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ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

PRELIMINARY SUBSURFACE SOIL INVESTIGATION AND PAVEMENT DESIGN REPORT

**S. Chambers Rd. & Hess Rd. Project
Lot 1, Block 10, Douglas County Filing 1, 13.803 Acres, Commercial and
Residential
Parker, Colorado**

PREPARED FOR:

**Ventana Capital
9801 East Easter Avenue
Centennial, CO 80112**

JOB NO. 167366

December 6, 2018

Respectfully Submitted,

RMG – Rocky Mountain Group

A handwritten signature in blue ink that reads "Michael R. Anderson".

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Staff Geologist**

Reviewed by,

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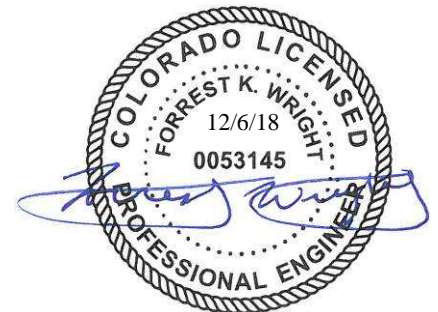


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GENERAL SITE AND PROJECT DESCRIPTION

Project Description

The site is located in the southwest portion of Parker, Colorado, northwest of the intersection of South Chambers Road and Hess Road. The approximate location of the site is shown on the Site Vicinity Map, Figure 1.

The project is to consist of mixed commercial, single-family residential and public park construction across approximately 13.8 acres at the site. More specifically, RMG understands construction at the site will include:

- 72 single family lots of 1 to 2 stories in height with unknown use of basements.
- 8 commercial lots with buildings approximately 1 to 2 stories in height up to 10,660 square feet.
- 0.14 acres of park space in the northeast corner of the site.
- Roadways, drive aisles, parking areas, and entrances.

Rocky Mountain Group (RMG) was retained to explore the subsurface conditions at the site and develop preliminary geotechnical engineering recommendations for design and construction. A final grading plan and/or architectural drawings of the proposed structures have not been provided to RMG prior to the issuance of this report. We understand that the purpose of this report is for preliminary recommendations only and that they will not be used for final design or submittal for construction. Preliminary recommendations stated herein will need to be verified and may be subject to change according to the findings during the final investigation and subsurface exploration. RMG assumes that the construction will consist of mass site grading and overexcavation where required.

Existing Site Conditions

Available historical imagery indicates that the Arapahoe Canal ran north-south across the western side of the site. Additionally, a small unnamed drainage trending east-west bisected the site and appears to have fed the Arapahoe Canal. The Arapahoe Canal and unnamed drainage at the site were infilled during development of the surrounding areas prior to 2004. The site experienced site grading and construction activity during residential development to the surrounding area. Unknown amounts of fill may exist across the site but despite previous grading the site is presently undeveloped. Vegetation at the site consisted of native grasses and weeds along with few deciduous trees. Areas with little vegetation are primarily located on the western side of the site where bedrock was shallow and outcropping at the existing ground surface. Topography across the site consists of mild to moderate slopes downward from South Chambers Road to the east.

FIELD INVESTIGATION AND LABORATORY TESTING

Drilling

The subsurface conditions on the site were investigated by drilling five 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 auger drill rig to depths of approximately 20 to 30 feet below the existing ground surface (bgs). Samples were obtained in general accordance with ASTM D-3550 utilizing a 2½-inch OD modified California sampler. Explanation of Test Boring Logs is presented in Figure 2. The Test Boring Logs are presented in Figures 3 through 5.

Laboratory Testing

The moisture content for the recovered samples was obtained in the laboratory. Grain-size analysis, Atterberg Limits, Natural Dry Unit Weight/Density, Water Soluble Sulfate, and Denver Swell/Consolidation 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 Figure 6. Soil Classification Data are presented in Figures 7 and 8. Swell/Consolidation Test Results are presented in Figures 9 through 11.

GEOLOGY, FAULTING, AND SUBSURFACE CONDITIONS

Geologic Setting

The project site is located approximately 16.5 miles east of the southern Rocky Mountains, within the Colorado Piedmont section of the Great Plains Physiographic Province. Parker 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 Matthew L Morgan (2014) as early Paleocene-age to early to middle Eocene-age Facies unit four and five (Dawson and Arapahoe Formations), and late Pleistocene-age Older alluvium two.

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	0.176	Fa	1.6	Sms	0.282	Sds	0.188
1.0	S1	0.058	Fv	2.4	Sm1	0.139	Sd1	0.092

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

SUBSURFACE CONDITIONS

Subsurface Materials

The subsurface materials encountered in the test borings were classified using the Unified Soils Classification System (USCS).

Topsoil

From the surface, topsoil was encountered in test borings to approximately 3 inches bgs. 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 light brown to brown and relatively dry.

Native Soils

Underlying the surficial topsoil, native soils were encountered in test borings along the central and eastern portions of the site (B-1, B-2, B-3). Native soils were encountered to depths ranging from approximately 11 to 19 feet bgs. Native soils were generally classified as very stiff sandy fat clay. Native soils were visually classified as light brown to brown, reddish brown, light to dark gray, olive, with white mineral deposits and oxidation staining, and relatively dry to moist.

Bedrock

Bedrock was encountered underlying topsoil or in areas of outcroppings along the western portion of the site (B-4 and B-5) and continued to boring termination depths. In the central and eastern portions of the site bedrock was encountered underlying the native soils continuing to the termination depths. Bedrock appears to generally dip steeply from the west to the east across the site. Bedrock was generally classified as hard to very hard sandstone and firm to medium hard claystone. Bedrock was visually classified as light brown to brown, yellowish brown, light to dark gray, reddish gray, olive, with white mineral deposits and oxidation staining, and moist.

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 test boring B-4 at approximately 13 feet bgs at the time of field exploration. However, when checked five days subsequent to drilling, groundwater was encountered at approximately 12 feet bgs in test boring B-4. Groundwater was not encountered in the remaining test borings. 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.

PRELIMINARY 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 preliminary recommendations and adjust them, if necessary.

Geotechnical Considerations

The primary geotechnical concern at this site is low to moderately expansive native soils and bedrock. Volumetric change of expansive soil may cause excessive cracking and heaving of structures with shallow foundations, concrete slabs-on-grade, or pavements supported on these materials. In general, swell potential increases as the dry density increases and the moisture content decreases. Also the swell potential increases as the surcharge pressure on a soil decreases. Construction on soils known to be potentially expansive will have a significant impact to this project.

The native soil and bedrock samples tested exhibited variable swells ranging between approximately 0.1 to 2.9 percent when wetted against a surcharge pressure of 1,000 pounds per square foot (psf). The swelling soils were encountered across the site. The swelling soils are widespread throughout the site at different depths. These soils are not suitable for direct bearing of shallow foundations or floor slabs in their present condition. In order to reduce the potential for post-construction total and differential vertical movement we recommend project improvements include on-site soils and bedrock be overexcavated, moisture conditioned, and reused as compacted structural fill to a depth which results in as much as 6-7 feet of moisture conditioned structural fill beneath foundation components and floor slabs. Personnel of RMG should be present during the overexcavation process to observe and verify overexcavation depths and separation from expansive materials.

Fill soils were not encountered during our field investigation. However, our review of available historical imagery indicates that fill material may be encountered during construction, particularly within the area of the Arapahoe Canal and unnamed drainage previously mentioned. Additionally, this area may contain soft or loose alluvial soils in areas that are not identified on the Test Boring Logs. Furthermore, due to the variability in selection, placement, and compaction of fill soils, unsuitable fill soils may be encountered in excavations, even where none are indicated on the Test Boring Logs. It is recommended that new foundations extend down through the fill materials to bear on the native soils or bedrock below. As with expansive clay soils and bedrock, fill material and soft/loose alluvial soils are

not considered suitable for support of shallow foundations. Soft/loose soils may require removal (overexcavation) and/or scarification and recompaction if encountered.

Groundwater was encountered at depths that are not anticipated to affect construction at the site. However, due to the tendency of groundwater to fluctuate, groundwater may be encountered during excavation, even when not indicated on the Test Boring Logs. Depending on the conditions encountered in the excavation, additional drainage/dewatering systems and/or foundation stabilization may be recommended.

Preliminary recommendations based on the field investigation and laboratory testing, are presented below. These preliminary recommendations may vary based on anticipated cut/fill and excavation depths. RMG should review the preliminary recommendations once final grade and excavation depths have been determined. Additional investigations will be required prior to final recommendations and design values being provided. It must be understood that these recommendations should be verified after the individual lots have been drilled or after excavation on each individual lot is completed.

