Geotechnical Investigation
US 6 Bridge over Garrison Street
Lakewood, Colorado
CDOT Project No. FBR 0063-046 (19478)
RockSol Project No. 329.02
July 3, 2014

Prepared for:

Colorado Dept. of Transportation, Region 1

DOT
DEPARTMENT OF TRANSPORTATION

Prepared by:

RockSol Consulting Group, Inc.

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ATTACHMENTS

1.0 PROJECT PURPOSE AND DESCRIPTION

This report documents the geotechnical engineering investigation performed by RockSol Consulting Group, Inc. (RockSol) to assist with the bridge replacement of the existing three-span bridge structure, identified as the US 6 over Garrison Bridge (Structure No. F-16-ER). The new bridge structure is proposed as a single-span bridge over Garrison Street that will be slightly wider and longer than the existing bridge structure to accommodate wider shoulders within US 6 and to allow for new 8 foot wide sidewalks and 4 foot wide bike lanes along northbound and southbound Garrison Street.

Proposed construction phasing will include the construction of a temporary bridge to the south of the existing bridge structure and the construction of temporary retaining wall systems at the southwest and southeast quadrants of the overpass to allow westbound traffic to shift into the existing eastbound US 6 lanes while the westbound bridge section is removed and replaced.

Based on the as built plans (*(1) Federal Aid Project No. F012-2(8), dated 1963; 2) Federal Aid Project No. U 006-6(2), dated 1972; and 3) Federal Aid Project NH 0062-011, dated 1999*) provided by CDOT for the existing bridge structures, the original eastbound bridge structure (Structure No. F-16-ER) and westbound bridge structure (Structure No. F-16-EQ) foundation systems consist of steel piles at each abutment and treated timber piles at the pier locations. Six treated timber piles, approximately 12 inches in diameter, were driven at a batter angle of 2H:12V and connected with a pile cap at each column location. A median bridge structure was then constructed in 1973 between the existing eastbound and westbound bridge structures utilizing a steel pile foundation system at each column location and at the abutments.

The scope of work for this geotechnical investigation included:

- Preparing a drilling program to perform a subsurface investigation and implementing the program to collect soil samples for laboratory testing.
- Performing laboratory tests and analyzing the data.
- Preparing a geotechnical report presenting the field and laboratory data obtained, geological hazards, global stability analyses, and geotechnical recommendations for the proposed bridge structure and retaining walls.

The subsurface investigation program was conducted to obtain information on the subsurface soil, groundwater, and bedrock conditions for the proposed bridge structure and retaining walls. Surface and groundwater hydrology, hydraulic engineering, and environmental studies including contaminant characterization were not included in RockSol's scope of work.

2.0 PROJECT SITE CONDITIONS

The project is located in southern portion of Section 3 and the northern portion of Section 10 of Township 4 South, Range 69 West. Garrison Street is located west of Wadsworth Boulevard and east of Kipling Street in Lakewood, Colorado (see Figure 1, Site Vicinity Map). The existing US 6 bridge carries three lanes of traffic in each direction over Garrison Street and is approximately 90 feet in width. US 6 is presently surfaced with flexible pavement. The existing US 6 approach embankments are approximately 20 feet in height at the bridge abutments. Concrete slope paving (approximate 2H:1V slope) is present at each abutment with embankment side slopes of approximately 3H:1V to 4H:1V. Two existing cast-in-palce (CIP) retaining wall systems are located at the northwest and southeast quadrants of the interchange. The retaining wall located in the northwest quadrant ranges in exposed height from less than 1 foot to approximately 12 feet. The retaining wall located in the southeast quadrant ranges in

exposed height from approximately 3 feet to 20 feet. Embankment slopes of approximately 3H:1V to 4H:1V are present in the northeast and southwest quadrants of the interchange.

A mix of commercial and residential development borders the project area. Topography at the site generally consists of flat to mild slopes with a general trend of decreasing elevation to the north and east. Lakewood Gulch is located approximately 1,500 feet to the north and McIntyre Gulch is located approximately 1,800 feet to the south.

3.0 SUBSURFACE EXPLORATION

In August and September 2013, RockSol drilled 13 boreholes to evaluate the subsurface conditions for the US 6 over Garrison Bridge Replacement project. The borehole locations are identified as BR-1 through BR-6, RW-1 through RW-5 and PV-1 through PV-2, as shown on Figure 2, Borehole Location Plan and Figures 2A through 2D, Engineering Geology Sheets. Boreholes BR-1 through BR-6 were drilled at the approximate location of the proposed bridge structure, Boreholes RW-1 through RW-5 were drilled to assist with retaining wall foundation recommendations, and Boreholes PV-1 and PV-2 were drilled to assist with pavement thickness recommendations. The boreholes were located by field survey provided by the project surveyor (HKS). Horizontal and vertical locations were then provided to RockSol for inclusion on the Borehole Location Plan and on the borehole logs.

Truck mounted CME-45 and CME-55 drill rigs were used for drilling and sampling. The boreholes were advanced using 4-inch outside diameter solid stem augers and 8 inch outside diameter hollow stem augers to maximum depths ranging from approximately 10 feet to 80 feet below existing grades. The boreholes were logged in the field by a representative of RockSol with the depth to groundwater noted at the time of drilling. A monitoring well was drilled and installed near Borehole BR-4 for the project environmental team (Pinyon Environmental). Except for the monitoring well, the boreholes were backfilled at the completion of drilling and groundwater level checks. Boreholes drilled within existing pavement were patched with concrete and asphalt patch mixes.

Subsurface materials were sampled and resistance of the soil to penetration of the sampler was performed using modified California barrel and standard split spoon samplers. The modified California barrel sampler has an outside diameter of approximately 2.5 inches and an inside diameter of 2 inches. The standard split spoon sampler used had an outside diameter of 2 inches and an inside diameter of 1⅜-inches. Brass tube liners were used with the modified California barrel sampler. Brass tube liners are not used with the standard split spoon sampler.

Penetration Tests were performed at selected intervals using both a standard rope-cathead lift system and an automatic lift system. Both hammer lift systems used a hammer weighing 140 pounds and falling 30 inches. The standard split spoon sampling method is the Standard Penetration Test (SPT) described by ASTM Method D-1586. Penetration Tests were performed using the modified California barrel sampler with a standard hammer weighing 140 pounds falling 30 inches per ASTM D3550. The modified California Barrel sampling method is similar to the SPT test with the difference being the sampler dimensions and the number of 6-inch intervals driven with the hammer. Correlation of blow counts obtained from a modified California sampler to blow counts obtained from a standard split spoon sampler is not available. However, it is RockSol's experience that blow counts obtained with the modified California sampler tend to be slightly greater than a standard split spoon sampler. Penetration resistance values (blow counts) were recorded for each sampling event. Blow counts, when properly evaluated, indicate the relative density or consistency of the soils.

Depths at which the samples were taken, the type of sampler used, and the blow counts that were obtained are shown on the Boring Logs for each borehole. Individual Borehole Logs are included in Appendix A. Engineering Geology Sheets for the project are included in Figures 2A through 2D.

4.0 LABORATORY TESTING

Soil samples retrieved from the borehole locations were examined by the project geotechnical engineer in the RockSol laboratory. Selected samples were tested and classified according to the Unified Soil Classification System (USCS). The following laboratory tests were performed in accordance with the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and current local practices:

- Natural Moisture Content (ASTM D-2216)
- Percent Passing No. 200 Sieve (ASTM D-1140)
- Liquid and Plastic Limits (ASTM D-4318)
- Dry Density (ASTM D-2937)
- Gradation (ASTM C-117 and C-136)
- Water Soluble Sulfate Content (CDOT CP-L 2103)
- Soil Classification (ASTM D-2487, ASTM D-2488, and AASHTO M145)
- Swell Test (ASTM D-4546)
- Water Soluble Chloride Content (AASHTO T291-91)
- Standard Test Method for pH of Soils (ASTM D4972-01)
- Soil Resistivity (ASTM G187 - Soil Box)
- Unconfined Compressive Strength Test (ASTM D2166)

Laboratory test results were used to characterize the engineering properties of the subsurface material. For soil classification, RockSol conducted sieve analyses and Atterberg Limits tests.Swell tests were used to determine the swell or consolidation characteristics of the subsurface materials. Lab testing was also performed on selected samples to determine the water soluble sulfate content of subsurface materials to assist with cement type recommendations. Laboratory test results are presented in Appendix B and are also summarized on the Borehole Logs presented in Appendix A.

5.0 SUBGRADE CHARACTERIZATION

Subsurface conditions generally consist of silty to clayey sand and sandy clay fill material within the US 6 approach embankments at Garrison Street and native soils consisting of silty to clayey sand and sandy clay overlying sedimentary bedrock. The sedimentary bedrock consisted of claystone with sandstone layers in parts. Groundwater was encountered at depths ranging from 14 feet to 37 feet below existing grades during drilling operations. Descriptions of the surface and subsurface conditions encountered in the boreholes are provided below and are also summarized on the Borehole Logs presented in Appendix A.

Roadway Pavement

Flexible pavement (asphalt) was encountered at the ground surface at eight borehole locations. Where flexible roadway pavement was encountered on US 6, the thickness generally ranged

from 6.0 inches to 9.5 inches. At Boreholes BR-1, BR-2, BR-5, PV-1, and RW-2 approximately 4.0 inches to 8.5 inches of flexible asphalt pavement was noted overlying 7.5 inches to 10.5 inches of rigid pavement. Aggregate base course material was not noted below the pavement sections. The pavement core recovered at Borehole BR-5 included a layer of asphalt pavement, 8¼ inches in thickness, over 8½ inches rigid pavement, which was over a layer of asphalt pavement approximately 3¼ inches in thickness.

Topsoil

Topsoil was encountered at the ground surface at four borehole locations. The topsoil encountered was lightly organic sandy silt which supported a sparse covering of grasses and weeds. A topsoil thickness of approximately 3 inches to 6 inches was estimated based on field observations.

Fill Material

Beneath the pavement and topsoil, subsurface conditions encountered generally consisted of fill material to approximate depths ranging from 3 feet to 24 feet below existing grades and appears to be associated with the roadway embankment for US 6 over Garrison and the entrance and exit ramps for US 6. Fill material was not noted in Borehole BR-3. The fill material encountered generally consisted of medium stiff to very stiff sandy clay with gravel in parts. In Boreholes BR-2, BR-6, PV-1, and PV-2, fill material consisting of silty to clayey sand with gravel was encountered. A 2-foot layer of concrete debris was encountered at borehole location BR-2 at an approximate elevation of 5,502 feet, near the bottom of the embankment fill material.

Based on laboratory test results, the fill material encountered predominantly classified as A-6 soils by the American Association of State Highway and Transportation Officials (AASHTO) soil classification system. A-7-6 soils were also encountered. A summary of laboratory test results with soil classifications is presented in Appendix B.

Native Soils

Native soils encountered below the fill material or ground surface consisted of loose to dense silty to clayey sand with gravel in parts and stiff to hard sandy clay extending to elevations ranging from 5,455 feet to 5,460 feet where sedimentary bedrock was encountered.

Bedrock

Sedimentary bedrock was encountered beneath the native soils in Boreholes BR-1 through BR-6 and RW-5 at elevations ranging from 5,455 feet to 5,461 feet during drilling operations. The bedrock generally consisted of very hard claystone. Very hard clayey sandstone and siltstone bedrock layers were also noted in Boreholes BR-1 through BR-6. Bedrock was not noted to the maximum depths drilled (approximately 10 feet to 50 feet) at Boreholes PV-1, PV-2 and RW-1 through RW-4.

Groundwater

Groundwater was encountered in 11 boreholes at elevations ranging from 5,479 feet to 5,493 feet (approximate depths ranging from 14 feet to 37 feet below existing grades) during drilling operations. Groundwater was not encountered to the maximum depths drilled (approximately 10 feet below existing grades) at Boreholes PV-1 and PV-2.

A summary of the bedrock and groundwater elevations encountered is presented in Table 1. The approximate groundwater and bedrock elevations are rounded to the nearest one-half foot

and are based on the depth to groundwater and bedrock noted during drilling and sampling operations and the ground surface elevations provided by the project surveyor.

Based on the groundwater elevations presented in Table 1, there appears to be a decreasing gradient predominately to the east. Based on the bedrock elevations presented in Table 1, the bedrock surface elevation appears to be decreasing in the northeast direction.

Table 1 – Approximate Groundwater and Bedrock Elevations

Borehole	Ground Elevation (feet)	Groundwater Elevation (feet)	Bedrock Elevation (feet) Note 1
BR-1	5,520.8	5,487	5,459
BR-2	5,521.3	5,486	5,458
BR-3	5,501.2	5,485	5,458
BR-4	5497.8	5,483.5	5,455
BR-5	5,520.4	5,483	5,455
BR-6	5,501.1	5,483	5,460
RW-1	5,514.0	5,493	Not Encountered
RW-2	5,518.9	5,490	Not Encountered
RW-3	5,504.8	5,491	Not Encountered
RW-4	5,516.4	5,479	Not Encountered
RW-5	5,499.5	5,479.5	5,461

Expansive Soil Discussion

Swell potential in the subgrade soils obtained within the upper 5 feet below existing and proposed pavement grades ranged from 0.0 percent (swell) to 1.8 percent (swell), when tested with a 200 pound per square foot (psf) surcharge, with the average swell less than 1 percent.

Swell potential in the subgrade soils obtained at a depth greater than 5 feet below existing and proposed grades ranged from -1.0 percent (consolidation) to 1.4 percent (swell), when tested with a 200-psf to 1,000-psf surcharge.

Based on the swell test data, the subgrade soils appear to possess a low swell potential and low consolidation potential. Based on our understanding of the proposed improvements for this project, it is RockSol's opinion that special earthwork requirements for swell mitigation is not deemed necessary for this project.

Sulfate Resistance Discussion

Cementitious material requirements for concrete in contact with site soils or groundwater are based on the percentage of water soluble sulfate in either soil or groundwater that will be in contact with concrete constructed for this project. Mix design requirements for concrete exposed to water soluble sulfates in soils or water is considered by CDOT as shown in Table 2 and in the Standard Specifications for Road and Bridge Construction, dated 2011 (CDOT Table 601-2).

Table 2
Requirements to Protect Against Damage to Concrete by Sulfate Attack from External Sources of Sulfate

Severity of sulfate exposure	Water-soluble sulfate (SO_4), in dry soil, percent	Sulfate (SO_4), in water, ppm	Water Cementitious Ratio, maximum	Cementitious Material Requirements
Class 0	0.00 to 0.10	0 to 150	0.45	Class 0
Class 1	0.11 to 0.20	151 to 1,500	0.45	Class 1
Class 2	0.21 to 2.0	1,500 to 10,000	0.45	Class 2
Class 3	2.01 or greater	10,001 or greater	0.40	Class 3

The concentration of water soluble sulfates measured in 21 soil samples obtained from RockSol's exploratory boreholes was less than 0.1 percent by weight. Based on the results of the water soluble sulfate testing, Exposure Class 0 is considered appropriate for concrete in contact with subgrade materials for the project.

Corrosion Resistance Discussion

Water soluble chloride content, pH and electrical resistivity tests were performed on bulk samples obtained from the boreholes and are summarized in Table 3. The electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-187).

Table 3 – Corrosion Resistance Summary

Borehole	Sample Depth (feet)	AASHTO Soil Classification	Water Soluble Sulfate (%)	Water Soluble Chloride (%)	pH	CR Level
BR-1	19	-	0.00	0.01	7.3	0
BR-2	1.4 - 10	A-6(6)	0.02	0.06	7.3	1
BR-3	1.9 - 14	A-6(8)	0.00	0.01	6.9	0
BR-3	39	-	0.01	-	-	0
BR-3	49	A-7-5 (26)	0.01	-	-	0
BR-4	0 - 10	A-7-6 (14)	0.02	0.01	7.6	0
BR-4	4	-	0.00	-	-	0
BR-4	49	A-7-6 (37)	0.01	-	-	0
BR-5	1.25 - 10	A-7-6 (10)	0.01	0.07	7.2	1
BR-5	10 - 20	A-7-6 (16)	0.01	0.05	7.0	0
BR-6	4	-	0.01	-	-	0
BR-6	34	-	0.02	-	-	0
PV-1	1.25 - 10	A-7-6 (8)	0.00	0.06	7.7	1
PV-2	0.75 - 5	A-6 (19)	0.00			0
RW-1	14	-	0.00	-	-	0
RW-2	1 - 5	A-6 (4)	0.01	0.05	8.0	0
RW-2	14	-	0.01	-	-	0
RW-3	0 - 10	A-7-6 (9)	0.00	0.04	7.3	0
RW-3	2	A-4 (0)	0.00	-	-	0
RW-4	24	-	0.00	-	-	0
RW-5	4	-	0.00	-	-	0

Of the three variables (water soluble sulfate, water soluble chloride, and pH) that are used in determining the CR level, the water soluble chloride content appears to be the predominant component affecting the CR level selection. The water soluble sulfate and pH components do

not appear to contribute to an elevated CR level selection. The CDOT CR levels attributed to tests performed on samples obtained from each borehole are presented in Table 3 of this report. CDOT CR levels range from CR0 to CR6 with CR0 being the lowest level. The current CDOT Pipe Materials Selection Policy can be accessed at the following link: http://www.coloradodot.info/business/designsupport/design-docs/cdot_pipe_selection_policy/view.

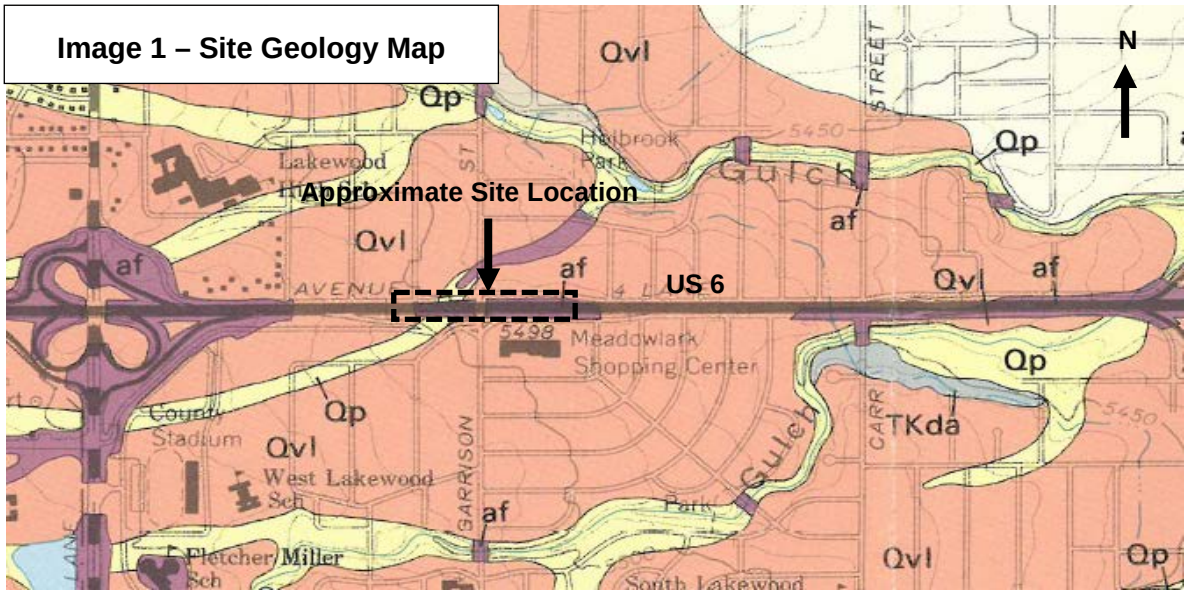
In addition, seven electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-187). Electrical resistivity testing was performed on bulk samples obtained within the upper 10 feet at borehole locations BR-2, BR-4, BR-5, PV-1, RW-2, RW-3 and was performed on bulk samples obtained within the upper 10 feet to 20 feet at Borehole BR-5. Based on the laboratory electrical resistivity test results (all seven less than 1,000 Ohm-cm), an aggressive corrosion condition for steel pipe and reinforcement bars is indicated for the project site based on criteria presented in Table 3.9 of FHWA report *FHWA0-IF-3-017, Geotechnical Engineering Circular No.7 – Soil Nail Walls*. The *Geotechnical Engineering Circular No.7 – Soil Nail Walls document* can be accessed at the following link:

http://isddc.dot.gov/OLPFiles/FHWA/016917.pdf.

6.0 GEOLOGICAL SETTING

The project site is located between two gulches, Lakewwod Gulch and McIntyre Gulch, and approximately 3 miles south of the southern limits of the geologic floodplain of Clear Creek. Based on the 1979 USGS *Geologic Map of the Greater Denver Area, Front Range Urban Corridor* by Donald E. Trimble and Michael N. Machette (see Image 1 – Site Geology Map below, modified by RockSol), the site is underlain by Verdos Alluvium (Qvl) generally consisting of boulder cobble gravel and artificial fill material (af) associated with the bridge approach embankments. Post-Piney and Piney Creek Alluvium (Qp), Loess (Ql) and Broadway Alluvium (Qb) soil deposits are mapped to the south and north of the US 6 and Garrison interchange and generally consist of sands, gravels, silts, clays, and minor amounts of cobbles and boulders deposited by existing and historic stream flows.

Image 1 – Site Geology Map



Bedrock units are not mapped within the interchange area but the Denver Formation (Tkda) is mapped at or near the surface approximately ½ mile to the east. Based on information

presented in the USGS geologic map and information obtained in the RockSol boreholes drilled for this investigation, the sedimentary bedrock encountered in the boreholes appear to be consistant with the Denver Formation. The Denver Formation generally consists of claystone, sandstone, siltstone, and conglomerate.

7.0 SEISMICITY DISCUSSION

RockSol boreholes terminated at depths less than 100 feet below the ground surface and shear wave velocity testing was not performed. Based on the subsurface conditions encountered and using the Method B procedure of AASHTO Table C3.10.3.1-1, it is RockSol's opinion that AASHTO Seismic Site Class D is appropriate for design of the US6 Bridge over Garrison Street structure. Soil conditions necessary for Site Class E and F were not encountered by RockSol. Shear wave velocity testing would be necessary to determine if Site Class C conditions, or higher, are present. Seismic design parameters for Seismic Site Class D are discussed below.

Seismic design parameters were obtained from the 2007 United States Geological Survey (USGS) Seismic Design Parameters CD (Version 2.10) using the AASHTO Earthquake Motion Parameters Program. The values provided are for a 7 percent probability of exceedance in 75 years. Interpolated values for Peak Ground Acceleration Coefficient (PGA), Spectral Acceleration Coefficient at Period 0.2 sec (S_s), and Spectral Acceleration Coefficient at Period 1.0 sec (S_1) were obtained using the latitude and longitude for the bridge structure.

The seismic acceleration coefficients obtained (data based on 0.05 degree grid spacing) are presented in Table 4.

Table 4 – Seismic Acceleration Coefficients

Location (Latitude°/Longitude°)	Peak Ground Acceleration (PGA)	Spectral Acceleration Coefficient - S_s (Period 0.2 sec)	Spectral Acceleration Coefficient - S_1 (Period 1.0 sec)
US6 Bridge over Garrison Street (39.725486°/-105.100224°)	0.061	0.130	0.034

The acceleration coefficients are then used to obtain Site Factors F_{pga}, F_a, and F_v based on the defined Site Class as shown in Tables 3.10.3.2-1, 3.10.3.2-2, and 3.10.3.2-3 of the *AASHTO LRFD*. A summary of the Site Factor values are shown in Table 5.

Table 5 – Seismic Site Factor Values

Bridge Location	F_{pga} (at zero-period on acceleration spectrum)	F_a (for short period range of acceleration spectrum)	F_v (for long period range of acceleration spectrum)
US6 Bridge over Garrison Street	1.60	1.60	2.40

Seismic Performance Zone determination is based on the value of the Acceleration Coefficient, S_{D1}, as determined by *Eq. 3.10.4.2-6* of the *AASHTO LRFD* ($S_{D1} = F_v \times S_1$).

Table 6 outlines the Seismic Zone determination and Acceleration Coefficient obtained for the proposed US 6 bridge structure over Garrison Street.

Table 6 – Seismic Performance Zone

Bridge Location	Acceleration Coefficient (S_{D1})	Seismic Zone (1)
US6 Bridge over Garrison Street	0.083	1

Note (1): Seismic Zone 1 is assigned when $S_{D1} \leq 0.15$.

8.0 BRIDGE FOUNDATION RECOMMENDATIONS

Based on the subsurface conditions encountered and the type of structure proposed, drilled shafts and driven piles are viable foundation options for the new US 6 over Garrison Bridge Structure and the temporary bridge structure. Preliminary geotechnical design parameters for the drilled shaft and driven pile foundation systems are presented in Sections 8.1 and 8.2.

8.1 Drilled Shafts Alternative

Drilled shafts will provide support by embedment into sedimentary bedrock. Based on the subsurface conditions encountered in RockSol's geotechnical investigation, it is anticipated that claystone bedrock will be the predominant type of bedrock encountered. It is also anticipated that sandstone bedrock will be encountered. For axial bearing, a minimum shaft penetration into competent bedrock of 10 feet is recommended for drilled shafts less than 5 feet in diameter. For drilled shafts 5 feet and greater in diameter, a minimum penetration into competent bedrock of 15 feet is recommended. If needed, the embedment length may be increased to provide additional resistance to lateral loads and to provide additional axial capacity. The minimum embedment criteria is provided to extend the shaft beyond the zone of weathering typically encountered at the surface of the sedimentary bedrock.

Drilled shaft diameters shall be sufficient to satisfy axial, bending, and lateral load resistance requirements. In addition, the shaft diameters shall be sufficient to allow for use of casing, if required, and placement of reinforcement with adequate concrete cover.

Based on our evaluation, recommended nominal (unfactored) base resistance and nominal (unfactored) side resistance values for the bedrock material are presented in Table 7 for use with Load and Resistance Factor Design (LRFD) methods.

Table 7 - Base and Side Resistance Values for Drilled Shafts
US 6 over Garrison Street

Location	Estimated Competent Bedrock Elevation (feet)	Nominal Resistance (unfactored)		Allowable Capacity (ASD) (Note 1)	
		Base Resistance (ksf)	Side Resistance (ksf)	Bearing Resistance (ksf)	Side Resistance (ksf)
West Abutment	5,459 (North End) to 5,458 (South End)	92	7.5	40	3.0
East Abutment	5,455 (North End) to 5,460 (South End)				

Due to the depth to bedrock at this bridge location, the side resistance is applicable to the entire portion of the shaft embedded in competent bedrock. Side resistance in the soil zone above competent bedrock should be neglected.

For LRFD strength limit state evaluation, a resistance factor of 0.50 is recommended for base/ tip resistance and a resistance factor of 0.50 is recommended for side resistance evaluation for redundant single shafts. For evaluation of uplift, a resistance factor of 0.35 is recommended for single shafts and 0.45 for multiple shafts acting as a group. Per AASHTO LRFD Bridge Design specifications (Sixth Edition) Section 10.5.5.2.4, the resistance factors for base/tip and side resistance should be reduced by 20 percent when applied to a single shaft supporting a bridge pier. Where the resistance factor is decreased in this manner, the redundancy factor (η_R) provided in AASHTO Article 1.3.4 should be 1.0.

Additional design and construction considerations are listed below.

(a) The construction of drilled shafts should follow the guidelines specified in the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 503, 2011," and subsequent revisions. CDOT uses the FHWA document "Drilled Shafts: Construction Procedures and LRFD Design Methods, FHWA-NHI-10-016, May 2010" as a basis for their specifications.

(b) During construction of the drilled shafts, casing or slurry will be required to support the excavation where groundwater exists and or where holes are unstable due to soil conditions. During drilling operations, groundwater was encountered at approximate elevations ranging from 5,483 feet to 5,486 feet, approximately 23 feet to 28 feet above the bedrock material. Caving conditions are anticipated in the native soils encountered at and below groundwater. Caving is not anticipated in the bedrock material. If casing is used for the "dry method" placement, water pressure may result in seepage of water around the bottom of the casing resulting in erosion of the bedrock materials. "Wet condition" placement is anticipated to be required for drilled shafts due to the length of the casing anticipated. If casing is used and is set into the bedrock material, the minimum embedment/penetration depth into bedrock should initiate from the bottom of the casing. Due to the presence of groundwater and soils anticipated to cave, cross-hole sonic logging (CSL) during construction is recommended for all drilled shafts. Where groundwater exists and or where holes are unstable due to soil conditions, CSL should be performed on the caissons to insure construction quality.

(c) Prior to the placement of the concrete, the drilled shaft excavation, including the bottom should be cleaned of all loose material. For wet conditions (more than two inches of water), concrete placement by "tremie" methods should be used.

(d) Lateral load capacity of the drilled shafts should be evaluated. Geotechnical parameters for evaluation of lateral load capacity are provided in Tables 8D and 9D.

(e) All piers should be reinforced as required for resistance to axial, bending, lateral and uplift stresses.

(f) Drilled shafts should be constructed at least four shaft diameters center to center. For closely spaced drilled shafts, the axial and lateral capacities should be appropriately reduced. Group action of drilled shafts should be analyzed on an individual basis to assess the appropriate reduction.

8.2 Driven Piles Alternative

Alternatively, the US 6 over Garrison Street structure, including the abutments, may be supported on driven steel H-piles (Grade 50 steel, or better required). RockSol recommends the piles be driven to practical refusal in the bedrock. Based on the subsurface conditions

encountered in our boreholes, practical refusal is estimated to occur within 5 feet of penetration into bedrock.

For the LRFD method, a nominal (ultimate) geotechnical capacity (combined skin and end bearing) of 36 kips per square inch multiplied by the steel cross section area (expressed in square inches) of the pile, can be used. A resistance factor of 0.65 is recommended for LRFD strength limit state design for axial compression when monitoring is performed on at least one pile per abutment using a Pile Driving Analyzer (PDA). During construction, pile driving shall be monitored per CDOT requirements per Section 502 of the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), 2011". Monitoring shall be conducted using a PDA to determine the condition of the pile, the efficiency of the hammer and the static bearing capacity of the pile, and to establish the pile driving criteria.

Additional design and construction considerations for driven piles are presented below.

(a) Steel piling, pile driving equipment, and installation of the driven steel H-piles should follow the guidelines specified in "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 502, 2011".

(b) Lateral load parameters presented in Tables 8D and 9D may be used for lateral load analysis. Battered piles may be used to resist the lateral loads. The battered piles inclination should be within one (1) horizontal to four (4) vertical.

(c) RockSol anticipates that up to 5 feet of pile penetration into bedrock will be required to meet refusal criteria. The actual length of the piles should be determined during installation.

(d) Center to center pile spacing should not be less than 30 inches or 2.5 pile diameters. For evaluation of horizontal pile foundation movement, the effects of group interaction shall be evaluated in accordance with AASHTO LRFD Bridge Design Specifications, Section 10.7.2.4.

(e) Predrilling is not anticipated by RockSol based on the conditions encountered in our boreholes. If significant penetration (greater than 5 feet) into bedrock is necessary for lateral resistance requirements, pre-drilling may be required. Pile tips should be protected against damage using driving shoes during penetration into the sedimentary bedrock. Concrete debris was noted during drilling operations in Borehole BR-2 at an approximate elevation of 5,502 feet (19 feet below existing grade).

(f) Potential damage to the property or adjacent structures during pile installation due to noise and vibrations should be evaluated.

Idealized Profile – West Abutment - US 6 Bridge over Garrison Street

Based on subsurface conditions encountered, RockSol has prepared idealized profiles for the west and east abutments generally consisting of cohesive soil over cohesionless soil over claystone bedrock. The claystone bedrock can be considered as cohesive soil, not rock. The idealized soil profiles and the associated soil parameters are intended for use with FB-Multipier and L-Pile.

Idealized profiles are presented in Tables 8A through 8C and Tables 9A through 9C for the west and east abutments at the north side, mid-line, and south side of the abutment alignments. Soil parameters for the idealized profiles are presented in Tables 8D and 9D. Tables 8 and 9 were developed by RockSol based on conditions noted in Boreholes BR-1 through BR-6.

Table 8A - US 6 over Garrison Street
Idealized Profile - Abutment 1 (West Abutment) at North Side
Groundwater Elevation: 5,487 feet

Elevation (feet)	Material Type	Idealized Soil Layer Number
5,520 to 5,484	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Above Water Table)	1
5,484 to 5,459	cohesionless – Sand, medium dense (O'Neill's Sand)	2
Below 5,459	cohesive - CLAYSTONE, hard to very hard (Reese and Welch's Stiff Clay Above Water Table)	3

Table 8B - US 6 over Garrison Street
Idealized Profile - Abutment 1 (West Abutment) at Mid-Line
Groundwater Elevation: 5,486 feet

Elevation (feet)	Material Type	Idealized Soil Layer Number
5,519 to 5,486	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Above Water Table)	1
5,486 to 5,458	cohesionless – Sand, medium dense (O'Neill's Sand)	2
Below 5,458	cohesive - CLAYSTONE, hard to very hard (Reese and Welch's Stiff Clay Above Water Table)	3

Table 8C - US 6 over Garrison Street
Idealized Profile - Abutment 1 (West Abutment) at South Side
Groundwater Elevation: 5,485 feet

Elevation (feet)	Material Type	Idealized Soil Layer Number
5,501 to 5,485	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Above Water Table)	1
5,485 to 5,464	cohesionless – Sand, medium dense (O'Neill's Sand)	2
5,464 to 5,458	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Above Water Table)	1
Below 5,458	cohesive - CLAYSTONE, hard to very hard (Reese and Welch's Stiff Clay Above Water Table)	3

Table 8D - US 6 over Garrison Street
Idealized Profile Soil Parameters - Abutment 1 (West Abutment)

Soil Property	Idealized Soil Layer Number		
	1	2	3
Total Unit Weight, pcf	120	125	125
Undrained Shear Strength, psf	1,500	-	5,000
Strain, e_{50} (%)	0.010	-	0.005
Subgrade Modulus, pci (above water table)	500	100	1,000
Subgrade Modulus, pci (below water table)	-	60	-
Poisson's Ratio	0.40	0.30	0.25
Elastic Modulus, psi	7,000	-	25,000
Shear Modulus, ksi	2.5	0.40	10
Young's Modulus, psf	-	150,000	-
Angle of Internal Friction, degree's	-	32	-

Table 9A - US 6 over Garrison Street
Idealized Profile - Abutment 2 (East Abutment) at North Side
Groundwater Elevation: 5,483.5 feet

Elevation (feet)	Material Type	Idealized Soil Layer Number
5,498 to 5,484	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Above Water Table)	1
5,484 to 5,480	cohesionless – Sand, medium dense (O'Neill's Sand)	2
5,480 to 5,469	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay below Water Table)	1
5,469 to 5,455	cohesionless – Sand, medium dense (O'Neill's Sand)	2
Below 5,455	cohesive - CLAYSTONE, hard to very hard (Reese and Welch's Stiff Clay Above Water Table)	3

Table 9B - US 6 over Garrison Street
Idealized Profile - Abutment 2 (East Abutment) at Mid-Line
Groundwater Elevation: 5,483 feet

Elevation (feet)	Material Type	Idealized Soil Layer Number
5,519 to 5,482	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Above Water Table)	1
5,482 to 5,455	cohesionless – Sand, medium dense (O'Neill's Sand)	2
Below 5,455	cohesive – CLAYSTONE and clayey SANDSTONE, hard to very hard (Reese and Welch's Stiff Clay Above Water Table)	3

Table 9C - US 6 over Garrison Street
Idealized Profile - Abutment 2 (East Abutment) at South Side
Groundwater Elevation: 5,483 feet

Elevation (feet)	Material Type	Idealized Soil Layer Number
5,501 to 5,496	cohesionless – Sand, medium dense (O'Neill's Sand)	2
5,496 to 5,486	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Above Water Table)	1
5,486 to 5,460	cohesive – CLAY, stiff (Reese and Welch's Stiff Clay Below Water Table)	1
Below 5,460	cohesive – CLAYSTONE and clayey SANDSTONE, hard to very hard (Reese and Welch's Stiff Clay Above Water Table)	3

Table 9D - US 6 over Garrison Street
Idealized Profile Soil Parameters - Abutment 2 (East Abutment)

Soil Property	Idealized Soil Layer Number		
	1	2	3
Total Unit Weight, pcf	120	125	125
Undrained Shear Strength, psf	1,500	-	5,000
Strain, e_{50} (%)	0.010	-	0.005
Subgrade Modulus, pci (above water table)	500	100	1,000
Subgrade Modulus, pci (below water table)	52	60	-
Poisson's Ratio	0.40	0.30	0.25
Elastic Modulus, psi	7,000	-	25,000
Shear Modulus, ksi	2.5	0.40	10
Young's Modulus, psf	-	150,000	-
Angle of Internal Friction, degree's	-	32	-

9.0 EMBANKMENT AND SITE GRADING

Where fill material is to be placed on existing slopes steeper than 4 (H):1 (V), benching must be performed to tie the new fill into the existing slope per 2011 CDOT Standard Specifications for Road and Bridge Construction (CSSRBC), Section 203. Benching into the existing slopes shall allow sufficient bench width to accommodate placing and compaction equipment to operate in a horizontal orientation.

