Architecture
Structural
Geotechnical

Materials Testing
Forensic
Civil/Planning

ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

SUBSURFACE SOIL INVESTIGATION

Townhomes at Pine Drive
10940 Pine Drive
Parker, Colorado

PREPARED FOR:

M & B Construction Services, Inc.
14 Inverness Drive East
Suite G-136
Englewood, CO 80112

JOB NO. 178236

December 21, 2020

Respectfully Submitted,
RMG – Rocky Mountain Group

Matthew Meier E.I.
Geotechnical Staff Engineer

Reviewed by,
RMG – Rocky Mountain Group

COLORADO LICENSED
DALE W. GUILLEN
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PROFESSIONAL ENGINEER

Dale W. Guillen, P.E.
Geotechnical Project Manager

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GENERAL SITE AND PROJECT DESCRIPTION

Project Description

The site is located in the northeastern corner of Douglas County, Colorado. More specifically, the site is located at 10940 Pine Drive. The approximate location of the site is shown on the Site Vicinity Map, Figure 1.

The project is to consist of fifteen townhome buildings, associated amenities, drive aisles, and parking. The proposed construction is to be two to three stories in height, and are not anticipated to include any below grade space.

Rocky Mountain Group (RMG) was retained to explore the subsurface conditions at the site and develop preliminary geotechnical engineering recommendations for design and construction. These recommendations are considered preliminary and are not intended for design or construction. Additional investigation will be required along with information regarding intended construction prior to providing design recommendations. This report does not include recommendations for detention/retention ponds, slope stability, infiltration, retaining wall design, along with recommendations not specifically included in this report.

Existing Site Conditions

The site is presently developed for residential use with auxiliary structures on the property. The existing structures have not been evaluated as part of this report. The existing site conditions are shown in Image 1 below based available from Google Earth imagery.

Image 1: Aerial Image of Existing Site Conditions (circa 2019)

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 about 20 to 35 feet below the existing ground surface. 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. An 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, 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 through 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 20 miles east of the southern Rocky Mountains, within the Colorado Piedmont section of the Great Plains Physiographic Province. The City of 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 Trimble (1979) as Loess. 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 to moderate 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, 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	S_S	0.172	F_a	1.6	S_{MS}	0.276	S_{DS}	0.184
1.0	S_1	0.057	F_v	2.4	S_{M1}	0.137	S_{D1}	0.091

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

Subsurface Materials

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

Native Soils

From the ground surface, native soils were encountered in the test borings to approximately 4.5 to 17 below the existing ground surface in test borings B-3, B-4, and B-5 and to the termination depths in test borings B-1 and B-2. The native soils were generally classified as loose to medium dense silty sand and stiff to very stiff sandy clay. The native soils were visually described as tan, dark brown, light brown, and moist.

Bedrock

In test borings B-3 through B-5, bedrock was encountered below the native soils continuing to the termination depths. The bedrock was generally classified as weathered to very hard claystone. The bedrock was visually described as blue to gray, dark brown to brown, and moist.

Groundwater

Groundwater was not encountered in the test borings at the time of drilling. 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. Recommendations stated herein assume that the site will experience mass overexcavation prior to development and that additional investigations will be performed within the building footprints for final recommendations. These recommendations are considered preliminary. RMG understands that additional investigations will be required for recommendations to be used in design or construction of individual buildings. Individual building recommendations may require additional lots to be overexcavated based on findings presented at that time. 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

Fill materials were not encountered in the test borings. However, backfill materials from the original construction may be encountered. It is recommended that the new foundations extend down through the fill materials to bear on the native soils below. 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.

The native soils and bedrock are considered low to very highly expansive. 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 0.3 to 7.0 percent when wetted against a surcharge pressure of 1,000 pounds per square foot. The swelling soils and bedrock are widespread throughout the site at different depths. The soils and bedrock 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 be overexcavated, moisture conditioned, and reused as compacted engineered fill to a depth which results in as much as 10-feet of moisture conditioned engineered 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. During investigation of individual buildings additional investigation and testing may identify increased swell in areas not currently requiring overexcavation. At that time overexcavation of identified lots may be required.

Preliminary recommendations based on the field investigation and laboratory testing, are presented below. It must be understood that these recommendations should be verified after additional investigation and also after the 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 engineered 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 undocumented fill, native soils, and bedrock. The undocumented fill and native soils will generally be excavatable with heavy-duty earth moving equipment. The excavation activities may generate oversize material (particles larger than 3 inches) that will not be suitable for use as backfill without additional processing. The excavated on-site native soils may be reused as engineered fill 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 "C" soil with a temporary slope inclination of 1-1/2H:1V. 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 undocumented fill and native soil and bedrock have low to very high swell potential and may not be suitable for direct bearing of shallow foundations or floor slabs in its present condition. We preliminarily recommend the overexcavation of native soil within the areas of overexcvation beneath foundations and floor slabs, moisture conditioning, and replacement as *Engineered Fill* to depths which result in as much as 10-feet of moisture-conditioned, compacted engineered fill. Additionally, all undocumented fill within the site should be removed and replaced as compacted

Engineered Fill pending evaluation for suitability by RMG. 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. Engineered fill should be observed and tested during placement as indicated in the following section, to ensure proper compaction.

Engineered 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 should generally be free of topsoil, organics, debris, particles greater than 3 inches in diameter, and other deleterious materials.

Moisture-conditioned structural fill 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).

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 material should be generally free of topsoil, organics, particles greater than 4-inches, debris, and other deleterious materials. Backfill 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 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 Standard Proctor's maximum dry density.