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 proposed structure and improvement areas should be stripped of existing vegetation, 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 structural fill. In areas to receive engineered fill, the exposed subgrade should be scarified, moisture conditioned, and compacted per the recommendations set forth herein.

Excavations

Excavations for the project are expected to encounter native soils and bedrock. The native soils will generally be excavatable with heavy-duty earth moving equipment. Excavation rates will be very slow within bedrock and the use of more aggressive excavation techniques, such as single-shank rippers, hoe-rams, or rock breaking equipment, may be needed to achieve proposed grades. The contractor for this project should anticipate increase wear and tear on equipment when excavating bedrock. The excavation activities may generate oversize material (particles larger than 3 inches) that will not be suitable for use as backfill. Bedrock was encountered at depths ranging between approximately 0.25 to 19 feet bgs. The excavated on-site native soils and bedrock may be reused as structural fill if needed, provided the recommendations set forth herein are implemented.

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 A” soil when applying the OSHA guidelines. For excavations within the bedrock, either “Type A” soil conditions and/or “Stable Rock” is appropriate. 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.

Overexcavation and Replacement

The native clayey soil and claystone bedrock have low to moderate swell potential and may not be suitable for direct bearing of shallow foundations or floor slabs in their present condition. We preliminarily recommend the overexcavation of native soils and bedrock beneath foundations and floor slabs, moisture conditioning, and replacement as structural fill to depths which result in as much as 4-6 feet of moisture-conditioned compacted structural beneath all foundation components and floor slabs. If claystone bedrock is to be reused as moisture-conditioned compacted structural fill it will require additional processing and preparation. Reduction in overexcavation can be assessed once final grading plans and additional subsurface investigations have been conducted. The base of the fill prism should extend outward and upward from the outside edge of the building footprints on a 1:1 (horizontal: vertical) slope to include areas under building appurtenances. Structural fill should be observed and tested during placement as indicated in the following section, to ensure proper compaction.

Moisture Conditioned Structural Fill

Areas to receive moisture-conditioned structural fill should have topsoil removed and the upper 6 inches of the exposed surface soils 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.

Moisture-conditioned 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.

Moisture-conditioned structural fill shall consist of moisture-conditioned, on-site native soils and bedrock, and should generally be free of topsoil, organics, debris, particles greater than 3 inches in diameter, and other deleterious materials. Particles of non-expansive material or crystalline rock may be included up to 6 inches in diameter.

Moisture-conditioned structural fill materials shall be moisture-conditioned to a minimum of 0 percent to 4 percent above optimum moisture content (as determined by the Standard Proctor test, ASTM D-698).

Claystone materials used as moisture-conditioned structural fill shall be processed to contain claystone fragments no greater than 3 inches in diameter. When claystone is to be incorporated, the fill materials will require being processed with construction disc, sheepsfoot roller, and bladed until the material is well mixed and free of large clods and brought to proper moisture content. Claystone materials shall be moisture-conditioned to a minimum of 1 percent to 4 percent above optimum moisture content (as determined by the Standard Proctor test, ASTM D-698). Properly processing claystone material as structural fill does not eliminate swell potential of the moisture-conditioned and compacted claystone fill. These recommendations are intended to reduce the swell potential within the claystone structural fill. It is incumbent upon the contractor to ensure proper moisture-conditioning of the claystone material to reduce the swell potential and meet the stated specifications. If claystone materials are to be stockpiled during construction activity, the claystone materials should be re-wet and re-mixed to replace the surficial moisture lost to evaporation during the resting period. The processing and placement of

claystone material as moisture conditioned structural fill should be observed by a representative of RMG.

The moisture-conditioned materials should be placed in maximum 8" compacted lifts. These materials should be compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). Material not meeting the above requirements shall be reprocessed.

Materials used for moisture-conditioned structural fill should be approved by RMG prior to use. Moisture-conditioned 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 3 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 may encounter “Type A” soils and “Stable Rock” 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.

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, or if water is found in the excavated utility trenches, 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.

PRELIMINARY FOUNDATION RECOMMENDATIONS

The preliminary foundation recommendations presented below are based on the preliminary subsurface soil findings documented in this report. The final recommendations for each individual site will depend on the subsurface investigation for that specific lot to be conducted at a later time after final grading and overexcavation has occurred. RMG should be retained for each individual site for further soil exploration and will then provide specific foundation recommendations for each individual lot. Depending on the effectiveness of the overexcavation, moisture conditioning, and replacement, foundations may consist of continuous bearing spread footing foundations or alternatively spread footings with a minimum dead load.

Spread footing foundation bearing on structural fill may be designed for maximum allowable bearing pressures in the range of 2,000 to 2,500 psf. A minimum dead load spread footing foundation may be designed for a minimum dead load of 600 to 800 psf with a maximum allowable bearing pressure in the range of 2,000 to 2,500.

Spread footing foundation bearing on sandstone bedrock may be designed for maximum allowable bearing pressures in the range of 2,500 to 3,000 psf with no minimum dead load requirement.

Foundation components must be below all organic material and should extend 36 inches or more below the lowest exterior finished grade for frost protection. Continuous wall footings should have a width of 16 or more inches, and column footings should have a width of 24 or more inches. Footings should be reinforced in accordance with the recommendations of the structural engineer. The bearing capacity may be increased by one-third when considering loads of short duration such as wind or seismic forces. The foundations should preferably be proportioned such that the resultant force from design loads, including lateral loads, falls within the kern (i.e., middle one-third of the footing base).

LATERAL EARTH PRESSURES

Foundation and basement walls should be designed to resist lateral earth pressures. For onsite backfill materials, the estimated range of equivalent fluid pressures will be 40 to 60 pcf for active conditions and 60 to 80 pcf for at-rest conditions. 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.

INTERIOR FLOOR SYSTEMS

The following sections present our preliminary recommendations for slab-on-grade floors and isolating interior partitions.

Slab-on-Grade Floors

Slab performance risk evaluation is an engineering judgement which is used as a predictor of the general magnitude of potential slab heave, and the risk of poor slab performance. The Slab Performance Risk for slabs bearing atop undisturbed, on-site soils and bedrock at this site is judged to be highly variable from 'Low' to 'Moderate' based on the criteria in the following table.

Table 2: Slab Performance Risk Categories

Slab Performance Risk Category	Representative Percent Swell (500 psf Surcharge)	Representative Percent Swell (1,000 psf Surcharge)
Low	0 to < 3	0 to < 2
Moderate	3 to < 5	2 to < 4
High	5 to < 8	4 to < 6
Very High	>8	>6

Note: Based on Colorado Association of Geotechnical Engineers, Guidelines for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area, 1996).

The Colorado Association of Geotechnical Engineers (CAGE) recommends structural floors where the slab performance risk is judged to be high or very high. This risk is anticipated to be reduced by the overexcavation and replacement measures specified herein. However, the owner must understand that vertical slab movement on the order of four inches or more is considered possible for soils/bedrock of low to moderate expansion potential and for structural fill after removal (overexcavation) of expansive soils/bedrock. In some cases, vertical movement may exceed this range. 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. Control and construction joints should be placed in accordance with the latest guidelines and standards published by the American Concrete Institute (ACI) and applicable local Building Code requirements. Slabs should also be separated from any utility components by isolation joints. Mechanical equipment supported on slabs should be provided with expandable/collapsible sections in order to allow movement of the slab without damage to the equipment or structure.

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

Structural Floors

If movement cannot be tolerated, a structural floor system (supported by the foundation independently of the subgrade soils) is recommended for the interior floor system of the proposed structures. This may include conventional floor framing or a structural concrete slab adequately voided from the soil below. Suspended slab systems include the TellaFirma concept, which uses a post-tensioned structural concrete slab poured on the ground and raised to create the required floor space. Garage floor slabs supported on the on-site soils may experience vertical movement of one to six inches, or more.

If a non-concrete system is used, environmental health hazards associated with mold growth in crawlspaces must be reduced by utilizing “clean” construction methods. The floor should be properly sealed and vented. A ventilation system activated by temperature and humidity levels may be required in the crawlspace. The entire floor system and ventilation system should be designed by a qualified professional.

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

Interior Partitions

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 buildings 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. Homeowners 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

A subsurface perimeter drain is recommended around portions of structures which will have habitable or storage space located below the finished ground surface. This includes crawlspace and walkout portions of foundations, if applicable. A perimeter drain detail is provided in Figure 12.