9.1 Material Specifications

The following material specifications are presented for earthwork on the project.

1. Soil Embankment: As stated in the 2011 CSSRBC, Section 203.03, material shall be soil predominately of materials smaller than No. 4 sieve in diameter, with a maximum particle size of less than 6 inches in diameter recommended. Soil embankment shall be constructed with moisture and density control. It is anticipated that material

excavated from the proposed cut slopes may be reused as embankment material; however, additional testing will need to be performed to confirm Project specifications.

2. Retaining Wall Backfill: Shall consist of granular material meeting CDOT Structure Backfill (Class 1) requirements presented in the 2011 CSSRBC Section 703.08 or CDOT Class 6 Aggregate Base Course presented in Section 703.03 of the 2011 CSSRBC.

3. Unsuitable Material: Vegetation, brush, sod, trash, and other deleterious substances shall not be placed in embankment, excavation backfill, or structural backfill.

9.2 Compaction Specifications

Compaction of fill materials should be achieved near optimum moisture content. A representative of the geotechnical engineer should observe and test fill placement operations. The minimum compaction recommended for specific applications is presented in Table 10.

Table 10 –Compaction Specifications

AASHTO Classification	Minimum Relative Compaction (Percentage of MDD), %	Moisture Content (Deviation from OMC)
A-1, A-2-4, A-2-5, A-3,	95% of AASHTO T180	-2 to +2
A-2-6, A-2-7, A-4, A-5, A-6 and A-7	95% of AASHTO T99	-2 to +2

9.3 Subgrade Preparation

Prior to construction of foundations and embankments the underlying subgrade should be properly prepared by removal of all organic matter (topsoil), debris, loose material, and any deleterious material identified by the Project Engineer followed by scarification, moisture conditioning and recompaction. Unless otherwise specified, the minimum depth of scarification, moisture conditioning and re-compaction in all cases shall be 6 inches and compacting to a minimum of 95 percent of maximum dry density (MDD) as determined by AASHTO T99 (standard proctor) and moisture conditioned to within 2 percent of Optimum Moisture Content (OMC). Cobbles greater than 6 inches in diameter, if encountered, should be removed from the scarification zone.

10.0 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

Proper construction practices, in accordance with CDOT Standard Specifications for Road and Bridge Construction, should be followed during site preparation, earthwork, excavations, and embankment and retaining wall construction for the suitable long term performance of the proposed improvements. Excavation support should be provided to maintain onsite safety and the stability of excavations and slopes. Excavations shall be constructed in accordance with local, state and federal regulations including OSHA guidelines. The contractor must provide a competent person to determine compliance with OSHA excavation requirements. For preliminary planning, existing fill material and native soils may be considered as OSHA Type C soils.

The actual subsurface conditions between boring locations may vary from the information obtained at specific boring locations and described in this report.

Surface drainage patterns may be altered during construction and surface drainage must be controlled to prevent excessive moisture infiltration into the subgrade soils at all retaining wall locations during and after construction. Concrete paved surface drainage swales are recommended at the top of all retaining walls and slopes to catch and transport surface drainage away from the walls and slopes.

Environmentally contaminated material, if encountered, should be characterized and removed under the direction of the project environmental consultant. Design and construction plans should be reviewed and onsite construction should be observed by the professional engineers.

11.0 LIMITATIONS

This geotechnical field investigation was conducted in general accordance with the scope of work. The geotechnical practices are similar to that used in the Colorado Front Range area with similar soil conditions and our understanding of the proposed work. This report has been prepared by RockSol for use by the Colorado Department of Transportation exclusively for the project described in this report. The report is based on our exploratory boreholes and does not take into account variations in the subsurface conditions that may exist between boreholes. Additional investigation is required to address such variation. If during construction activities, materials or water conditions appear to be different from those described herein, RockSol should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. RockSol is not responsible for liability associated with interpretation of subsurface data by others.

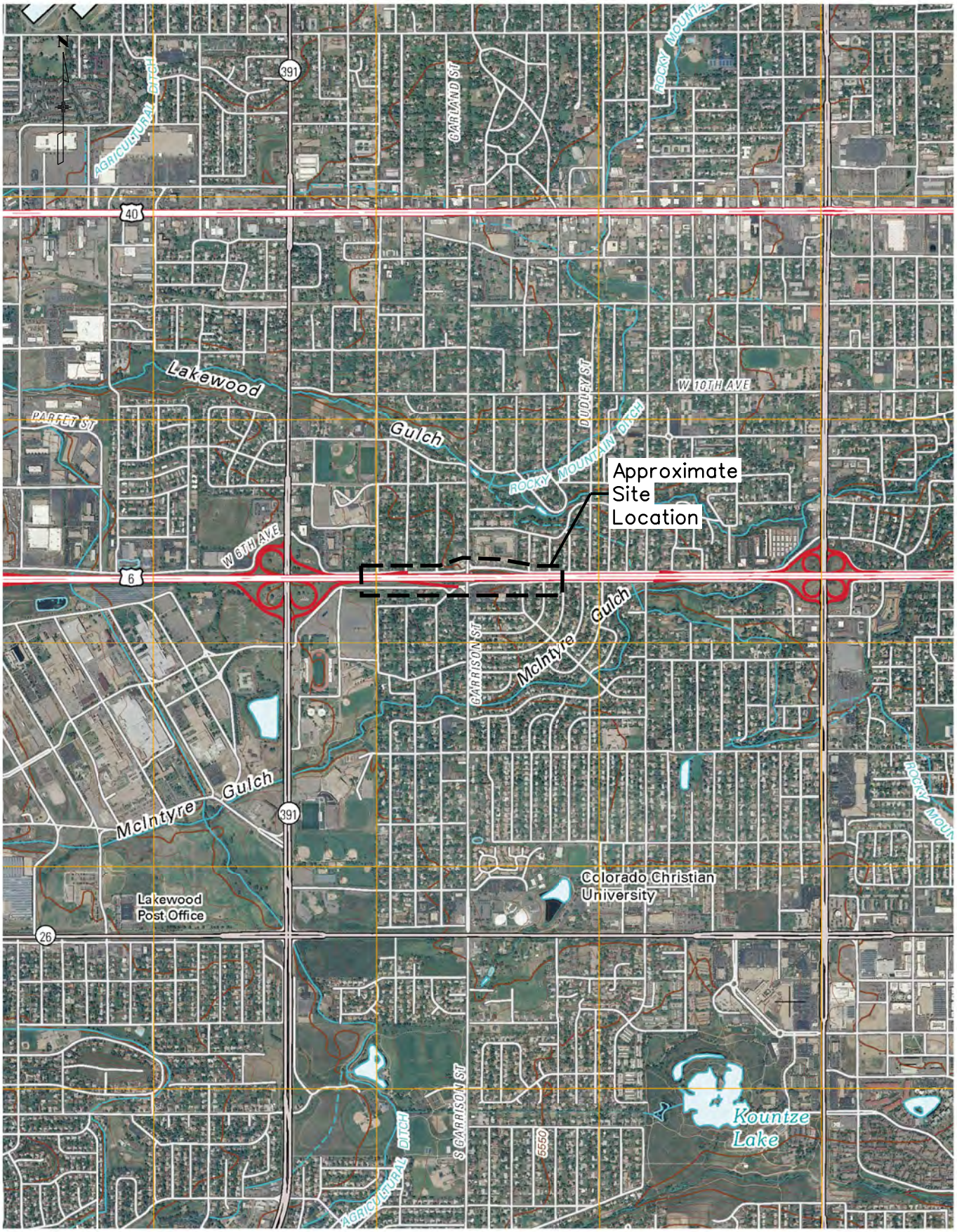


IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY, JUNE 2009, FORT LOGAN, COLORADO QUADRANGLE, 2011

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		Figure 1

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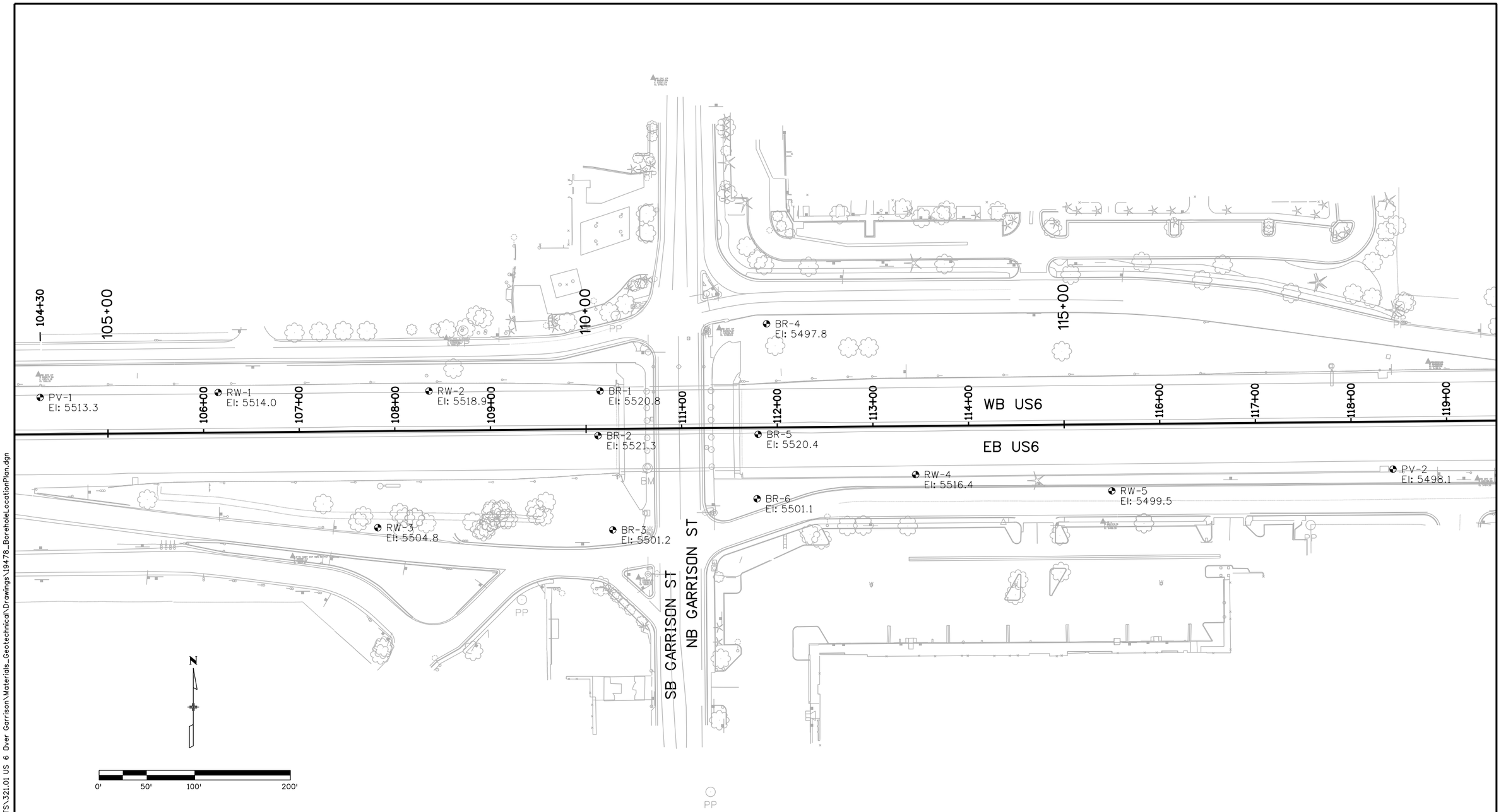

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RockSol Project No. 321.01	Unit Leader _		

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Sheet Revisions		
Date:	Comments	Init.

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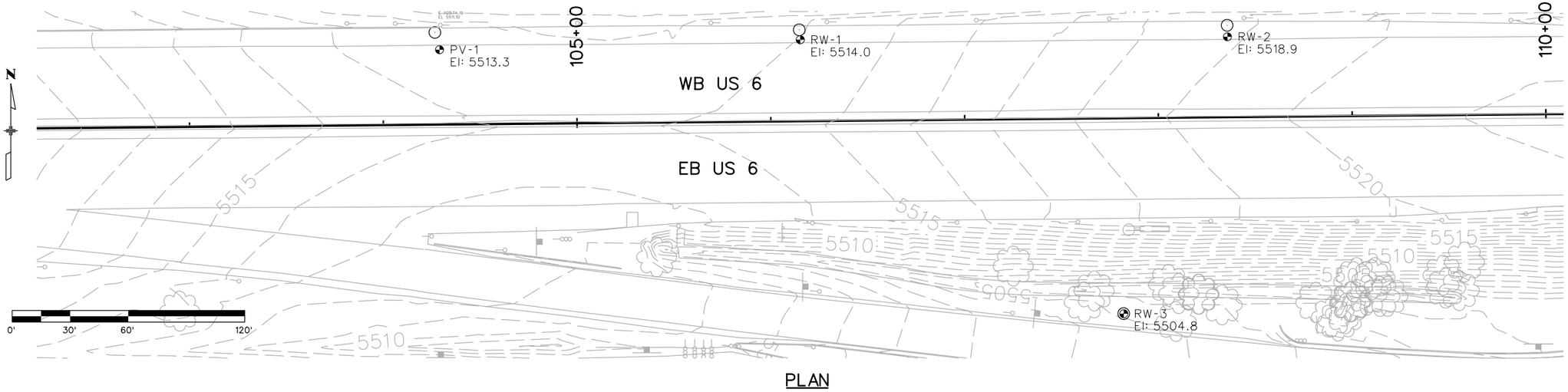
As Constructed
No Revisions:
Revised:
Void:

US 6 OVER GARRISON STREET
BOREHOLE LOCATION PLAN

Designer: R. LEPRO
Detailer: S. MCKANNA-KOON
Sheet Subset:
Structure Numbers
Subset Sheets: of

Project No./Code
19478
Figure 2

WORK IN PROGRESS



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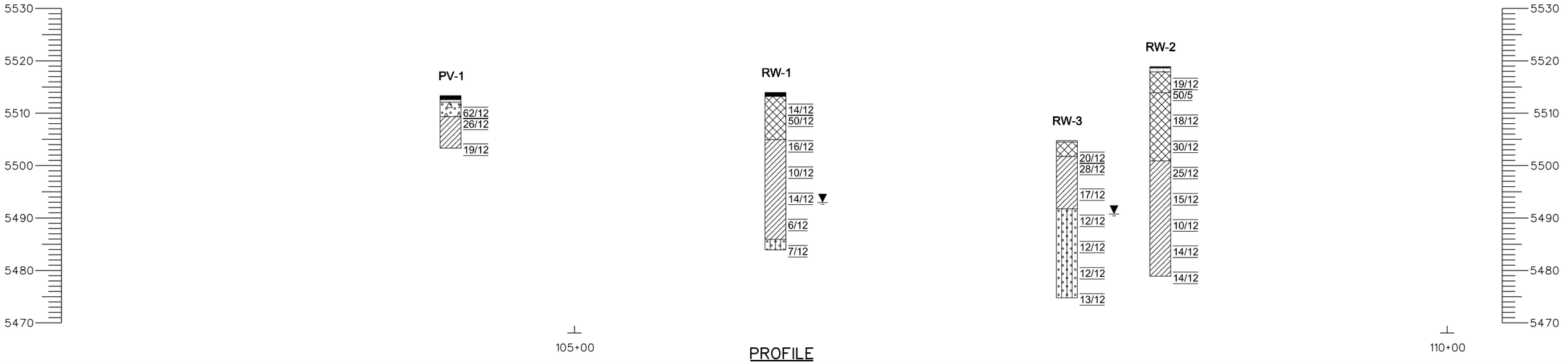


PROFILE

SUMMARY OF TEST RESULTS

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
PV-1	1,25-10	46	24	48	SC	A-7-6 (8)			0,00
PV-1	2						6,0	119,9	
PV-1	4						22,4	99,5	
PV-1	9						30,1	89,5	
RW-1	2						20,6	106,2	
RW-1	4						3,0	138,1	
RW-1	9						25,4	97,7	
RW-1	14						26,0	96,5	0,00
RW-1	19						29,1	92,3	
RW-1	24						37,4	85,1	
RW-1	29						30,2	90,3	
RW-2	1-5	38	18	44	SC	A-6 (4)			0,01
RW-2	2						18,6	108,9	
RW-2	4						17,3	110,7	
RW-2	9	31	16	30	SC	A-2-6 (1)	11,4	111,6	
RW-2	14						14,5	111,9	0,01
RW-2	19	47	27	76	CL	A-7-6 (20)	20,4	105,4	
RW-2	24						17,9	105,4	
RW-2	29						22,9	103,2	
RW-2	39						24,6	99,7	
RW-3	0-10	43	23	54	CL	A-7-6 (9)			0.00
RW-3	2	NP	NP	47	SM	A-4 (0)	10,1	117,8	0,00
RW-3	4						19,7	108,8	
RW-3	9						18,7	107,2	
RW-3	14	40	17	38	SC	A-6 (2)	25,9	97,7	
RW-3	19						27,3	97,2	
RW-3	24						30,7	96,0	

TYPE OF MATERIAL

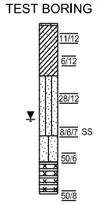
LITHOLOGY

- Asphalt Pavement
- Fill - CLAY
- Native - TOPSOIL
- Native - SAND, gravelly
- Native - CLAY
- Native - SILT, sandy
- Bedrock - Interbedded SILTSTONE/CLAYSTONE
- Concrete
- Fill - SAND
- Native - SAND, silty
- Native - SAND, clayey
- Native - CLAY, sandy
- Bedrock - CLAYSTONE
- Bedrock - SANDSTONE

SEE INDIVIDUAL LOG SHEETS FOR ADDITIONAL DESCRIPTION OF MATERIAL ENCOUNTERED

LEGEND

TEST BORING



- B — Bridge Borehole
- Ground Water Level At Time of Drilling
- 3/12 — 9 Blows for 12 Inches
- 50/3 — 50 Blows for 3 Inches
- 8/6/7 SS — Split Spoon Sampler Required 8 Blows for 6 Inches Required 6 Blows for 6 Inches Required 7 Blows for 6 Inches

BORING ID NOTED AT THE TOP OF LOG
BLOW COUNTS OBTAINED WITH SPLIT SPOON SAMPLERS ARE NOTED WITH "SS", ALL OTHER BLOW COUNTS OBTAINED WITH A MODIFIED CALIFORNIA BARREL SAMPLER
SEE INDIVIDUAL LOG SHEETS FOR MORE DETAIL

Print Date: 11/13/2013
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Horiz. Scale: As Noted Vert. Scale: As Noted
RockSol Project No. 321.01 Unit Leader Initials

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Sheet Revisions		
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Region 1 KPB

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No Revisions:
Revised:
Void:

US 6 OVER GARRISON STREET
ENGINEERING GEOLOGY

Designer: J. Biller
Detailer: S. McKanna-Koon
Sheet Subset:
Structure Numbers
Subset Sheets: of

Project No./Code
19478
Figure 2A

WORK IN PROGRESS

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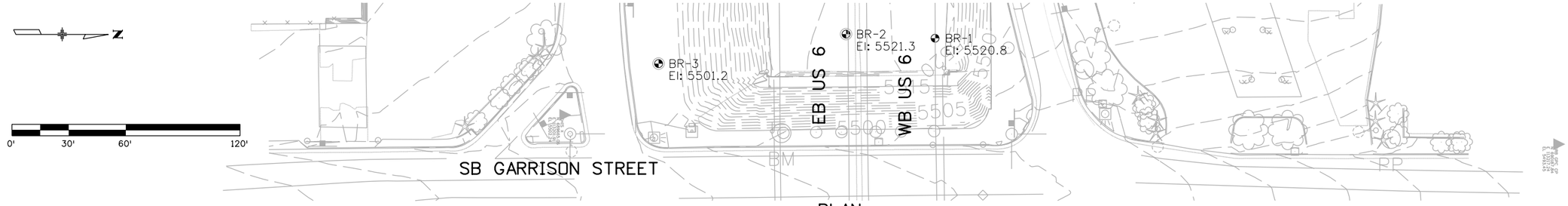

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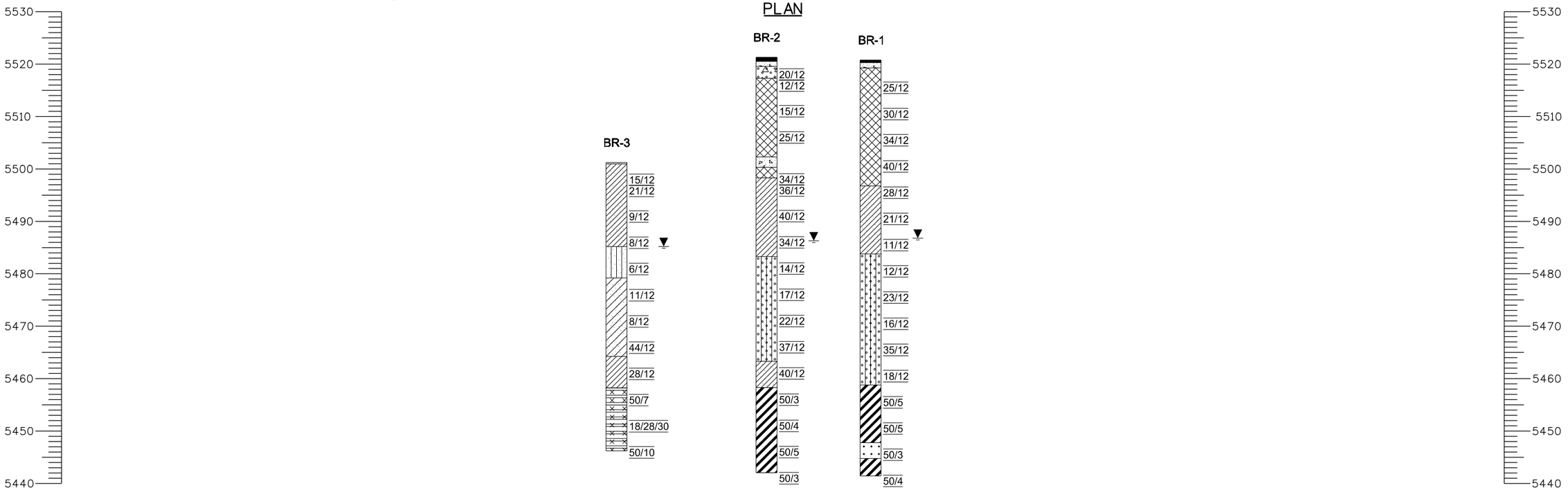

PROFILE

SUMMARY OF TEST RESULTS

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
BR-1	4						21.4	104.8	
BR-1	9	32	17	59	CL	A-6 (7)	18.1	108.5	
BR-1	14						19.1	109.8	
BR-1	19						21.8	101.7	0.00
BR-1	24						24.1	99.9	
BR-1	29	52	28	70	CH	A-7-6 (19)	25.9	97.6	
BR-1	34						31.2	91.5	
BR-1	44						25.5	100.8	
BR-1	54						31.3	91.0	
BR-1	59						21.5	109.5	
BR-1	69						33.2	86.7	
BR-1	74						21.0	102.9	
BR-1	79						20.9	107.7	
BR-2	1.4-10	40	21	48	SC	A-6 (6)			0.02
BR-2	2						15.4	103.2	
BR-2	4						24.9	98.2	
BR-2	9						23.9	97.0	
BR-2	14						19.6	109.9	
BR-2	21						24.7	99.0	
BR-2	24						20.6	104.8	
BR-2	29						19.2	109.3	
BR-2	34	38	20	56	CL	A-6 (8)	22.3	104.9	
BR-2	39						31.3	90.0	
BR-2	44						31.8	90.6	
BR-2	49						30.7	91.9	
BR-2	54	40	18	48	SC	A-6 (5)	25.8	97.8	
BR-2	59						21.0	106.9	
BR-2	64	46	22	52	CL	A-7-6 (8)	24.6	96.6	
BR-2	69						26.2	93.8	
BR-2	79						22.7	100.4	
BR-3	1.9-14	40	15	64	CL	A-6 (8)			0.00
BR-3	2						15.3	110.3	
BR-3	4						14.6	117.2	
BR-3	9						16.4	108.4	
BR-3	14						28.6	94.2	
BR-3	19	32	3	54	ML	A-4 (0)	33.1	90.9	
BR-3	24						27.3	97.6	
BR-3	34						25.5	102.1	
BR-3	39						29.8	93.4	0.01
BR-3	44						28.1	98.1	
BR-3	49	59	22	92	MH	A-7-5 (26)	31.5		0.01
BR-3	54						25.3	97.0	

TYPE OF MATERIAL

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- Asphalt Pavement
- Concrete
- Fill - CLAY
- Fill - SAND
- Native - TOPSOIL
- Native - SAND, silty
- Native - SAND, gravelly
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- Native - CLAY
- Native - CLAY, sandy
- Native - SILT, sandy
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- Bedrock - Interbedded SILTSTONE/CLAYSTONE
- Bedrock - SANDSTONE

SEE INDIVIDUAL LOG SHEETS FOR ADDITIONAL DESCRIPTION OF MATERIAL ENCOUNTERED

LEGEND

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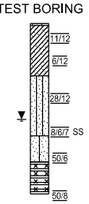

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Print Date: 1/16/2014
File Name: 19478_Engineering_Geology_SB_Garrison.dgn
Horiz. Scale: As Noted Vert. Scale: As Noted
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Region 1 KPB

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No Revisions:
Revised:
Void:

US 6 OVER GARRISON STREET
ENGINEERING GEOLOGY

Designer: J. Biller
Detailer: S. McKanna-Koon
Sheet Subset:
Structure Numbers
Subset Sheets: of

Project No./Code
19478
Figure 2B

WORK IN PROGRESS

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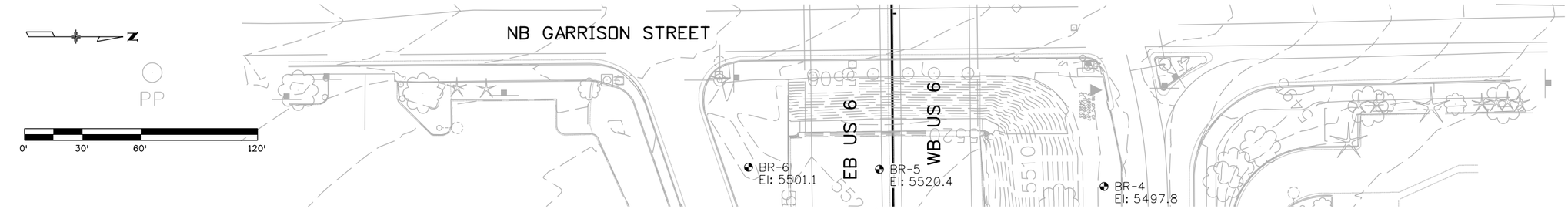

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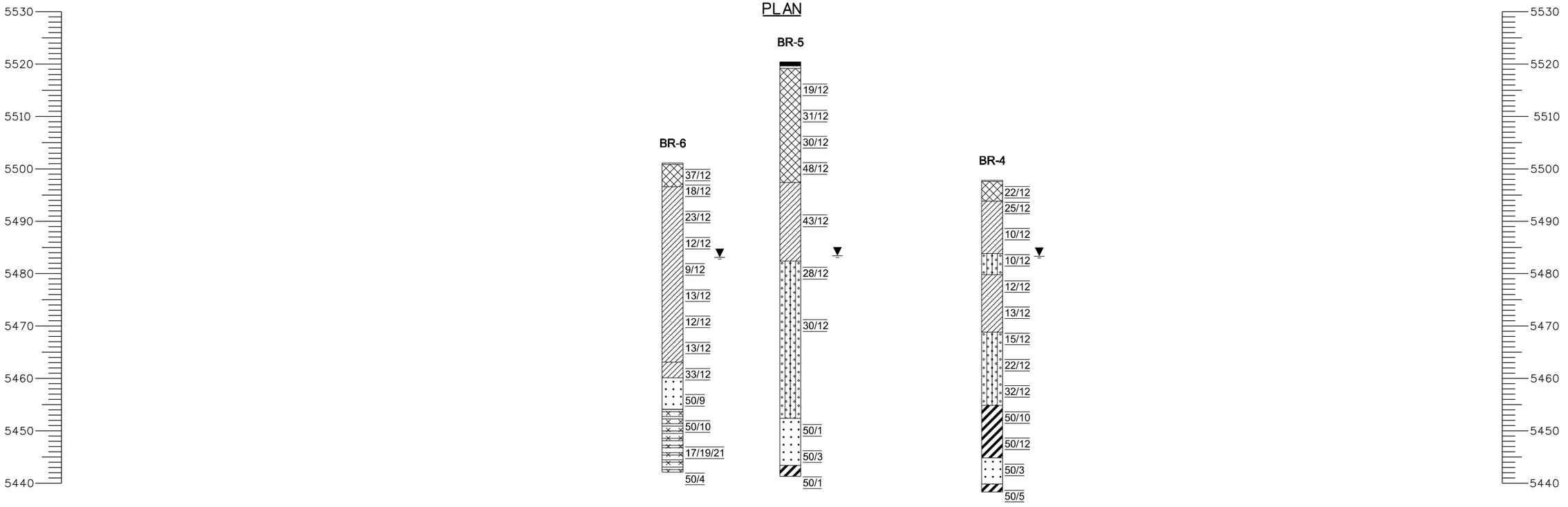


PROFILE

SUMMARY OF TEST RESULTS

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
BR-4	0-10	46	24	66	CL	A-7-6 (14)			0.02
BR-4	2						13.6	91.8	
BR-4	4						19.8	108.2	0.00
BR-4	9						21.5	100.7	
BR-4	14	39	14	44	SC	A-6 (3)	30.1	98.0	
BR-4	19						29.0	96.9	
BR-4	24						35.6	88.1	
BR-4	29	41	18	47	SC	A-7-6 (5)	29.6	95.6	
BR-4	34						24.0	104.1	
BR-4	39	26	2	20	SM	A-1-b (0)	19.9	110.1	
BR-4	44						22.1	108.8	
BR-4	49	61	32	98	CH	A-7-6 (37)	30.7	92.0	0.01
BR-4	54						22.6	103.1	
BR-4	59						18.2	108.1	
BR-4	74						26.9	96.5	
BR-5	1.25-10	46	27	52	CL	A-7-6 (10)			0.01
BR-5	4						26.7	97.3	
BR-5	9						22.6	103.5	
BR-5	-20								
BR-5	10-20	52	30	60	CH	A-7-6 (16)			0.01
BR-5	14						20.0	107.2	
BR-5	19						17.8	111.1	
BR-5	29						17.0	113.7	
BR-5	49						26.3	97.2	
BR-5	74						26.9	96.5	
BR-6	2	NP		14	SM	A-1-a (0)	3.2	132.6	
BR-6	4						19.2	109.5	0.01
BR-6	9						21.7	103.8	
BR-6	14						24.8	99.8	
BR-6	19						25.1	100.9	
BR-6	24								
BR-6	29						29.8	91.7	
BR-6	34						27.7	96.2	0.02
BR-6	39						28.4	94.9	
BR-6	44						21.0	106.0	
BR-6	49						25.4	94.0	
BR-6	54	60	21	93	MH	A-7-5 (26)	34.9		

TYPE OF MATERIAL

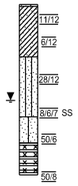
LITHOLOGY

- Asphalt Pavement
- Fill - CLAY
- Native - TOPSOIL
- Native - SAND, gravelly
- Native - CLAY
- Native - SILT, sandy
- Bedrock - Interbedded SILTSTONE/CLAYSTONE
- Concrete
- Fill - SAND
- Native - SAND, silty
- Native - SAND, clayey
- Native - CLAY, sandy
- Bedrock - CLAYSTONE
- Bedrock - SANDSTONE

SEE INDIVIDUAL LOG SHEETS FOR ADDITIONAL DESCRIPTION OF MATERIAL ENCOUNTERED

LEGEND

TEST BORING



- B — Bridge Borehole
- Ground Water Level At Time of Drilling
- 9/12 — 9 Blows for 12 Inches
- 50/3 — 50 Blows for 3 Inches
- 8/6/7 SS — Split Spoon Sampler Required 8 Blows for 6 Inches Required 6 Blows for 6 Inches Required 7 Blows for 6 Inches

BORING ID NOTED AT THE TOP OF LOG
BLOW COUNTS OBTAINED WITH SPLIT SPOON SAMPLERS ARE NOTED WITH "SS", ALL OTHER BLOW COUNTS OBTAINED WITH A MODIFIED CALIFORNIA BARREL SAMPLER
SEE INDIVIDUAL LOG SHEETS FOR MORE DETAIL