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 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 C" 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 thin loose lifts, moisture conditioned as required and compacted to 95 percent of the Standard Proctor. 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, 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

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 engineered fill may be designed for maximum allowable bearing pressures in the range of 2,000 to 2,500 psf with a minimum dead load spread footing foundation may be designed for a minimum dead load of 800 to 1,000 psf.

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. These lateral earth pressures do not apply to shoring or retaining wall design.

INTERIOR FLOOR SYSTEMS

The following sections present our 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 ‘High” 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 one to three inches is considered possible for soils/bedrock of low to high expansion potential and for engineered 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 four 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 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. 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 the structure which will have habitable or storage space located below the finished ground surface. This includes crawlspace and walkout portions of foundations, if applicable.

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.

PRELIMINARY PAVEMENT RECOMMENDATIONS

Preliminary pavement recommendations by RMG are based off the general guidelines set forth by the latest edition of the Town of Parker Roadway Design and Construction Criteria Manual. These preliminary recommendations are not intended for design or construction and are the engineer's best estimate based on available data. Actual pavement sections may be increased based on additional information.

- Composite Section — 5 inches AC over 6 inches Road Base
- Full Depth AC Section — 7 inches AC
- Full Depth Concrete — 6 inches Concrete

AC = Asphalt Concrete

The majority the onsite soils consisted of silty sands and sandy clay which classifies as A-2-6, A-6, and A-7 per the American Association of State Highway and Transportation Officials (AASHTO). **A final soil investigation and pavement recommendations will need to be performed after overlot grading has been completed and utilities have been installed in the areas of the roadways.** The following recommendations are preliminary and subject to change in the final pavement recommendation report.

The subgrade materials for the soils in the area are expansive, to reduce the swell potential, it is recommended that the subgrade soils below the pavement be moisture treated. Moisture treatment is the process of removing the soil, moisture conditioning the soil until the soil is between 1 and 4 percent over optimum, then recompacting the soil to a minimum of 95 percent of Standard Proctor density (AASHTO T 99). **The soils should be moisture treated to depths of 5-feet below the bottom of the pavement section and extend curb-to-curb or to the back-of-walk if attached to the curb or monolithic.** Lifts should be a maximum of 8-inches prior to compacting. If the laboratory swell test results of the subgrade materials have over 2% swell during the final pavement design investigation, additional swell mitigation may be needed. **A commonly accepted method by the within the area for swell mitigation is an additional 12 inches of aggregate base course that is not included in the pavement thickness sections above. This method of swell mitigation will require approval by Town of Parker prior to issuing of the**

recommendations. Additionally, if the material can not be adequately processed to mitigate potential swell lime stabilization may be required.

The exposed surface should then be proof rolled with a pneumatic-tired vehicle. Any soils which are noted to be pumping or deforming excessively under the moving wheel loads are considered to have a low support value. At least the top 8 inches of these areas should be stabilized chemically or stabilized mechanically. An alternative to subgrade stabilization is to remove and replace the material with properly compacted structural fill or road base material. Moisture/compaction tests and proof roll observations shall be performed by a representative of our office.

Pavements shall be sloped away from surrounding buildings to remove surface water. Periodic maintenance of the pavements should be performed to extend the life of the pavement.

CONCRETE

Sulfate testing was performed on selected samples based on ASTM C1580. Test results showed 0.00% by weight, indicating the soils present Class 0 (negligible) sulfate exposure. Based on these results Type I/II cement or an 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.

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 recompacted. 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.

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.

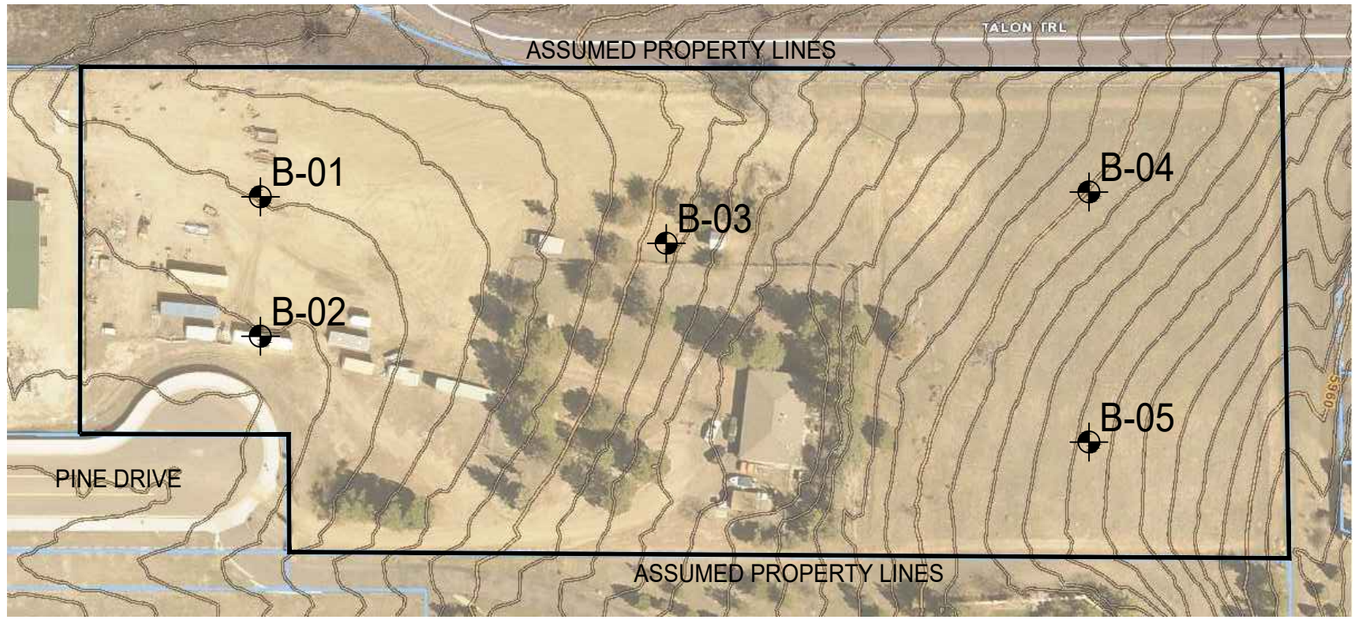
This report has been prepared for the exclusive use by **M & B Construction Services, Inc.** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are 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