A subsurface perimeter drain is designed to intercept some types of subsurface moisture and not others. Therefore, the drain could operate properly and not mitigate all moisture problems relating to foundation performance or moisture intrusion into the basement area.

CONSTRUCTION IN COLD OR WET WEATHER

During construction, the site should be graded such that surface water can drain readily away from the building areas. Given the soil conditions, it is important to avoid ponding of water in or near excavations. Water that accumulates in excavations should be promptly pumped out or otherwise removed and these areas should be allowed to dry out before resuming construction. Berms, ditches, and similar means should be used to decrease stormwater entering the work area and to efficiently convey it off site.

Earthwork activities undertaken during the cold weather season may be difficult and should be done by an experienced contractor. Fill should not be placed on top of frozen soils. The frozen soils should be removed prior to the placement of fill or other construction material. Frozen soil should not be used as engineered fill or backfill. The frozen soil may be reused (provided it meets the selection criteria) once it has thawed completely. In addition, compaction of the soils may be more difficult due to the viscosity change in water at lower temperatures.

If construction proceeds during cold weather, foundations, slabs, or other concrete elements should not be placed on frozen subgrade soil. Frozen soil should either be removed from beneath concrete elements, or thawed and recompact. To limit the potential for soil freezing, the time passing between excavation and construction should be minimized. Blankets, straw, soil cover, or heating may be used to discourage the soil from freezing.

PRELIMINARY PAVEMENT DESIGN

It is not known at this time if local residential roadways, drive aisles, and parking areas at the proposed development will be maintained privately and/or by the city/county. For the purpose of this preliminary pavement design, RMG assumes that the proposed pavement areas will be maintained by the City of Parker. This is considered a preliminary pavement design and does not meet the regulatory

requirements or design criteria of the final design. Preliminary recommendations provided are from information generated from preliminary borings which are not considered to be at or near final design grades of the proposed roadways.

Preliminary pavement design criteria in this report gives options for full depth and composite asphalt pavement sections. Final pavement grades have not been provided at this time. Additional investigation within the proposed pavement areas will be required to provide final pavement recommendations. Final recommendations will require samples to be taken after grading of the roadways have been completed and the subgrade is rough cut.

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 Parker “Street Classification and Roadway Design Criteria” and “Pavement Section Design” (PRDC), and Colorado Department of Transportation methodology.

Subgrade Preparation

Section 6.4 of the PRDC requires mitigation measures for soils with swell test results greater than or equal to 2.0 percent swell with a 200 pounds per square foot (psf) surcharge at specified compaction per CDOT at optimum moisture content. Additionally, mitigation may be required of soil conditions exhibiting collapse, low density, and/or a shallow water table.

Clay will be prone to swelling and heaving upon wetting. The native soil and bedrock samples tested exhibited variable swells ranging between approximately 0.1 to 2.9 percent when wetted against a surcharge pressure of 1,000 psf. These samples were taken of in-situ conditions and not representative of the requirements of the final pavement design. Furthermore, these samples were wetted at a surcharge greater than the surcharge required as indicated in the PRDC and may experience greater swell potential under a smaller surcharge. We preliminarily recommend that clay and claystone encountered at subgrade elevation should be overexcavated as much as 5 feet, 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 98 percent of Standard Proctor test, (ASTM D-698), or treated in accordance with City of Parker mitigation measures. If expansive soil mitigation is made, the soil treatment shall extent to one foot beyond the back-of-curb (if detached walk or not walk), or to one foot beyond the back-of-walk (if attached walk or monolithic walk).

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 98 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.

Preliminary 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 fat clay (A-7-6) soils existing on site. Pavement design parametric input data follows the guidelines presented in Section 6.0 of the PRDC. The roadway is assumed to be classified as “Local Residential - >50 Residential Units”. The pavement design parameters and design calculations for Flexible Pavements are presented below:

Table 3 - Design Parameters

	Pavement	Source
ESAL	73,000	PRDC Table 6-1
Serviceability Loss	2.0	CDOT Table 1.5
Assumed R-Value	5.0	--
Reliability	80	CDOT Table 1.3
Standard Deviation	-0.841	CDOT Table 1.4
Calculated Subgrade Resilient Modulus (MR)	3,025psi	PRDC Section 6.2.3

The Subgrade Resilient Modulus (M_R) of 3,025 pounds per square inch (psi) was calculated using equations developed by the Colorado Department of Transportation.

Flexible Pavement Design

Section 6.3 of PRDC specifies a minimum full depth flexible pavement thickness of 5.0 inches and minimum composite flexible pavement sections of 5.0 inches of asphalt and maximum 8.0 inches of base for flexible pavements of “Local-Residential - >50 Residential Units” sites. The flexible pavement design parameters are presented below. Design calculations are based on the general equation ($SN = a_1 D_1 + a_2 D_2 + a_3 D_3 + \dots$) as presented in Section 6.2.3 of the PRDC.

Table 4 - Strength Coefficients

	Pavement	Source
Asphalt (HMA)	0.44	CDOT Table 3.2
Aggregate Base Course (ABC)	0.15	CDOT Table 3.2

The following Structural Number is recommended based on Figure 3.1 “Design Nomograph for Flexible Pavements” in the CDOT manual.

Table 5 - Structural Numbers

	Pavement
Structural Number	3.6

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 Range of Hot Mix Asphalt Pavement thickness = $D_1 = 5.5 - 7.0$ inches
 Calculated Range of ABC thickness = $D_2 = 4.0 - 8.0$ inches

Required Minimum Hot Mix Asphalt Pavement thickness = 5.0 inches (Section 6.3)
 Maximum Base thickness = 8.0 inches (Section 6.3)

The following Composite Hot Mix Asphalt Pavement section is recommended.

Table 6 – Recommended Composite Hot Mix Asphalt Pavement Sections

Section Type	HMA (in)	Base Layer (in)
Hot Mix Asphalt Pavement with Aggregate Base Course	5.5 – 7.0	4.0 - 8.0

Full Depth Hot Mix Asphalt

As an alternative to the Hot Mix Asphalt plus 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 = $D_1 = 8.5$ inches
 Required Minimum Full Depth Hot Mix Asphalt Pavement thickness = 7.0 inches
 (Section 6.3)

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

Table 7 – Recommended Full Depth Hot Mix Asphalt Pavement Sections

Section Type	HMA (in)	SS (in)
Hot Mix Asphalt Pavement	8.5	--

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, which meets the requirements of a job-mix formula established by a qualified engineer. Grading S should be used for the lower lift(s) and grading SX should be used for the surface course. Pavement layer thickness should be 2 to 3 inches for the lower lift(s) and 1.5 to 2.5 inches for the surface course with tack coat layer(s) in between. The geotechnical engineer should be retained to review the proposed pavement mix designs, grading, and lift thicknesses prior to construction.

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 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557)

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 and composite samples based on ASTM C1580. Test results showed 0.07 percent by weight, indicating the soils present negligible (Class 0) sulfate exposure. Based on these results Type I/II cement or equivalent mixture according to ACI 201.2R-10 is suggested for concrete in contact with the subsurface materials. Cement type shall be designed and approved by a licensed Colorado Professional Engineer and Foundation Designer. 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 preliminary 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.

