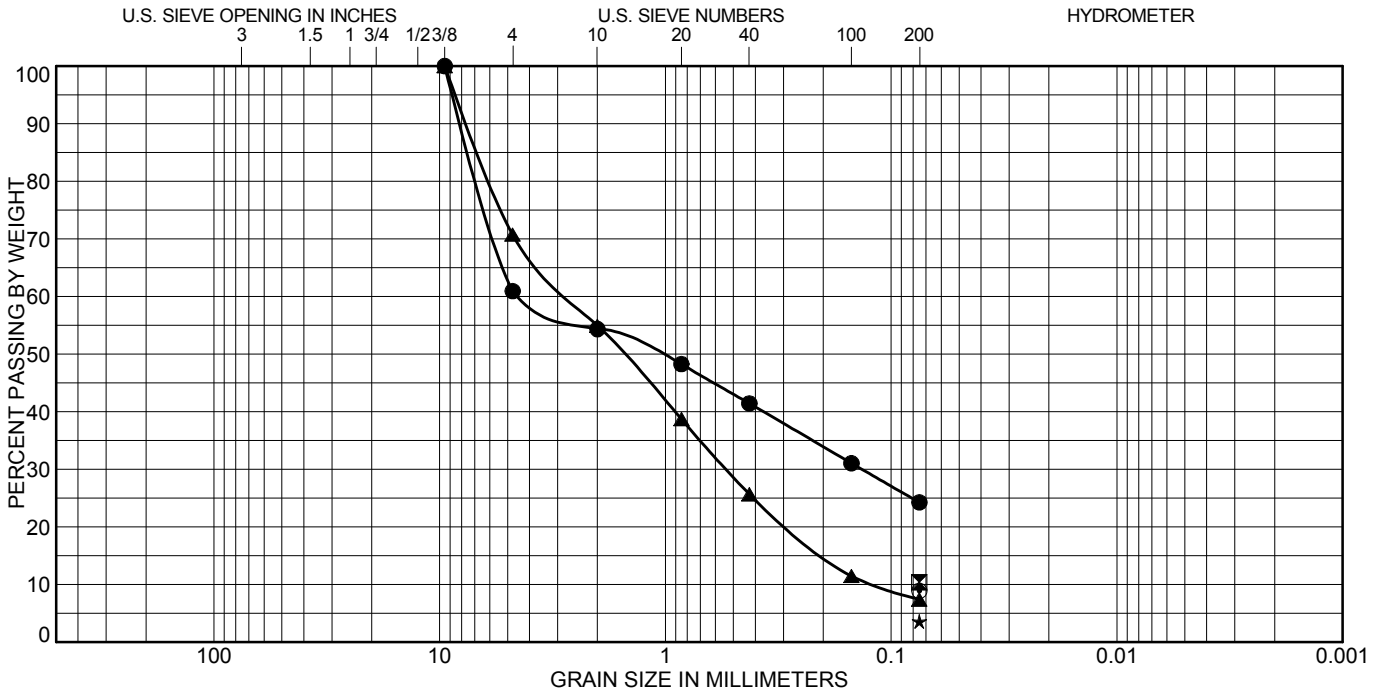
SOIL CLASSIFICATION DATA

JOB No. 166729

FIGURE No. 11

DATE 10/30/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI
●	B-05	9.0				
⧓	B-06	4.0				
▲	B-08	4.0				
★	B-09	4.0				
⊙	B-09	14.0				

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	B-05	9.0	39.1	36.7	24.3	
⧓	B-06	4.0			10.4	
▲	B-08	4.0	29.2	63.4	7.4	
★	B-09	4.0			3.6	
⊙	B-09	14.0			8.9	