TEST BORING LOCATION PLAN

NOT TO SCALE

APPROXIMATE BORING LOCATION

N
W E
S

VICINITY MAP

NOT TO SCALE

N
W E
S

ARCHITECTS RMG ENGINEERS
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TOWNHOMES AT PINE DRIVE
10940 PINE DRIVE
PARKER, COLORADO
M & B CONSTRUCTION SERVICES, INC.

ENGINEER:	DWG
DRAWN BY:	MAM
CHECKED BY:	DWG
	12.21.2020
REVISION:	DATE:

SITE VICINITY MAP AND BORING LOCATION PLAN

SHEET No.
FIG. 1

JOB No. 178236

SOILS DESCRIPTION


CLAYSTONE


SANDY CLAY


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 (%)

ROCKY MOUNTAIN GROUP

Architectural
Structural
Forensics

ARCHITECTS RMG ENGINEERS

Geotechnical
Materials Testing
Civil, Planning

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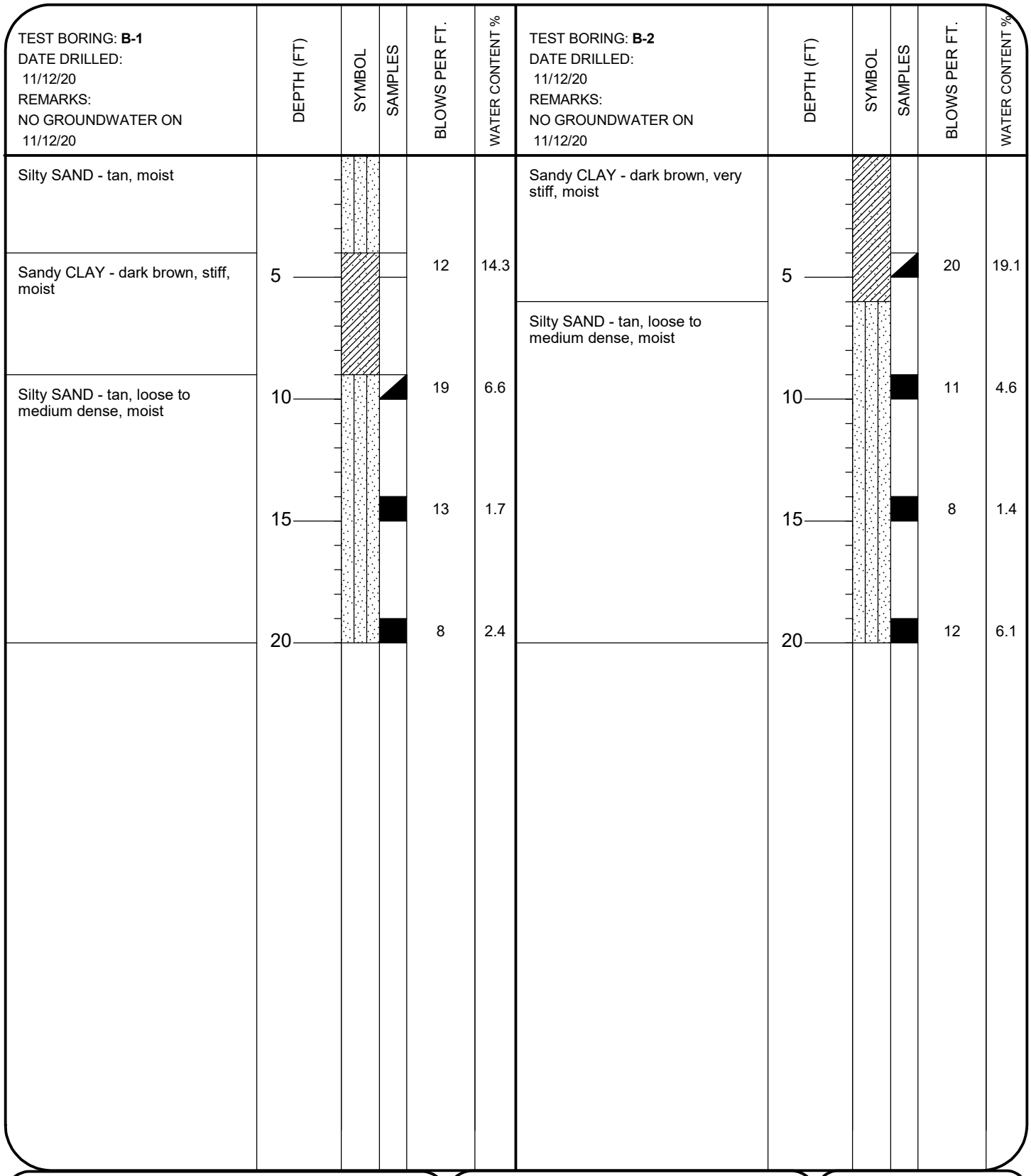
EXPLANATION OF TEST BORING LOGS