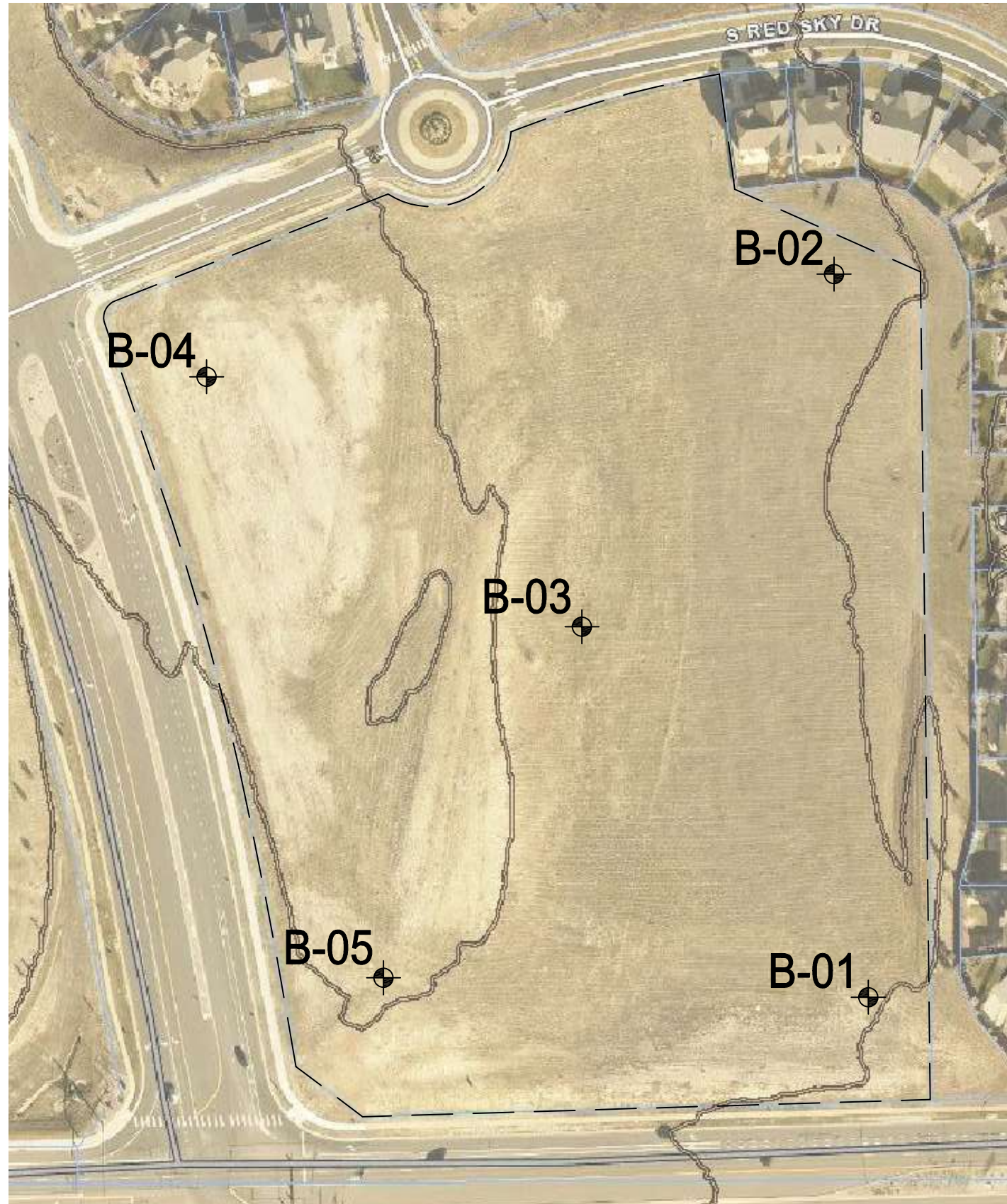
This report has been prepared for the exclusive use by **Ventana Capital** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon 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.

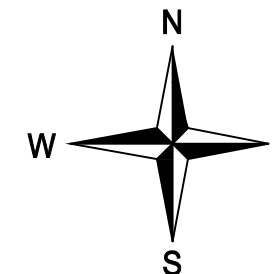
The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including 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



VICINITY MAP
NOT TO SCALE



TEST BORING LOCATION PLAN

NOT TO SCALE



LIMITS OF THE INVESTIGATION



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**S CHAMBERS RD AND
HESS RD
PARKER, COLORADO**
VENTANA CAPITAL

ENGINEER:	FKW
DRAWN BY:	MAM
CHECKED BY:	FKW
	12.03.2018

REVISION:	DATE:





**SITE VICINITY MAP
AND BORING
LOCATION PLAN**

SHEET No.

FIG. 1







JOB No. 167366

SOILS DESCRIPTION

-  CLAYSTONE
-  SANDSTONE
-  SANDY CLAY
-  TOPSOIL

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 LOGS

JOB No. 167366

FIGURE No. 2

DATE 11/27/18

TEST BORING: B-1 DATE DRILLED: 10/24/18 ELEVATION (FT): NO GROUNDWATER ON 10/29/18	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	TEST BORING: B-2 DATE DRILLED: 10/24/18 ELEVATION (FT): NO GROUNDWATER ON 10/29/18	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
TOPSOIL: light brown, relatively dry Sandy Fat CLAY - light brown to reddish brown with white mineral deposits, stiff to very stiff, relatively dry	5		▲	38	-	TOPSOIL: brown, relatively dry Sandy Fat CLAY - brown, olive, dark gray, with oxidation staining, stiff to very stiff, relatively dry to moist	5		▲	19	26.2
CLAYSTONE - brown, gray to dark gray with oxidation staining, medium hard, moist	10		▲	16	9.9		10		▲	16	17.7
	15		▲	50/11"	29.9		15		▲	22	--
	20		▲	50	-	CLAYSTONE - brown to light gray to dark gray with white mineral deposits and oxidation staining, firm to medium hard, relatively dry	20		▲	30	-
										50/10"	-

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TEST BORING LOG

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FIGURE No. 3

DATE 12/6/18

TEST BORING: B-3 DATE DRILLED: 10/24/18 ELEVATION (FT): NO GROUNDWATER ON 10/29/18	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %	TEST BORING: B-4 DATE DRILLED: 10/24/18 ELEVATION (FT): GROUNDWATER @ 12.2' 10/29/18	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
TOPSOIL: light brown, relatively dry Sandy Fat CLAY - light brown to light gray with white mineral deposits and oxidation staining, stiff to very stiff, relatively dry	5		▲	22	17.2	TOPSOIL: light brown, relatively dry SANDSTONE - white to light brown, hard to very hard, relatively dry	5		▲	50/6"	5.6
CLAYSTONE - light gray to olive to brown to dark gray, medium hard to firm, moist	10		▲	24	16.9		10		▲	50/6"	--
	15		▲	40	24.8	CLAYSTONE - light gray, medium hard, wet	15		▲	50/5"	4.3
	20		▲	33	28.6		15		▲	50/8"	--
	25		▲	50/9"	29.1				▲	50/8"	--
			▲	50/9"	26.3				▲		

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TEST BORING LOG

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FIGURE No. 4

DATE 12/6/18

TEST BORING: B-5 DATE DRILLED: 10/24/18 ELEVATION (FT): NO GROUNDWATER ON 10/29/18	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
TOPSOIL: light brown, relatively dry CLAYSTONE - white to light brown to reddish gray to yellowish brown with white mineral deposits and oxidation staining, medium hard, relatively dry to moist				50 50/11" 50/10" 50/10"	-- 32.2 -- 23.5

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FIGURE No. 5

DATE 12/6/18

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-1	9.0	9.9					54.7			
B-1	14.0	29.9	88.9	70	37		70.5		0.1	CH
B-2	4.0	26.2	94.9	63	38		63.3		1.9	CH
B-2	9.0	17.7					58.2			
B-3	4.0	17.2								
B-3	9.0	16.9	104.8				85.7		2.9	
B-3	14.0	24.8								
B-3	19.0	28.6	92.5				80.3		1.6	
B-3	24.0	29.1								
B-3	29.0	26.3								
B-4	4.0	5.6				26.2	10.7			
B-4	14.0	4.3					11.6			
B-5	9.0	32.2	97.8				69.9		2.0	
B-5	19.0	23.5	102.5				54.3		0.3	