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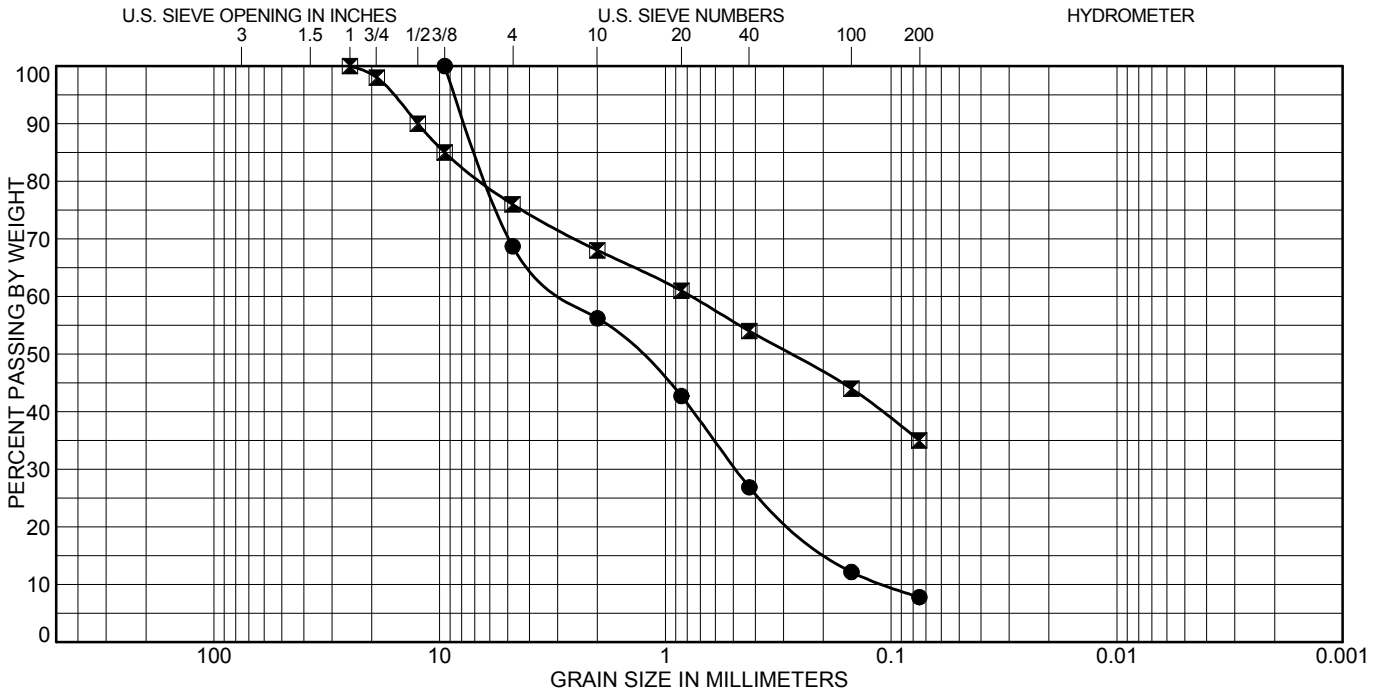
SOIL CLASSIFICATION DATA

JOB No. 166729

FIGURE No. 12

DATE 10/30/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI
●	**B-10**	**4.0**				
⧓	**C-1**	**1.0**	**CLAYEY SAND with GRAVEL(SC)**	**30**	**11**	**19**

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	**B-10**	**4.0**	**31.3**	**60.9**	**7.8**	
⧓	**C-1**	**1.0**	**24.0**	**41.0**	**35.0**	