JOB No. 178236

FIGURE No. 2

DATE Dec/21/2020



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TEST BORING LOGS

JOB No. 178236

FIGURE No. 3

DATE Dec/21/2020

TEST BORING: **B-3**
DATE DRILLED:
11/12/20
REMARKS:
NO GROUNDWATER ON
11/12/20

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
	Silty SAND - tan, medium dense, moist			
5			15	4.5
	Sandy CLAY - light brown, very stiff, moist			
10			34	15.3
15			38	36.9
	CLAYSTONE - blue to gray, medium hard to very hard, moist			
20				
25			50/8"	26.9
30				
			50/4"	22.0

TEST BORING: **B-4**
DATE DRILLED:
11/12/20
REMARKS:
NO GROUNDWATER ON
11/12/20

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
	Sandy CLAY - dark brown, very stiff, moist			
5			39	14.4
	CLAYSTONE - dark brown to brown, firm to medium hard, moist			
10			34	24.0
15			50/7"	21.7
20				14.6

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TEST BORING LOGS

JOB No. 178236

FIGURE No. 4

DATE Dec/21/2020

TEST BORING: **B-5**
DATE DRILLED:
11/12/20
REMARKS:
NO GROUNDWATER ON
11/12/20

DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
Silty SAND - tan, medium dense, moist				
5			15	12.6
CLAYSTONE - dark brown, weathered to medium hard, moist				
10			27	48.3
15			44	28.2
			50/9"	26.0

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TEST BORING LOGS

JOB No. 178236

FIGURE No. 5

DATE Dec/21/2020

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load (psf)	% Swell/ Collapse	USCS Classification
B-1	4.0	14.3		42	22		65.5			CL
B-1	9.0	6.6								
B-1	14.0	1.7				17.3	7.8			
B-1	19.0	2.4								
B-2	4.0	19.1	103.7	53	31		64.8		0.3	CH
B-2	9.0	4.6								
B-2	14.0	1.4								
B-2	19.0	6.1								
B-3	4.0	4.5				0.1	19.7			
B-3	9.0	15.3	107.2						5.9	
B-3	14.0	36.9								
B-3	24.0	26.9								
B-3	34.0	22.0								
B-4	4.0	14.4	120.7				78.5		7.0	
B-4	9.0	24.0	88.2	49	30		80.0		0.5	CL
B-4	14.0	21.7								
B-4	19.0	14.6								
B-5	4.0	12.6								
B-5	9.0	48.3	63.7						0.4	
B-5	14.0	28.2								
B-5	19.0	26.0								

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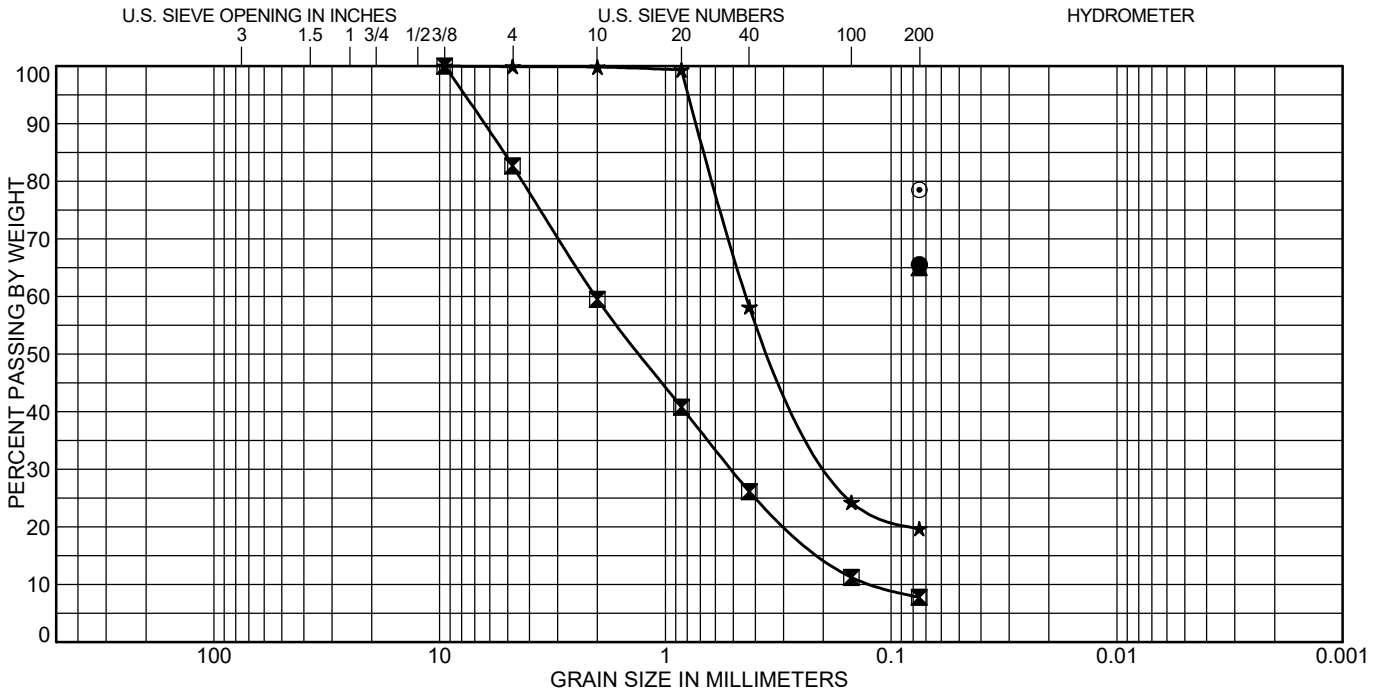
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 178236
FIGURE No. 6
PAGE 1 OF 1
DATE Dec/21/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI
●	B-1	4.0	SANDY LEAN CLAY(CL)	42	20	22
⊠	B-1	14.0				
▲	B-2	4.0	SANDY FAT CLAY(CH)	53	22	31
★	B-3	4.0				
⊙	B-4	4.0				