Print Date: 11/15/2013
File Name: 19478_Engineering_Geology_NB_Garrison.dgn
Horiz. Scale: As Noted Vert. Scale: As Noted
RockSol Project No. 321.01 Unit Leader Initials

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R-X

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
425 B Corporate Circle
Golden, CO 80401
Phone: 720-497-6954 FAX: 720-497-6951
Region 1 KPB

As Constructed
No Revisions:
Revised:
Void:

US 6 OVER GARRISON STREET
ENGINEERING GEOLOGY

Designer: J. Biller
Detailer: S. McKanna-Koon
Sheet Subset:
Structure Numbers
Subset Sheets: of

Project No./Code
19478
Figure 2C

WORK IN PROGRESS

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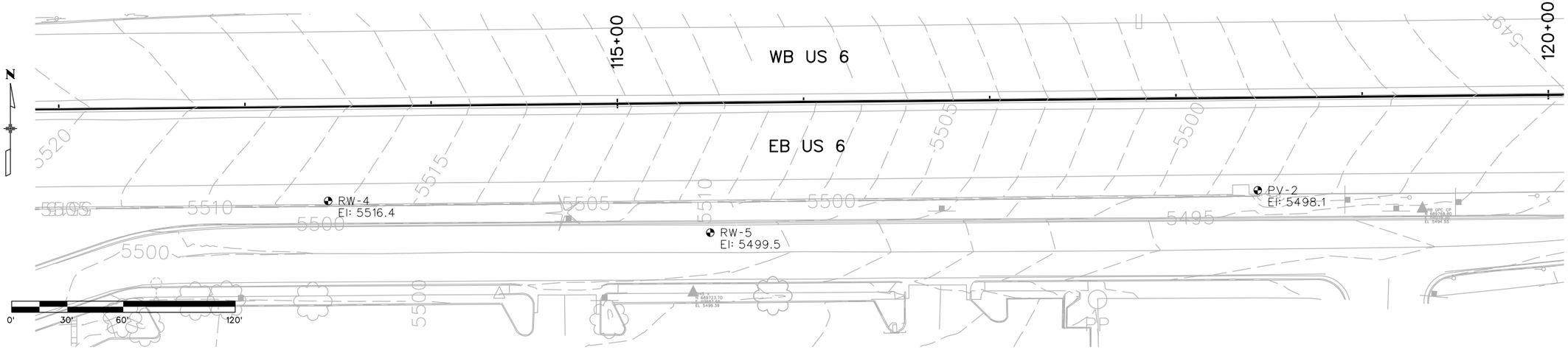
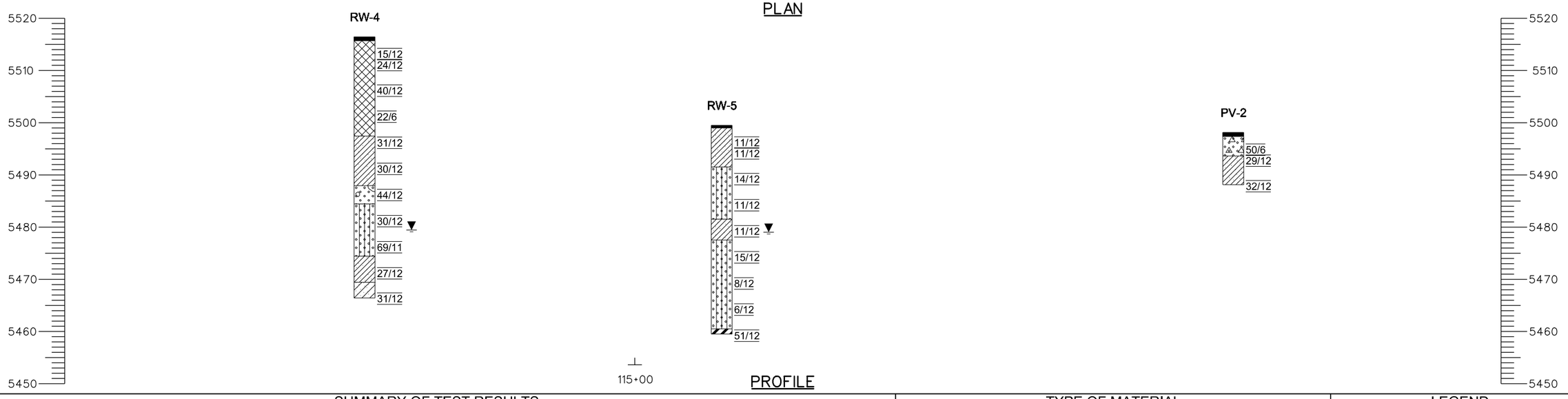


PLAN



PROFILE

SUMMARY OF TEST RESULTS

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
RW-4	2						17.8	112.7	
RW-4	4	37	18	49	SC	A-6 (5)	19.6	107.5	
RW-4	9						9.4	112.6	
RW-4	14						18.6	100.7	
RW-4	19	34	9	27	SM	A-2-4 (0)	16.0	110.0	
RW-4	24						17.7	106.6	0.00
RW-4	29						7.7	116.5	
RW-4	34						28.4	95.8	
RW-4	24						17.7	106.6	0.00
RW-4	29						7.7	116.5	
RW-4	34						28.4	95.8	
RW-4	39						29.1	98.4	
RW-4	44						30.8	89.5	
RW-4	49						31.9	90.7	
RW-5	2						27.9	96.8	
RW-5	4						19.2	104.3	0.00
RW-5	9	36	8	54	ML	A-4 (3)	15.5	104.9	
RW-5	14						21.8	99.9	
RW-5	19						19.0	109.5	
RW-5	39						26.3	100.6	
PV-2	0.75-5	38	22	87	CL	A-6 (19)			0.00
PV-2	2						5.7	125.2	
PV-2	4						23.4	102.0	
PV-2	9						22.5	10.1	

TYPE OF MATERIAL

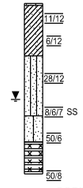
LITHOLOGY

- Asphalt Pavement
- Concrete
- Fill - CLAY
- Fill - SAND
- Native - TOPSOIL
- Native - SAND, silty
- Native - SAND, gravelly
- Native - SAND, clayey
- Native - CLAY
- Native - CLAY, sandy
- Native - SILT, sandy
- Bedrock - CLAYSTONE
- Bedrock - Interbedded SILTSTONE/CLAYSTONE
- Bedrock - SANDSTONE

SEE INDIVIDUAL LOG SHEETS FOR ADDITIONAL DESCRIPTION OF MATERIAL ENCOUNTERED

LEGEND

TEST BORING



- B — Bridge Borehole
- Ground Water Level At Time of Drilling
- 3/12 — 9 Blows for 12 Inches
- 50/3 — 50 Blows for 3 Inches
- 8/6/7 SS — Split Spoon Sampler Required 8 Blows for 6 Inches Required 6 Blows for 6 Inches Required 7 Blows for 6 Inches

BORING ID NOTED AT THE TOP OF LOG
BLOW COUNTS OBTAINED WITH SPLIT SPOON SAMPLERS ARE NOTED WITH "SS". ALL OTHER BLOW COUNTS OBTAINED WITH A MODIFIED CALIFORNIA BARREL SAMPLER
SEE INDIVIDUAL LOG SHEETS FOR MORE DETAIL

Print Date: 11/13/2013
File Name: 19478_Engineering_Geology_East_US6.dgn
Horiz. Scale: As Noted Vert. Scale: As Noted
RockSol Project No. 321.01 Unit Leader Initials

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R-X

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
DEPARTMENT OF TRANSPORTATION
425 B Corporate Circle
Golden, CO 80401
Phone: 720-497-6954 FAX: 720-497-6951
Region 1 KPB

As Constructed
No Revisions:
Revised:
Void:

US 6 OVER GARRISON STREET
ENGINEERING GEOLOGY

Designer: J. Biller
Detailer: S. McKanna-Koon
Sheet Subset:
Structure Numbers
Subset Sheets: of

Project No./Code
19478
Figure 2D

WORK IN PROGRESS

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Appendix A

Legend and Individual Borehole Logs

LEGEND

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

LITHOLOGY

- Asphalt Pavement
- Concrete Pavement
- Fill - CLAY
- Fill - SAND
- TOPSOIL
- Native - SAND, silty
- Native - SAND, gravelly
- Native - SAND, clayey
- Native - CLAY
- Native - CLAY, sandy
- Bedrock - CLAYSTONE
- Bedrock - SANDSTONE

SAMPLE TYPE

MODIFIED CALIFORNIA SAMPLER
2.5" O.D. AND 2" I.D.
WITH BRASS LINERS INCLUDED

SPLIT SPOON SAMPLER
2" O.D. AND 1 3/8" I.D.
NO LINERS

15/12 Indicates 15 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 12 inches.

50/11 Indicates 50 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 11 inches.

5,5,5 Indicates 5 blows, 5 blows, 5 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 18 inches.

▼ GROUND WATER LEVEL NOTED AT THE TIME OF DRILLING

RockSol Consulting Group, Inc.

BORING : BR-1

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/17/13 **COMPLETED** 9/17/13
GROUND ELEVATION 5520.8 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689860.5 **EAST** 113161.6
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: US6 WB Outside Shoulder West of Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 34.0 ft on 9/17/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5521	0		Asphalt Pavement, approximately 5"										
			Concrete Pavement, approximately 10.25"										
			(Fill) CLAY, sandy with gravel in parts, moist, grey and brown, very stiff to hard										
5516	5		(US 6 Embankment)	MC	25/12	1.8		104.8	21.4				
5511	10			MC	30/12			108.5	18.1	32	15	17	59.2
5506	15			MC	34/12			109.8	19.1				
5501	20			MC	40/12		0.00	101.7	21.8				
5496	25		(Native) CLAY, sandy, very moist to wet, light brown, very stiff to stiff	MC	28/12			99.9	24.1				
5491	30			MC	21/12			97.6	25.9	52	24	28	70.2
5486	35			MC	11/12			91.5	31.2				

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5486	35		(Native) CLAY, sandy, very moist to wet, light brown, very stiff to stiff *(continued)*										
			(Native) SAND, silty to slightly clayey, wet, light brown, medium dense										
5481	40			MC	12/12								
5476	45			MC	23/12			100.8	25.5				
5471	50			MC	16/12								
5466	55			MC	35/12			91.0	31.3				
5461	60			MC	18/12			109.5	21.5				
5456	65		(Bedrock) CLAYSTONE, silty, slightly moist, brown and grey, very hard	MC	50/5								
5451	70			MC	50/5			86.7	33.2				
5446	75		(Bedrock) SANDSTONE, clayey, slightly moist, brown, very hard	MC	50/3			102.9	21.0				

RockSol Consulting Group, Inc.

BORING : BR-1

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5446	75		(Bedrock) CLAYSTONE, moist, grey, very hard	MC	50/4	2.4		107.7	20.9				
			Bottom of hole at 79.3 feet.										

RockSol Consulting Group, Inc.

BORING : BR-2

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/16/13 **COMPLETED** 9/16/13
GROUND ELEVATION 5521.3 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689813.7 **EAST** 113159.5
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: EB US 6, Lane 1, West Side of Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 35.0 ft on 9/16/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5521	0		Asphalt Pavement approximately 7.5"										
			Concrete Pavement approximately 9.5"				0.02			40	19	21	47.9
			(Fill) SAND, silty to slightly clayey, moist, brown, medium dense	MC	20/12			103.2	15.4				
5516	5		(Fill) CLAY, with sand to sandy, very moist, brown and grey, stiff to very stiff	MC	12/12	0.2		98.2	24.9				
			(US 6 Embankment)										
5511	10			MC	15/12			97.0	23.9				
5506	15			MC	25/12			109.9	19.6				
5501	20		Concrete Debris										
			(Fill) CLAY, sandy, moist, brown, hard					99.0	24.7				
				MC	34/12								
			(Native) CLAY, sandy, moist, brown, hard	MC	36/12			104.8	20.6				
5496	25												
5491	30			MC	40/12			109.3	19.2				
5486	35		▼	MC	34/12			104.9	22.3	38	18	20	56.1

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

RockSol Consulting Group, Inc.

BORING : BR-2

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5481	40		(Native) SAND, silty to clayey, moist to wet, brown, medium dense to dense	MC	14/12			90.0	31.3				
5476	45			MC	17/12			90.6	31.8				
5471	50			MC	22/12			91.9	30.7				
5466	55			MC	37/12			97.8	25.8	40	22	18	47.6
5461	60		(Native) CLAY, sandy, very moist, brown, hard	MC	40/12			106.9	21.0				
5456	65		(Bedrock) CLAYSTONE, sandy in parts, very moist, brown, and grey, very hard	MC	50/3			96.6	24.6	46	24	22	51.8
5451	70			MC	50/4	1.4		93.8	26.2				
5446	75			MC	50/5								
			Bottom of hole at 79.3 feet.	MC	50/3			100.4	22.7				

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

RockSol Consulting Group, Inc.

BORING : BR-3

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/3/13 **COMPLETED** 9/3/13
GROUND ELEVATION 5501.2 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689715.1 **EAST** 113174.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: South West Corner of US 6 and Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Bottom of Embankment at west side of US 6 bridge over Garrison
WATER DEPTH 16.0 ft on 9/3/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5501	0		Topsoil, SILT, sandy, slightly moist, light brown, soft, approximately 3"										
			(Native) CLAY, sandy to very sandy with clayey sand in parts, moist to very moist to wet, brown, stiff to medium stiff	MC	15/12	2.7	0.00	110.3	15.3	40	25	15	63.8
5496	5			MC	21/12	2.7		117.2	14.6				
5491	10			MC	9/12	-0.3		108.4	16.4				
5486	15			MC	8/12	-0.7		94.2	28.6				
			(Native) SILT, sandy and clayey in parts, wet, brown, loose										
5481	20			MC	6/12			90.9	33.1	32	29	3	54.4
			(Native) SAND, clayey, wet, brown, medium dense										
5476	25			MC	11/12	-0.4		97.6	27.3				
5471	30			MC	8/12								
5466	35			MC	44/12			102.1	25.5				

RockSol Consulting Group, Inc.

BORING : BR-3

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5466	35		(Native) SAND, clayey, wet, brown, medium dense *(continued)*										
			(Native) CLAY, sandy, weathered claystone, moist, grey, very stiff										
5461	40			MC	28/12		0.01	93.4	29.8				
			(Bedrock) CLAYSTONE with INTERBEDED SILTSTONE, silty to sandy in parts, moist, grey brown, very hard										
5456	45			MC	50/7			98.1	28.1				
5451	50			SS	18/28/30		0.01		31.5	59	37	22	92.0
				MC	50/10			97.0	25.3				
			Bottom of hole at 54.8 feet.										

RockSol Consulting Group, Inc.

BORING : BR-4

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/4/13 **COMPLETED** 9/4/13
GROUND ELEVATION 5497.8 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689930.7 **EAST** 113335.7
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: North East Corner of 6th and Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 14.5 ft on 9/4/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	FINES CONTENT (%)
5498	0		Topsoil, CLAY, sandy, moist, brown, soft, approximately 3" in thickness				0.02			46	22	24	66.2
			(Fill) CLAY, sandy, moist, brown, very stiff	MC	22/12			91.8	13.6				
5493	5		(Native) CLAY, sandy, slightly moist to moist, brown, very stiff to stiff	MC	25/12	1.1	0.00	108.2	19.8				
5488	10			MC	10/12			100.7	21.5				
5483	15		(Native) SAND, silty to clayey, wet, brown, medium dense	MC	10/12			98.0	30.1	39	25	14	44.3
5478	20		(Native) CLAY, sandy with silty SAND in parts, moist to very moist, brown to dark brown, very stiff	MC	12/12			96.9	29.0				
5473	25			MC	13/12			88.1	35.6				
5468	30		(Native) SAND, silty to clayey with clay and gravel in parts, wet, brown, very stiff to dense	MC	15/12			95.6	29.6	41	23	18	47.4
5463	35			MC	22/12			104.1	24.0				

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

RockSol Consulting Group, Inc.

BORING : BR-4

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5463	35		(Native) SAND, silty to clayey with clay and gravel in parts, wet, brown, very stiff to dense *(continued)*										
5458	40			MC	32/12			110.1	19.9	26	24	2	20.4
5453	45		(Bedrock) CLAYSTONE, sandy silty in parts, very moist, brown and grey, very hard	MC	50/10			108.8	22.1				
5448	50			MC	50/12		0.01	92.0	30.7	61	29	32	97.6
5443	55		(Bedrock) SANDSTONE, clayey, slightly moist, light brown, very hard	MC	50/3			103.1	22.6				
			(Bedrock) CLAYSTONE, silty in parts, slightly moist, olive brown grey, very hard	MC	50/5			108.1	18.2				
			Bottom of hole at 59.5 feet.					96.5	26.9				

RockSol Consulting Group, Inc.

BORING : BR-5

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/16/13 **COMPLETED** 10/1/13
GROUND ELEVATION 5520.4 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689815.1 **EAST** 113326.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: EB US6, Lane 1, East Side of Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 37.0 ft on 9/16/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5520	0		Asphalt Pavement, approximately 8.25"										
			Concrete Pavement approximately 8.5"				0.01			46	19	27	52.2
			Asphalt Pavement, approximately 3.25"										
			(Fill) CLAY, sandy, organics in parts, very moist, grey and brown, very stiff to hard										
5515	5		(US 6 Embankment)	MC	19/12	0.3		97.3	26.7				
5510	10			MC	31/12		0.01	103.5	22.6	52	22	30	60.2
5505	15			MC	30/12			107.2	20.0				
5500	20			MC	48/12			111.1	17.8				
5495	25		(Native) CLAY, sandy, moist, brown, hard										
5490	30			MC	43/12			113.7	17.0				
5485	35												

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5485	35		(Native) CLAY, sandy, moist, brown, hard *(continued)*										
			(Native) SAND, silty to clayey, wet, brown, medium dense										
5480	40			MC	28/12								
5475	45												
5470	50			MC	30/12			97.2	26.3				
5465	55												
5460	60												
5455	65												
			(Bedrock) SANDSTONE, clayey, moist, light brown, very hard										
5450	70			MC	50/1								
5445	75			MC	50/3			96.5	26.9				

RockSol Consulting Group, Inc.

BORING : BR-5

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5445	75		(Bedrock) SANDSTONE, clayey, moist, light brown, very hard *(continued)*										
			(Bedrock) CLAYSTONE, wet, grey, very hard										
			Bottom of hole at 79.1 feet.	MC	50/1								

RockSol Consulting Group, Inc.

BORING : BR-6

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/3/13 **COMPLETED** 9/3/13
GROUND ELEVATION 5501.1 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689747.7 **EAST** 113325.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: South East Corner at US 6 and Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 18.0 ft on 9/3/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5501	0		Topsoil, SILT, sandy, slightly moist, light brown, soft										
			(Fill) SAND, silty with gravel, slightly moist, light brown, dense	MC	37/12			132.6	3.2	NP	NP	NP	14.1
5496	5		(Native) CLAY, sandy to very sandy, silty sandy in parts, moist to very moist, brown and grey, very stiff	MC	18/12	2.1	0.01	109.5	19.2				
5491	10			MC	23/12	1.2		103.8	21.7				
5486	15			MC	12/12	-0.3		99.8	24.8				
5481	20			MC	9/12	-0.5		100.9	25.1				
5476	25			MC	13/12	-0.3		94.5	29.9				
5471	30			MC	12/12	-1.0		91.7	29.8				
5466	35			MC	13/12		0.02	96.2	27.7				

RockSol Consulting Group, Inc.

BORING : BR-6

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5466	35		(Native) CLAY, sandy to very sandy, silty sandy in parts, moist to very moist, brown and grey, very stiff *(continued)*										
			(Native) CLAY, weathered claystone, silty in parts, moist, grey and brown, hard										
5461	40			MC	33/12			94.9	28.4				
			(Bedrock) SANDSTONE, clayey, moist, light brown, very hard										
5456	45			MC	50/9			106.0	21.0				
			(Bedrock) CLAYSTONE with INTERBEDED SILTSTONE, silty in parts, moist to very moist, brown, very hard										
5451	50			MC	50/10			94.0	25.4				
5446	55			SS	17/19/21				34.9	60	39	21	93.3
			Bottom of hole at 59.3 feet.	MC	50/4								

RockSol Consulting Group, Inc.

BORING : PV-1

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/17/13 **COMPLETED** 9/17/13
GROUND ELEVATION 5513.3 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689853.7 **EAST** 112576.0
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: WB US6 Shoulder 600' West of Garrison Bridge
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 9/17/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5513	0		Asphalt Pavement, approximately 7.25"										
			Concrete Pavement, approximately 7 1/8"				0.00			46	22	24	47.6
			(Fill) SAND, silty to clayey with gravel, moist, brown, very dense	MC	62/12			119.9	6.0				
5508	5		(Native) CLAY, sandy, very moist to moist, brown, very stiff	MC	26/12	0.0		99.5	22.4				
5503	10			MC	19/12			89.5	30.1				
			Bottom of hole at 10.0 feet.										

RockSol Consulting Group, Inc.

BORING : PV-2

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 10/1/13 **COMPLETED** 10/1/13
GROUND ELEVATION 5498.1 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689778.7 **EAST** 113990.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: Shoulder US 6 EB
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 10/1/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5498	0		Asphalt Pavement, Approximately 7.5"				0.00			38	16	22	86.6
			(Fill) SAND, gravel, moist, black and dark brown, dense	MC	50/6			125.2	5.7				
5493	5		(Native) CLAY, with sand to sandy, moist, grey and brown, very stiff	MC	29/12	0.7		102.0	23.4				
5488	10			MC	32/12			10.1	22.5				
			Bottom of hole at 10.0 feet.										

RockSol Consulting Group, Inc.

BORING : RW-1

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/19/13 **COMPLETED** 9/19/13
GROUND ELEVATION 5514.0 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689858.9 **EAST** 112762.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: WB US6 Shoulder 400' West of Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 21.0 ft on 9/19/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5514	0		Asphalt Pavement, approximately 9.25"										
			(Fill) CLAY and SAND, sandy, silty to gravelly, very moist, grey, stiff to very hard	MC	14/12	0.8		106.2	20.6				
5509	5			MC	50/12			138.1	3.0				
5504	10		(Native) CLAY, sandy to silty, moist to wet, dark grey and brown, very stiff to stiff	MC	16/12	0.0		97.7	25.4				
5499	15			MC	10/12	0.5	0.00	96.5	26.0				
5494	20			MC	14/12			92.3	29.1				
5489	25			MC	6/12	0.6		85.1	37.4				
5484	30		(Native) SAND, silty, very moist to wet, brown, loose	MC	7/12			90.3	30.2				
			Bottom of hole at 30.0 feet.										

RockSol Consulting Group, Inc.

BORING : RW-2

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/17/13 **COMPLETED** 9/19/13
GROUND ELEVATION 5518.9 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689860.4 **EAST** 112982.7
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: WB US6 Shoulder 200' West of Garrison Bridge
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH None Encountered on 9/17/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5519	0		Asphalt Pavement approximately 4"				0.01			38	20	18	43.9
			Concrete Pavement, approximately 7.5"										
			(Fill) CLAY, sandy, very moist, brown, very stiff to hard	MC	19/12	0.5		108.9	18.6				
5514	5			MC	50/5	0.7		110.7	17.3				
			Hit concrete at approximately 5' and stopped drilling. Borehole location offset 5 feet northwest and drilled 9/19/2013.										
			(Fill) SAND, silty to clayey with gravel, very sandy with silty sand, moist, dark grey and brown, medium dense to hard										
5509	10			MC	18/12			111.6	11.4	31	15	16	29.8
5504	15			MC	30/12	0.0	0.01	111.9	14.5				
			(Native) CLAY, sandy to silty with silty sand in parts, very moist to wet, brown, very stiff										
5499	20			MC	25/12			105.4	20.4	47	20	27	76.1
5494	25			MC	15/12			105.4	17.9				
5489	30			MC	10/12	-0.2		103.2	22.9				
5484	35			MC	14/12								

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5484	35		(Native) CLAY, sandy to silty with silty sand in parts, very moist to wet, brown, very stiff *(continued)*										
5479	40			MC	14/12			99.7	24.6				
			Bottom of hole at 40.0 feet.										

RockSol Consulting Group, Inc.

BORING : RW-3

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/4/13 **COMPLETED** 9/4/13
GROUND ELEVATION 5504.8 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689717.4 **EAST** 112929.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: Off ramp form EB 6th to Garrison
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 14.0 ft on 9/4/25013

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5505	0		Topsoil, SAND, gravelly, slightly moist, brown, loose, approximately 6"				0.00			43	20	23	54.3
			(Fill) CLAY, sandy with gravel in parts, moist, dark brown, very stiff	MC	20/12		0.00	117.8	10.1	NP	NP	NP	46.9
			(Native) CLAY, sandy, moist, brown, very stiff										
5500	5			MC	28/12	1.4		108.8	19.7				
5495	10			MC	17/12	-0.1		107.2	18.7				
			(Native) SAND, silty to clayey with gravel, sandy with clay in parts, silty to clayey, very moist to wet, medium dense										
5490	15			MC	12/12	-0.4		97.7	25.9	40	23	17	38.2
5485	20			MC	12/12			97.2	27.3				
5480	25			MC	12/12			96.0	30.7				
5475	30			MC	13/12								
			Bottom of hole at 30.0 feet.										

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

RockSol Consulting Group, Inc.

BORING : RW-4

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 10/1/13 **COMPLETED** 10/1/13
GROUND ELEVATION 5516.4 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689773.0 **EAST** 113491.7
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: Shoulder Pavement EB US6, 100' East of Garrison St.
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES
WATER DEPTH 37.0 ft on 10/1/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5516	0		Asphalt Pavement, approximately 7.75"										
			(Fill) CLAY, sandy with trace gravel, moist, grey and dark brown, very stiff	MC	15/12	0.1		112.7	17.8				
5511	5			MC	24/12			107.5	19.6	37	19	18	48.8
5506	10			MC	40/12			112.6	9.4				
5501	15			MC	22/6			100.7	18.6				
			Concrete rubble encountered between 16' and 19'										
5496	20		(Native) CLAY, sandy, gravelly, moist, brown, very stiff	MC	31/12			110.0	16.0	34	25	9	27.1
5491	25			MC	30/12	-0.3	0.00	106.6	17.7				
5486	30		(Native) SAND, gravelly, moist, light brown, dense	MC	44/12			116.5	7.7				
5481	35		(Native) SAND, silty with clay, moist to wet, light brown, medium dense to dense	MC	30/12	-0.2		95.8	28.4				

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

RockSol Consulting Group, Inc.

BORING : RW-4

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5481	35		(Native) SAND, silty with clay, moist to wet, light brown, medium dense to dense *(continued)*										
5476	40			MC	69/11			98.4	29.1				
			(Native) CLAY, sandy, wet, light brown, very stiff										
5471	45			MC	27/12			89.5	30.8				
			(Native) SAND, clayey, wet, light brown, medium dense										
5466	50							90.7	31.9				
			Bottom of hole at 50.0 feet.										
				MC	31/12								

RockSol Consulting Group, Inc.

BORING : RW-5

CLIENT TSH, Inc.
PROJECT NAME US 6 over Garrison Final Design
PROJECT NUMBER 329.02
PROJECT LOCATION Lakewood, CO
DATE STARTED 9/19/13 **COMPLETED** 9/19/13
GROUND ELEVATION 5499.5 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 689755.9 **EAST** 113696.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: US6 SE Frontage Road
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES EB US6 Frontage Road, Inside Lane
WATER DEPTH 20.5 ft on 9/19/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5500	0		Asphalt Pavement, approximately 6"										
			(Native) CLAY, sandy, very moist, brown, stiff	MC	11/12	3.0		96.8	27.9				
5495	5			MC	11/12	0.1	0.00	104.3	19.2				
			(Native) SAND, silty, clayey in parts, very moist, brown, medium dense										
5490	10			MC	14/12			104.9	15.5	36	28	8	54.3
5485	15			MC	11/12			99.9	21.8				
			(Native) CLAY, sandy to silty, very moist, brown, stiff										
5480	20			MC	11/12			109.5	19.0				
			(Native) SAND, silty to clayey with sandy clay in parts, very moist to wet, brown, loose to medium dense										
5475	25			MC	15/12								
5470	30			MC	8/12								
5465	35			MC	6/12								

LOG - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5465	35		(Native) SAND, silty to clayey with sandy clay in parts, very moist to wet, brown, loose to medium dense *(continued)*										
5460	40		(Bedrock) CLAYSTONE, silty in parts, moist, brown and grey, very hard	MC	51/12			100.6	26.3				
			Bottom of hole at 40.0 feet.										

Appendix B

Laboratory Test Results

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT TSH, Inc.

PROJECT NAME US 6 over Garrison Final Design

PROJECT NUMBER 329.02

PROJECT LOCATION Lakewood, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BR-1	4				1.8				21.4	104.8								
BR-1	9	32	15	17		59	CL	A-6 (7)	18.1	108.5								
BR-1	14								19.1	109.8								
BR-1	19								21.8	101.7		0.00		7.3	0.01			
BR-1	24								24.1	99.9								
BR-1	29	52	24	28		70	CH	A-7-6 (19)	25.9	97.6								
BR-1	34								31.2	91.5								
BR-1	44								25.5	100.8								
BR-1	54								31.3	91.0								
BR-1	59								21.5	109.5								
BR-1	69								33.2	86.7	43.7							
BR-1	74								21.0	102.9								
BR-1	79				2.4				20.9	107.7								
BR-2	1.4-10	40	19	21		48	SC	A-6 (6)				0.02	370 oHM-CM @ 23.5%	7.3	0.06			
BR-2	2								15.4	103.2								
BR-2	4				0.2				24.9	98.2								
BR-2	9								23.9	97.0								
BR-2	14								19.6	109.9								
BR-2	21								24.7	99.0								
BR-2	24								20.6	104.8								
BR-2	29								19.2	109.3								
BR-2	34	38	18	20		56	CL	A-6 (8)	22.3	104.9								
BR-2	39								31.3	90.0								
BR-2	44								31.8	90.6								
BR-2	49								30.7	91.9								
BR-2	54	40	22	18		48	SC	A-6 (5)	25.8	97.8								
BR-2	59								21.0	106.9								
BR-2	64	46	24	22		52	CL	A-7-6 (8)	24.6	96.6								
BR-2	69				1.4				26.2	93.8								
BR-2	79								22.7	100.4								

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT TSH, Inc.

PROJECT NAME US 6 over Garrison Final Design

PROJECT NUMBER 329.02

PROJECT LOCATION Lakewood, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BR-3	1.9-14	40	25	15		64	CL	A-6 (8)				0.00		6.9	0.01			
BR-3	2				2.7				15.3	110.3								
BR-3	4				2.7				14.6	117.2								
BR-3	9				-0.3				16.4	108.4								
BR-3	14				-0.7				28.6	94.2								
BR-3	19	32	29	3		54	ML	A-4 (0)	33.1	90.9								
BR-3	24				-0.4				27.3	97.6								
BR-3	34								25.5	102.1								
BR-3	39								29.8	93.4		0.01						
BR-3	44								28.1	98.1								
BR-3	49	59	37	22		92	MH	A-7-5 (26)	31.5			0.01						
BR-3	54								25.3	97.0	83.0							
BR-4	0-10	46	22	24		66	CL	A-7-6 (14)				0.02	575 Ohm-cm @ 31.1%	7.6	0.01			
BR-4	2								13.6	91.8								
BR-4	4				1.1				19.8	108.2		0.00						
BR-4	9								21.5	100.7								
BR-4	14	39	25	14		44	SC	A-6 (3)	30.1	98.0								
BR-4	19								29.0	96.9								
BR-4	24								35.6	88.1								
BR-4	29	41	23	18		47	SC	A-7-6 (5)	29.6	95.6								
BR-4	34								24.0	104.1								
BR-4	39	26	24	2		20	SM	A-1-b (0)	19.9	110.1								
BR-4	44								22.1	108.8								
BR-4	49	61	29	32		98	CH	A-7-6 (37)	30.7	92.0		0.01						
BR-4	54								22.6	103.1								
BR-4	59								18.2	108.1	65.7							
BR-4	74								26.9	96.5								
BR-5	1.25-10	46	19	27		52	CL	A-7-6 (10)				0.01	360 Ohm-cm @ 28.8%	7.2	0.07			
BR-5	4				0.3				26.7	97.3								
BR-5	9								22.6	103.5								

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT TSH, Inc.

PROJECT NAME US 6 over Garrison Final Design

PROJECT NUMBER 329.02

PROJECT LOCATION Lakewood, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BR-5	10-20	52	22	30		60	CH	A-7-6 (16)				0.01	380 Ohm-cm @ 30.8%	7.0	0.05			
BR-5	14								20.0	107.2								
BR-5	19								17.8	111.1								
BR-5	29								17.0	113.7								
BR-5	49								26.3	97.2								
BR-5	74								26.9	96.5								
BR-6	2	NP	NP	NP		14	SM	A-1-a (0)	3.2	132.6								
BR-6	4				2.1				19.2	109.5		0.01						
BR-6	9				1.2				21.7	103.8								
BR-6	14				-0.3				24.8	99.8								
BR-6	19				-0.5				25.1	100.9								
BR-6	24				-0.3				29.9	94.5								
BR-6	29				-1.0				29.8	91.7								
BR-6	34								27.7	96.2		0.02						
BR-6	39								28.4	94.9								
BR-6	44								21.0	106.0								
BR-6	49								25.4	94.0	86.1							
BR-6	54	60	39	21		93	MH	A-7-5 (26)	34.9									
PV-1	1.25-10	46	22	24		48	SC	A-7-6 (8)				0.00	360 Ohm-cm @ 29.1%	7.7	0.06			
PV-1	2								6.0	119.9								
PV-1	4				0.0				22.4	99.5								
PV-1	9								30.1	89.5								
PV-2	0.75-5	38	16	22		87	CL	A-6 (19)				0.00						
PV-2	2								5.7	125.2								
PV-2	4				0.7				23.4	102.0								
PV-2	9								22.5	10.1								
RW-1	2				0.8				20.6	106.2								
RW-1	4								3.0	138.1								
RW-1	9				0.0				25.4	97.7								
RW-1	14				0.5				26.0	96.5		0.00						

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PROJECT LOCATION Lakewood, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
RW-1	19								29.1	92.3								
RW-1	24				0.6				37.4	85.1								
RW-1	29								30.2	90.3								
RW-2	1-5	38	20	18		44	SC	A-6 (4)				0.01	430 Ohm-cm @ 25.8%	8.0	0.05			
RW-2	2				0.5				18.6	108.9								
RW-2	4				0.7				17.3	110.7								
RW-2	9	31	15	16		30	SC	A-2-6 (1)	11.4	111.6								
RW-2	14				0.0				14.5	111.9		0.01						
RW-2	19	47	20	27		76	CL	A-7-6 (20)	20.4	105.4								
RW-2	24								17.9	105.4								
RW-2	29				-0.2				22.9	103.2								
RW-2	39								24.6	99.7								
RW-3	0-10	43	20	23		54	CL	A-7-6 (9)				0.00	675 Ohm-cm @ 21.2%	7.3	0.04			
RW-3	2	NP	NP	NP		47	SM	A-4 (0)	10.1	117.8		0.00						
RW-3	4				1.4				19.7	108.8								
RW-3	9				-0.1				18.7	107.2								
RW-3	14	40	23	17	-0.4	38	SC	A-6 (2)	25.9	97.7								
RW-3	19								27.3	97.2								
RW-3	24								30.7	96.0								
RW-4	2				0.1				17.8	112.7								
RW-4	4	37	19	18		49	SC	A-6 (5)	19.6	107.5								
RW-4	9								9.4	112.6								
RW-4	14								18.6	100.7								
RW-4	19	34	25	9		27	SM	A-2-4 (0)	16.0	110.0								
RW-4	24				-0.3				17.7	106.6		0.00						
RW-4	29								7.7	116.5								
RW-4	34				-0.2				28.4	95.8								
RW-4	39								29.1	98.4								
RW-4	44								30.8	89.5								
RW-4	49								31.9	90.7								

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SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT TSH, Inc.