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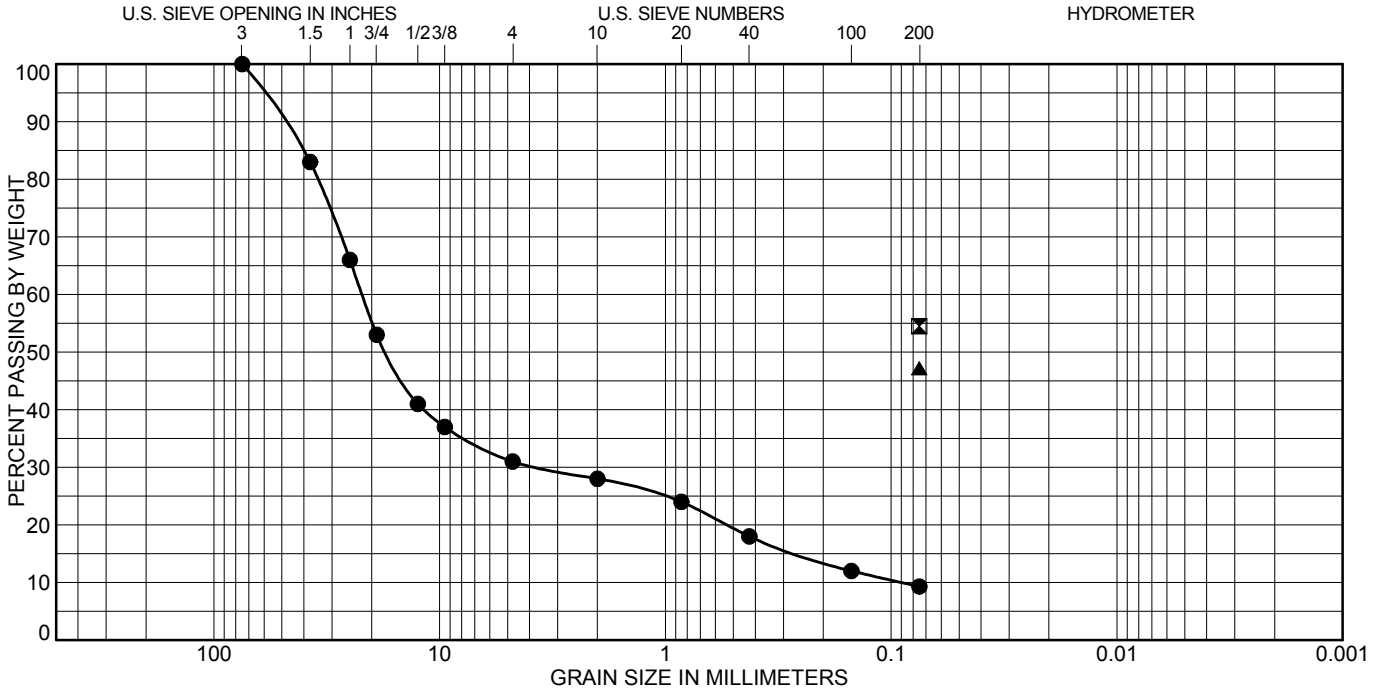
SOIL CLASSIFICATION DATA

JOB No. 166729

FIGURE No. 13

DATE 10/30/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	C-2	1.0	A-2-6 (0)	26	14	12	6.4	245.4
⧓	P-01	2.0	A-6 (10)	39	15	24		
▲	P-02	2.0	A-6 (4)	29	13	16		

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	C-2	1.0	69.0	21.7	9.3	
⧓	P-01	2.0			54.5	
▲	P-02	2.0			47.2	

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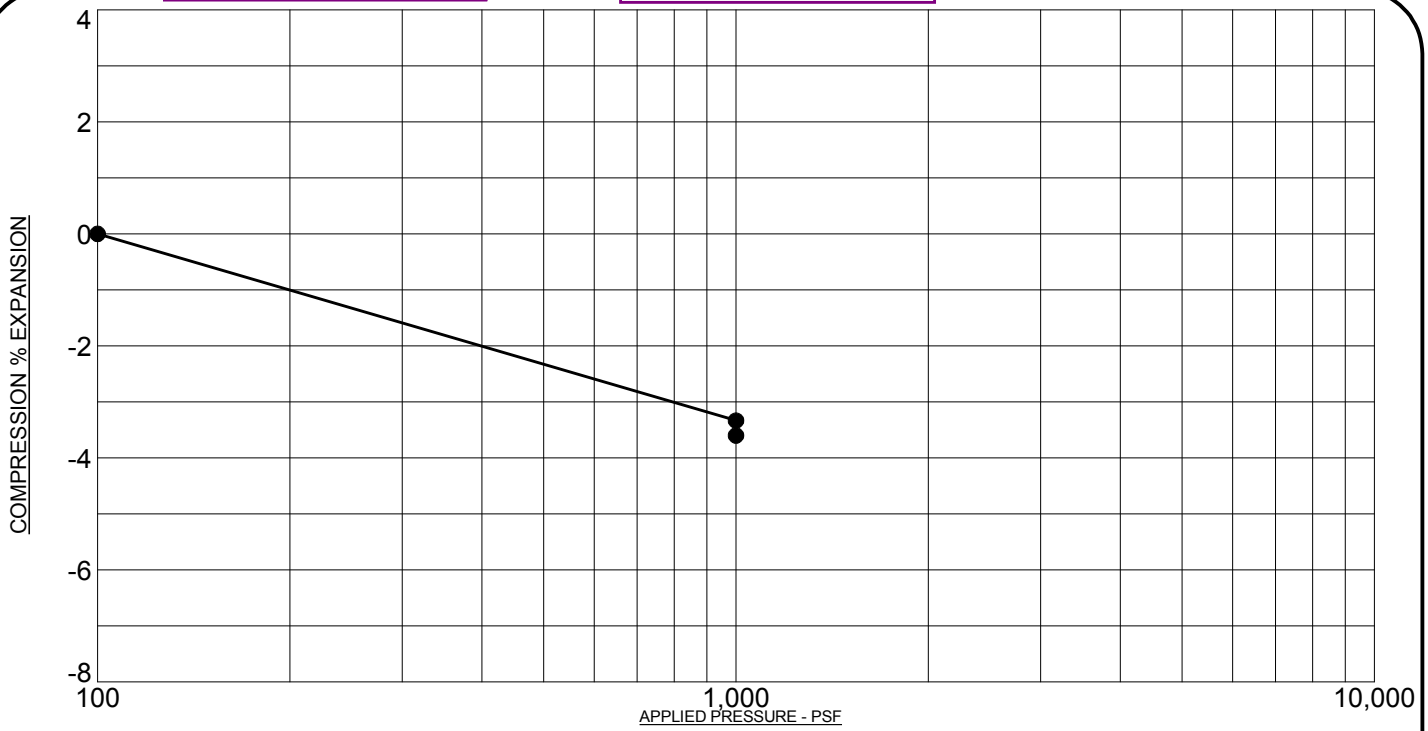
SOIL CLASSIFICATION DATA

