Geotechnical Investigation Report
Proposed Pear Park Fire Station
City of Grand Junction, Colorado

RockSol Project No. 599.05
September 25, 2020

Prepared for:

City of Grand Junction
333 West Avenue, Building C
Grand Junction, Colorado, 81501

Attention: Kirsten Armbruster, PE

Prepared by:

RockSol Consulting Group, Inc.
12076 Grant Street
Thornton, Colorado 80241
(303) 962-9300

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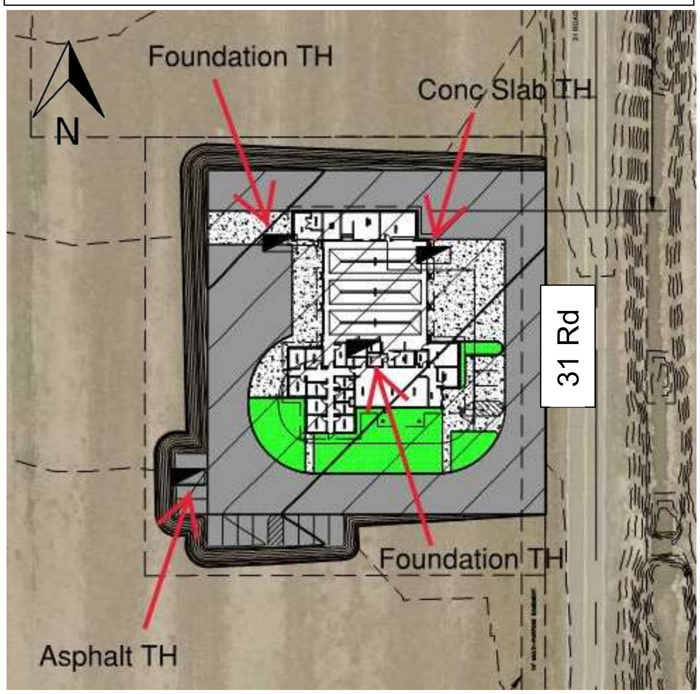
1.0 PROJECT PURPOSE AND DESCRIPTION

This report documents the geotechnical engineering investigation performed by RockSol Consulting Group, Inc. (RockSol) to assist with design of a proposed Fire Station for the City of Grand Junction. It is under the assumption that this fire station will be a two-story structure with interior slab-supported parking for fire trucks, living quarters, and offices. The exterior of the building will also include asphalt and concrete supported parking with concrete vehicle aprons, sidewalks, and landscaped areas. The Pear Park Fire Station Concept layout is shown in Image 1 below.

Image 1: Pear Park Fire Station Concept



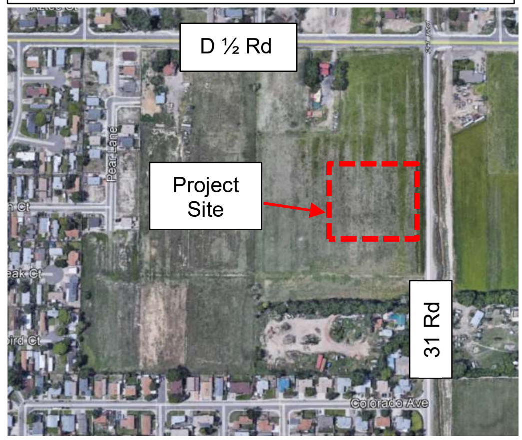
The scope of work for this geotechnical investigation included:

- Formulate a drilling pattern and perform the necessary subsurface investigation and collect samples as required.
- Perform appropriate laboratory tests and analyze the data to determine strength, allowable bearing capacity and corrosiveness of foundation material.
- Provide recommendations for foundation type and subgrade preparation.
- Provide recommendations for lateral earth pressure, if applicable.
- Provide recommendations for pavement sections (flexible and rigid pavement types).
- Provide recommendations for drainage, grading, and general earthwork.
- Evaluate potential geologic hazards at the site.
- Prepare a Geotechnical Investigation Report summarizing the subsurface conditions encountered, the results of the laboratory testing, geological hazards, pavement design recommendations, geotechnical parameters for foundation design, and earthwork recommendations.