PROJECT NAME US 6 over Garrison Final Design

PROJECT NUMBER 329.02

PROJECT LOCATION Lakewood, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
RW-5	2				3.0				27.9	96.8								
RW-5	4				0.1				19.2	104.3		0.00						
RW-5	9	36	28	8		54	ML	A-4 (3)	15.5	104.9								
RW-5	14								21.8	99.9								
RW-5	19								19.0	109.5								
RW-5	39								26.3	100.6								

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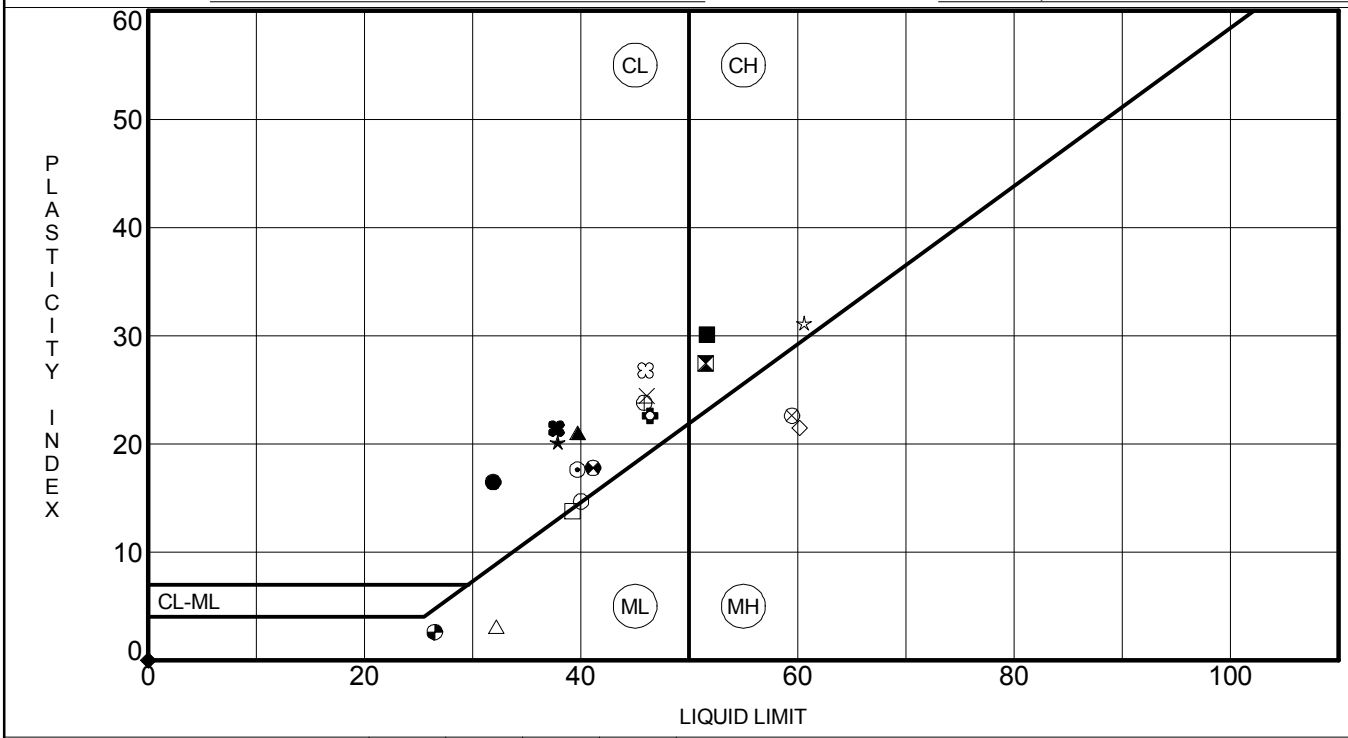
ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



	Specimen Identification		LL	PL	PI	Fines	Classification
●	BR-1	9	32	15	17	59.2	SANDY LEAN CLAY (CL)
⊠	BR-1	29	52	24	28	70.2	FAT CLAY with SAND (CH)
▲	BR-2	1-10.0	40	19	21	47.9	CLAYEY SAND (SC)
★	BR-2	34	38	18	20	56.1	SANDY LEAN CLAY (CL)
⊙	BR-2	54	40	22	18	47.6	CLAYEY SAND (SC)
✿	BR-2	64	46	24	22	51.8	(Bedrock) CLAYSTONE (CL)
○	BR-3	2-14.0	40	25	15	63.8	SANDY LEAN CLAY (CL)
△	BR-3	19	32	29	3	54.4	SANDY SILT (ML)
⊗	BR-3	49	59	37	22	92.0	(Bedrock) SILTSTONE (MH)
⊕	BR-4	0-10.0	46	22	24	66.2	SANDY LEAN CLAY (CL)
□	BR-4	14	39	25	14	44.3	CLAYEY SAND (SC)
⊛	BR-4	29	41	23	18	47.4	CLAYEY SAND (SC)
◒	BR-4	39	26	24	2	20.4	SILTY SAND (SM)
☆	BR-4	49	61	29	32	97.6	(Bedrock) CLAYSTONE (CH)
⊠	BR-5	1-10.0	46	19	27	52.2	SANDY LEAN CLAY (CL)
■	BR-5	10-20.0	52	22	30	60.2	SANDY FAT CLAY (CH)
◆	BR-6	2	NP	NP	NP	14.1	SILTY SAND with GRAVEL (SM)
◇	BR-6	54	60	39	21	93.3	(Bedrock) SILTSTONE (MH)
×	PV-1	1-10.0	46	22	24	47.6	CLAYEY SAND (SC)
✖	PV-2	1-5.0	38	16	22	86.6	LEAN CLAY (CL)

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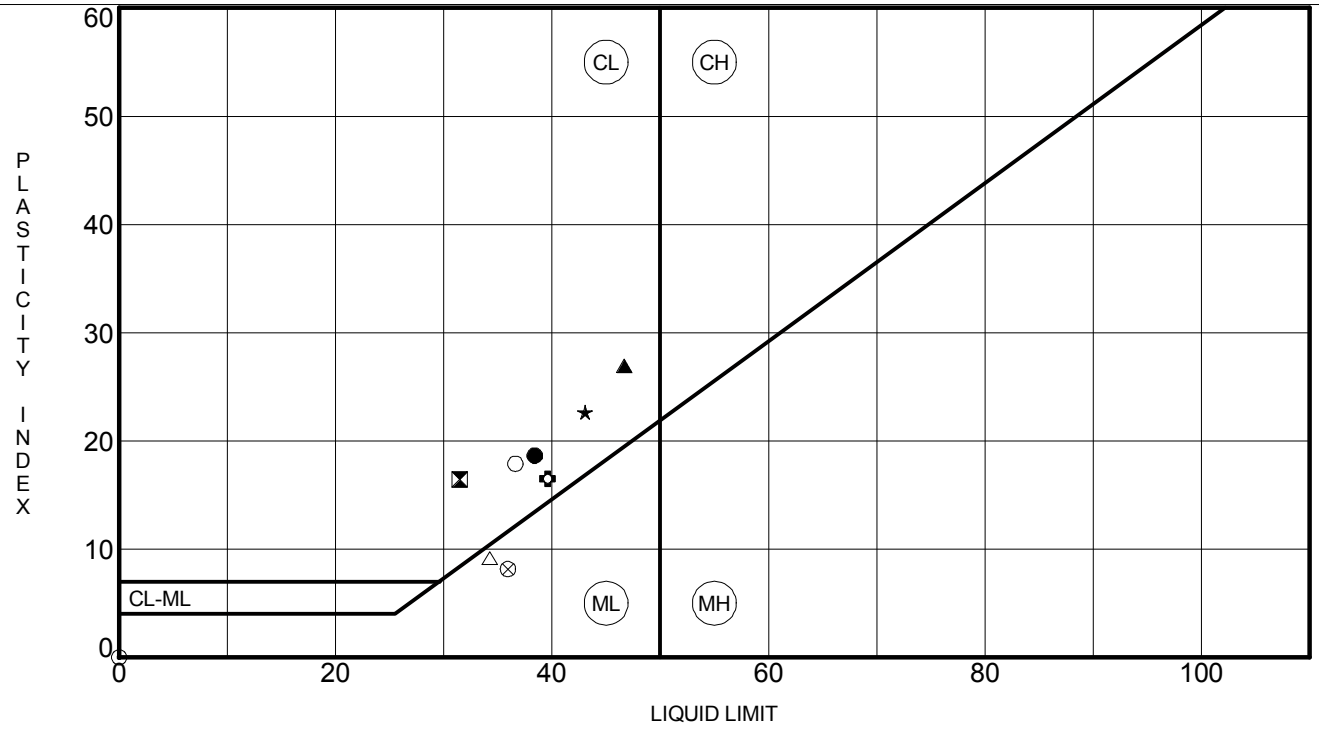
ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



	Specimen Identification		LL	PL	PI	Fines	Classification
●	RW-2	1-5.0	38	20	18	43.9	CLAYEY SAND with GRAVEL (SC)
⊠	RW-2	9	31	15	16	29.8	CLAYEY SAND with GRAVEL (SC)
▲	RW-2	19	47	20	27	76.1	LEAN CLAY with SAND (CL)
★	RW-3	0-10.0	43	20	23	54.3	SANDY LEAN CLAY (CL)
⊙	RW-3	2	NP	NP	NP	46.9	SILTY SAND (SM)
✿	RW-3	14	40	23	17	38.2	CLAYEY SAND (SC)
○	RW-4	4	37	19	18	48.8	CLAYEY SAND (SC)
△	RW-4	19	34	25	9	27.1	SILTY SAND (SM)
⊗	RW-5	9	36	28	8	54.3	SANDY SILT (ML)

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GRAIN SIZE DISTRIBUTION

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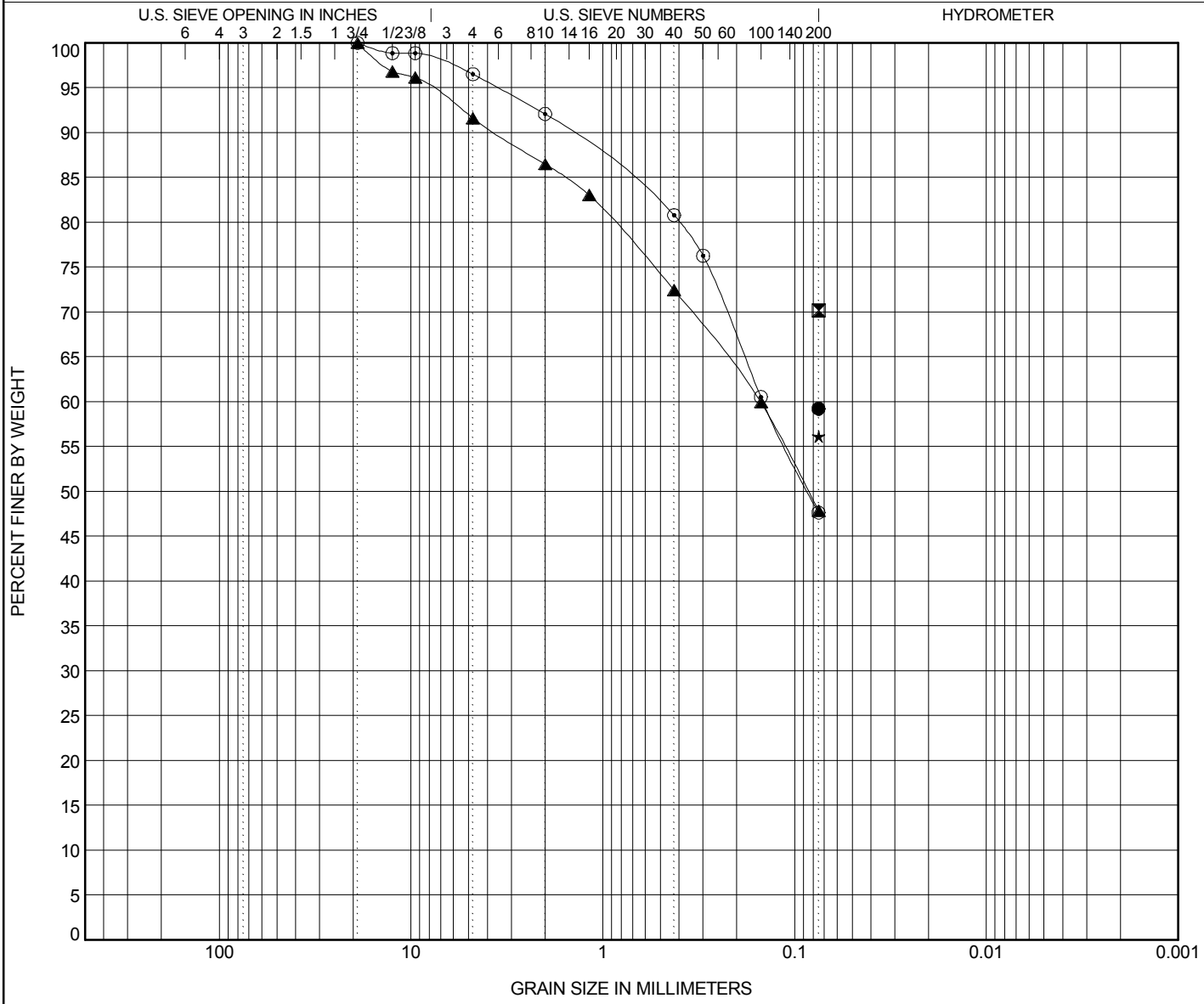
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**BR-1**	**9**	**SANDY LEAN CLAY (CL)**	**32**	**15**	**17**		
⊠	**BR-1**	**29**	**FAT CLAY with SAND (CH)**	**52**	**24**	**28**		
▲	**BR-2**	**1-10.0**	**CLAYEY SAND (SC)**	**40**	**19**	**21**		
★	**BR-2**	**34**	**SANDY LEAN CLAY (CL)**	**38**	**18**	**20**		
⊙	**BR-2**	**54**	**CLAYEY SAND (SC)**	**40**	**22**	**18**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BR-1**	**9**	**0.075**						**59.2**	
⊠	**BR-1**	**29**	**0.075**						**70.2**	
▲	**BR-2**	**1-10.0**	**19**	**0.151**			**8.4**	**43.8**	**47.9**	
★	**BR-2**	**34**	**0.075**						**56.1**	
⊙	**BR-2**	**54**	**19**	**0.146**			**3.5**	**48.9**	**47.6**	

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GRAIN SIZE DISTRIBUTION

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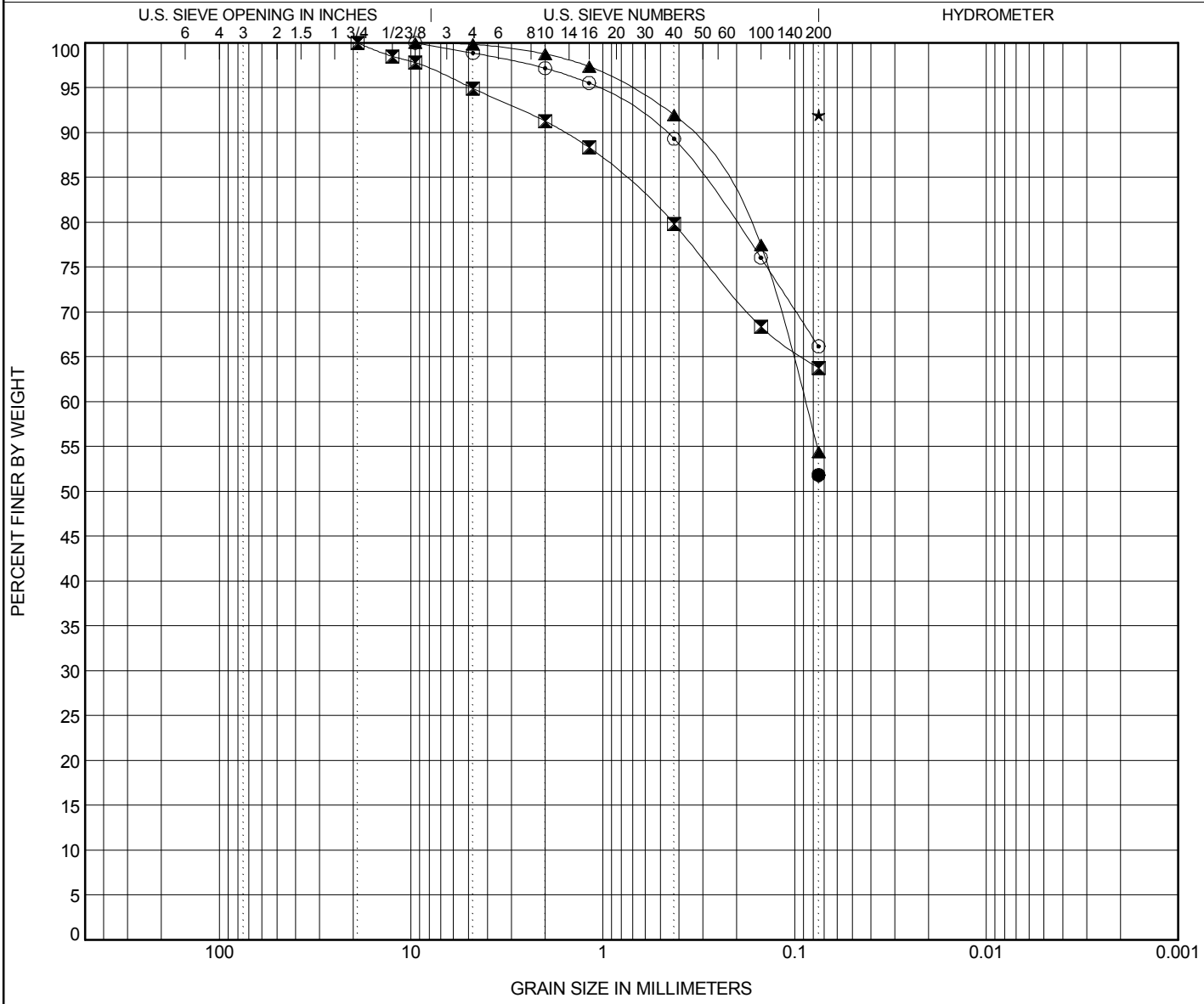

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BR-2	64	(Bedrock) CLAYSTONE (CL)	46	24	22		
⊠	BR-3	2-14.0	SANDY LEAN CLAY (CL)	40	25	15		
▲	BR-3	19	SANDY SILT (ML)	32	29	3		
★	BR-3	49	(Bedrock) SILTSTONE (MH)	59	37	22		
⊙	BR-4	0-10.0	SANDY LEAN CLAY (CL)	46	22	24		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-2	64	0.075						51.8	
⊠	BR-3	2-14.0	19				5.1	31.1	63.8	
▲	BR-3	19	9.5	0.089			0.2	45.5	54.4	
★	BR-3	49	0.075						92.0	
⊙	BR-4	0-10.0	9.5				1.1	32.7	66.2	

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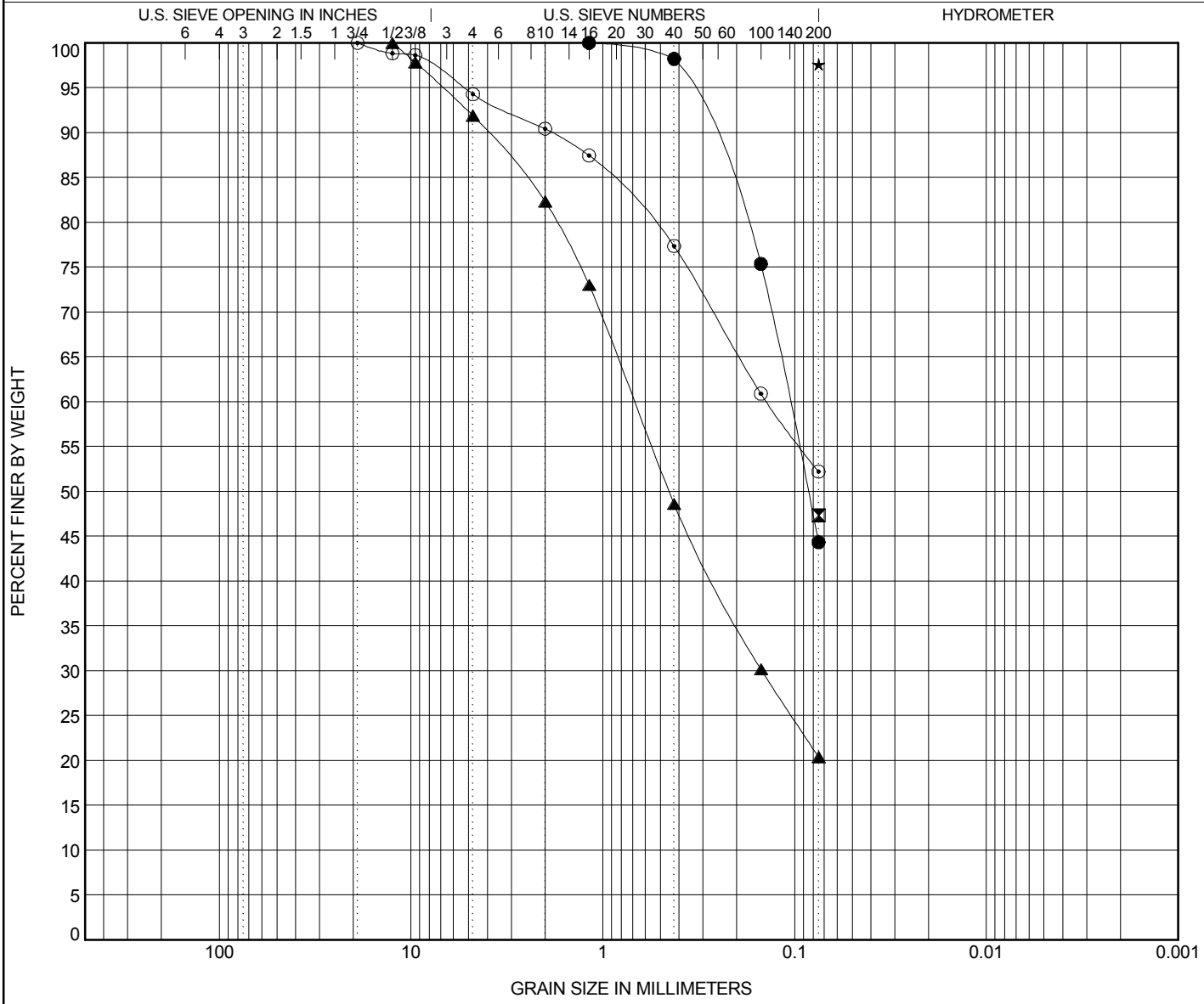

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BR-4	14	CLAYEY SAND (SC)	39	25	14		
⧓	BR-4	29	CLAYEY SAND (SC)	41	23	18		
▲	BR-4	39	SILTY SAND (SM)	26	24	2		
★	BR-4	49	(Bedrock) CLAYSTONE (CH)	61	29	32		
⊙	BR-5	1-10.0	SANDY LEAN CLAY (CL)	46	19	27		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-4	14	1.18	0.106			0.0	55.7	44.3	
⧓	BR-4	29	0.075						47.4	
▲	BR-4	39	12.5	0.684	0.148		8.1	71.5	20.4	
★	BR-4	49	0.075						97.6	
⊙	BR-5	1-10.0	19	0.14			5.7	42.1	52.2	

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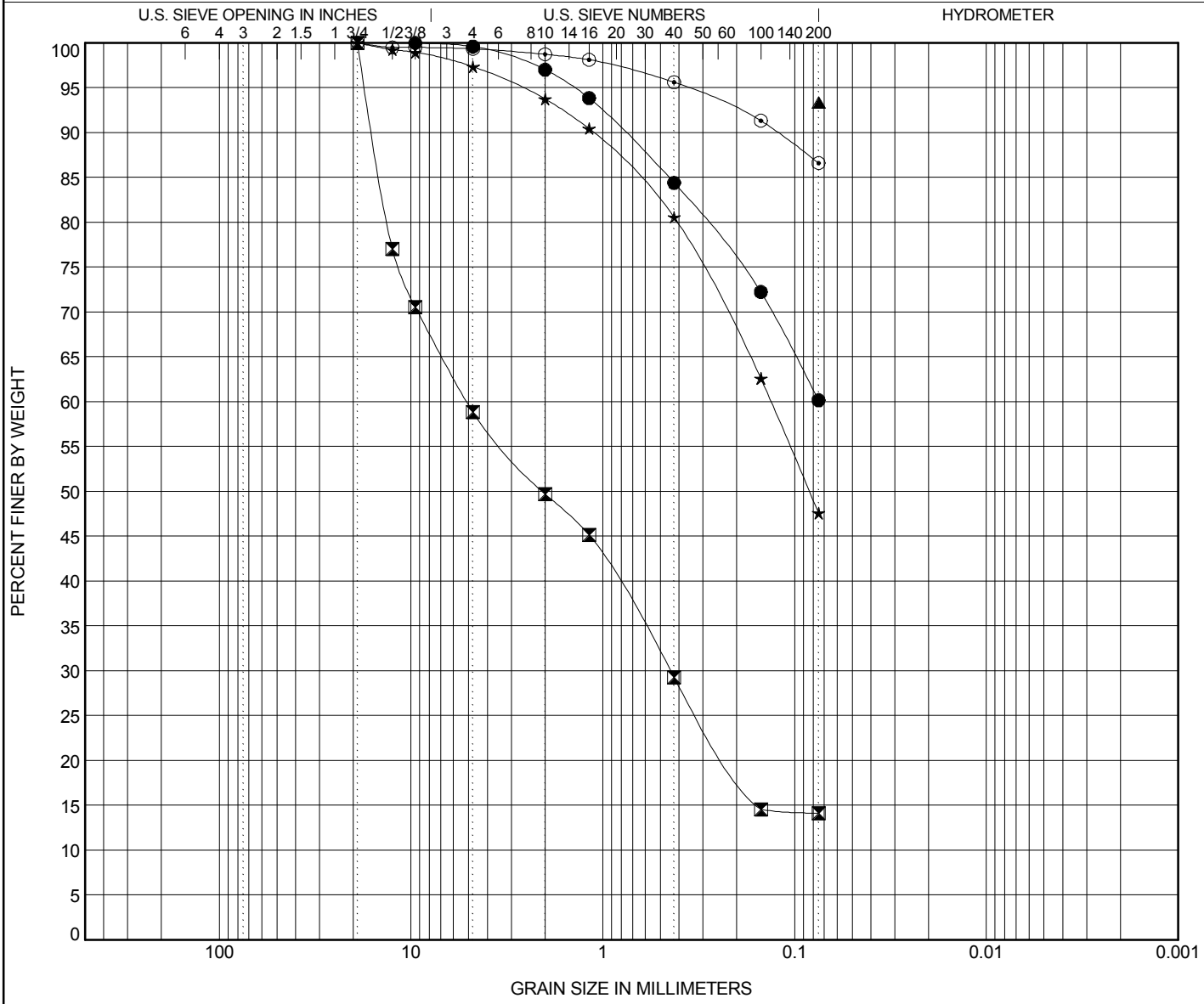

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BR-5	10-20.0	SANDY FAT CLAY (CH)	52	22	30		
⊠	BR-6	2	SILTY SAND with GRAVEL (SM)	NP	NP	NP		
▲	BR-6	54	(Bedrock) SILTSTONE (MH)	60	39	21		
★	PV-1	1-10.0	CLAYEY SAND (SC)	46	22	24		
⊙	PV-2	1-5.0	LEAN CLAY (CL)	38	16	22		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-5	10-20.0	9.5				0.4	39.4	60.2	
⊠	BR-6	2	19	5.084	0.445		41.1	44.7	14.1	
▲	BR-6	54	0.075						93.3	
★	PV-1	1-10.0	19	0.133			2.6	49.8	47.6	
⊙	PV-2	1-5.0	19				0.7	12.7	86.6	

GRADATION - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

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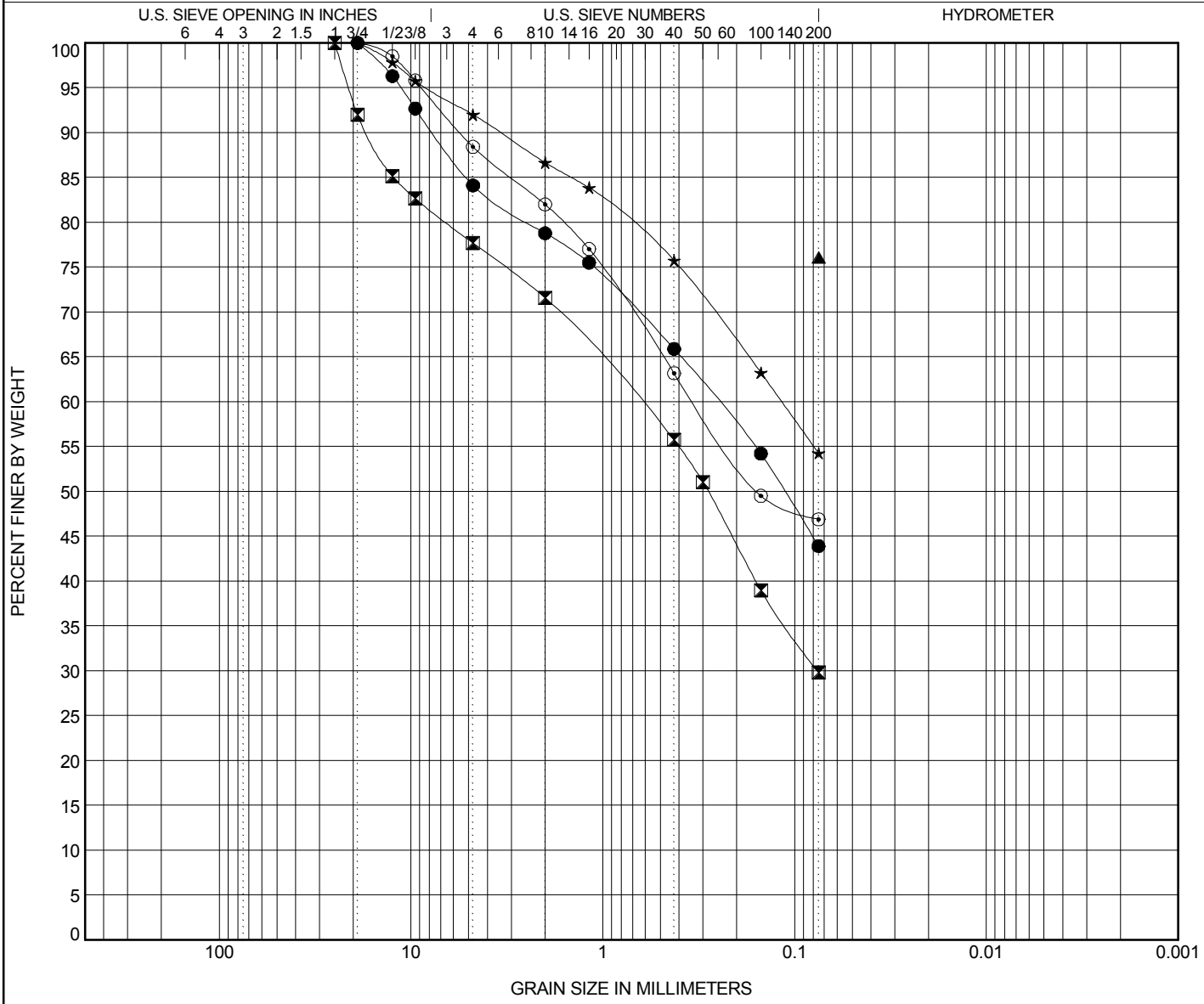

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	RW-2	1-5.0	CLAYEY SAND with GRAVEL (SC)	38	20	18		
⊠	RW-2	9	CLAYEY SAND with GRAVEL (SC)	31	15	16		
▲	RW-2	19	LEAN CLAY with SAND (CL)	47	20	27		
★	RW-3	0-10.0	SANDY LEAN CLAY (CL)	43	20	23		
⊙	RW-3	2	SILTY SAND (SM)	NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RW-2	1-5.0	19	0.251			15.9	40.2	43.9	
⊠	RW-2	9	25	0.645	0.076		22.3	47.9	29.8	
▲	RW-2	19	0.075						76.1	
★	RW-3	0-10.0	19	0.117			8.0	37.7	54.3	
⊙	RW-3	2	19	0.334			11.6	41.5	46.9	