JOB No. 166729

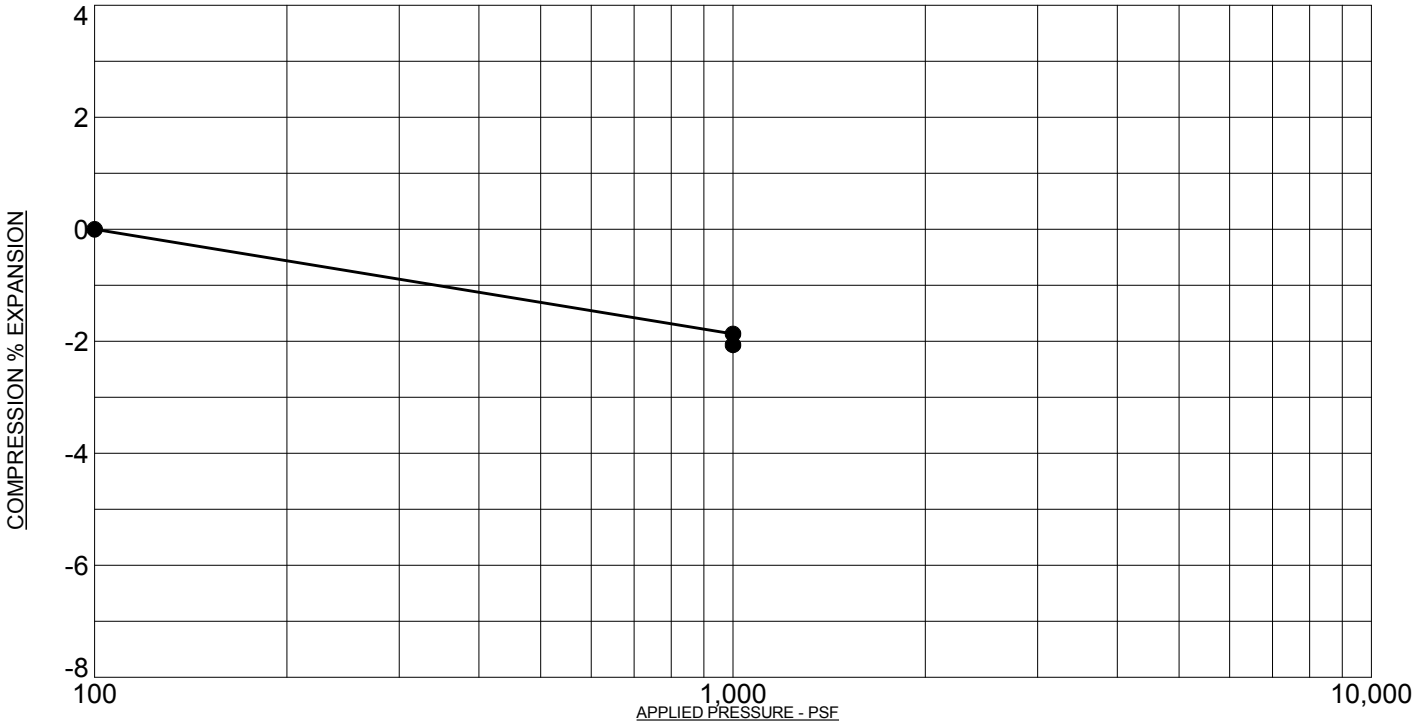
FIGURE No. 14

DATE 10/30/18



PROJECT: **5219 Allison St Arvada, CO**
SAMPLE DESCRIPTION: [FILL]**: Clayey SAND**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-01 @ 4 FT**
NATURAL DRY UNIT WEIGHT: **106.0 PCF**
NATURAL MOISTURE CONTENT: **11.8%**
PERCENT SWELL/COMPRESSION: **- 0.3**