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	B-1	4.0			65.5	
⊠	B-1	14.0	17.3	74.9	7.8	
▲	B-2	4.0			64.8	
★	B-3	4.0	0.1	80.2	19.7	
⊙	B-4	4.0			78.5	

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SOIL CLASSIFICATION DATA

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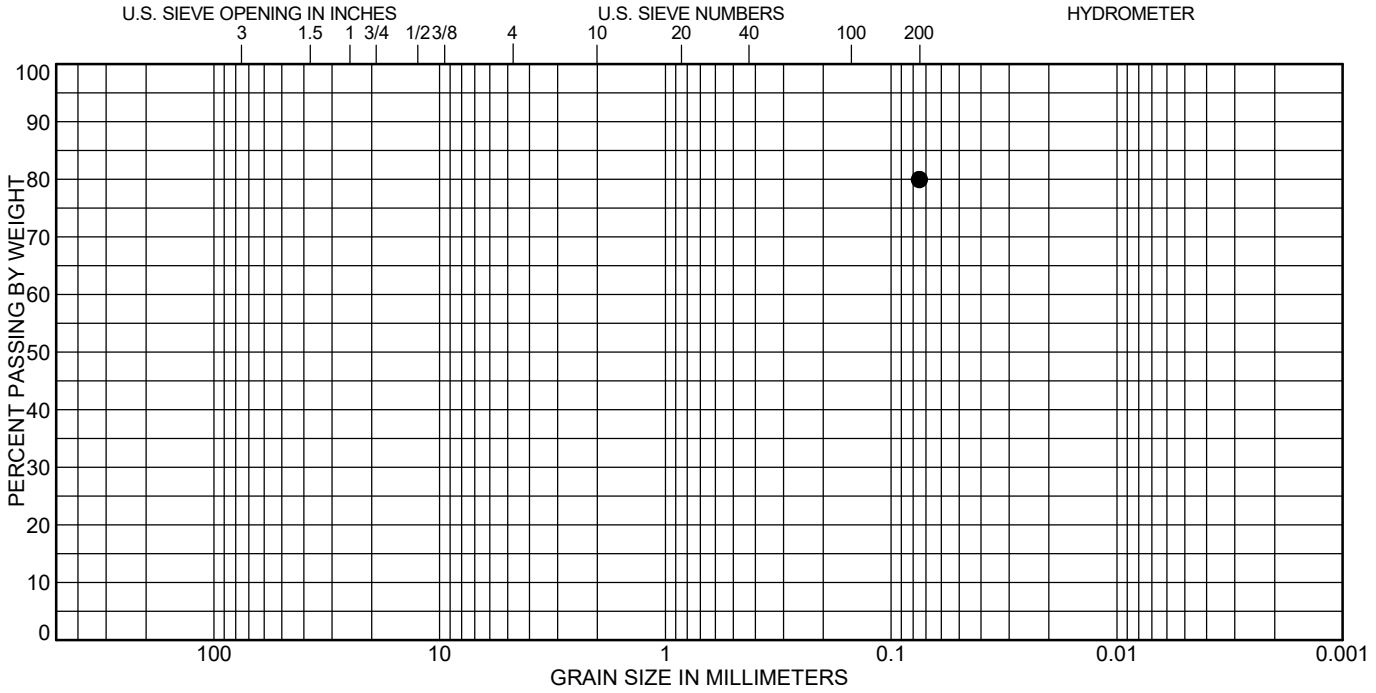
FIGURE No. 7

DATE Dec/21/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring	Depth (ft)	Classification	LL	PL	PI
● **B-4**	**9.0**	**LEAN CLAY with SAND(CL)**	**49**	**19**	**30**

Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
● **B-4**	**9.0**			**80.0**	