GRADATION - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

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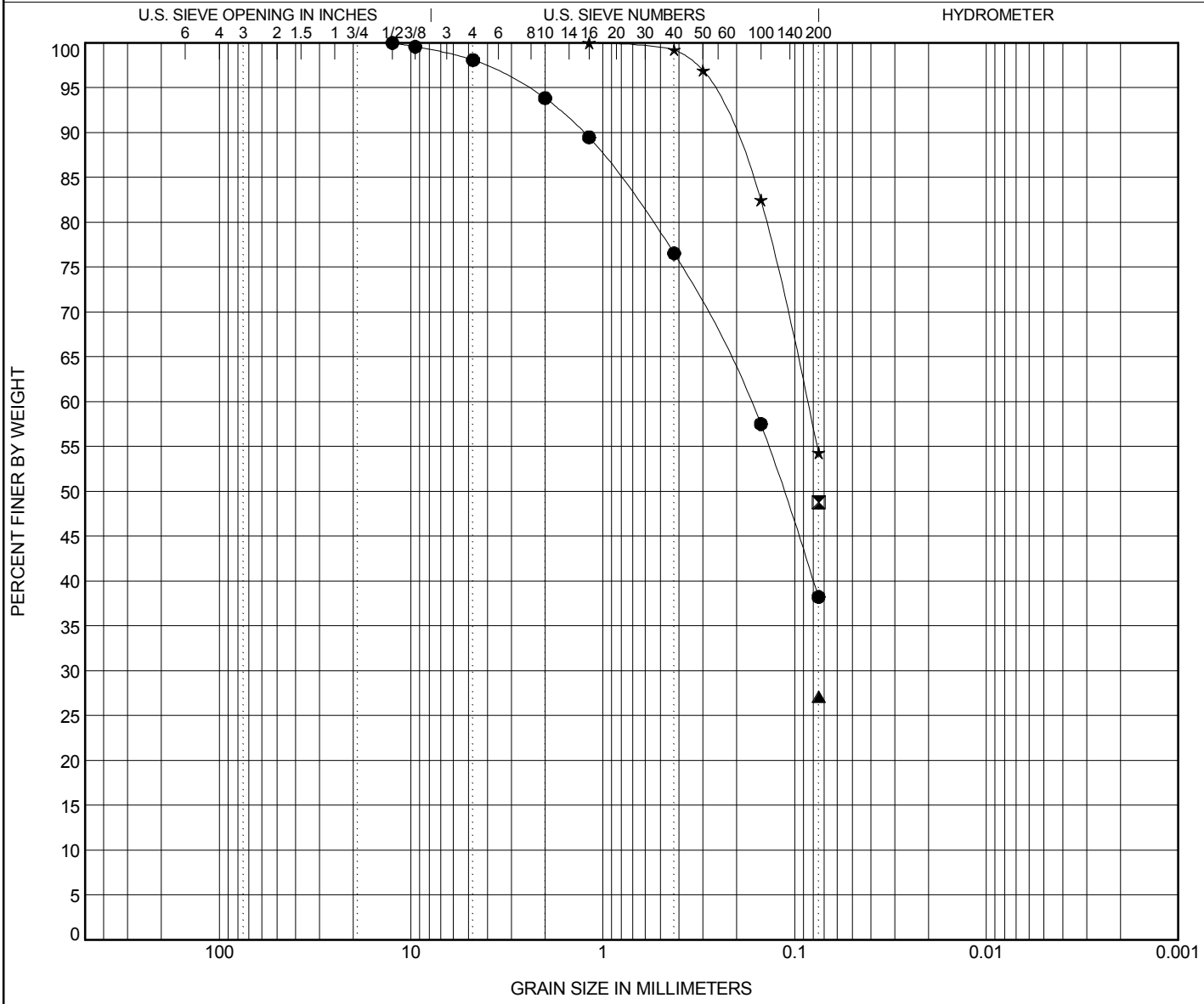


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**RW-3 14**	**CLAYEY SAND (SC)**	**40**	**23**	**17**		
⧓	**RW-4 4**	**CLAYEY SAND (SC)**	**37**	**19**	**18**		
▲	**RW-4 19**	**SILTY SAND (SM)**	**34**	**25**	**9**		
★	**RW-5 9**	**SANDY SILT (ML)**	**36**	**28**	**8**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**RW-3 14**	**12.5**	**0.172**			**1.9**	**59.9**	**38.2**	
⧓	**RW-4 4**	**0.075**						**48.8**	
▲	**RW-4 19**	**0.075**						**27.1**	
★	**RW-5 9**	**1.18**	**0.086**			**0.0**	**45.7**	**54.3**	

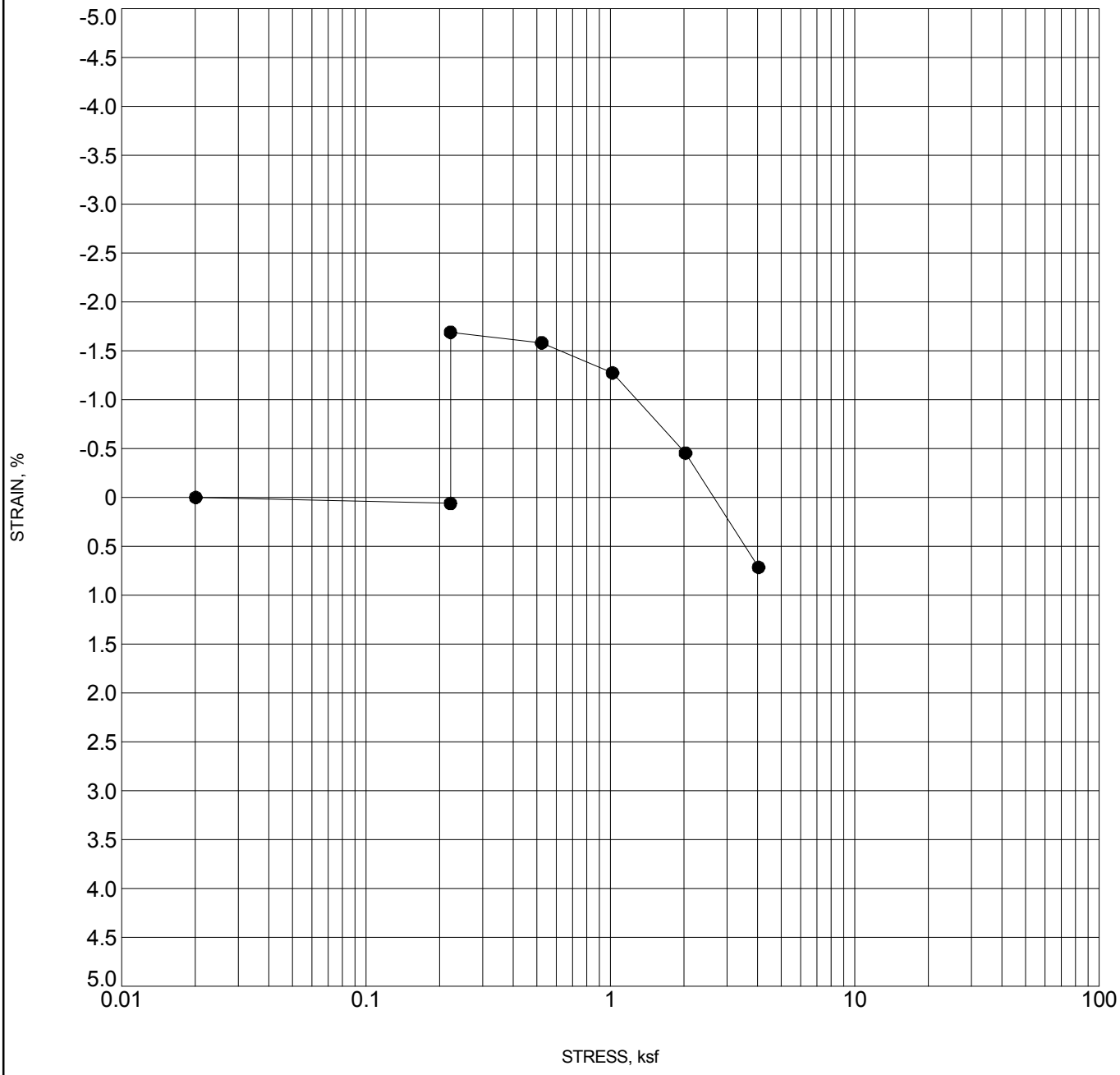
GRADATION - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-1 4**	**SANDY CLAY**	**1.8**	**104.8**	**21.4**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

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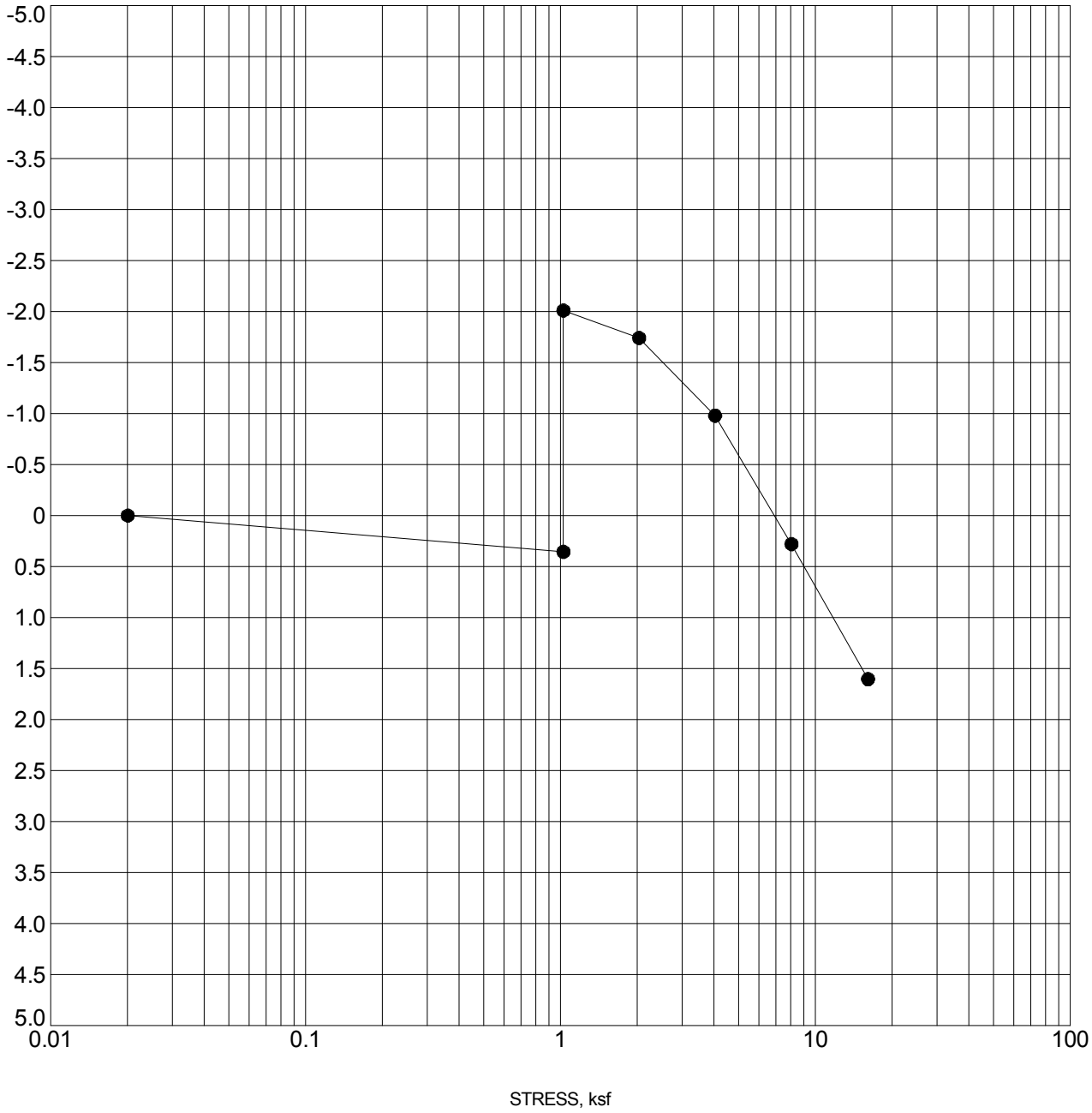

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-1**	**79**	**(Bedrock) CLAYSTONE**	**2.4**	**107.7**	**20.9**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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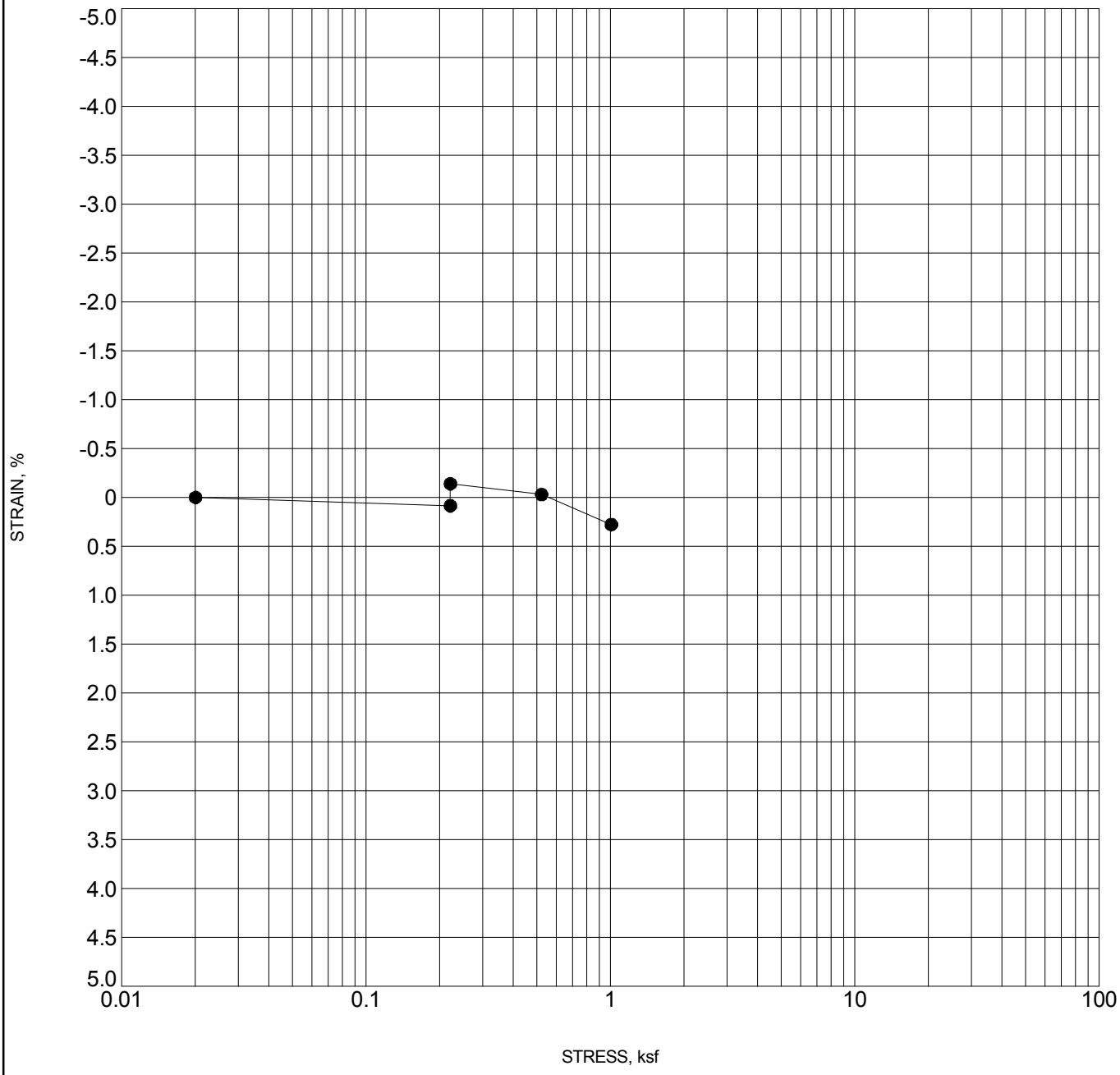
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-2 4**	**SANDY CLAY**	**0.2**	**98.2**	**24.9**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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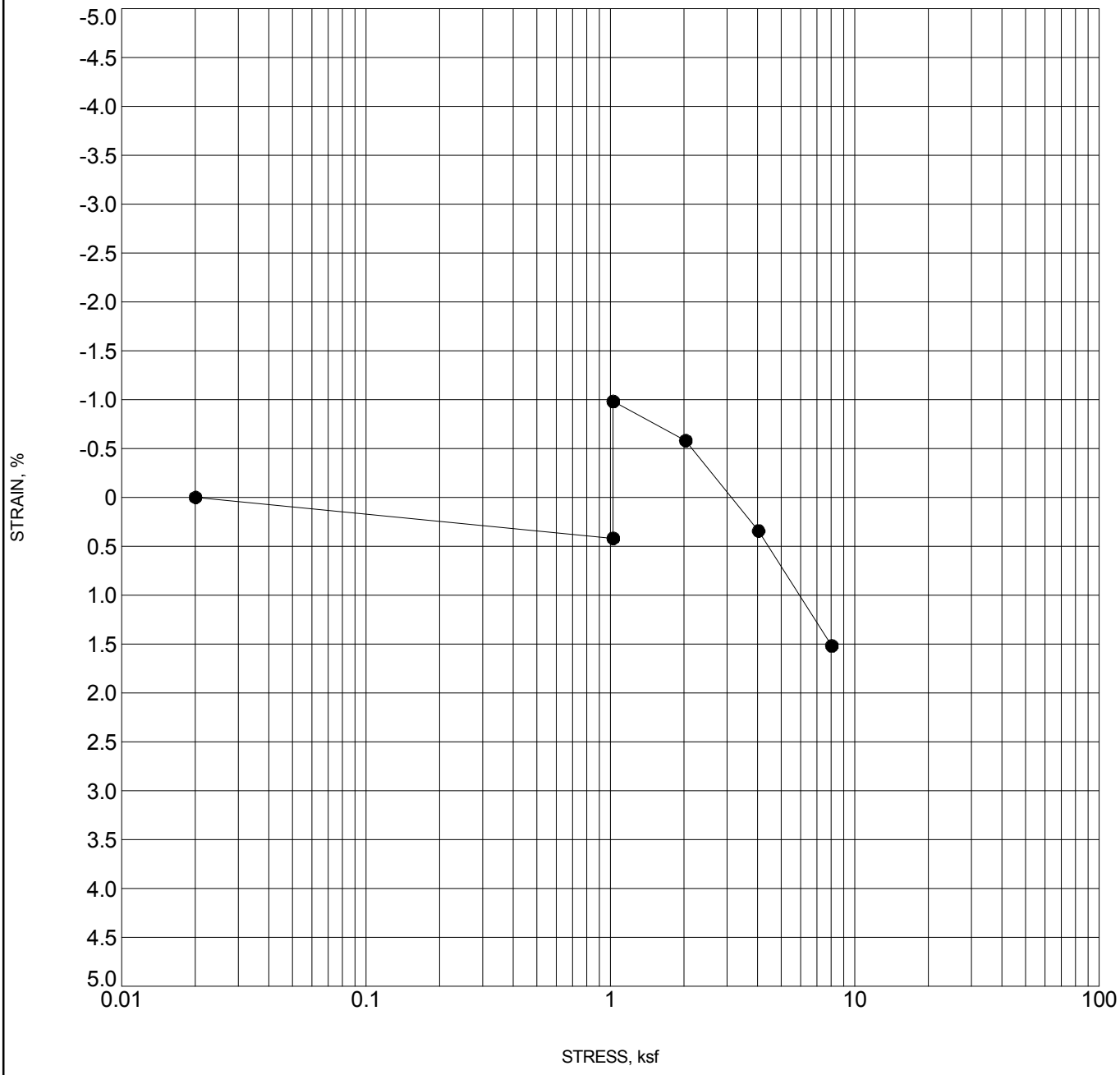

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-2**	**69**	**(Bedrock) CLAYSTONE**	**1.4**	**93.8**	**26.2**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

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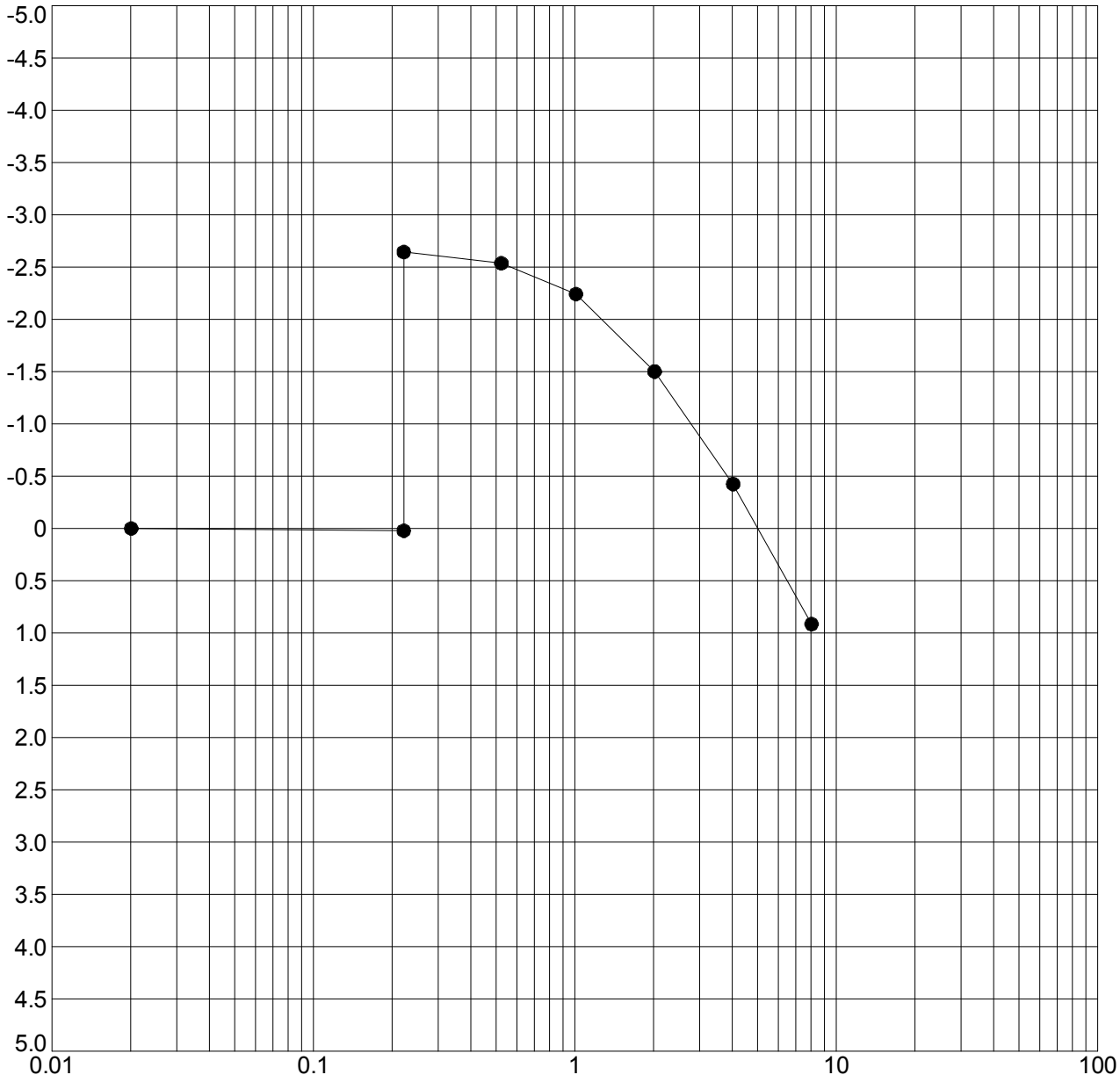
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



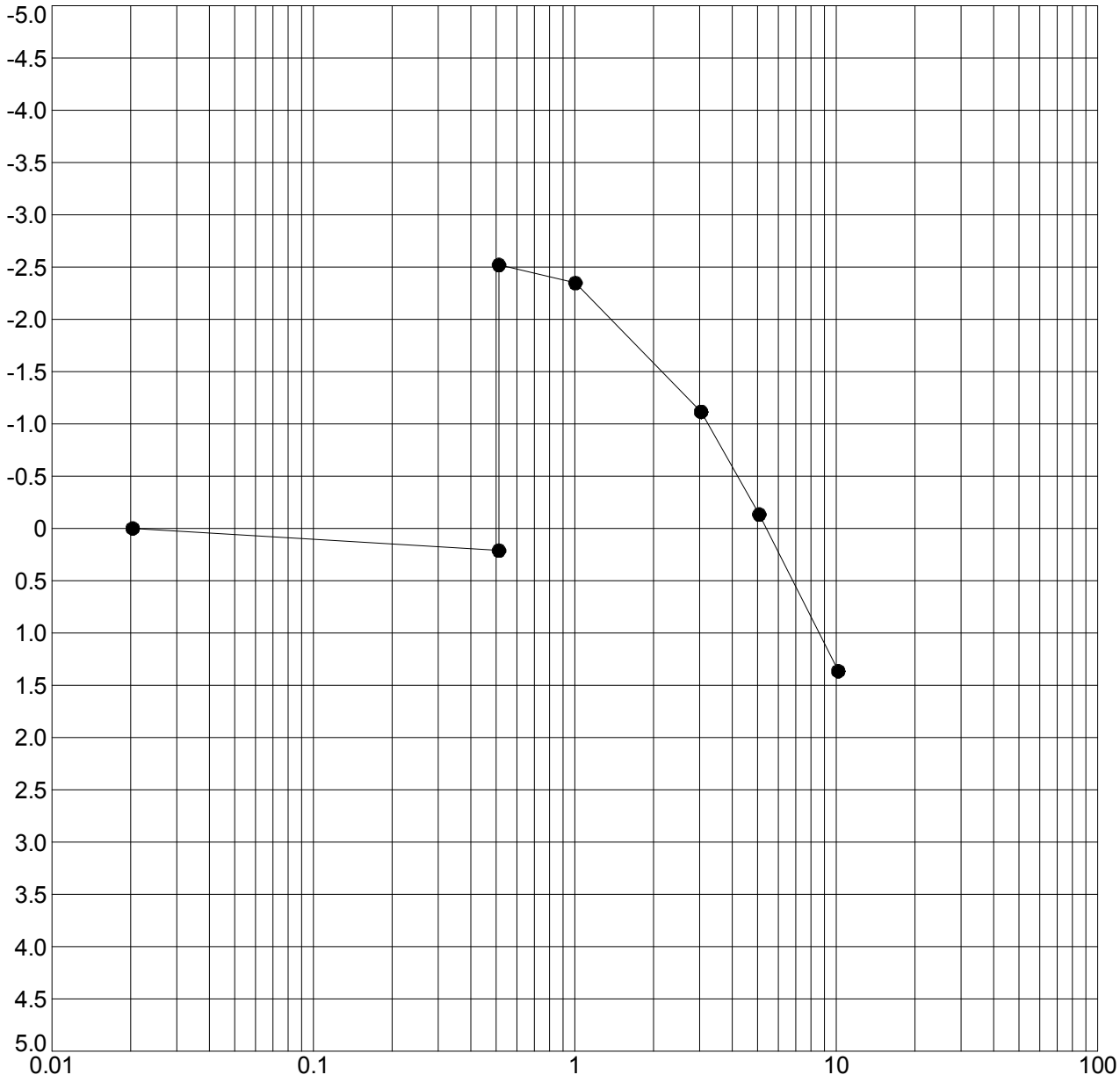
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-3 2**	**SANDY CLAY**	**2.7**	**110.3**	**15.3**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-3 4**	**SANDY CLAY**	**2.7**	**117.2**	**14.6**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

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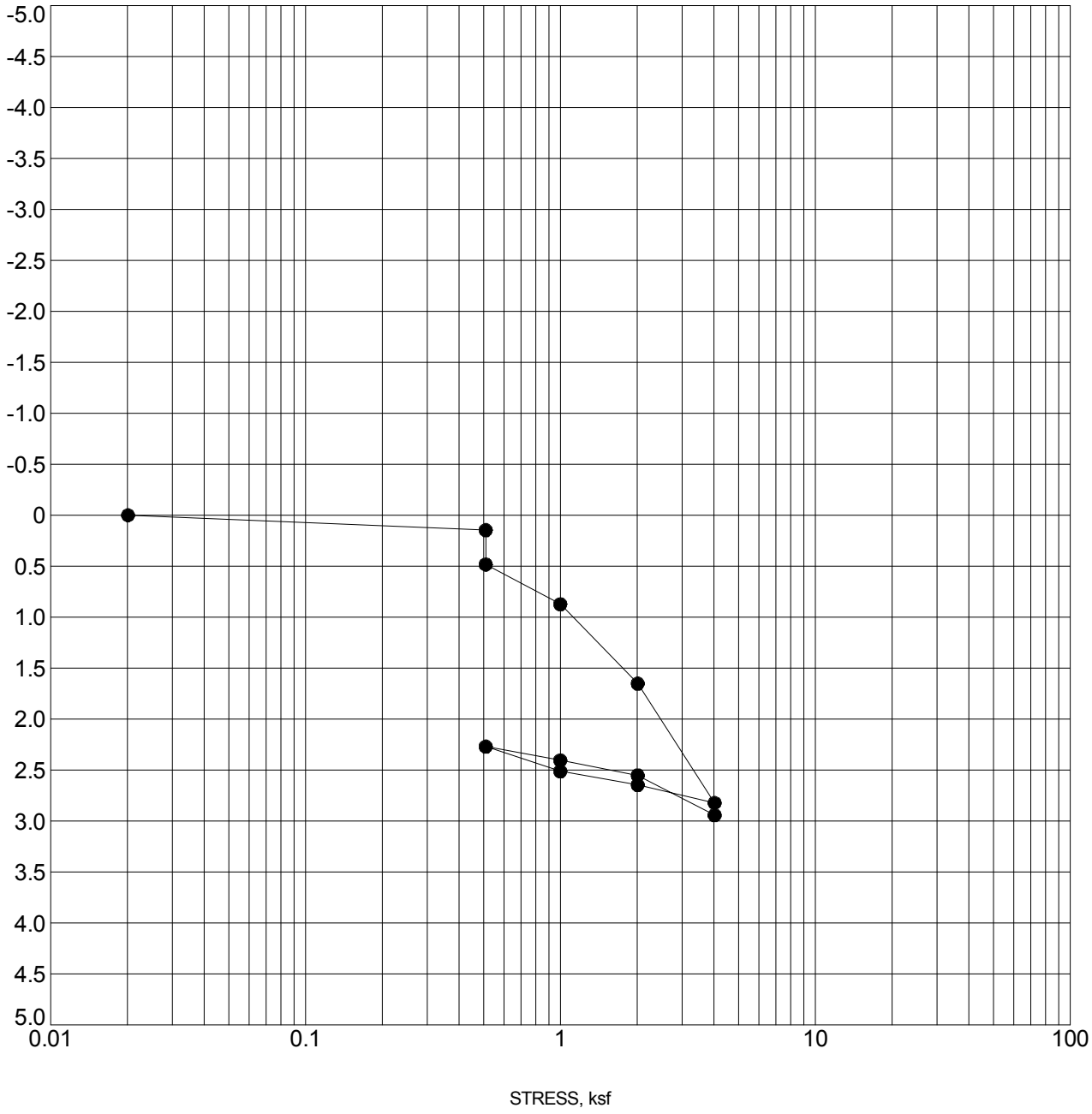
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-3 9**	**SANDY CLAY**	**-0.3**	**108.4**	**16.4**

SWELL - CONSOLIDATION TEST

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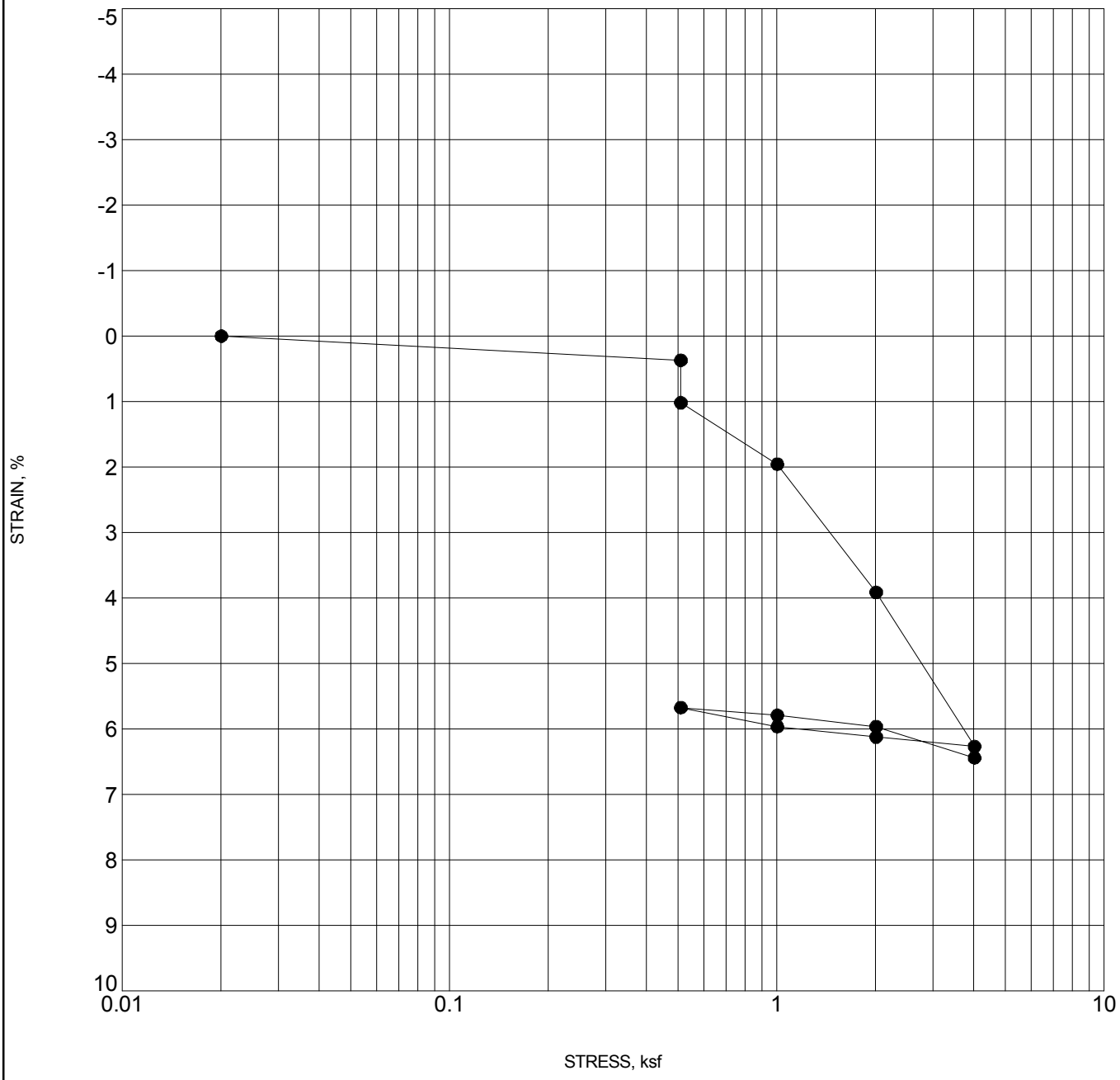
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-3**	**14**	**SANDY CLAY**	**-0.7**	**94.2**	**28.6**