PROJECT: **5219 Allison St Arvada, CO**
SAMPLE DESCRIPTION: [FILL]**: Clayey SAND**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-02 @ 4 FT**
NATURAL DRY UNIT WEIGHT: **121.7 PCF**
NATURAL MOISTURE CONTENT: **11.1%**
PERCENT SWELL/COMPRESSION: **- 0.2**

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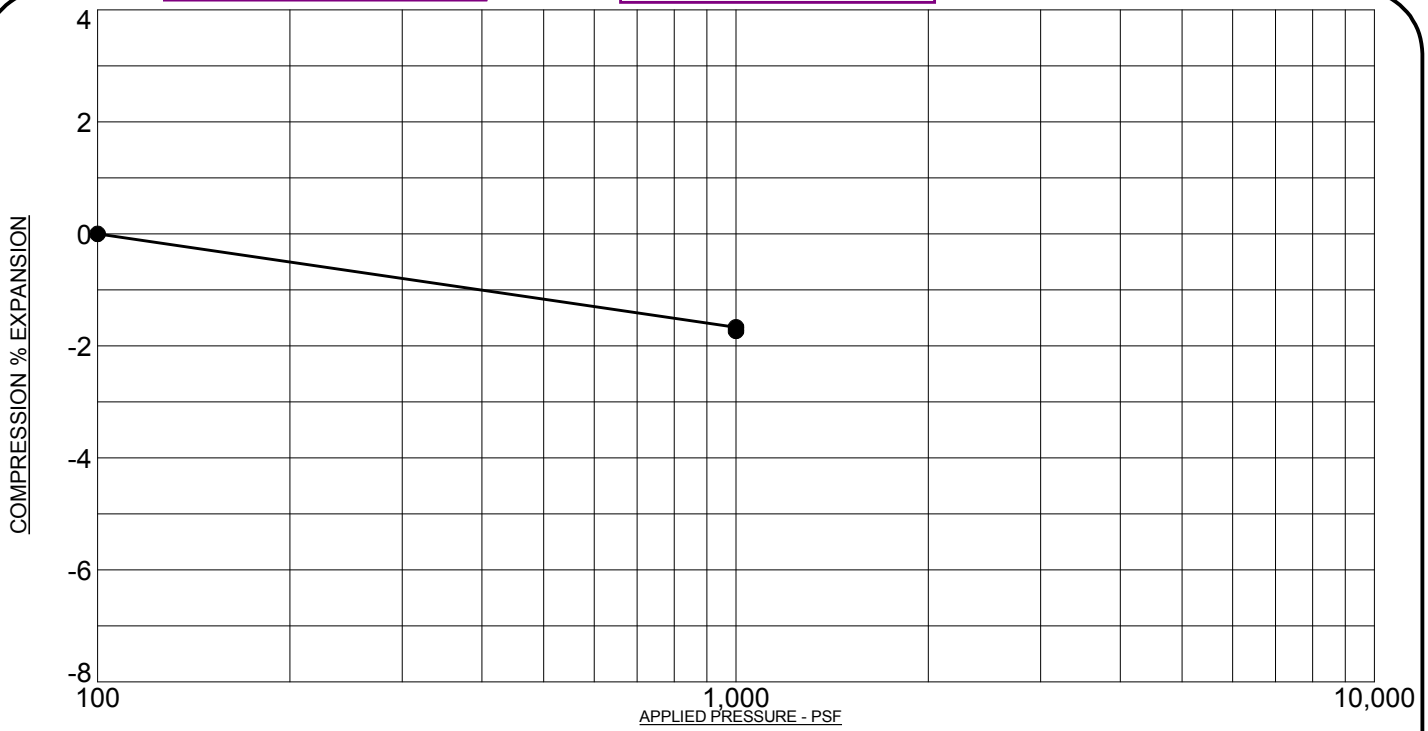
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 166729