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SOIL CLASSIFICATION DATA

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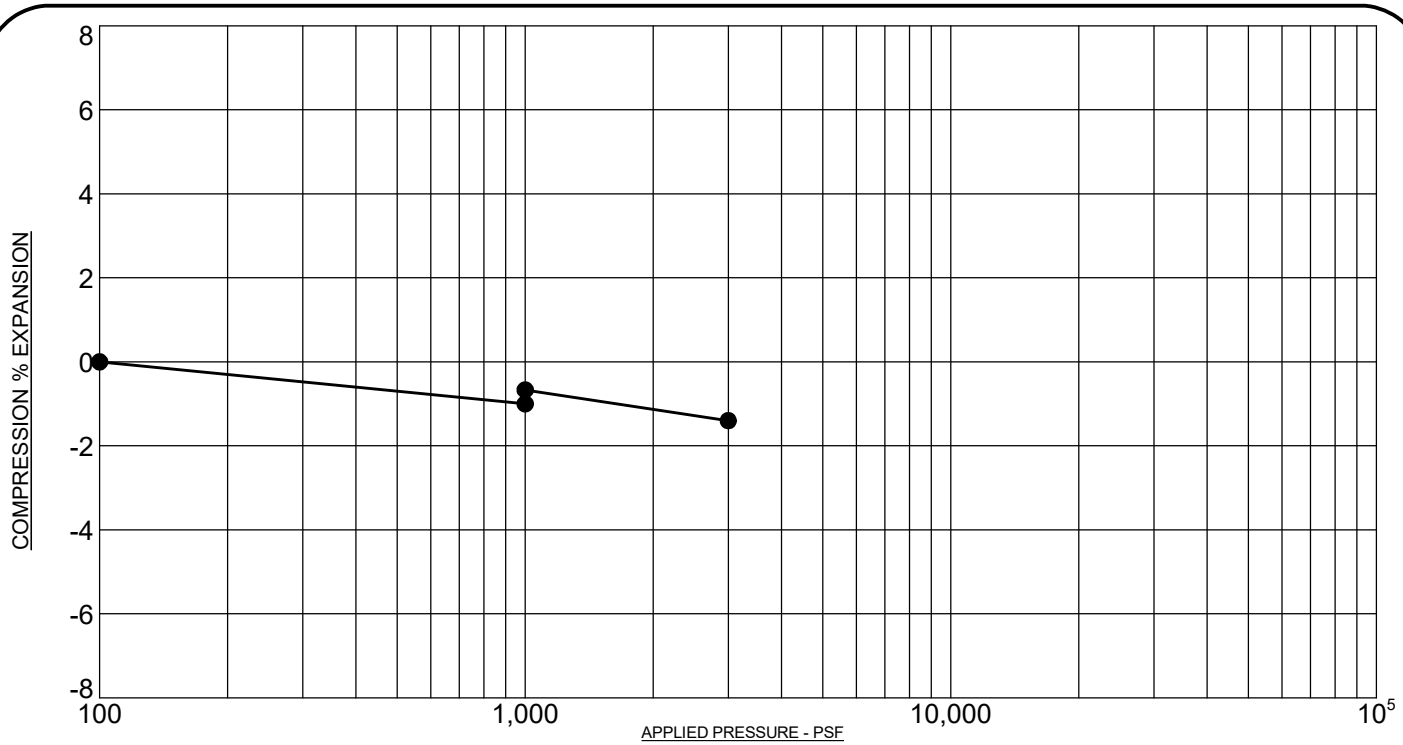
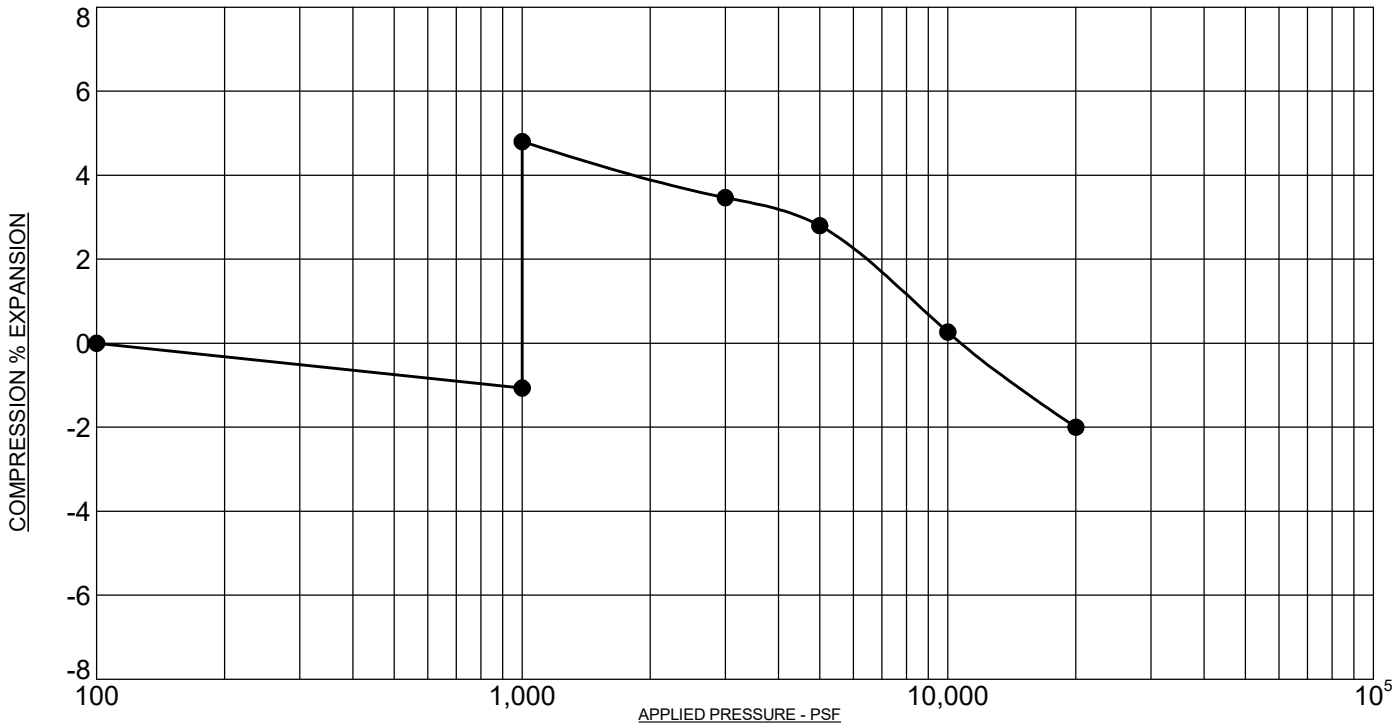
FIGURE No. 8

DATE Dec/21/2020



PROJECT: **Townhomes at Pine Drive Parker, Colorado**
SAMPLE DESCRIPTION: **Sandy Clay**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-2 @ 4 FT**
NATURAL DRY UNIT WEIGHT: **103.7 PCF**
NATURAL MOISTURE CONTENT: **19.1%**
PERCENT SWELL/COMPRESSION: **0.3**



PROJECT: **Townhomes at Pine Drive Parker, Colorado**
SAMPLE DESCRIPTION: **Sandy Clay**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-3 @ 9 FT**
NATURAL DRY UNIT WEIGHT: **107.2 PCF**
NATURAL MOISTURE CONTENT: **15.3%**
PERCENT SWELL/COMPRESSION: **5.9**