2.0 PROJECT SITE CONDITIONS

The project site is located in Section 16, Township 1 South, Range 1, east of the Ute Principal Meridian in the City of Grand Junction in Mesa County, Colorado. The project site is bounded to the north by D ½ Road, to the east by 31 Road (see Image 2). To the south the site is bounded by homes on Colorado Avenue and A&F Landscaping & Trucking property, and to the west by homes on Pear Lane, Grosbeak Court, and Hummingbird Court. Developments near or adjacent to the site include agricultural fields to the north and west, residential developments on the west and south sides, and limited businesses. Topography at the site generally consists of flat to mild slopes trending south.

Image 2: Site Map - Google Earth



3.0 SUBSURFACE EXPLORATION

On June 8, 2020, RockSol drilled four boreholes to evaluate subsurface conditions at the project site. The borehole locations are identified as B-1 through B-4, as shown in Appendix A, Borehole Location Map. Boreholes B-1 through B-4 were drilled at the approximate location of the proposed Pear Park Fire Station. Borehole B-1 and B-3 were drilled to assist with foundation design for the proposed fire station building. Borehole B-2 was drilled to assist with concrete slab design. Borehole B-4 was drilled to assist with asphalt pavement design.

A truck mounted CME-45 drill rig was used for drilling and sampling. The boreholes were advanced using 4.25-inch outside diameter solid stem augers to maximum depths ranging from approximately 5 feet to 25.5 feet below existing grades for boreholes B-1 through B-4. The boreholes were logged in the field by a representative of RockSol with the depth to groundwater noted at the time of drilling. The boreholes were backfilled with sand and pea gravel material at the completion of sampling activities.

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. Penetration Tests were performed using an automatic lift system and a hammer weighing 140 pounds falling 30 inches.

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.

The standard split spoon sampling method is the Standard Penetration Test (SPT) described by ASTM Method D-1586.

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 per ASTM D3550. 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 Borehole Logs (See Appendix B).

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)
- Soil Classification (ASTM D-2487, ASTM D-2488, and AASHTO M145)
- Gradation (ASTM D6913)
- Water-Soluble Sulfate Content (CDOT CP-L 2103)
- Water-Soluble Chloride Content (AASHTO T291-91)
- Standard Test Method for pH of Soils (ASTM D4972-01)
- Soil Resistivity (ASTM G187 - Soil Box)
- Swell Test (ASTM D-4546)

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. 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 C and are also summarized on the Borehole Logs presented in Appendix B.

5.0 SUBGRADE CHARACTERIZATION

5.1 Subsurface Materials

Subsurface conditions generally consist of native sandy clay soils overlying gravelly sand and sandy gravel. Fill soils were not encountered in the boreholes drilled by RockSol. Groundwater was encountered at approximate depths ranging from 8 feet to 15 feet below existing grades during drilling operations. See Table 5.1 for ground surface and groundwater elevations where encountered. 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 B.

Table 5.1 Approximate Ground Surface and Groundwater Elevations

Borehole	Ground Surface Elevation (ft)	Depth to Groundwater (ft)	Groundwater Elevation (ft)	Maximum Depth Drilled Elevation (ft)
B-1	4637.96	15.3	4622.66	4617.46
B-2	4638.00	8.7	4629.30	4623.00
B-3	4637.70	8.5	4629.20	4612.20
B-4	4636.99	4.0	4632.99	4636.00

Topsoil

Approximately 3 inches of clayey sand topsoil was encountered at the surface at each borehole location. The topsoil supported a moderate growth of grass and weed vegetation.

<u>Native Soils</u>

Native soils encountered below the topsoil material generally consisted of a clay layer over a sandy clay layer, all overlying gravelly sand and sandy gravel. Soft to medium stiff, slightly moist to very moist clay was noted as the top layer approximately 5 feet to 12 feet below existing grade in all boreholes. Below that, 5-foot to 11-foot layers of soft to very stiff, moist to very wet sandy clay was encountered at all deep borings above dense to very dense, wet sand with gravel and gravelly sand.

<u>Bedrock</u>

Bedrock was not encountered to the depths drilled. Based on discussions with local (Grand Junction area) geotechnical drilling personnel, bedrock is estimated to be 30 to 35 feet below the ground surface at the subject location.