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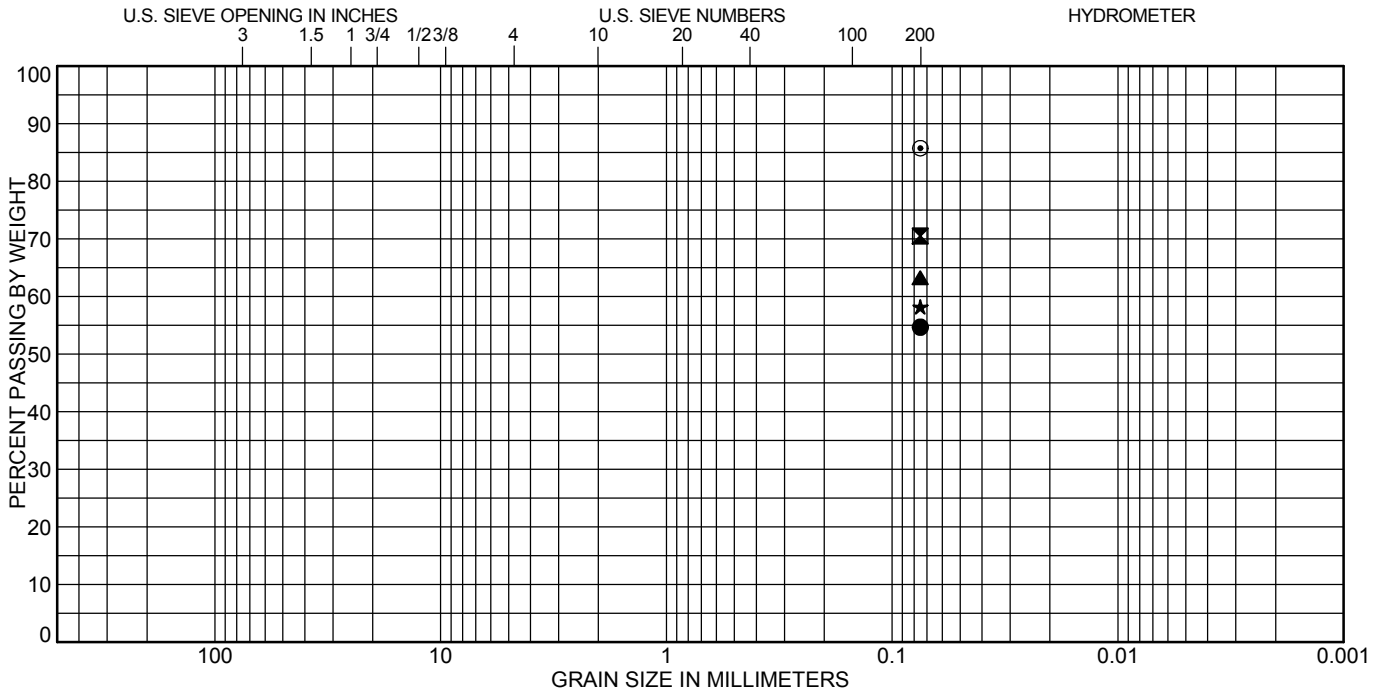
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SUMMARY OF LABORATORY TEST RESULTS

JOB No. 167366
FIGURE No. 6
PAGE 1 OF 1
DATE 11/27/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring	Depth (ft)	Classification	LL	PL	PI
● B-1	9.0				
☒ B-1	14.0	FAT CLAY with SAND(CH)	70	33	37
▲ B-2	4.0	SANDY FAT CLAY(CH)	63	25	38
★ B-2	9.0				
⊙ B-3	9.0				

Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
● B-1	9.0			54.7	
☒ B-1	14.0			70.5	
▲ B-2	4.0			63.3	
★ B-2	9.0			58.2	
⊙ B-3	9.0			85.7	

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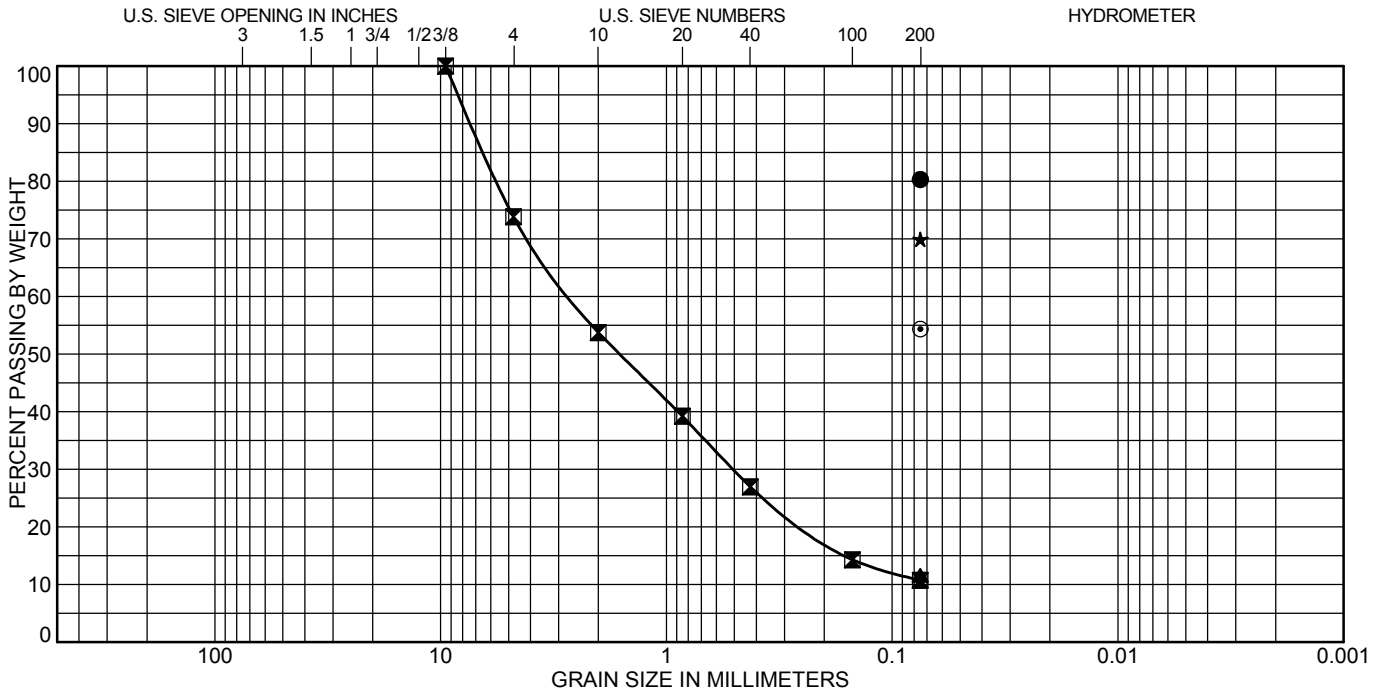
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SOIL CLASSIFICATION DATA

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FIGURE No. 7

DATE 11/27/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring	Depth (ft)	Classification	LL	PL	PI
● B-3	19.0				
☒ B-4	4.0				
▲ B-4	14.0				
★ B-5	9.0				
⊙ B-5	19.0				

Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
● B-3	19.0			80.3	
☒ B-4	4.0	26.2	63.1	10.7	
▲ B-4	14.0			11.6	
★ B-5	9.0			69.9	
⊙ B-5	19.0			54.3	

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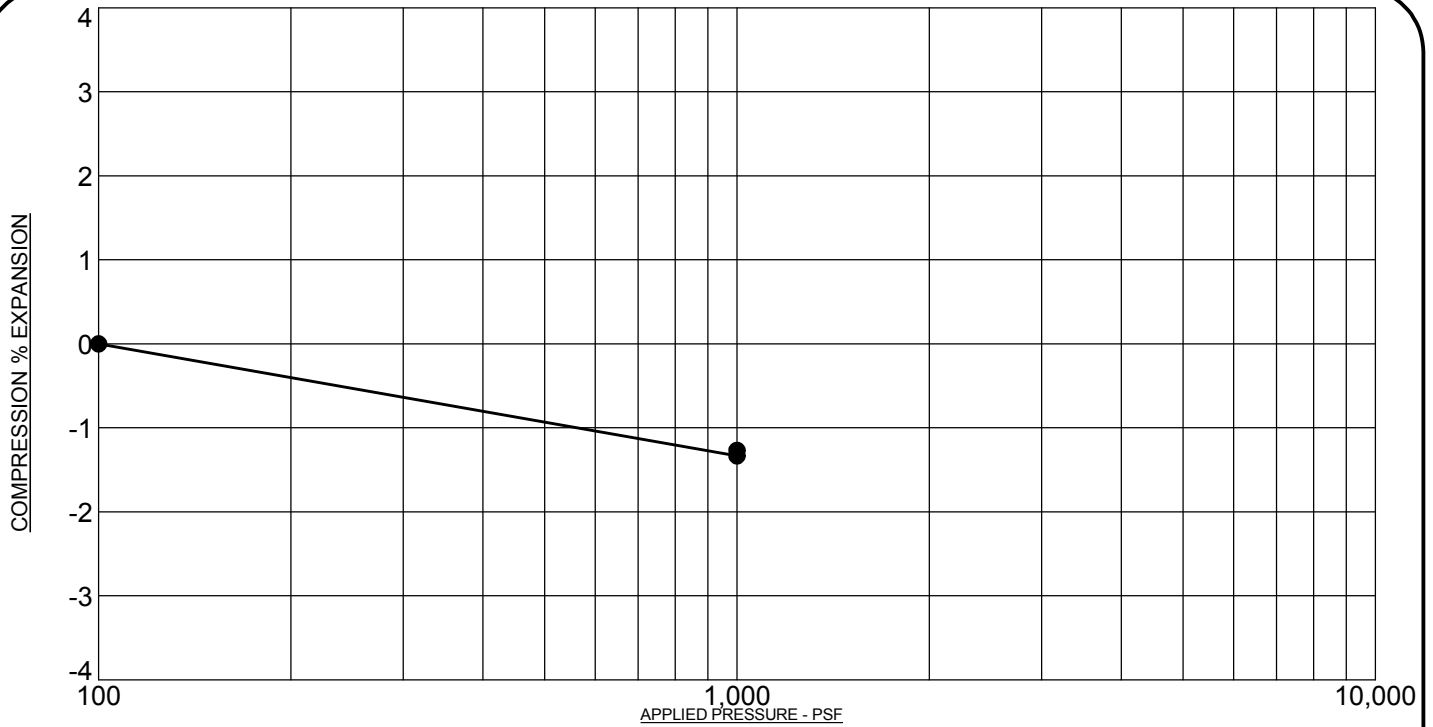
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SOIL CLASSIFICATION DATA