SWELL - CONSOLIDATION TEST

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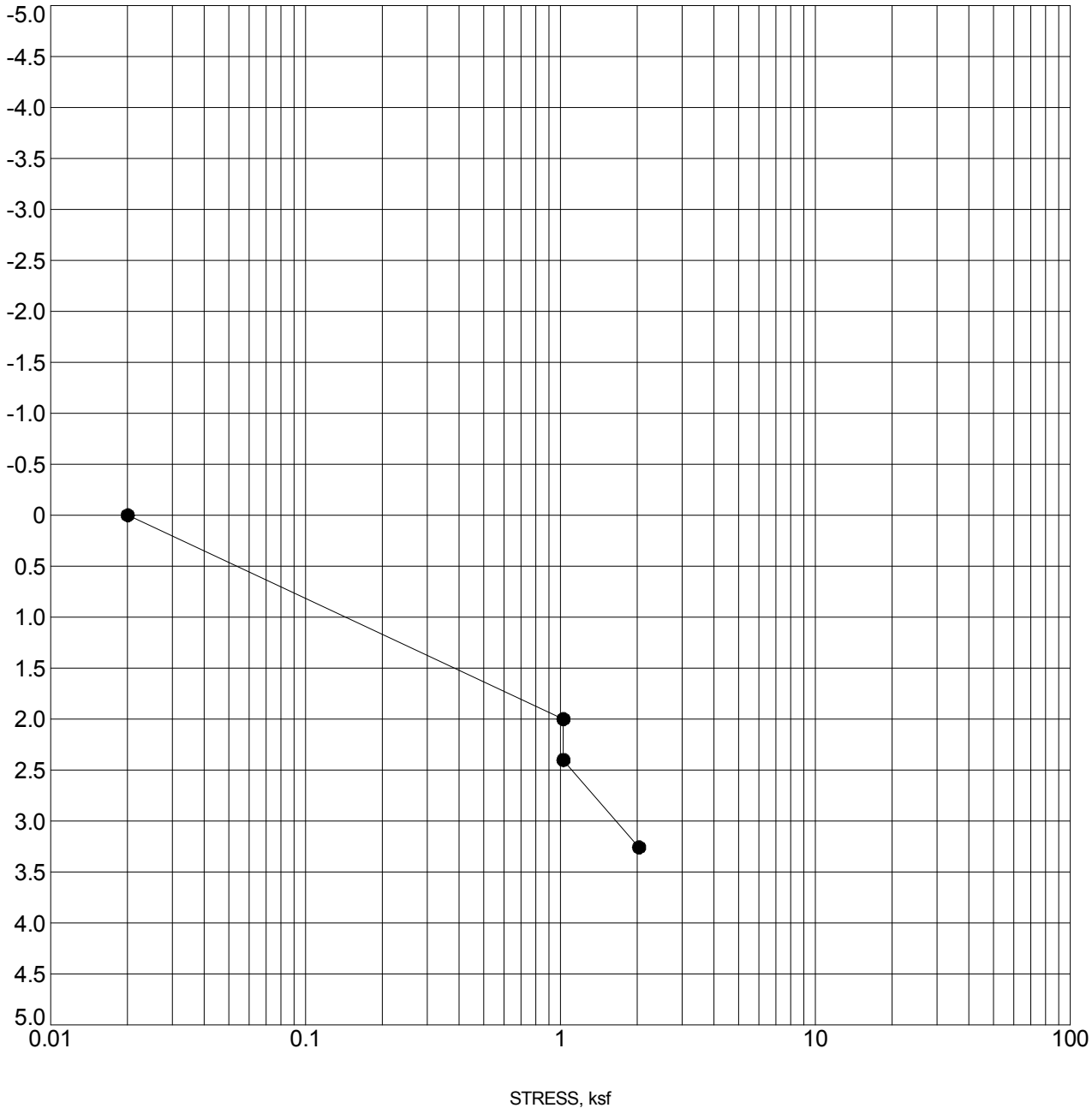

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-3**	**24**	**CLAYEY SAND**	**-0.4**	**97.6**	**27.3**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

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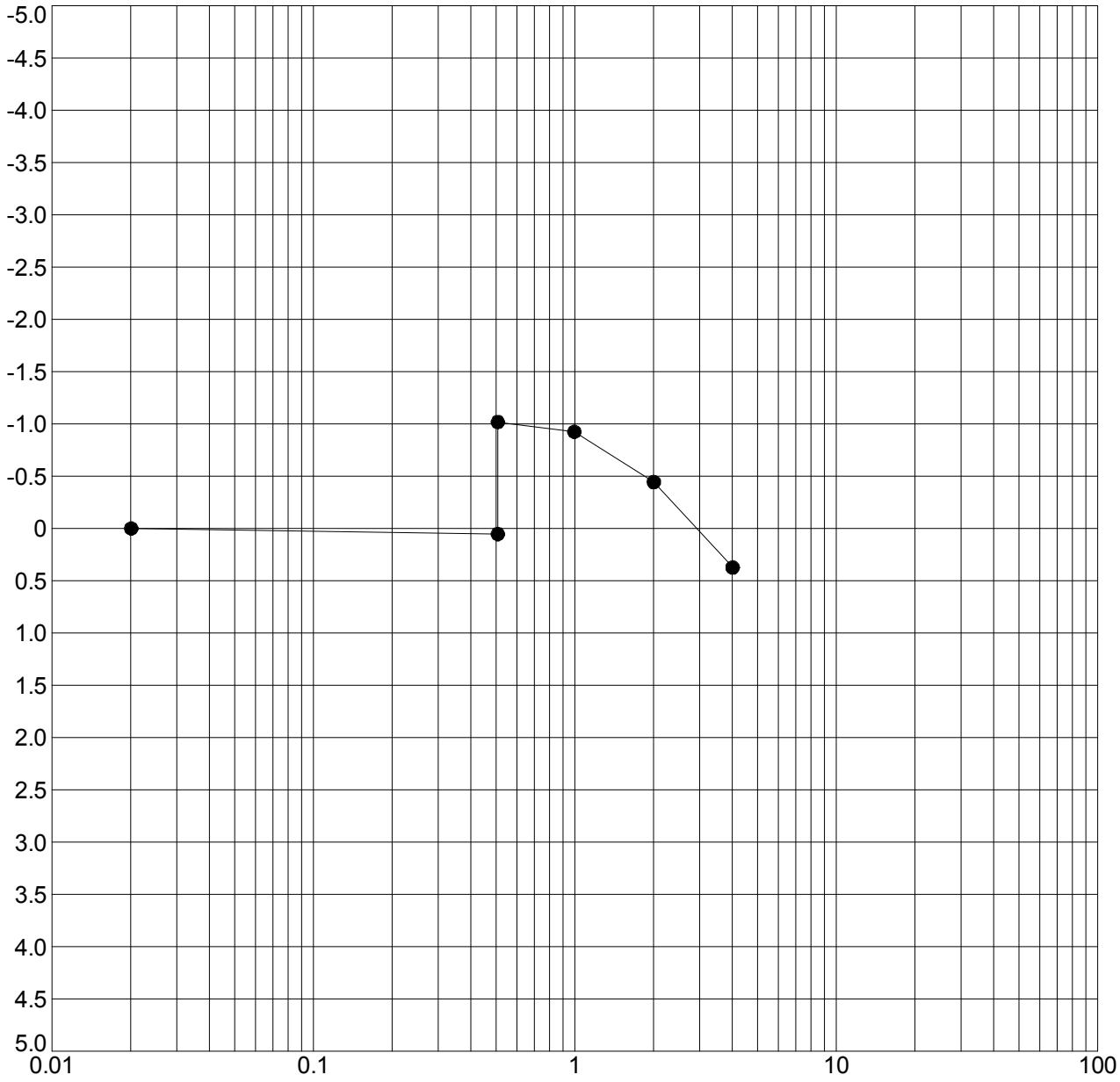
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-4 4**	**SANDY CLAY**	**1.1**	**108.2**	**19.8**

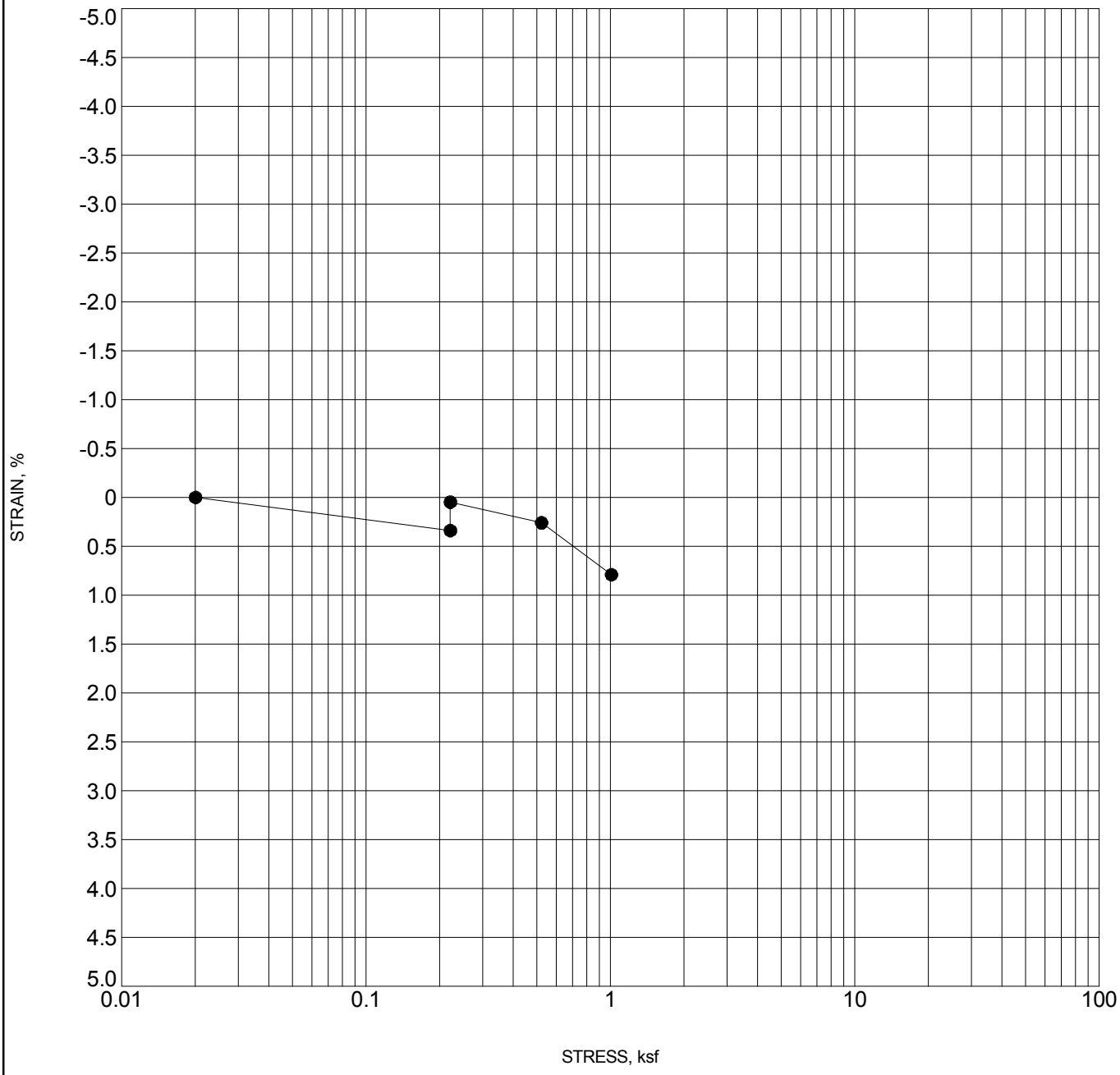
SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-5 4**	**SANDY CLAY**	**0.3**	**97.3**	**26.7**

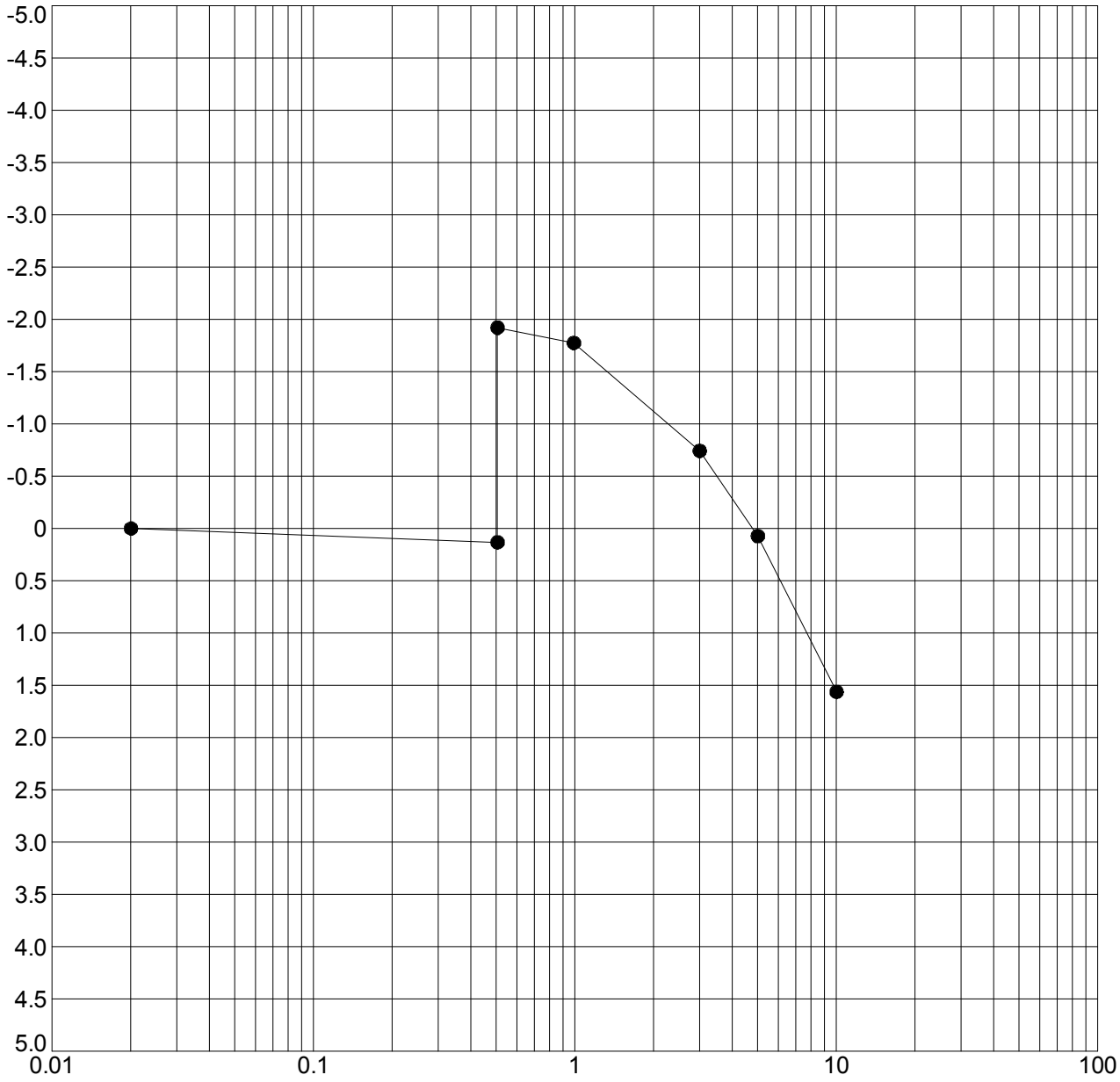
SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6 4**	**SANDY CLAY**	**2.1**	**109.5**	**19.2**

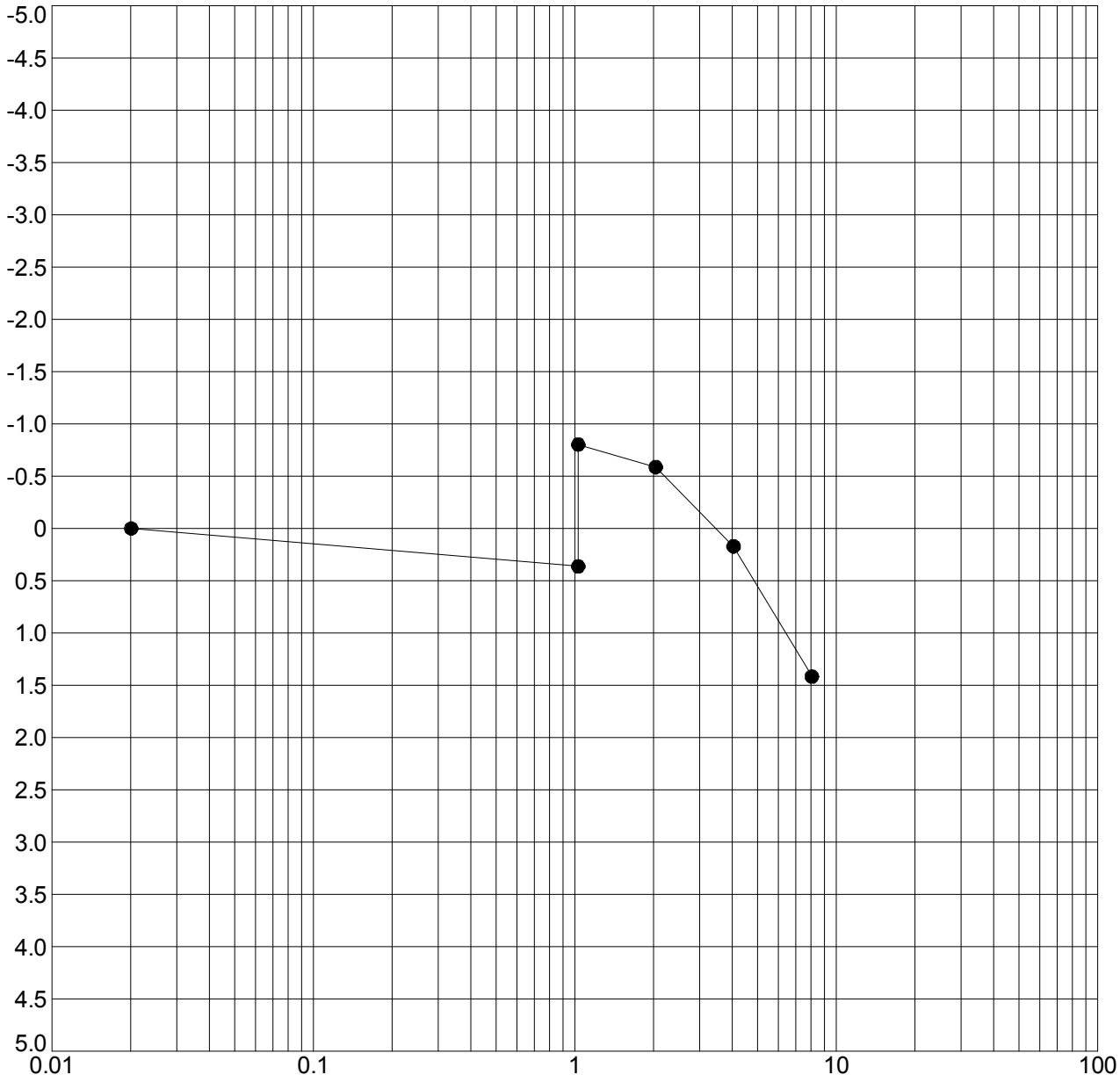
SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6 9**	**SANDY CLAY**	**1.2**	**103.8**	**21.7**

SWELL - CONSOLIDATION TEST

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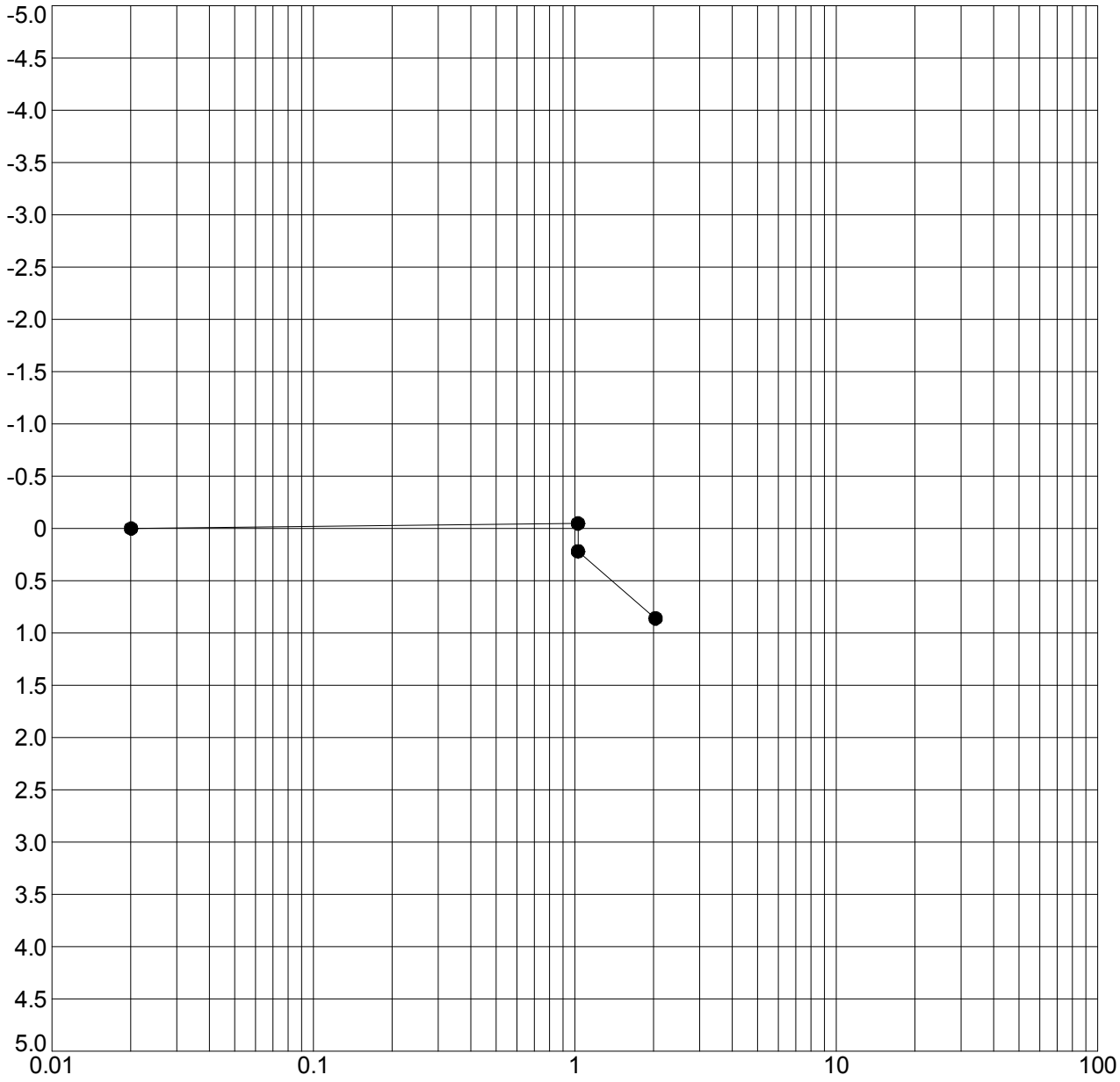

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6 14**	**SANDY CLAY**	**-0.3**	**99.8**	**24.8**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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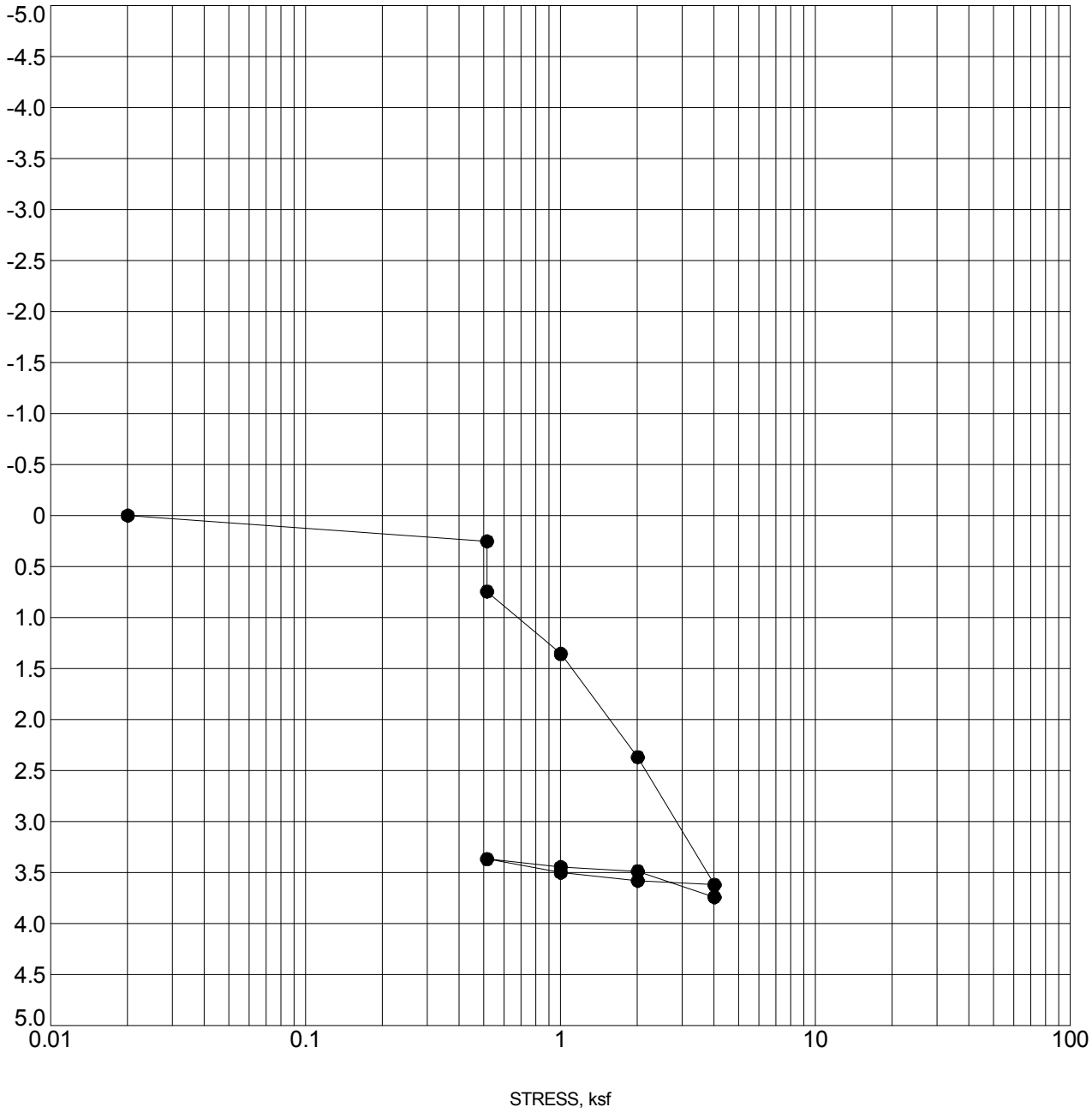
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**19**	**SANDY CLAY**	**-0.5**	**100.9**	**25.1**

SWELL - CONSOLIDATION TEST

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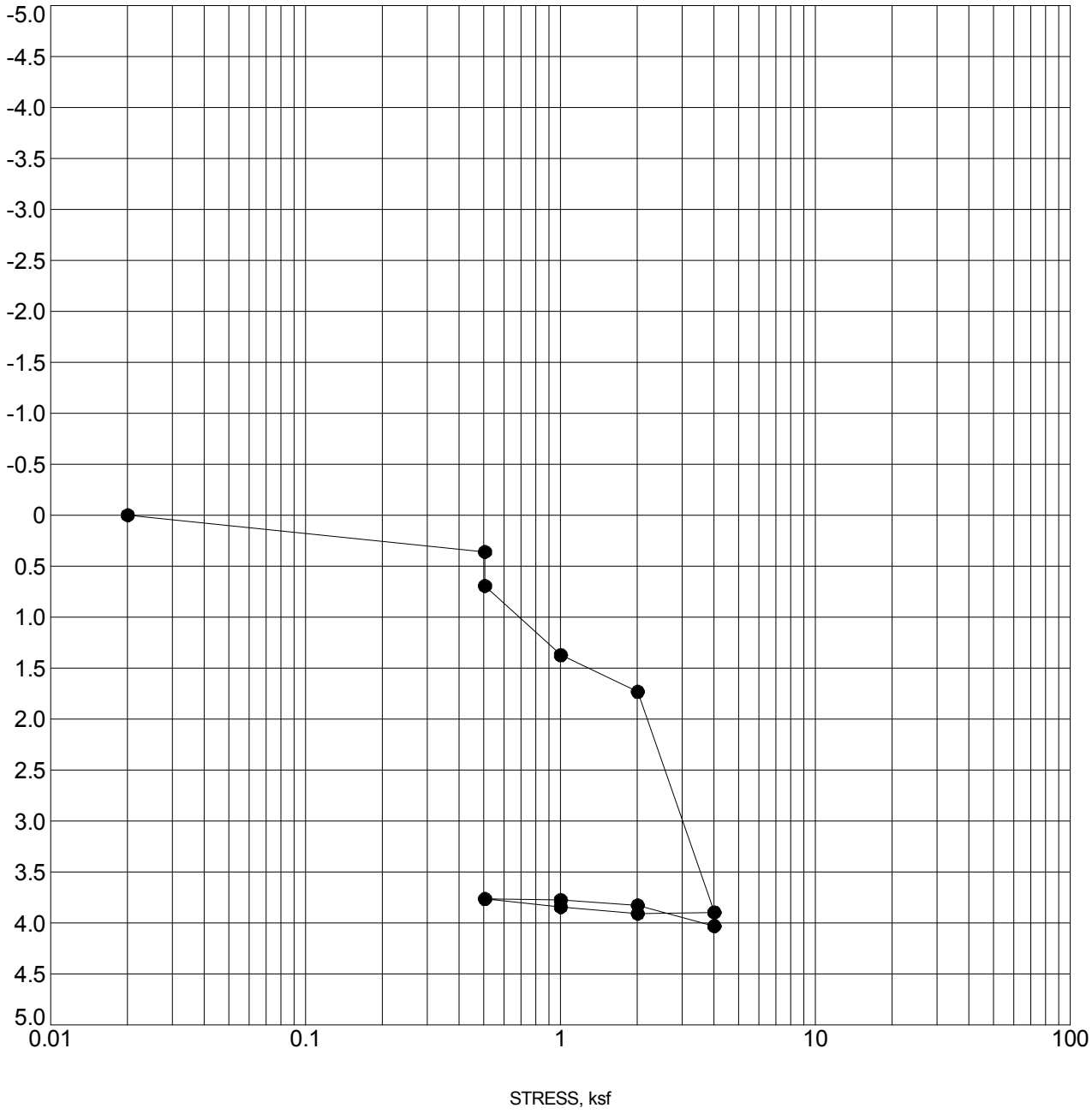
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**24**	**SANDY CLAY**	**-0.3**	**94.5**	**29.9**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

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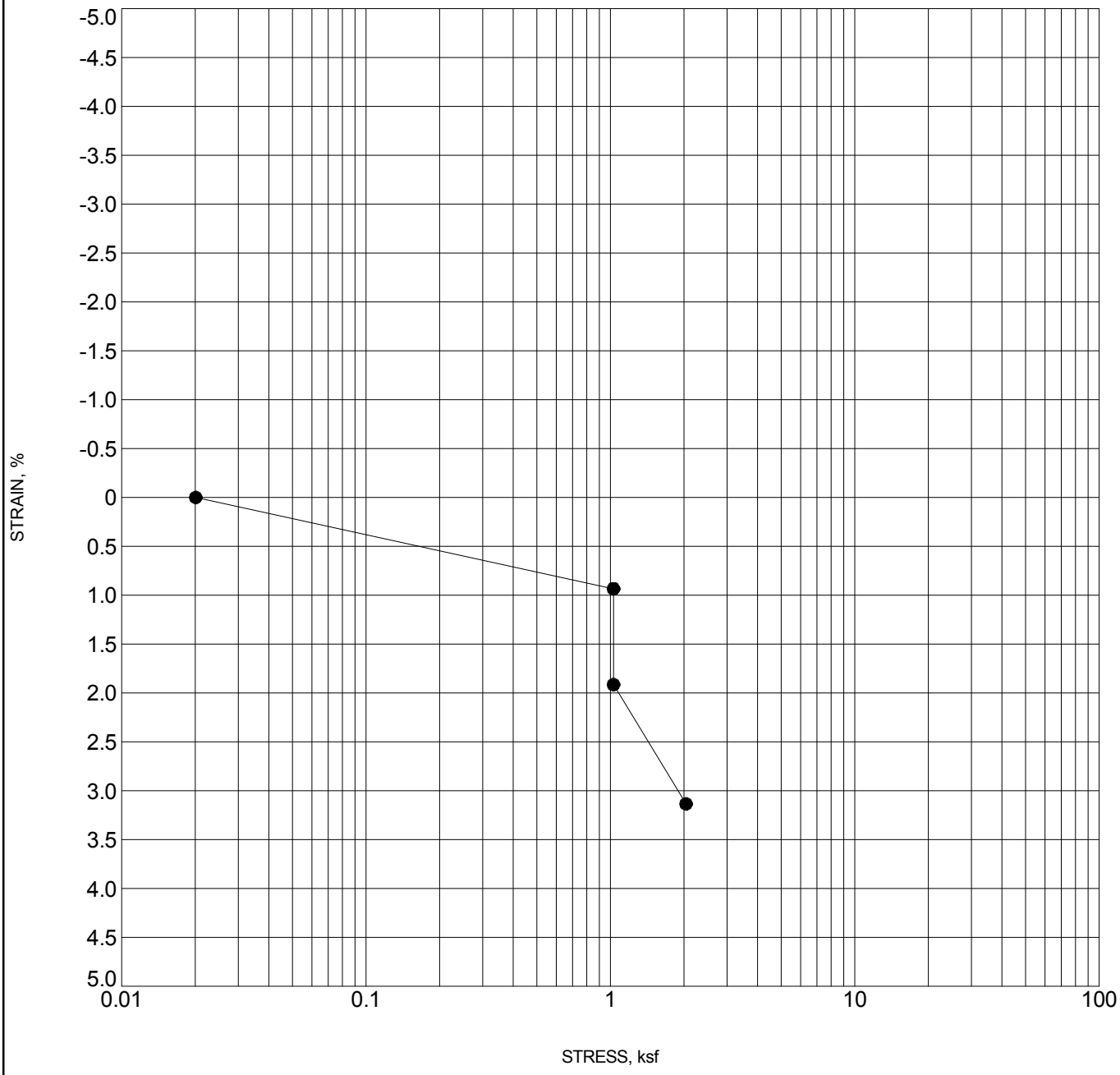
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**29**	**SANDY CLAY**	**-1.0**	**91.7**	**29.8**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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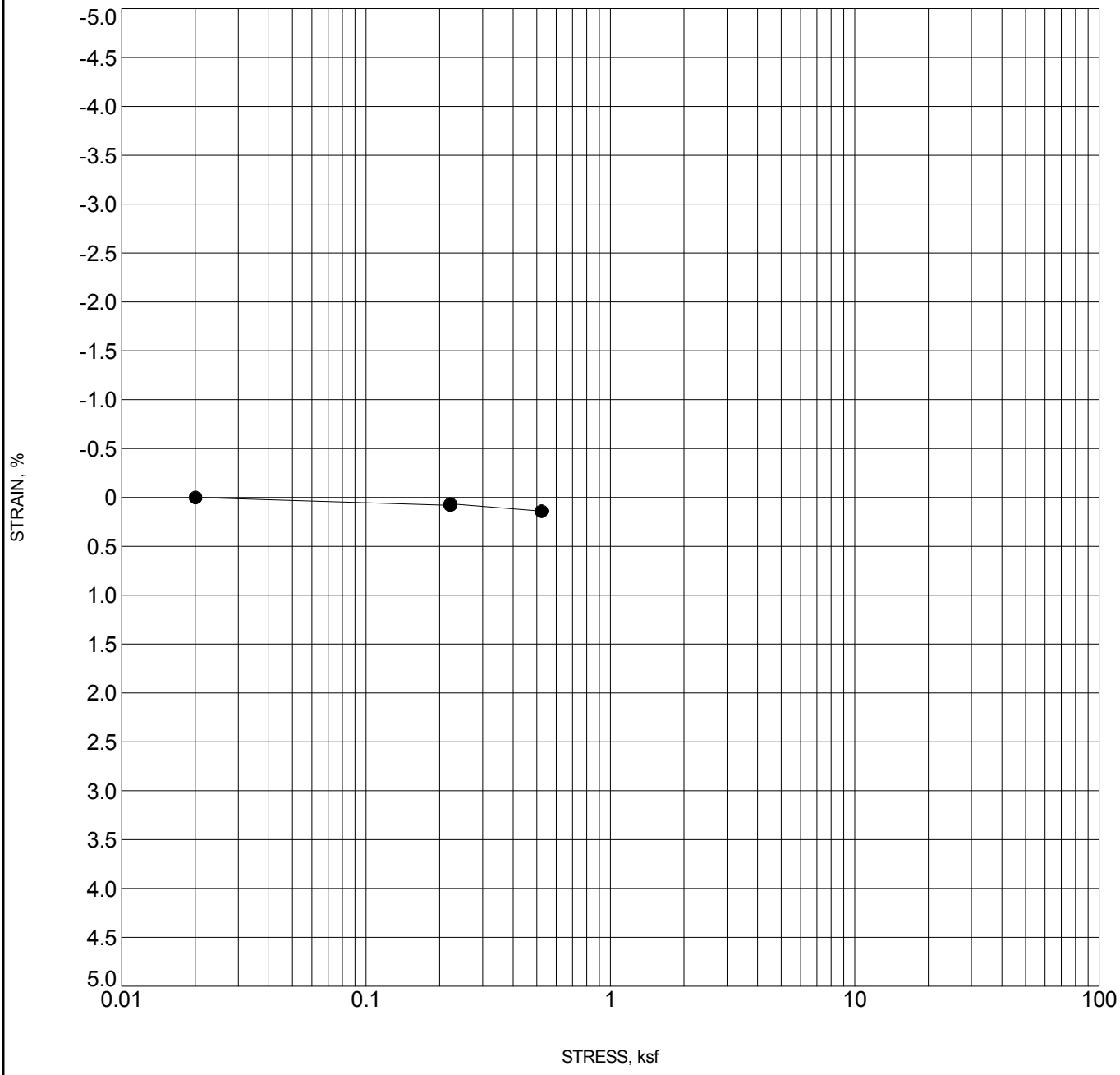