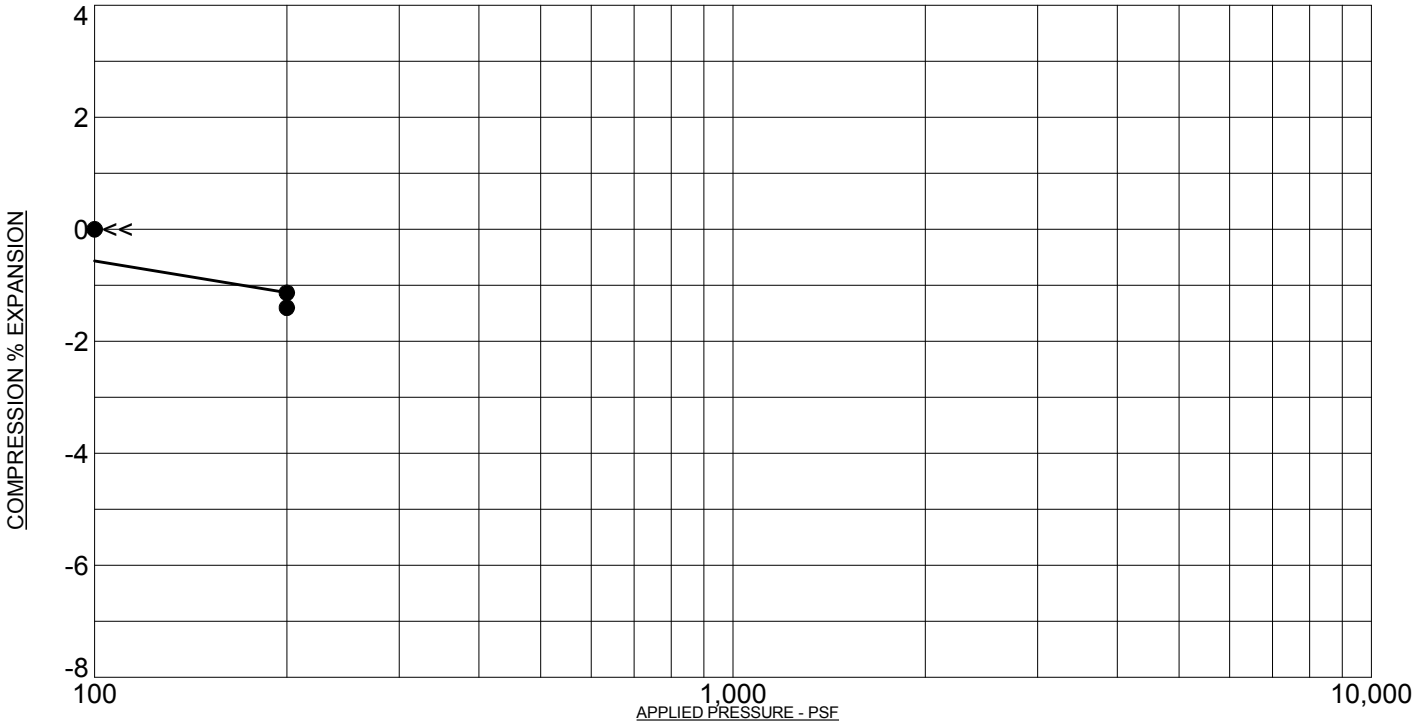
FIGURE No. 17

DATE 10/30/18



PROJECT: **5219 Allison St Arvada, CO**
SAMPLE DESCRIPTION: [FILL]**: Sandy CLAY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-04 @ 4 FT**
NATURAL DRY UNIT WEIGHT: **99.4 PCF**
NATURAL MOISTURE CONTENT: **20.2%**
PERCENT SWELL/COMPRESSION: **- 0.1**



PROJECT: **5219 Allison St Arvada, CO**
SAMPLE DESCRIPTION: [FILL]**: Sandy CLAY ((A-6(10))**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 200 PSF

SAMPLE LOCATION: **P-01 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **106.1 PCF**
NATURAL MOISTURE CONTENT: **18.1%**
PERCENT SWELL/COMPRESSION: **- 0.3**