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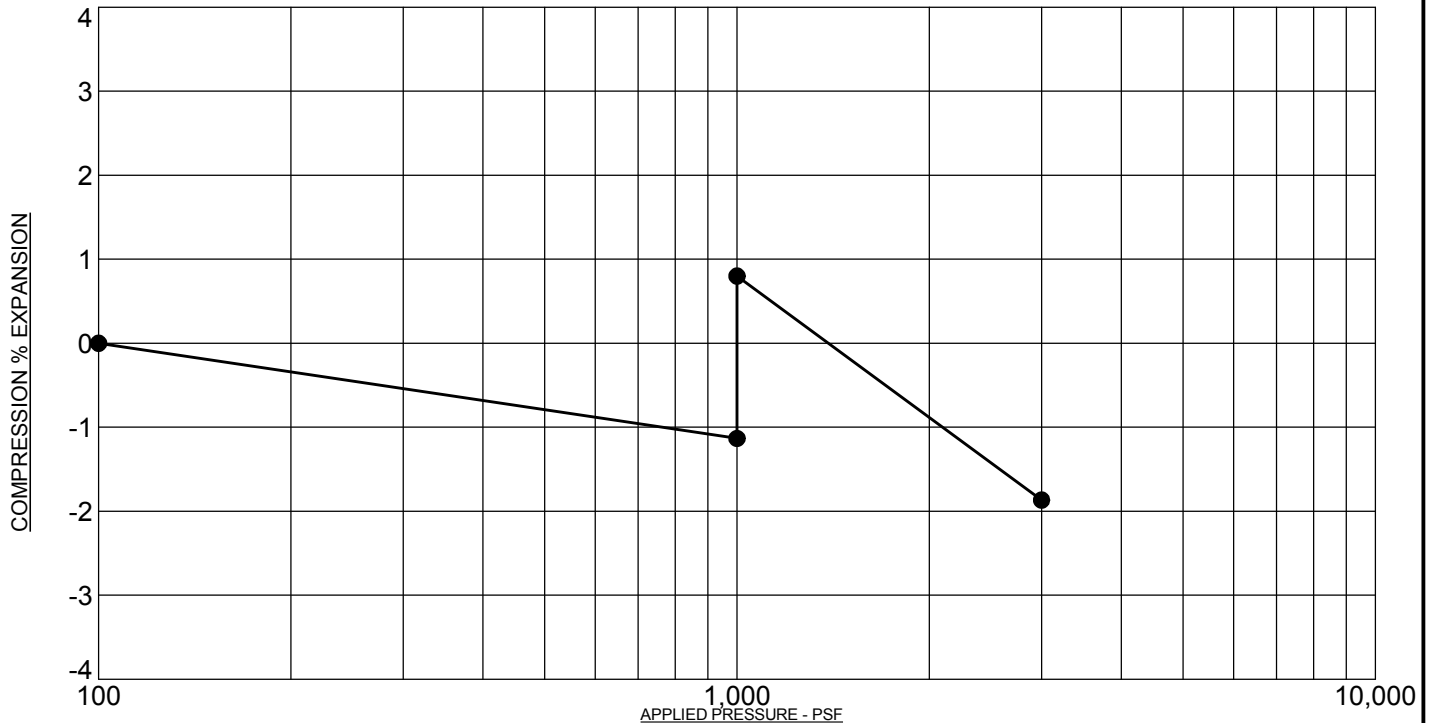
FIGURE No. 8

DATE 11/27/18



PROJECT: S. Chambers Road & Hess Road Project Parker, Colorado
 SAMPLE DESCRIPTION: CLAYSTONE
 NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: B-1 @ 14 FT
 NATURAL DRY UNIT WEIGHT: 87.1 PCF
 NATURAL MOISTURE CONTENT: 29.9%
 PERCENT SWELL/COMPRESSION: 0.1



PROJECT: S. Chambers Road & Hess Road Project Parker, Colorado
 SAMPLE DESCRIPTION: Sandy Fat CLAY
 NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: B-2 @ 4 FT
 NATURAL DRY UNIT WEIGHT: 93.8 PCF
 NATURAL MOISTURE CONTENT: 26.2%
 PERCENT SWELL/COMPRESSION: 1.9

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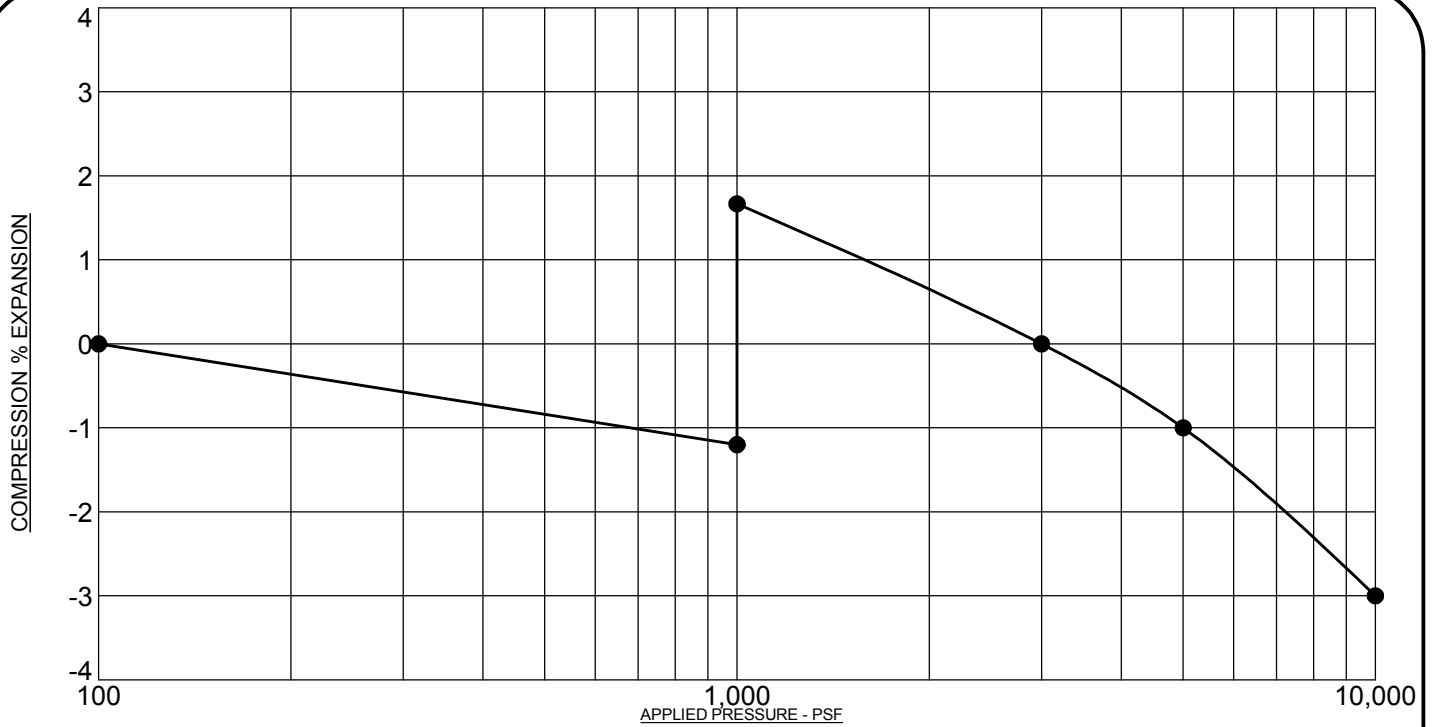
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SWELL/CONSOLIDATION TEST RESULTS