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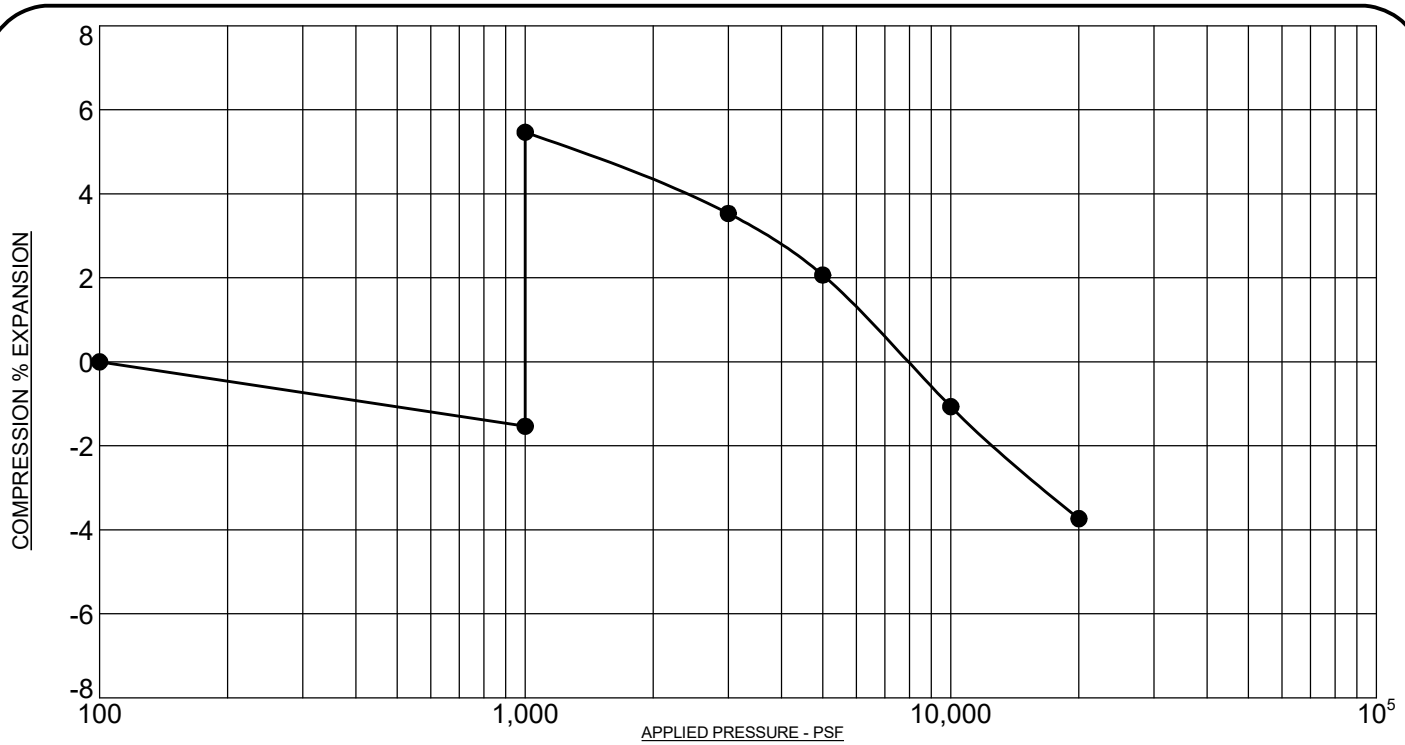
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 178236