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-1 4**	**SANDY CLAY**	**0.0**	**99.5**	**22.4**

SWELL - CONSOLIDATION TEST

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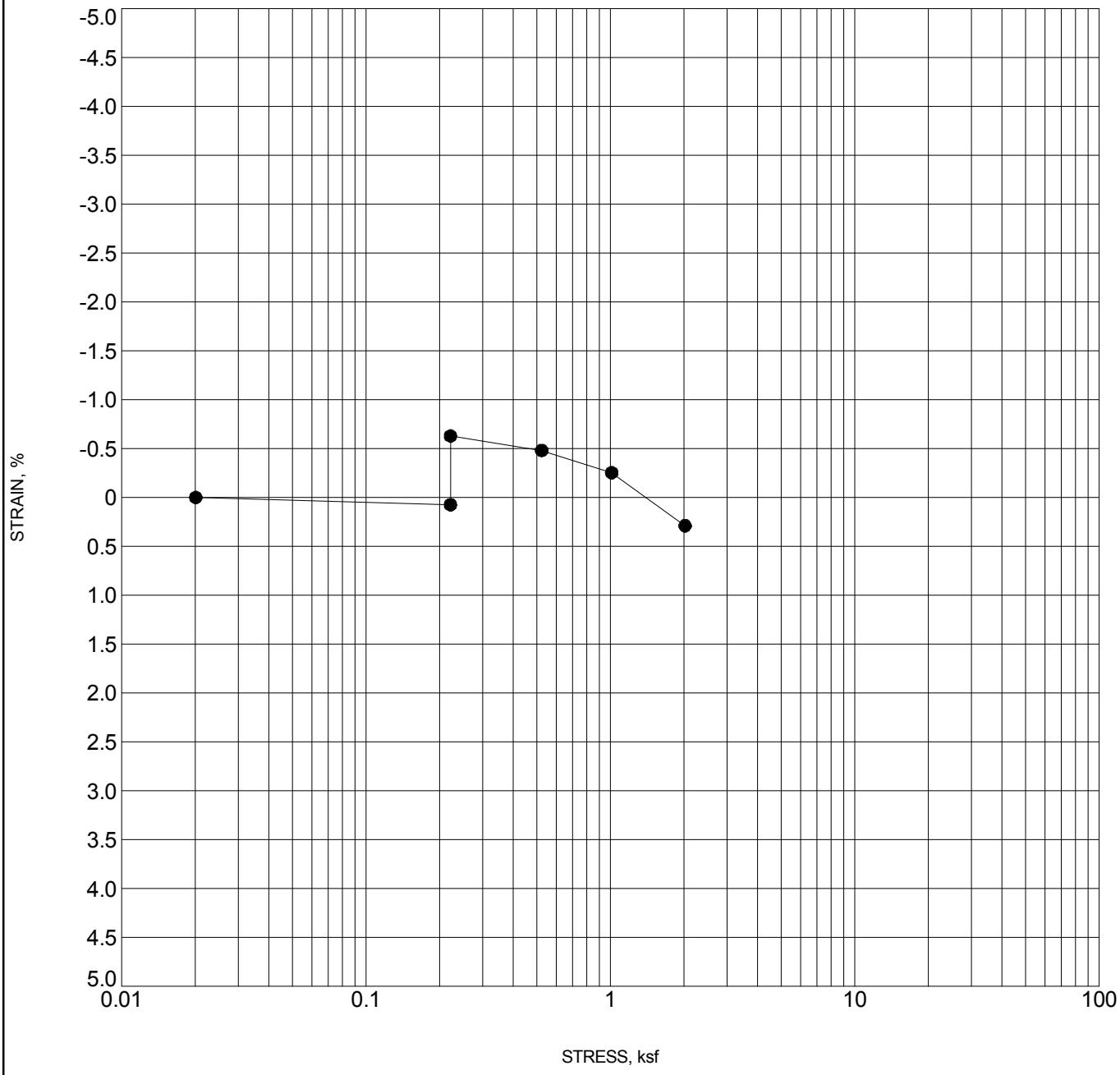
PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-2 4**	**CLAY with SAND**	**0.7**	**102.0**	**23.4**

SWELL - CONSOLIDATION TEST

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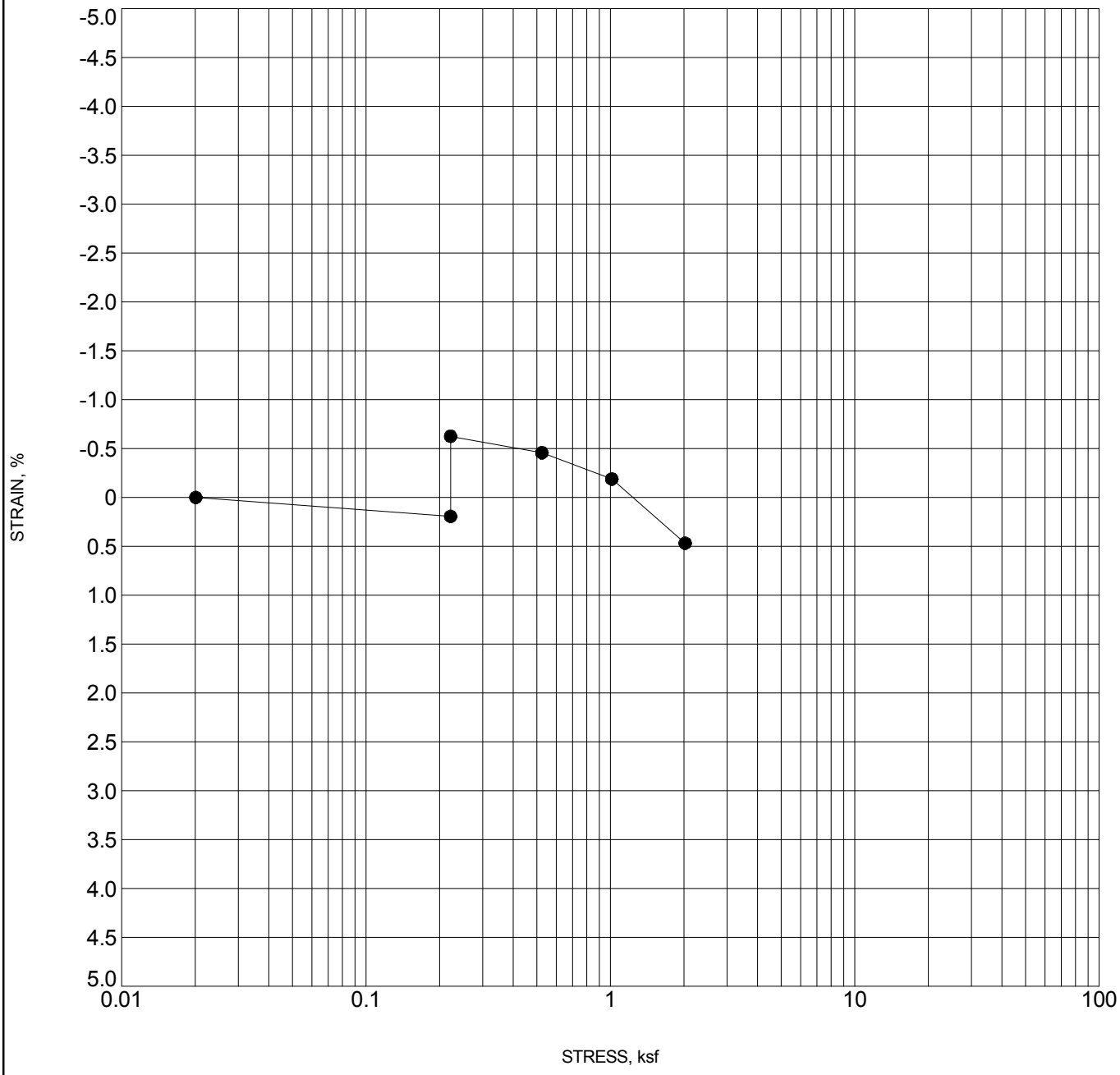

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1 2**	**SANDY CLAY**	**0.8**	**106.2**	**20.6**

SWELL - CONSOLIDATION TEST

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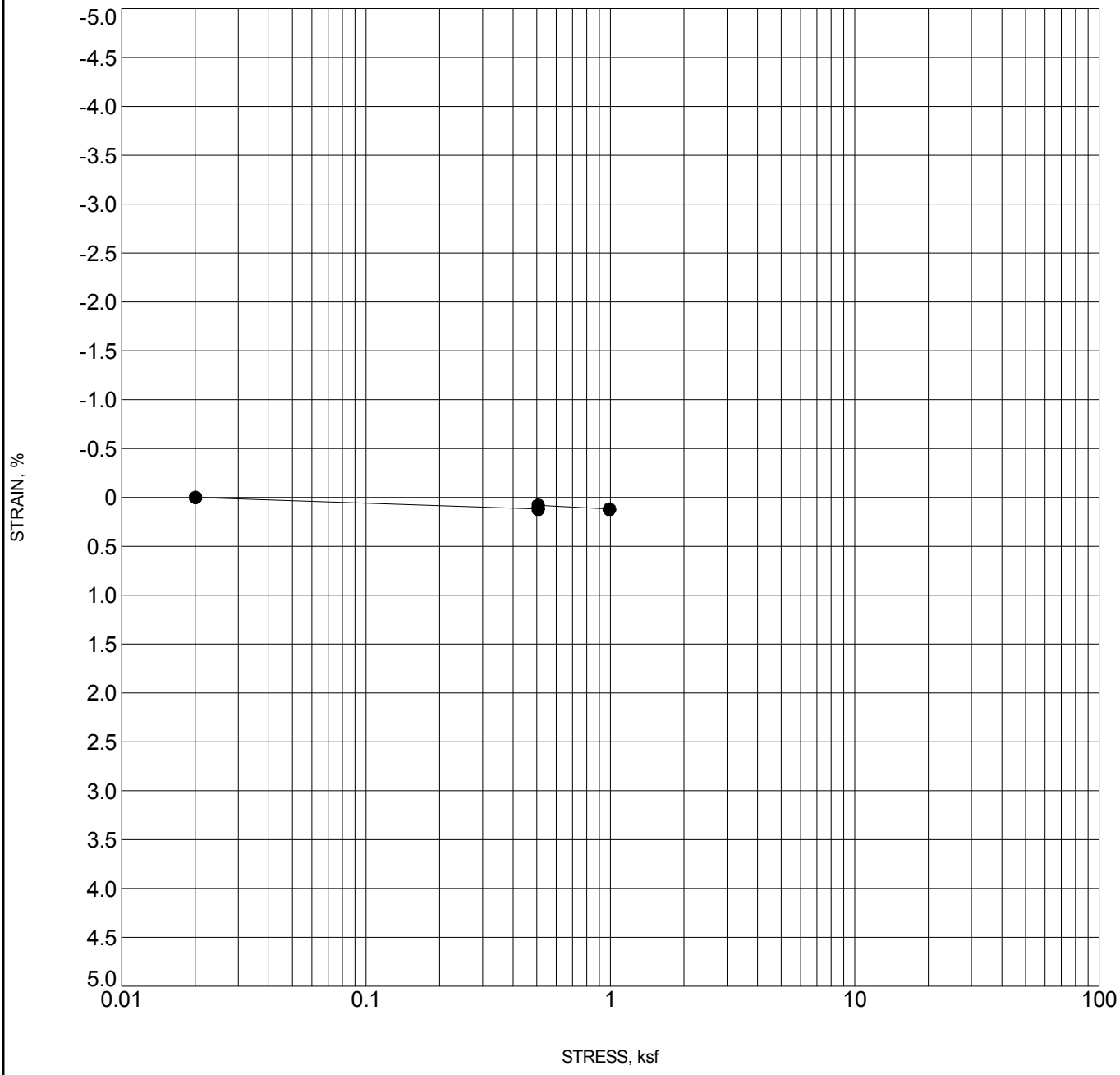

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1 9**	**SANDY CLAY**	**0.0**	**97.7**	**25.4**

SWELL - CONSOLIDATION TEST

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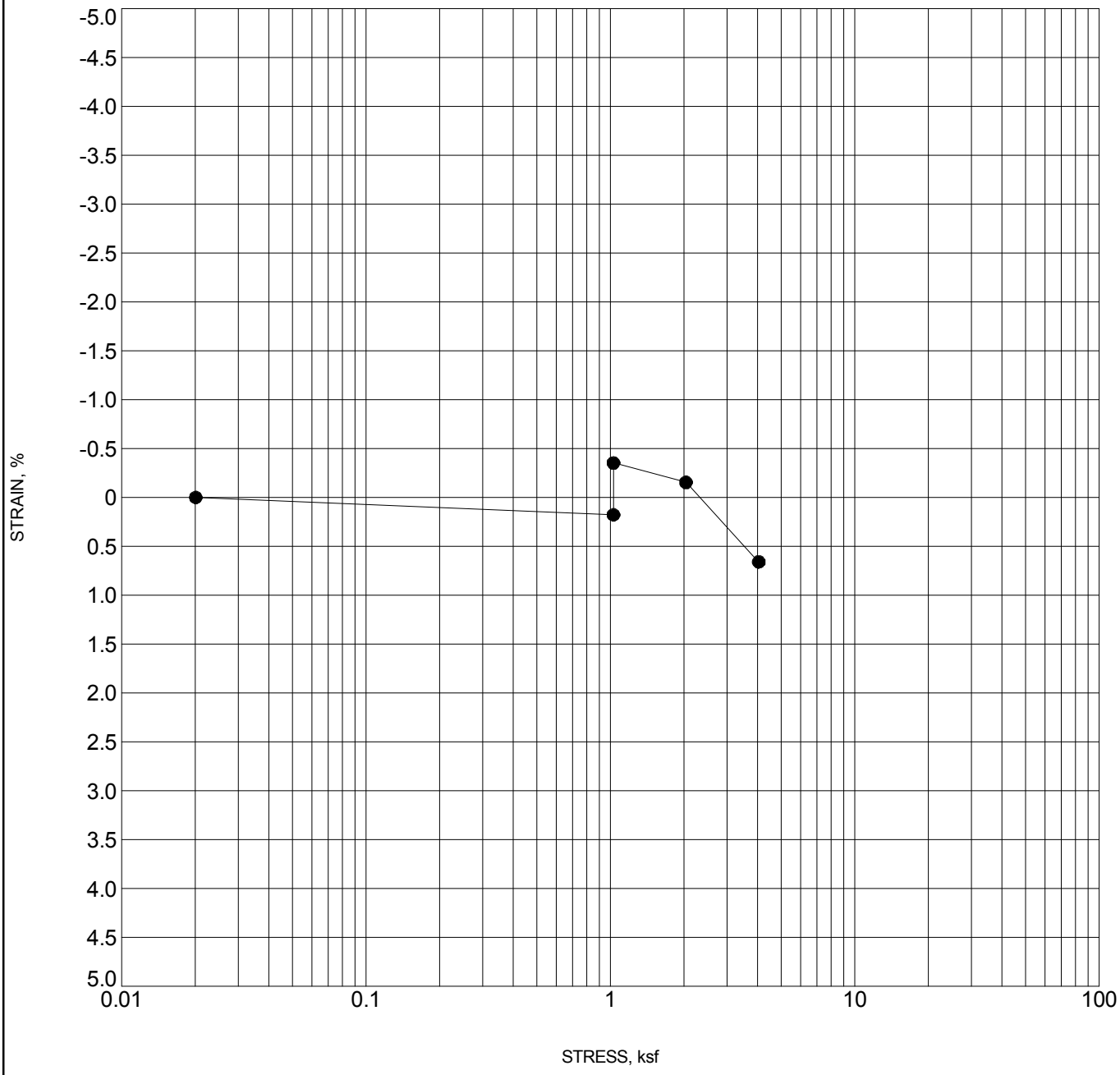

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1**	**14**	**SANDY CLAY**	**0.5**	**96.5**	**26.0**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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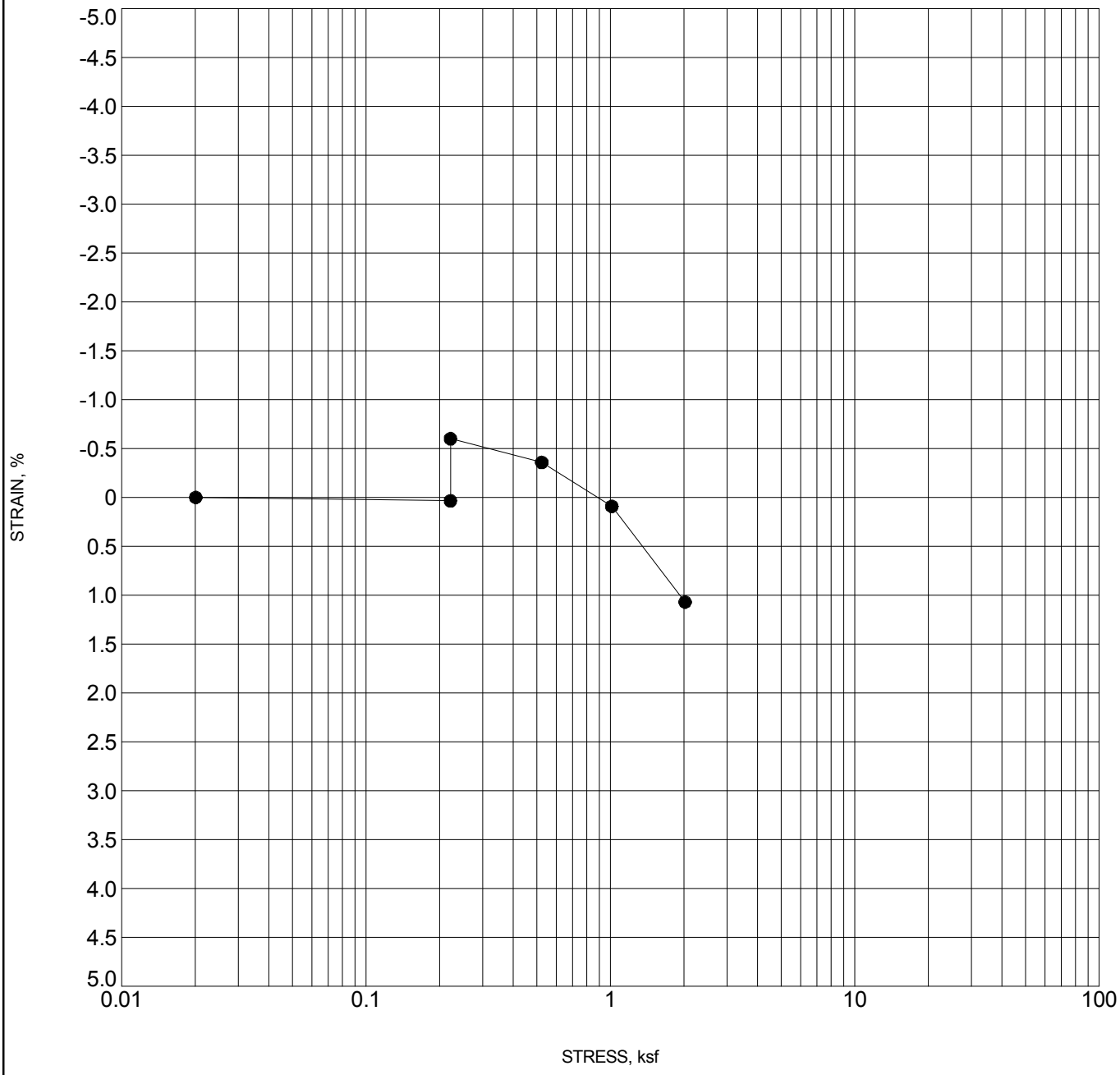

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1**	**24**	**SANDY CLAY**	**0.6**	**85.1**	**37.4**

SWELL - CONSOLIDATION TEST

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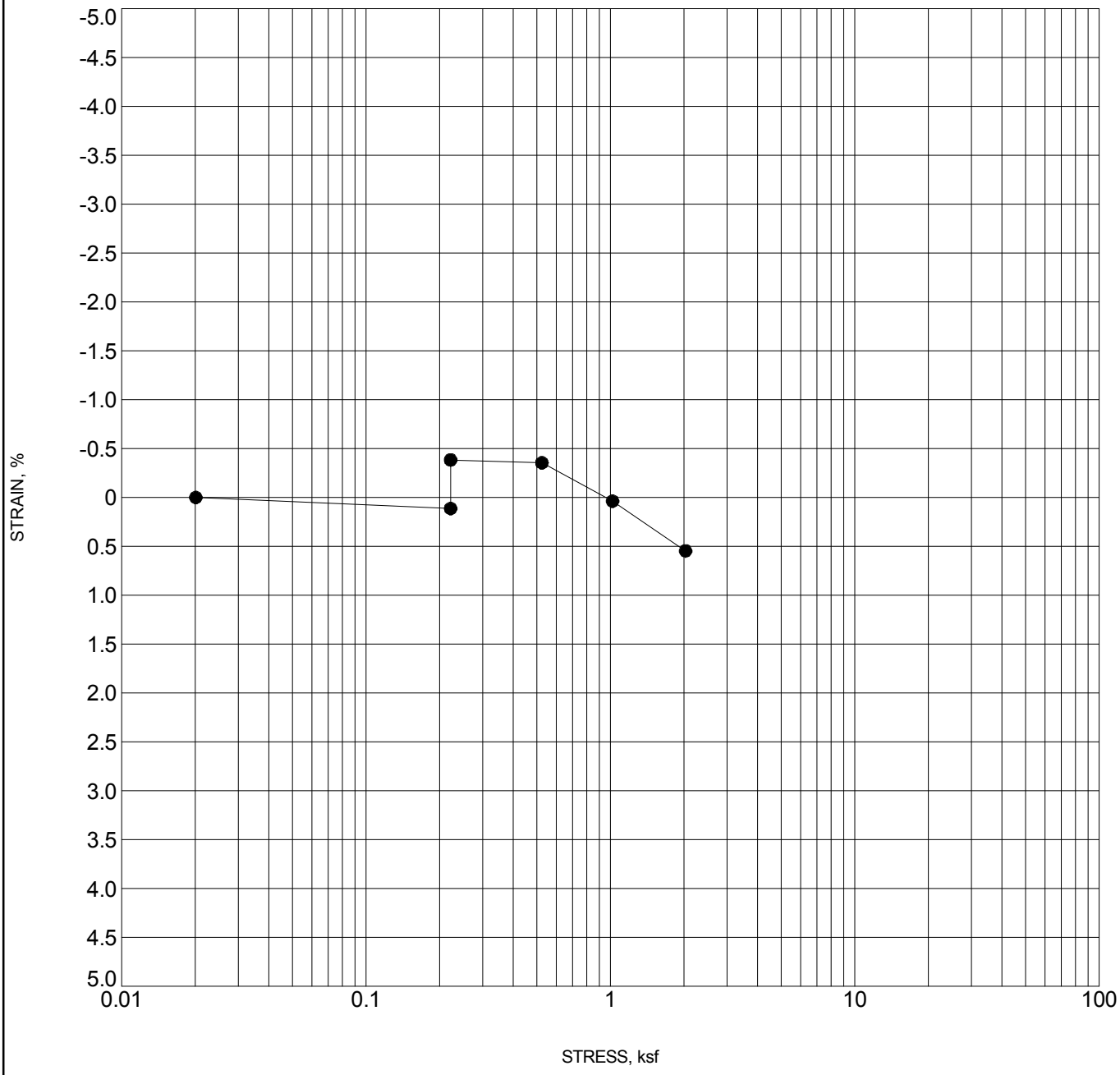

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-2**	**2**	**SANDY CLAY**	**0.5**	**108.9**	**18.6**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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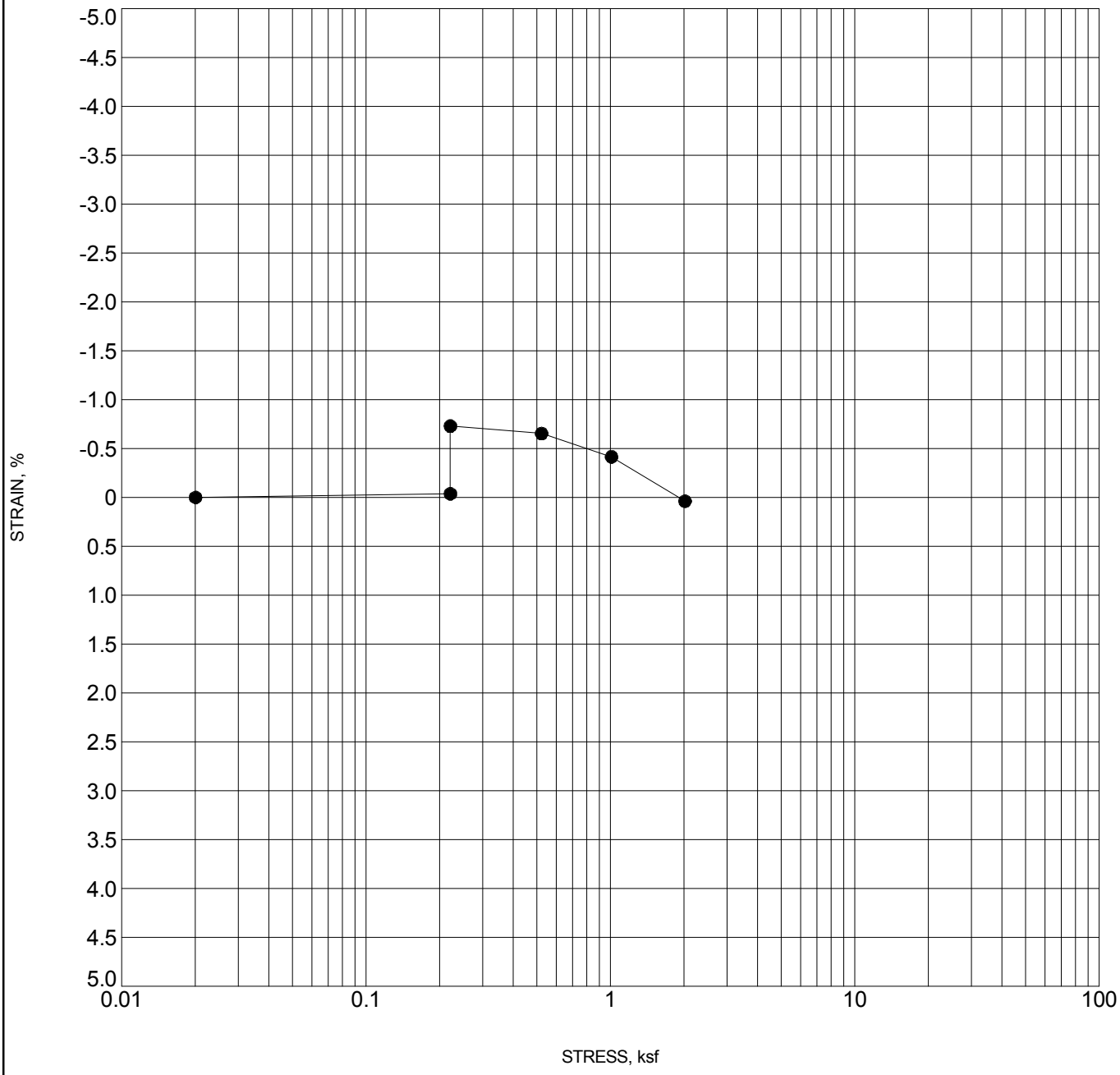

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-2 4**	**SANDY CLAY**	**0.7**	**110.7**	**17.3**

SWELL - CONSOLIDATION TEST

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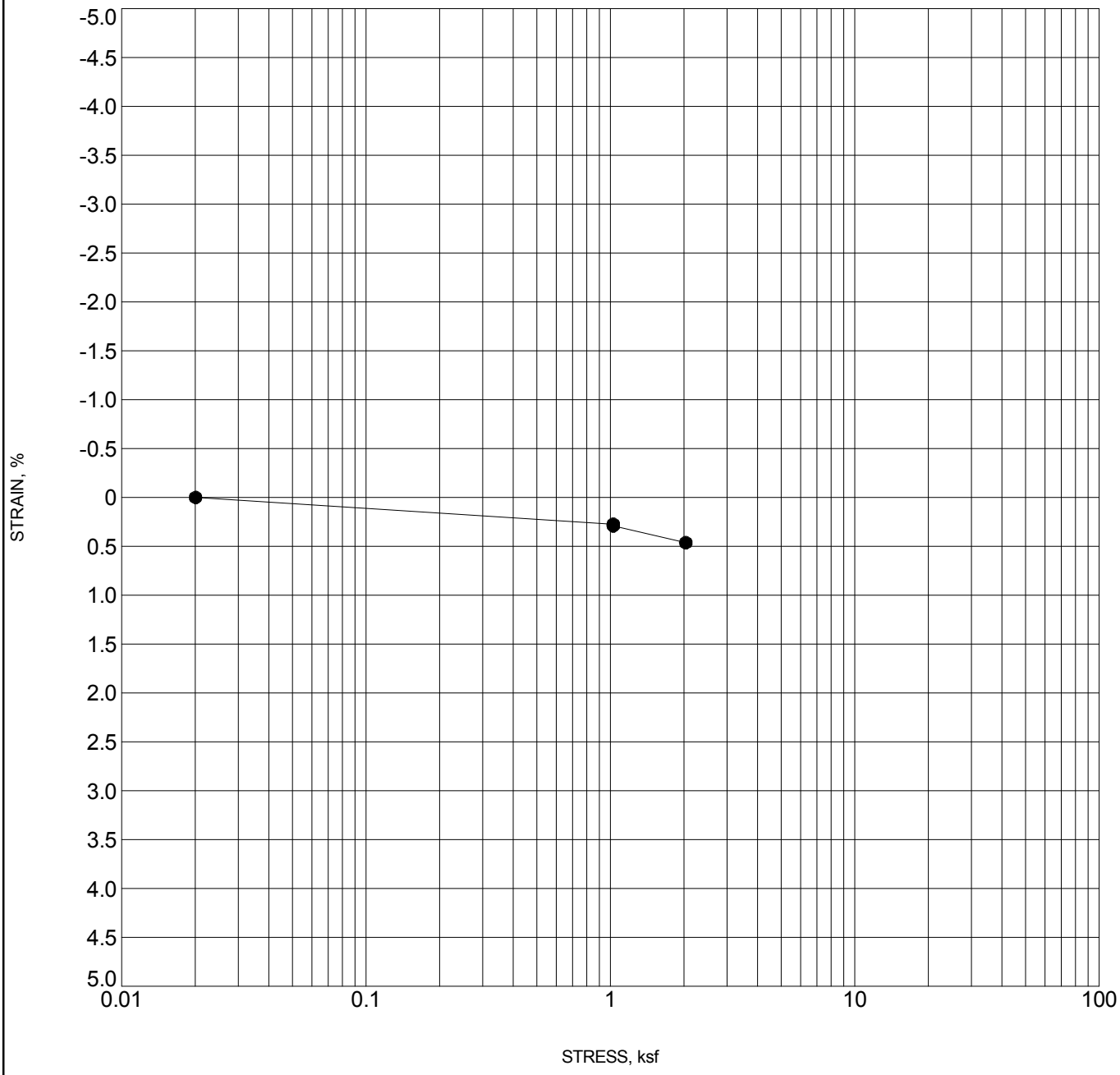