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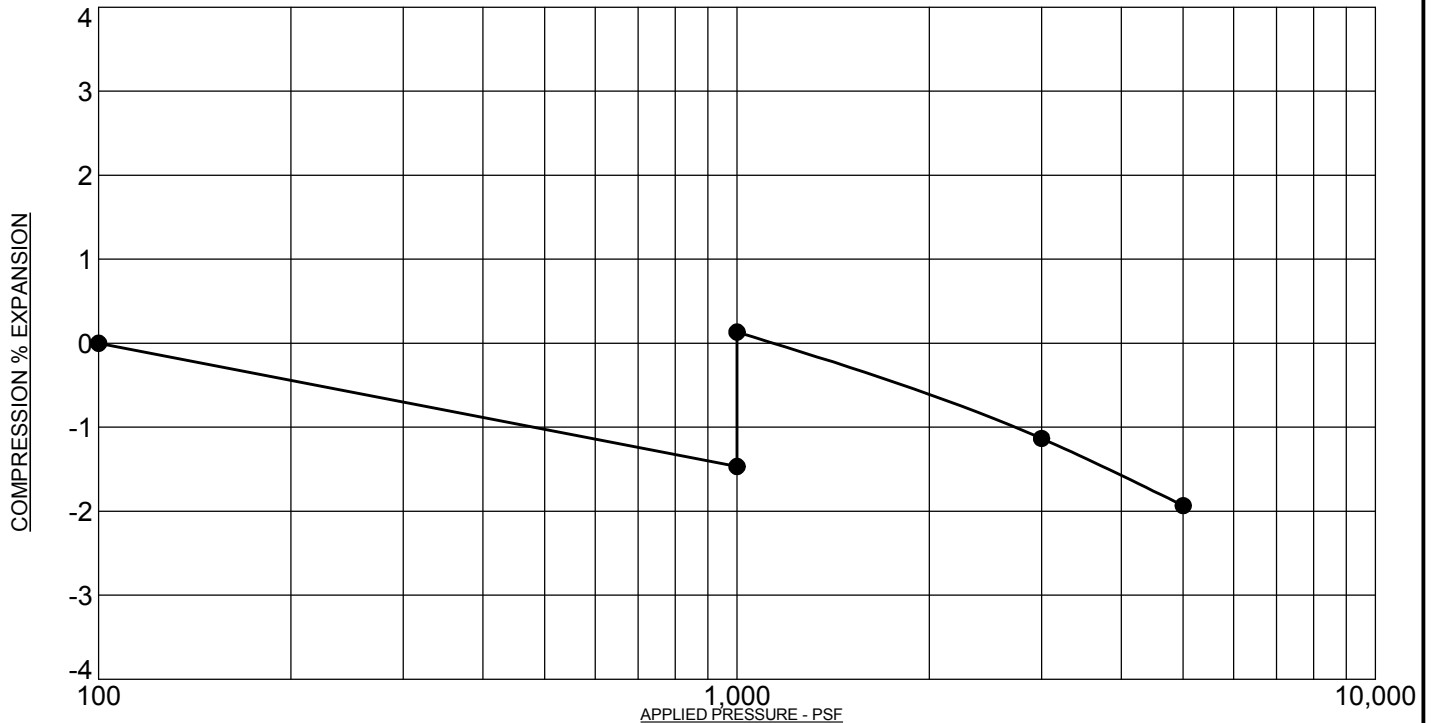
FIGURE No. 9

DATE 11/27/18



PROJECT: S. Chambers Road & Hess Road Project Parker, Colorado
 SAMPLE DESCRIPTION: Sandy Fat CLAY
 NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: B-3 @ 9 FT
 NATURAL DRY UNIT WEIGHT: 110.1 PCF
 NATURAL MOISTURE CONTENT: 16.9%
 PERCENT SWELL/COMPRESSION: 2.9



PROJECT: S. Chambers Road & Hess Road Project Parker, Colorado
 SAMPLE DESCRIPTION: CLAYSTONE
 NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: B-3 @ 19 FT
 NATURAL DRY UNIT WEIGHT: 94.6 PCF
 NATURAL MOISTURE CONTENT: 28.6%
 PERCENT SWELL/COMPRESSION: 1.6

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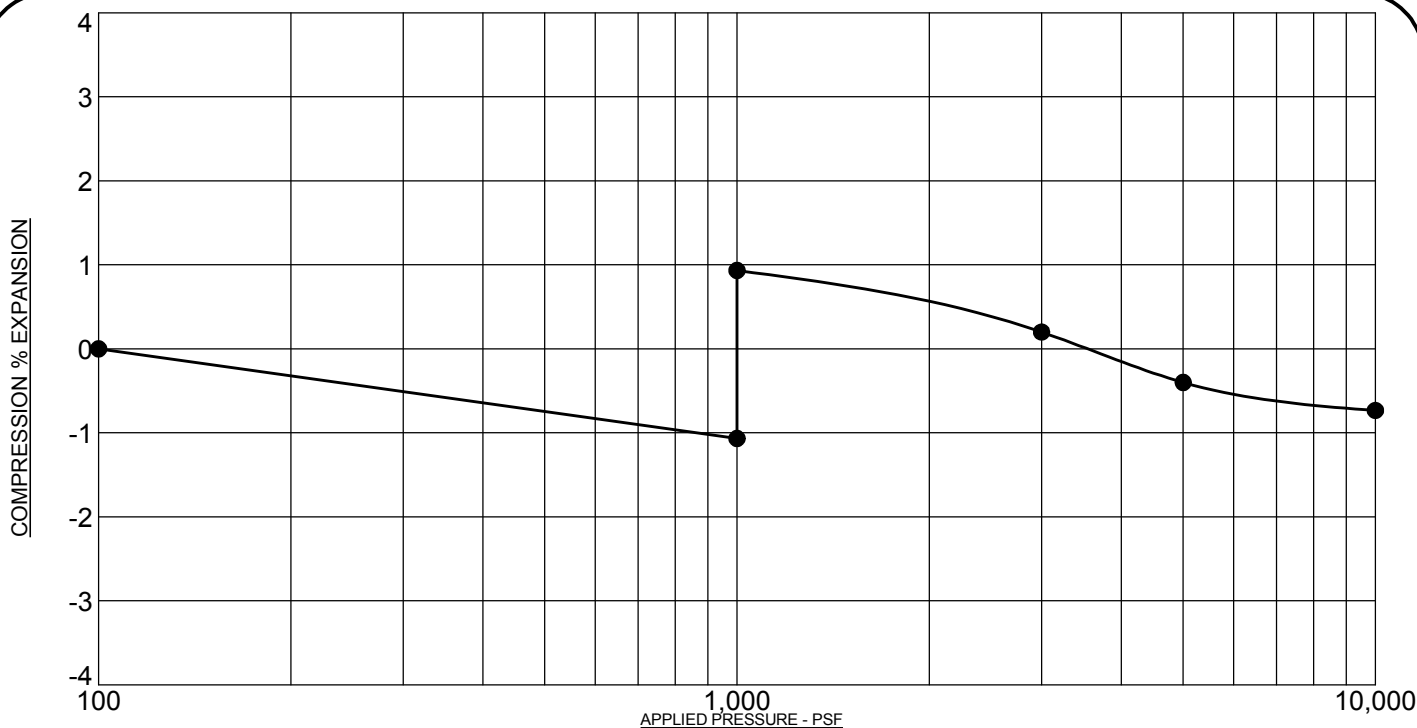
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SWELL/CONSOLIDATION TEST RESULTS