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Colorado Spings, CO 80918
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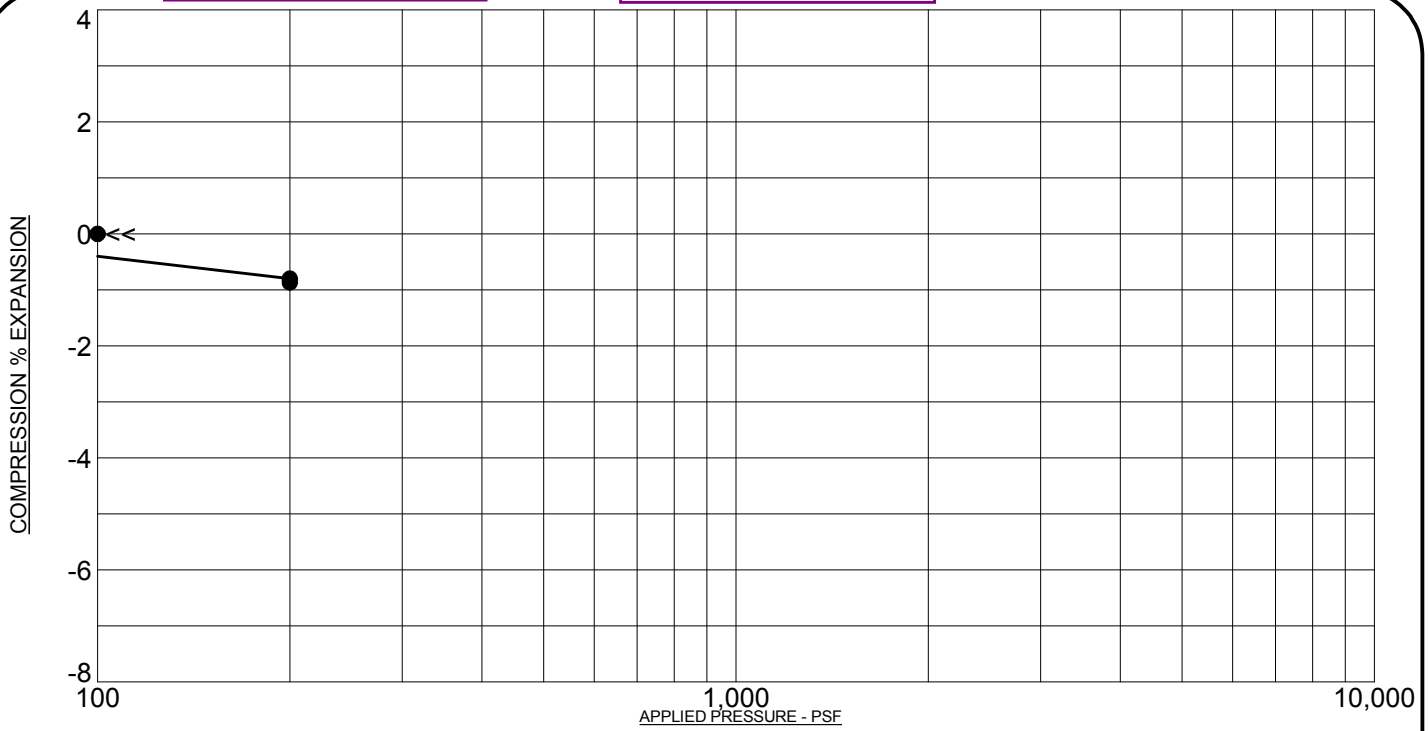
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

SWELL/CONSOLIDATION TEST RESULTS

JOB No. 166729

FIGURE No. 18

DATE 10/30/18



PROJECT: **5219 Allison St Arvada, CO**
SAMPLE DESCRIPTION: [FILL]**: Sandy CLAY ((A-6(4))**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 200 PSF

SAMPLE LOCATION: **P-02 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **109.5 PCF**
NATURAL MOISTURE CONTENT: **12.9%**
PERCENT SWELL/COMPRESSION: **- 0.1**

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SWELL/CONSOLIDATION TEST RESULTS