<u>Groundwater</u>

Groundwater was encountered in the boreholes at depths ranging from approximately 4 feet to 15 feet (approximate elevations ranging from 4,622 feet to 4,629 feet) below existing grades at the time of drilling. Groundwater at this site is likely influenced primarily by the Colorado River located approximately 3,800 feet to the south. Close to the site are two lakes known as West Lake and East Lake, they are located about 3,200 feet southwest from the project site. Also, about 2,000 feet south of the project site is the Mesa County Ditch. Groundwater levels at the site may be subject to seasonal change due to the Mesa County Ditch, water levels in the Colorado River, and long-term precipitation trends.

5.2 Swell/Consolidation Potential of Subgrade Soils

Based on swell test results and plasticity index (PI) testing, the subgrade soils encountered within the upper 14 feet of the surface of proposed Pear Park Fire Station exhibit low swell potential and low to moderate consolidation potential (-2.3 to 2.8 percent swell under approximate in situ surcharge pressure). Twelve swell/consolidation tests were performed on samples obtained from Boreholes B-1, B-2, B-3, and B-4 at approximate depths of 2 feet, 4 feet, 9 feet, and 14 feet.

5.3 Cement Type/Sulfate Resistance Discussion

The City of Grand Junction uses the 2018 International Building Code (IBC 2018) for development of concrete resistance parameters. The IBC 2018 references the American Concrete Institute (ACI) for such parameters. 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 the ACI as shown in Table 5.1 and in the Building Code Requirements for Structural Concrete (ACI 318-08) (ACI Table 4.3.1).

Table 5.1 Requirements to Protect Against Damage to Concrete by Sulfate Attack from External Sources of Sulfate

Exposure Class	Water-soluble sulfate (SO_4), in dry soil, percent	Sulfate (SO_4), in water, ppm	Water Cementitious Ratio, maximum	Cementitious Material Requirements (ASTM C150)
S0	0.00 to <0.10	0 to <150	Not Applicable	No Restriction
S1	0.10 to < 0.20	151 to <1,500	0.50	Type II
S2	0.20 to 2.0	1,500 to 10,000	0.45	Type V
S3	2.01 or greater	10,001 or greater	0.45	Type V plus pozzolan

The concentration of water-soluble sulfates measured in soil samples obtained from RockSol's exploratory boreholes varied from 0.03 percent to 2.00 percent by weight. Based on the results of the water-soluble sulfate testing, Exposure Class S2 is recommended for concrete in contact with subgrade materials for the project. For Exposure Class S2, Type V cement is recommended. As an alternative, other available cement types such as Type III or Type 1 are permitted if the C_3A content is less than 5 percent. A compressive concrete strength of 4,500 psi is recommended for the S2 Exposure Class.

5.4 Corrosion Resistance Discussion

Water- soluble sulfate and chloride content, pH and electrical resistivity tests were performed and are summarized in Table 5.2. The electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-187).

Table 5.2 – Corrosion Resistance Summary

Borehole Location	Sample Depth (ft)	Water Soluble Chloride (%)	Saturated Resistivity (ohm-cm) at Moisture content (%)	Water Soluble Sulfate (% by weight)	pH	CR Level
B-1	4	--	--	**2.00**	--	CR 5
B-2	0-5	0.0200	300 Ohm-cm @ 23%	**0.82**	7.9	CR 4
B-2	2	--	--	**0.03**	--	CR 0
B-3	0-10	0.0200	400 Ohm-cm @ 20%	**0.86**	8.0	CR 4
B-3	9	--	--	**0.64**	--	CR 4
B-4	0-5	0.0100	1,000 Ohm-cm @ 21%	**0.16**	7.9	CR 2