JOB No. 167366

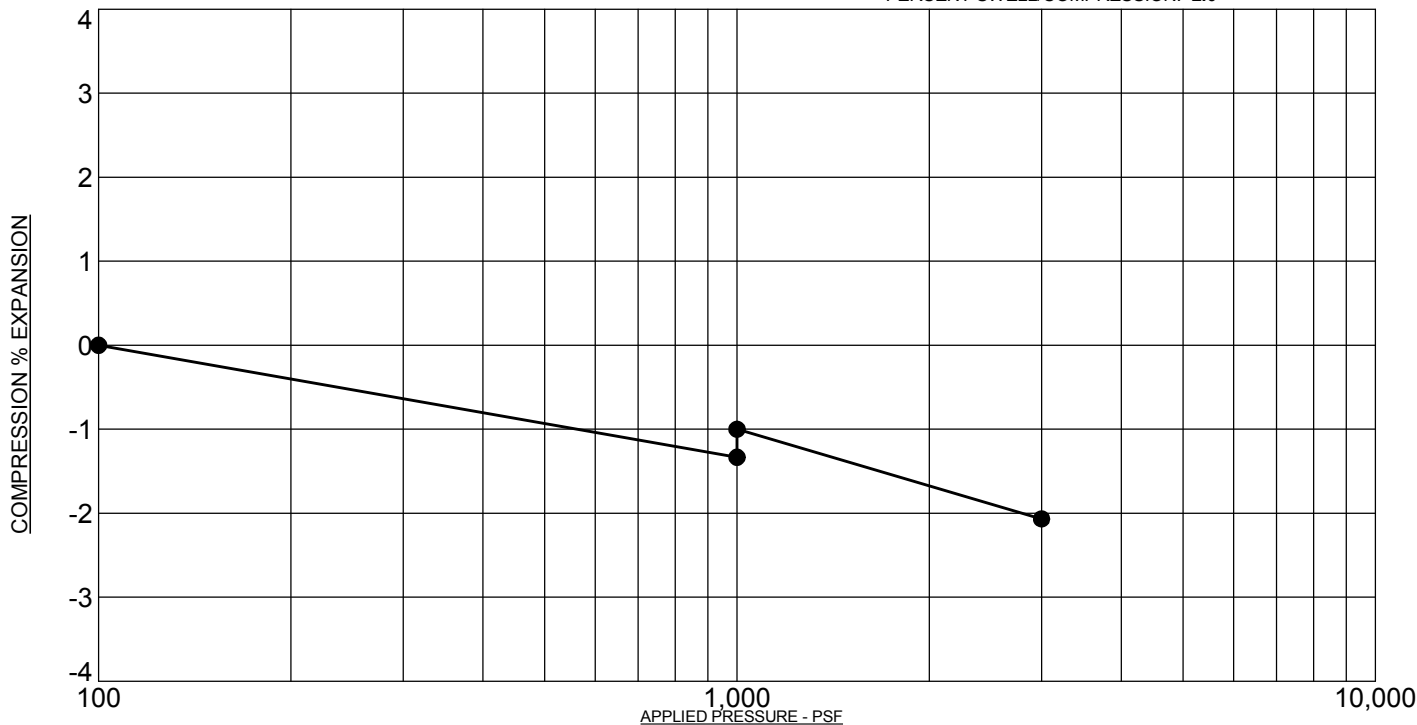
FIGURE No. 10

DATE 11/27/18



PROJECT: S. Chambers Road & Hess Road Project Parker, Colorado
 SAMPLE DESCRIPTION: CLAYSTONE
 NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: B-5 @ 9 FT
 NATURAL DRY UNIT WEIGHT: 97.8 PCF
 NATURAL MOISTURE CONTENT: 32.2%
 PERCENT SWELL/COMPRESSION: 2.0



PROJECT: S. Chambers Road & Hess Road Project Parker, Colorado
 SAMPLE DESCRIPTION: CLAYSTONE
 NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: B-5 @ 19 FT
 NATURAL DRY UNIT WEIGHT: 102.5 PCF
 NATURAL MOISTURE CONTENT: 23.5%
 PERCENT SWELL/COMPRESSION: 0.3

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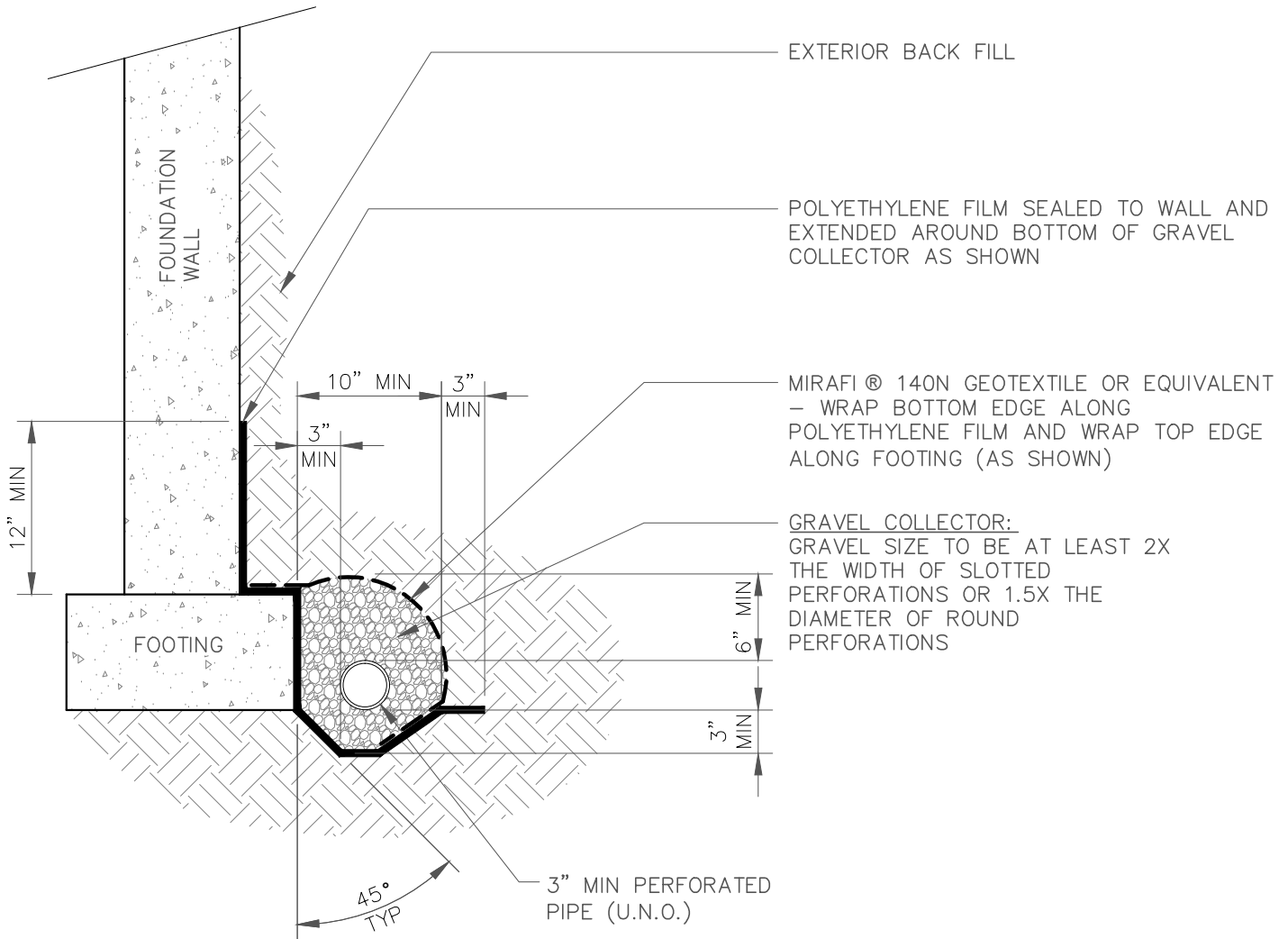
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SWELL/CONSOLIDATION TEST RESULTS

JOB No. 167366

FIGURE No. 11

DATE 11/27/18



GENERAL NOTES:

1. BOTTOM OF DRAIN PIPE SHALL BE AT OR BELOW BOTTOM OF FOOTING AT ALL LOCATIONS
2. ALL DRAIN PIPE SHALL BE PERFORATED PLASTIC, WITH THE EXCEPTION OF THE DISCHARGE PORTION WHICH SHALL BE SOLID, NON-PERFORATED PIPE.
3. MINIMUM GRADE FOR DRAIN PIPE SHALL BE 1%, OR 3 INCHES OF FALL IN 25 FEET.
4. DRAIN PIPE SHALL BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. IF A GRAVITY OUTFALL CANNOT BE ACHIEVED, THEN A SUMP PIT AND PUMP SHALL BE USED.
5. ALL DRAIN COMPONENTS SHALL BE RATED/APPROVED BY THE MANUFACTURER FOR THE INSTALLED DEPTH AND APPLICATION
6. DRAIN SYSTEM, INCLUDING THE OUTFALL OF THE DRAIN, SHALL BE OBSERVED BY QUALIFIED PERSONNEL PRIOR TO BACKFILLING TO VERIFY INSTALLATION.



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**SPREAD FOOTINGS
PERIMETER DRAIN**

FIG No. 12