JOB No. 166729

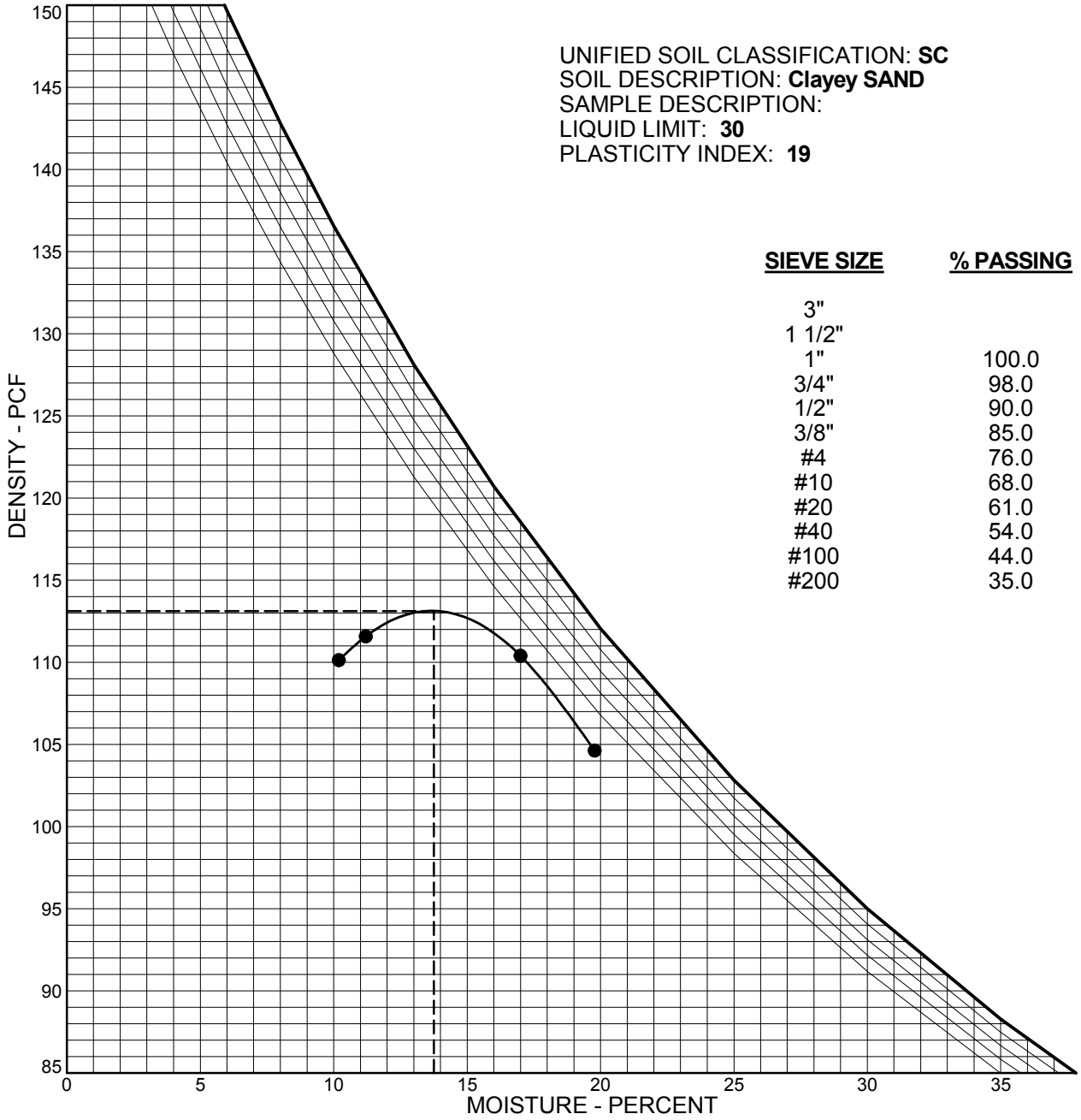
FIGURE No. 19

DATE 10/30/18

CLIENT: Royal Oak

SAMPLE NUMBER: C-1

PROJECT: **5219 Allison St Arvada, CO**



UNIFIED SOIL CLASSIFICATION: **SC**
SOIL DESCRIPTION: **Clayey SAND**
SAMPLE DESCRIPTION:
LIQUID LIMIT: **30**
PLASTICITY INDEX: **19**

SIEVE SIZE	% PASSING
3"	
1 1/2"	
1"	100.0
3/4"	98.0
1/2"	90.0
3/8"	85.0
#4	76.0
#10	68.0
#20	61.0
#40	54.0
#100	44.0
#200	35.0

DESIGNATION **ASTM D-AASHTO T-99**
MAX. DRY DENSITY **113.3 pcf**
OPTIMUM MOISTURE **13.8 %**
FRACTION USED **-#4**
MOLD VOLUME **0.0333 cu.ft.**

NOTE: ZERO AIR VOIDS CURVES PLOTTED FOR:
Gs = 2.60
Gs = 2.65
Gs = 2.70
Gs = 2.75
Gs = 2.80

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MOISTURE-DENSITY RELATION CURVE

JOB No. 166729

FIGURE No. 20

DATE 10/30/18