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-2**	**14**	**SANDY CLAY**	**0.0**	**111.9**	**14.5**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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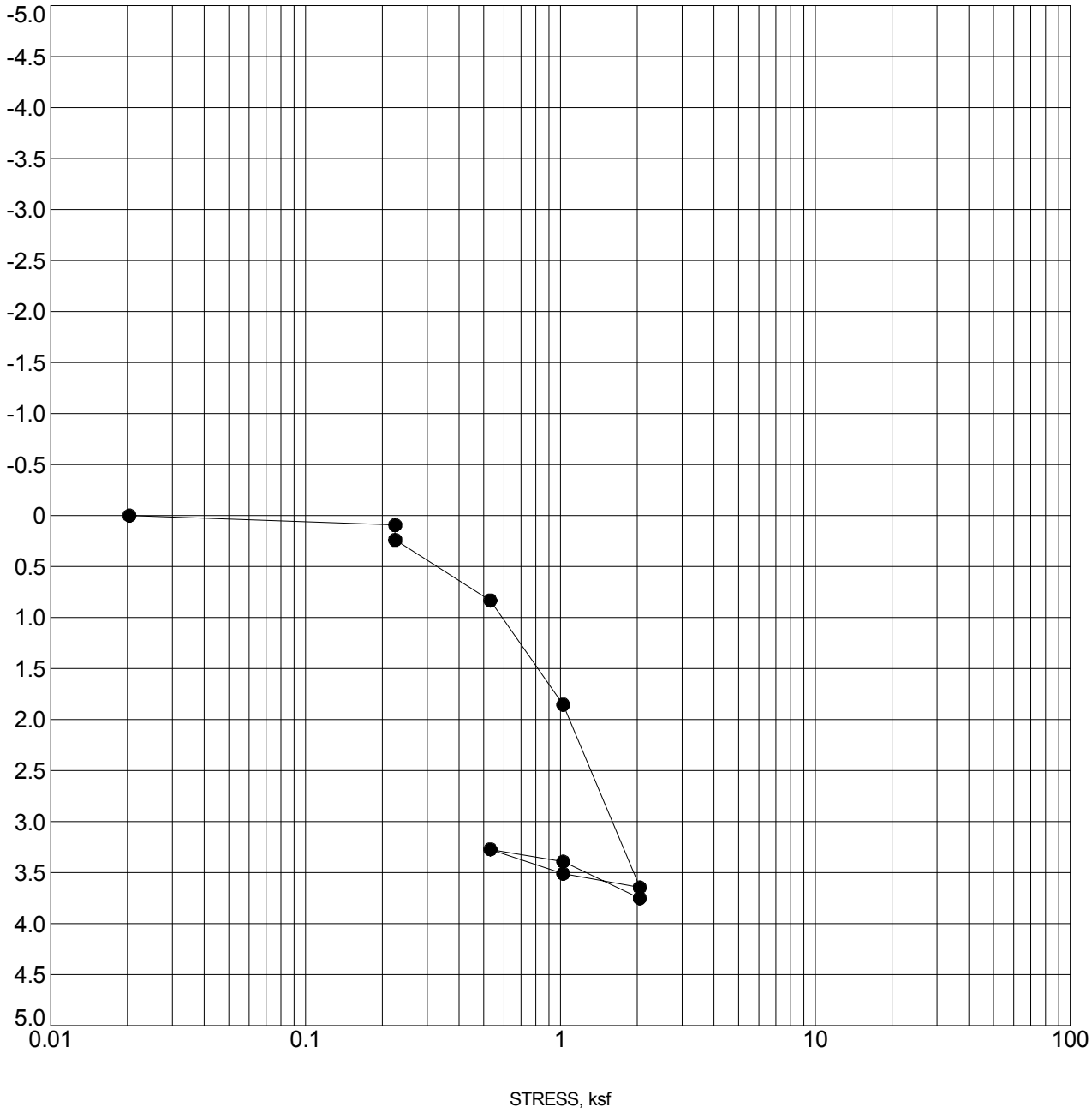

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-2**	**29**	**SANDY CLAY**	**-0.2**	**103.2**	**22.9**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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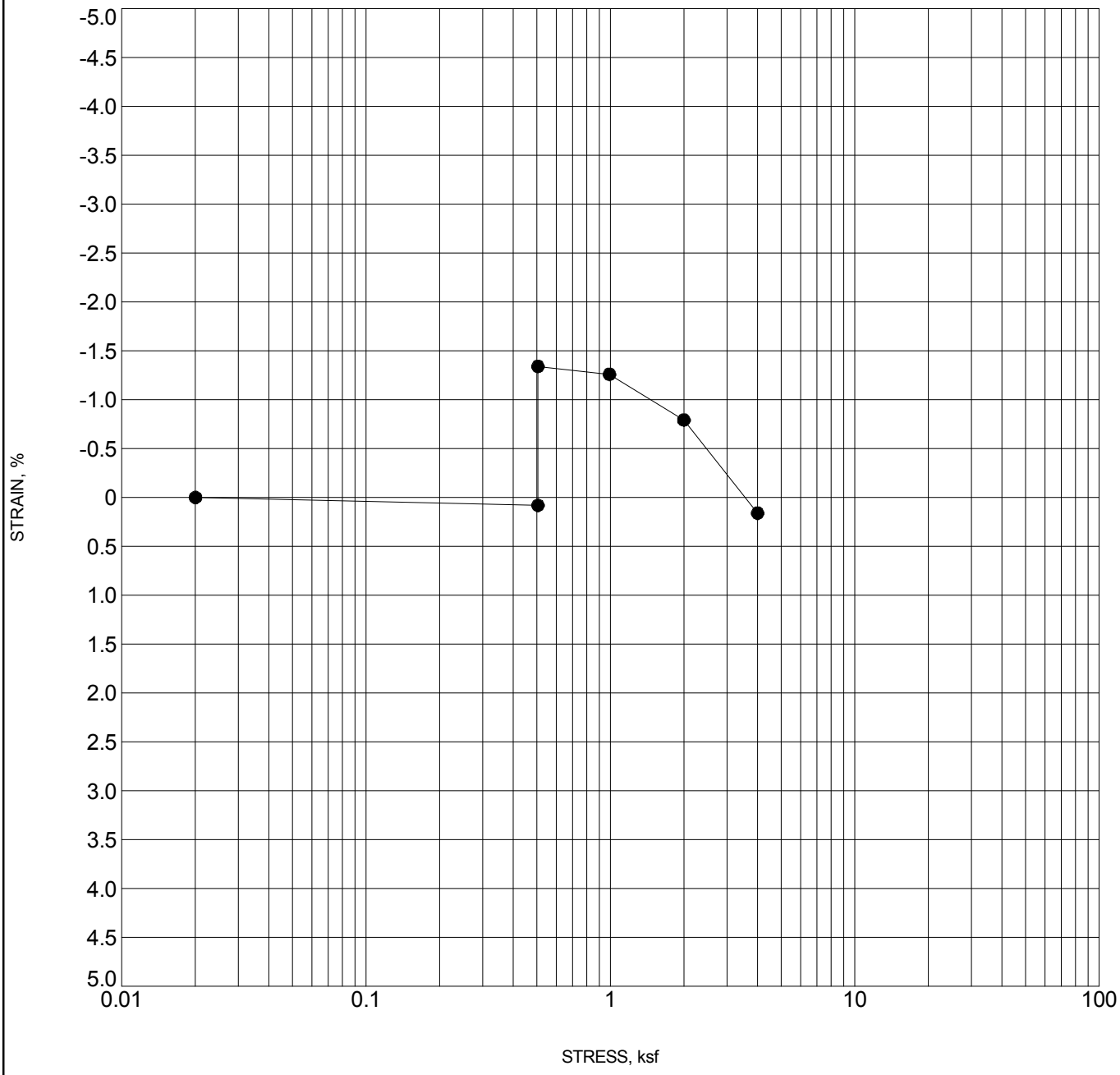

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-3**	**4**	**SANDY CLAY**	**1.4**	**108.8**	**19.7**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

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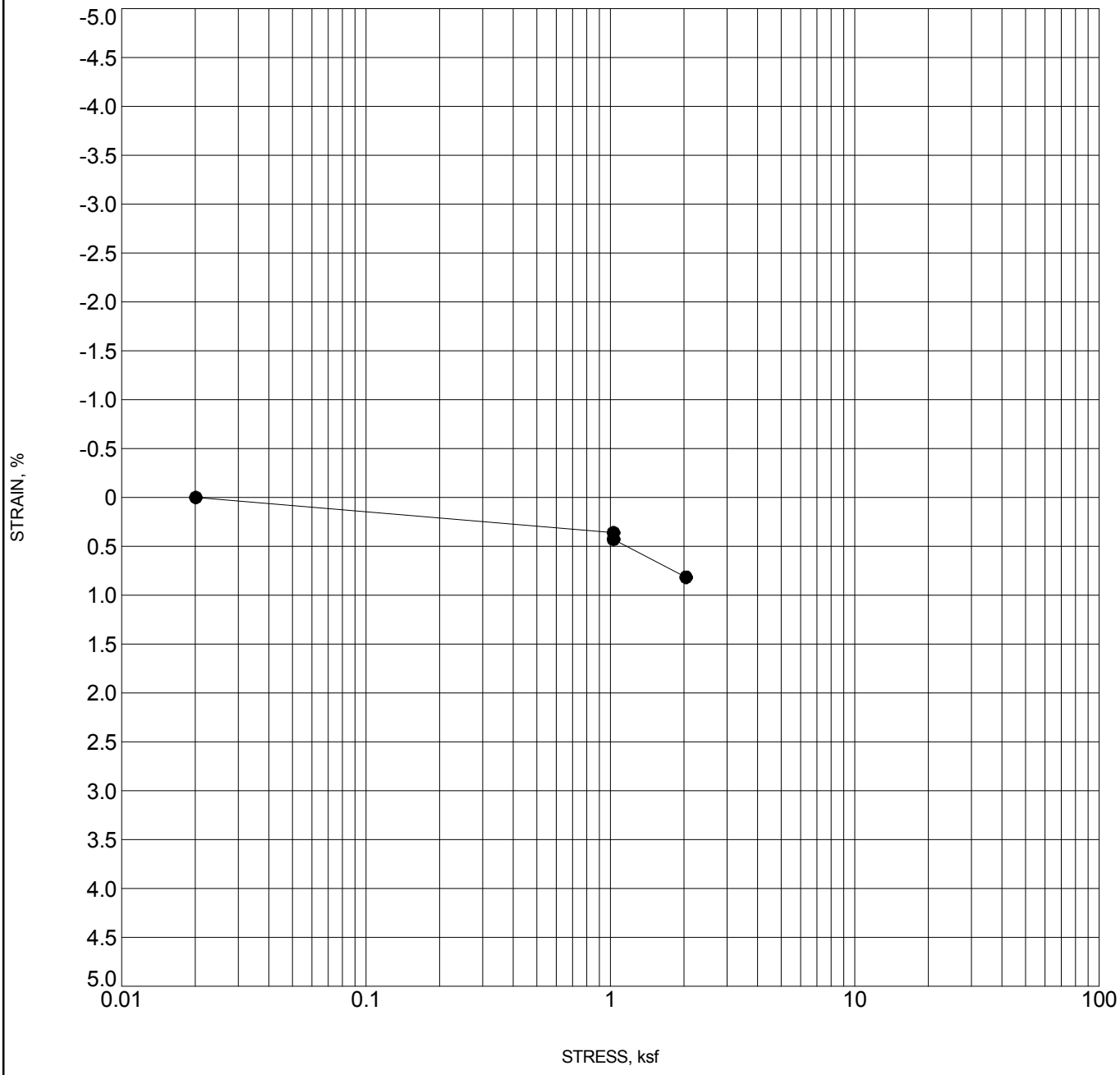


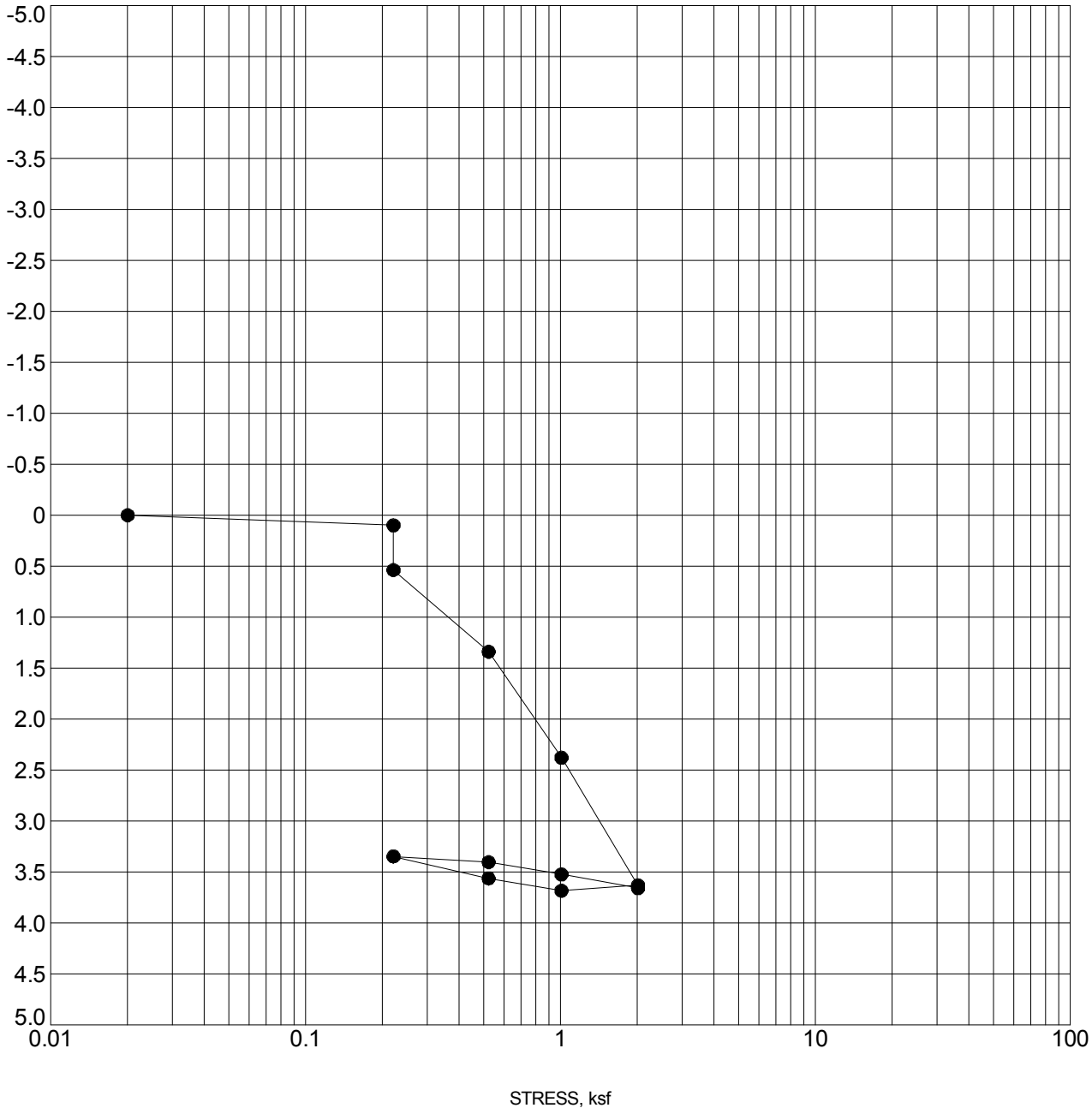
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-3 9**	**SANDY CLAY**	**-0.1**	**107.2**	**18.7**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT TSH, Inc. **PROJECT NAME** US 6 over Garrison Final Design

PROJECT NUMBER 329.02 **PROJECT LOCATION** Lakewood, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-3**	**14**	**CLAYEY SAND (SC)**	**-0.4**	**97.7**	**25.9**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

SWELL - CONSOLIDATION TEST

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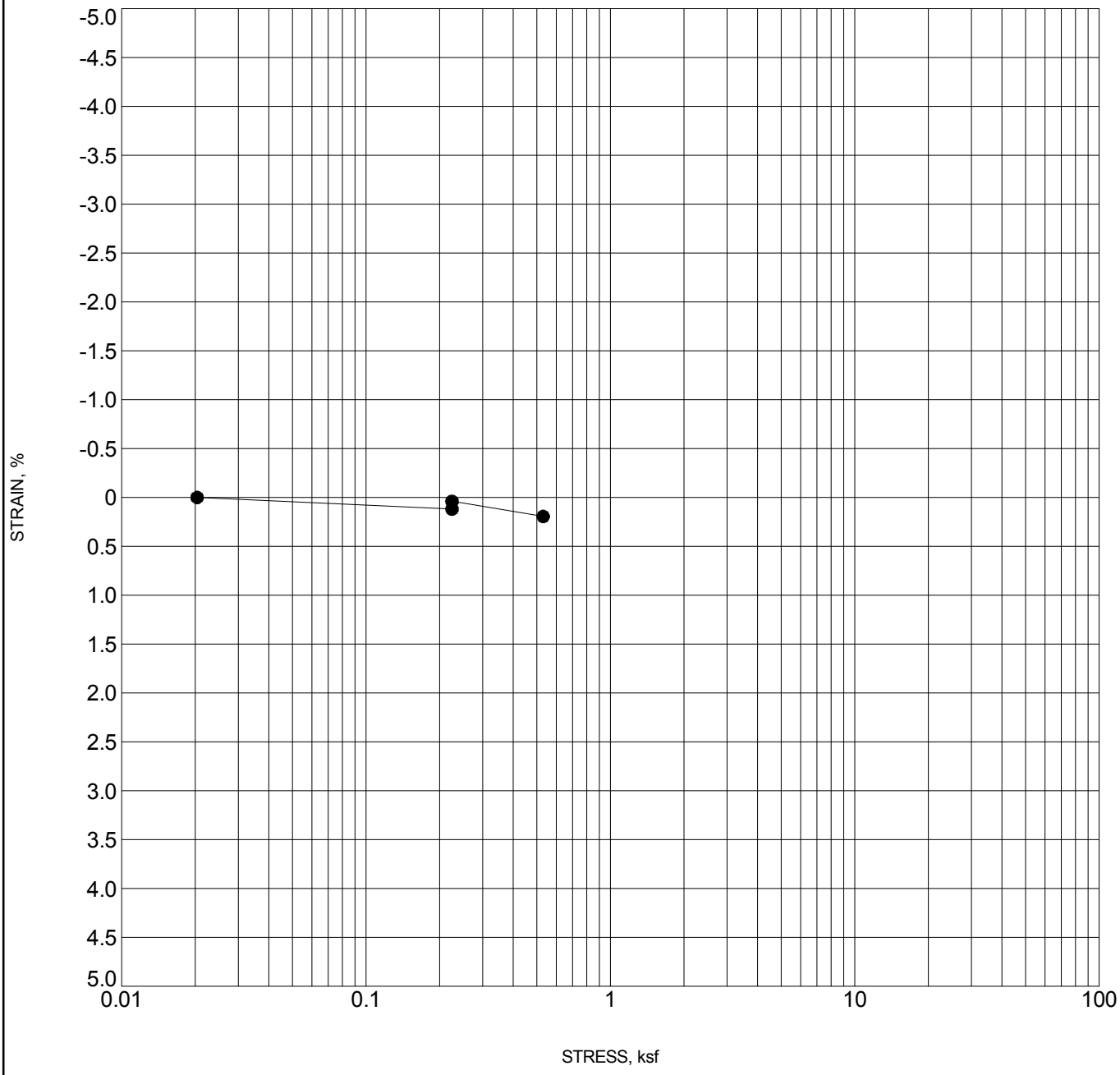

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-4 2**	**SANDY CLAY**	**0.1**	**112.7**	**17.8**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

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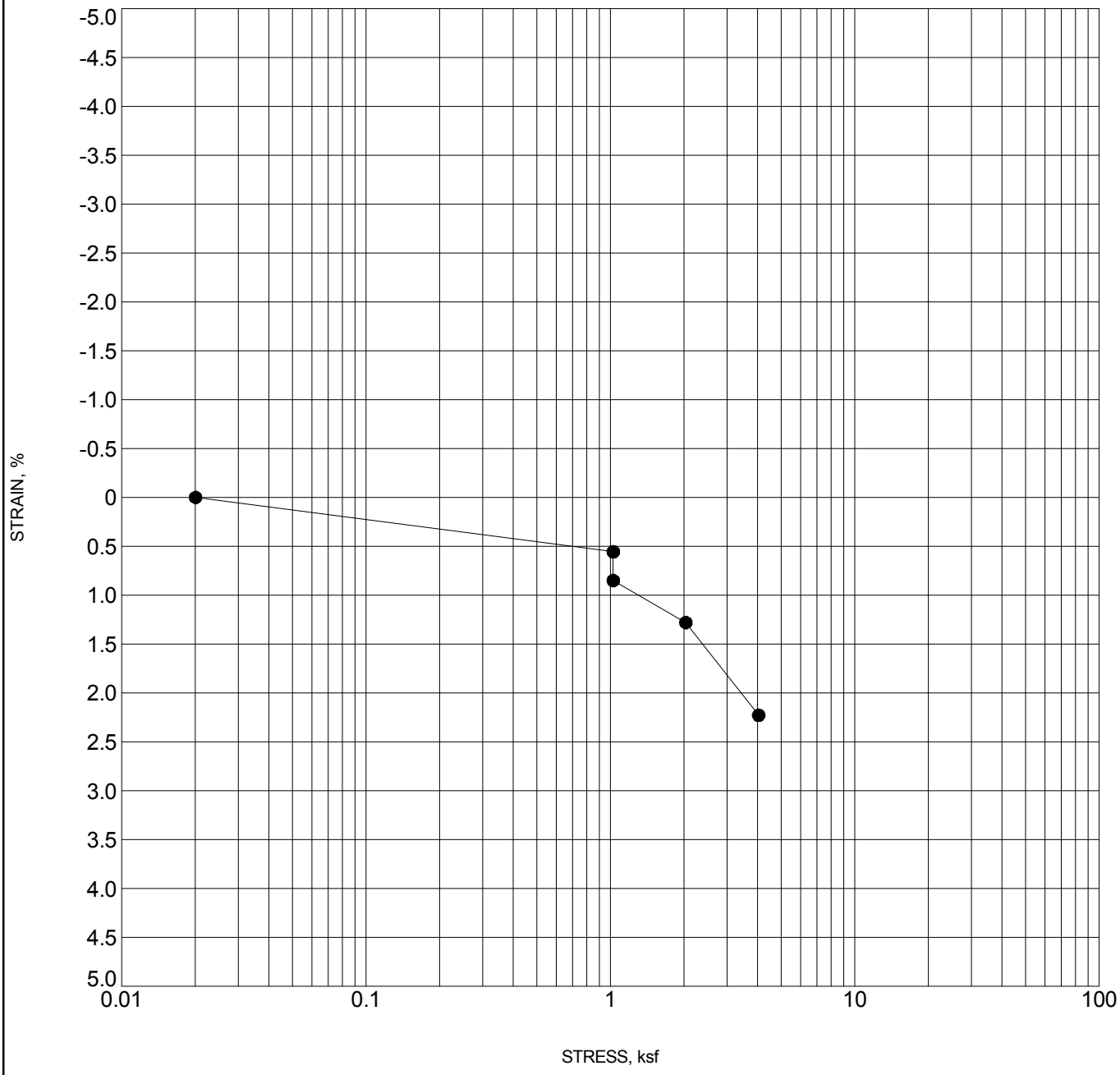

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-4**	**24**	**SANDY CLAY**	**-0.3**	**106.6**	**17.7**

SWELL - STANDARD US6 OVER GARRISON FINAL DESIGN.GPJ ROCKSOL TEMPLATE.GDT 7/2/14

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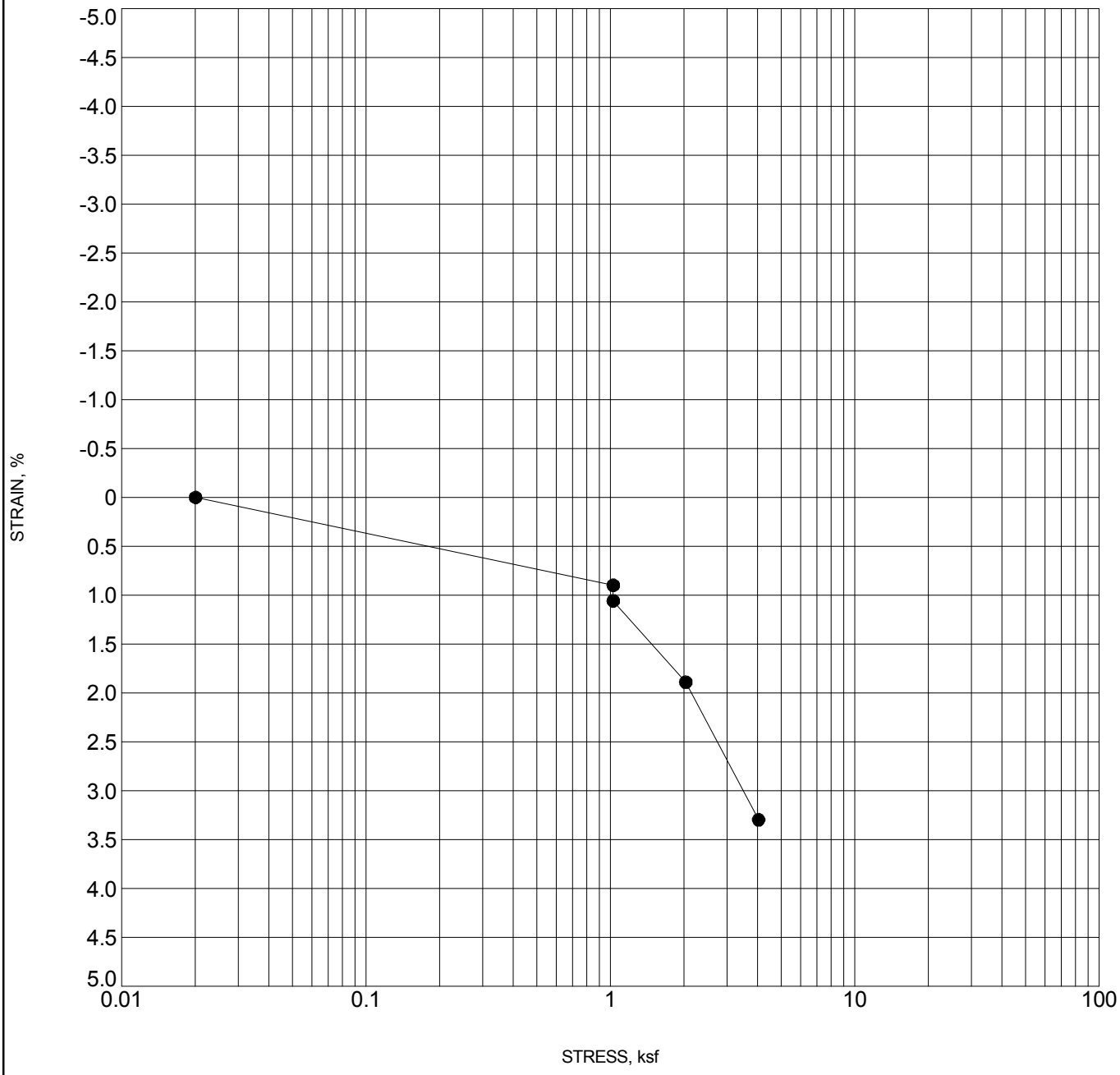

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-4**	**34**	**SILTY SAND with CLAY**	**-0.2**	**95.8**	**28.4**

SWELL - CONSOLIDATION TEST

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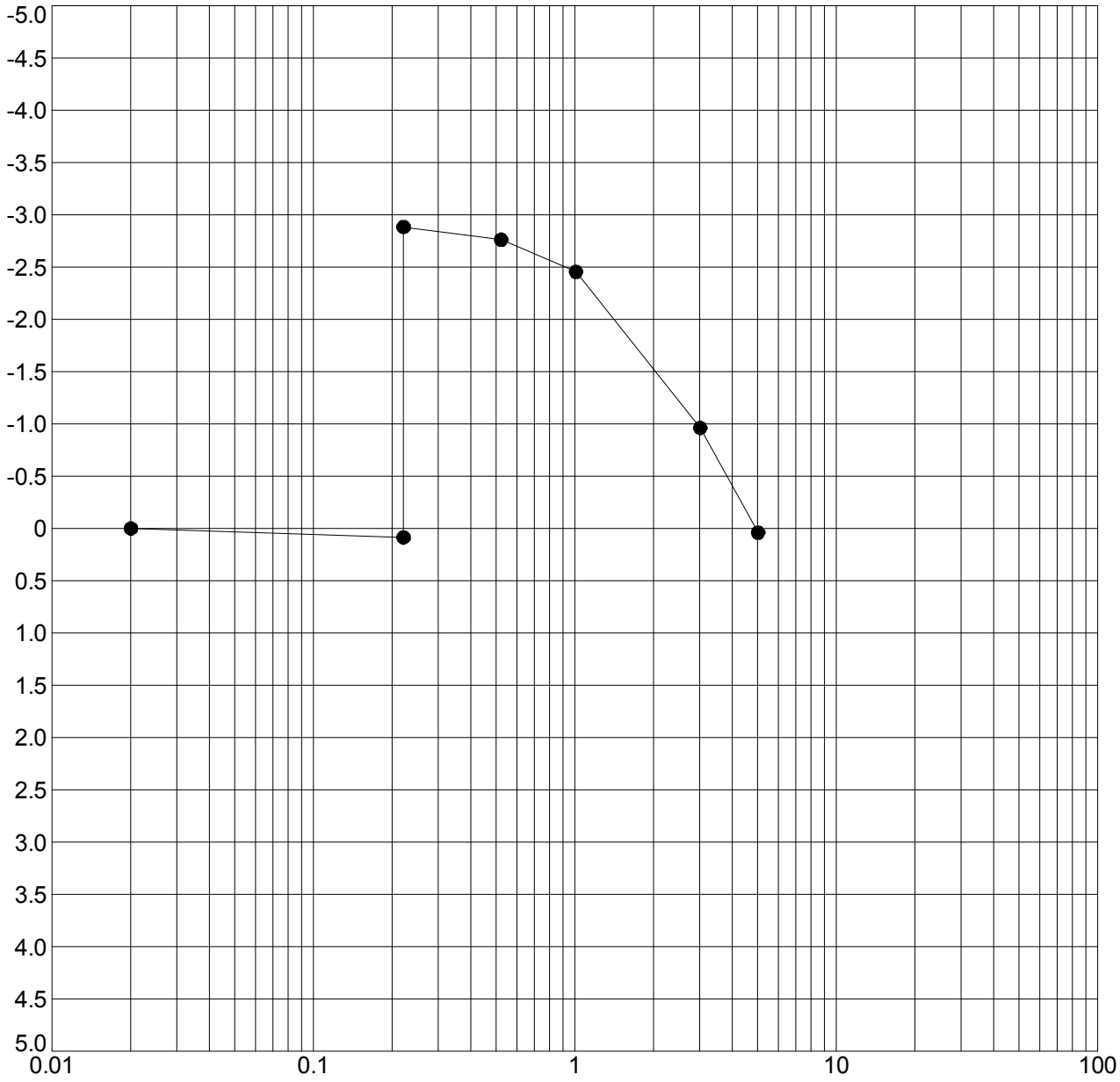

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-5 2**	**SANDY CLAY**	**3.0**	**96.8**	**27.9**

SWELL - CONSOLIDATION TEST

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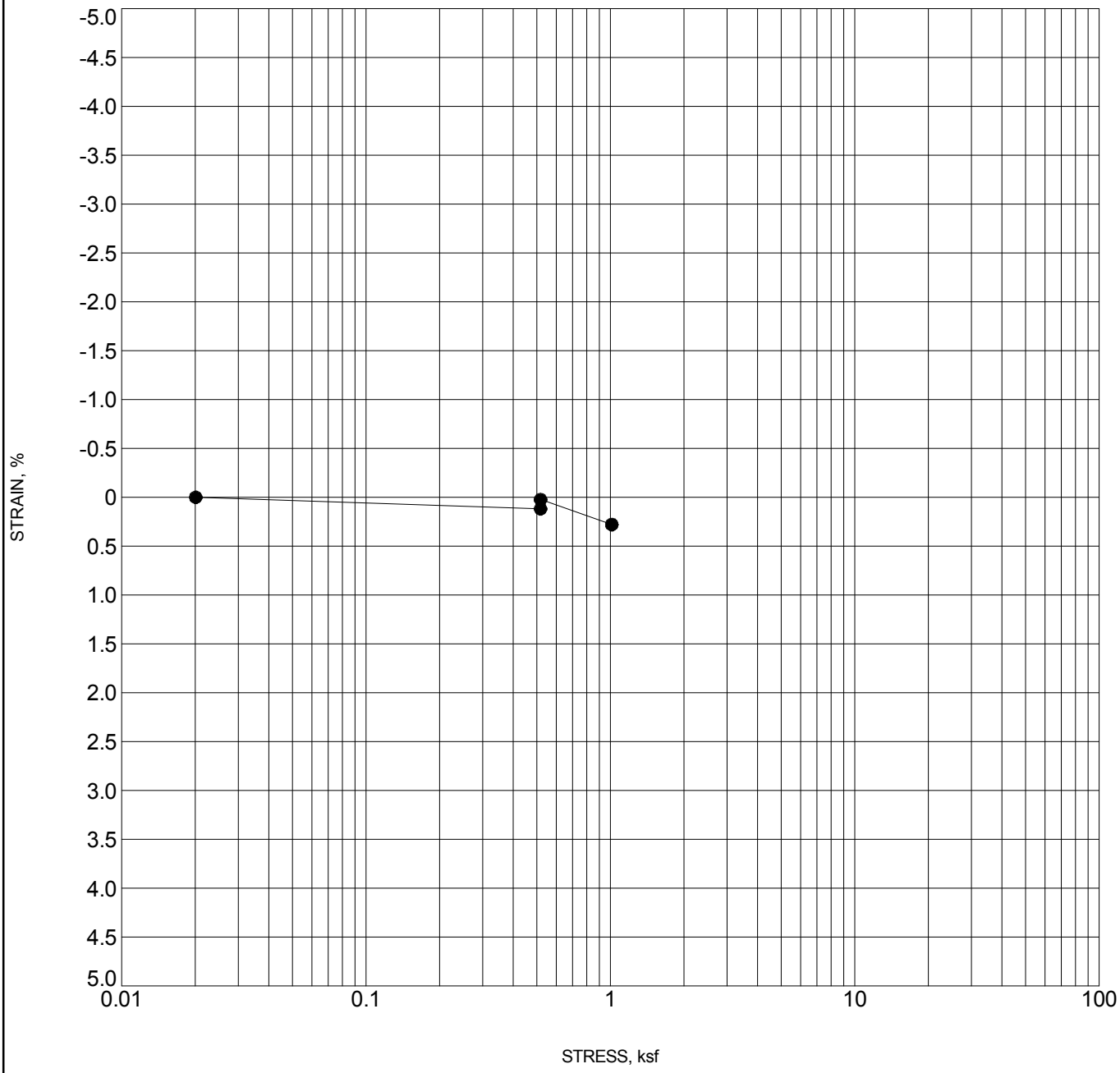

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-5 4**	**SANDY CLAY**	**0.1**	**104.3**	**19.2**