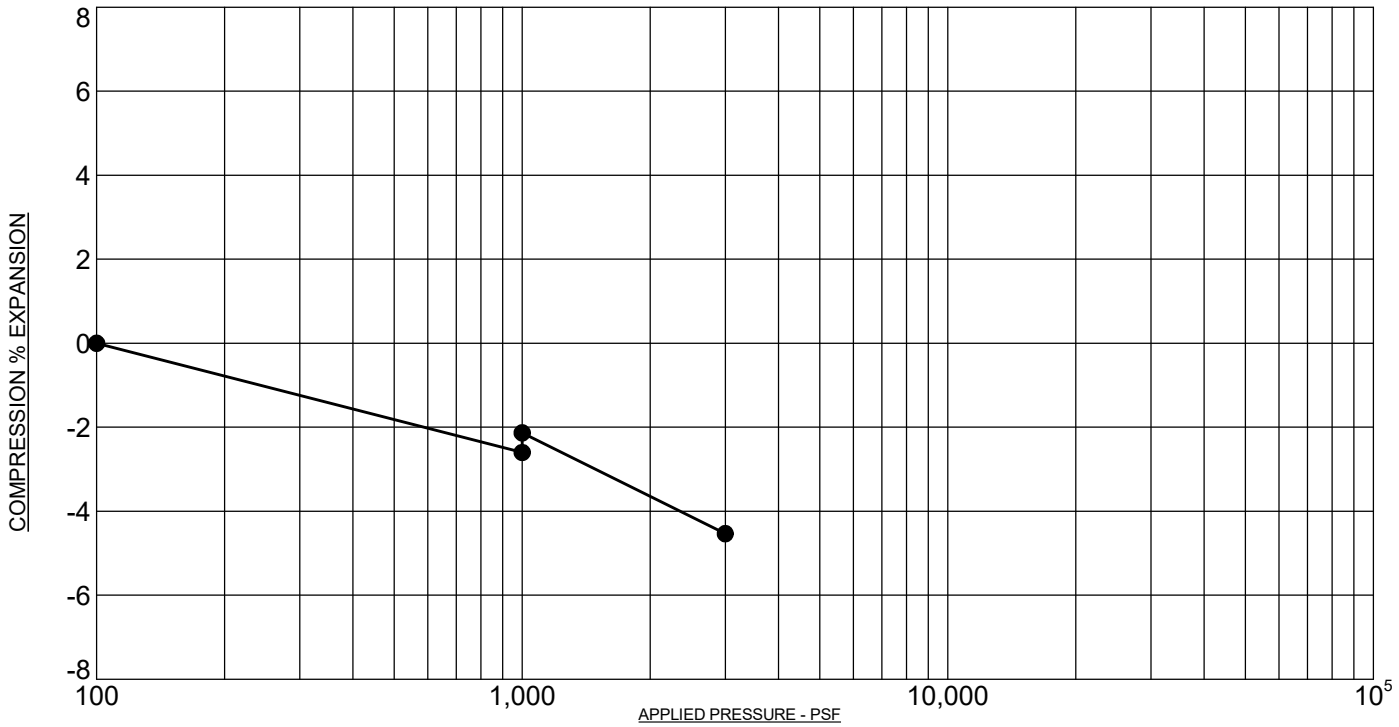
FIGURE No. 9

DATE Dec/21/2020



PROJECT: **Townhomes at Pine Drive Parker, Colorado**
SAMPLE DESCRIPTION: **Sandy Clay**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-4 @ 4 FT**
NATURAL DRY UNIT WEIGHT: **120.7 PCF**
NATURAL MOISTURE CONTENT: **14.4%**
PERCENT SWELL/COMPRESSION: **7.0**



PROJECT: **Townhomes at Pine Drive Parker, Colorado**
SAMPLE DESCRIPTION: **Claystone**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-4 @ 9 FT**
NATURAL DRY UNIT WEIGHT: **88.2 PCF**
NATURAL MOISTURE CONTENT: **24.0%**
PERCENT SWELL/COMPRESSION: **0.5**

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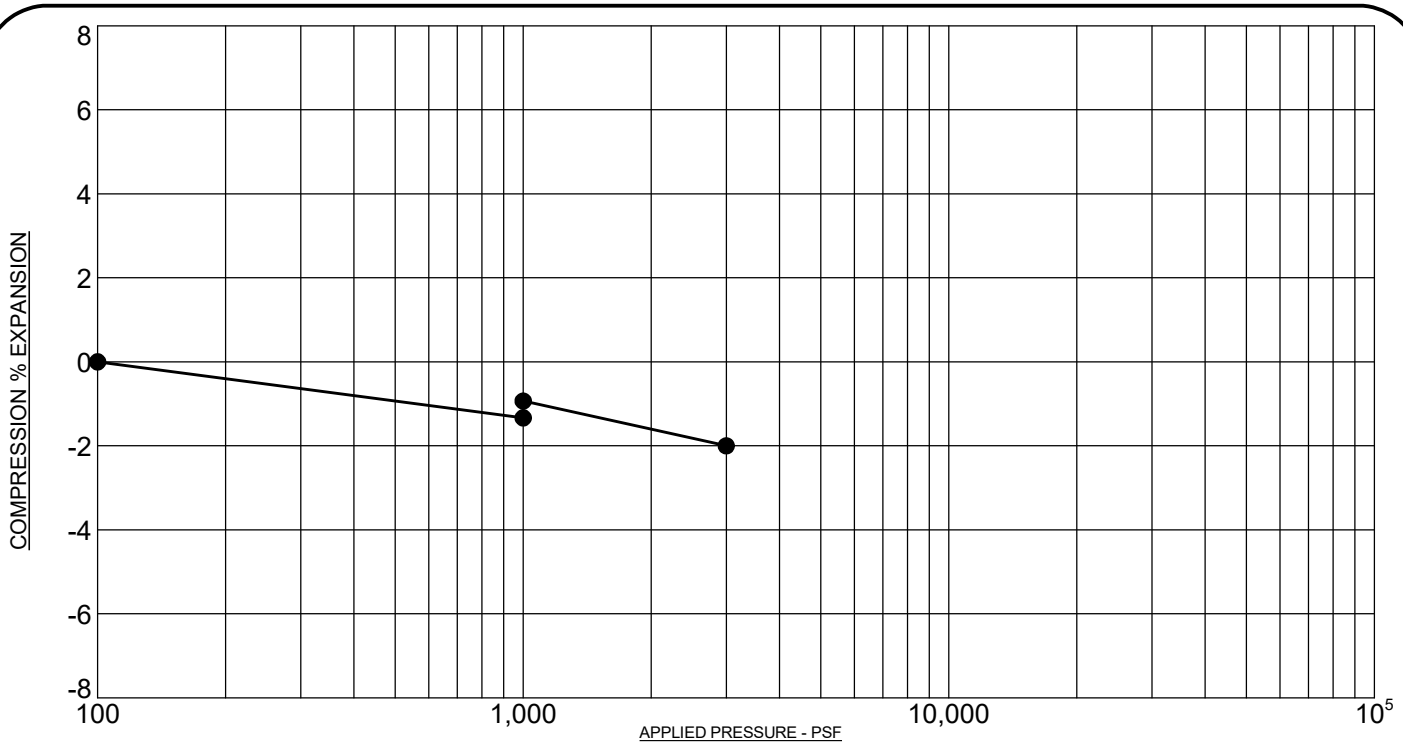
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 178236

FIGURE No. 10

DATE Dec/21/2020



PROJECT: **Townhomes at Pine Drive 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: **63.7 PCF**
NATURAL MOISTURE CONTENT: **48.3%**
PERCENT SWELL/COMPRESSION: **0.4**

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SWELL/CONSOLIDATION TEST RESULTS

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FIGURE No. 11

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