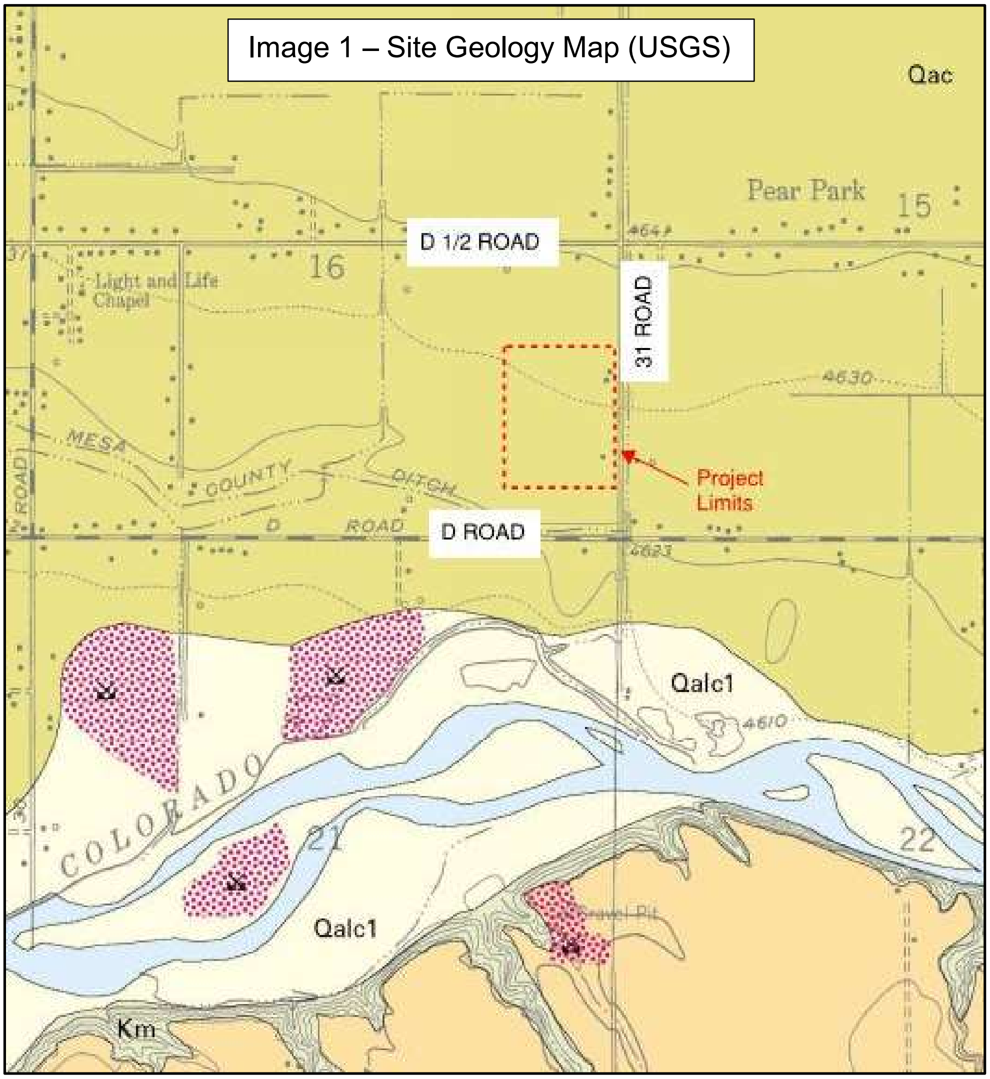
Comparison of the test results of the sulfate, chloride, and pH testing performed with *Table 1 - Guidelines for Selection of Corrosion Resistance Levels as presented in the CDOT Pipe Materials Selection Guide,* dated April 30, 2015, suggests corrosion resistance (CR) levels of CR 0, CR 2, CR 4 and CR 5 are present within the project limits. Additional testing at specific structure locations may be performed to provide structure specific corrosion resistance recommendations. Of the three variables (water-soluble sulfate, water-soluble chloride, and pH) that are used in determining the CR level, the water-soluble sulfate content appears to be the predominant component affecting the CR level selection. In Table 5.2, we have used "bold" text to identify the test result variable that is contributing to the CR Level above 0. Based on available data, the proposed Pear Park Fire Station should be considered as a CR 4 category.

In addition, electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-187). Comparison of the results of the electrical resistivity testing performed with *Table 2 – Minimum Pipe Thickness For Metal Pipes Based On The Resistivity And pH Of The Adjacent Soil* as presented in the *CDOT Pipe Materials Selection Guide,* effective April 30, 2015, suggests the minimum required gauge thickness for metal pipe material, if used for this project, is *0.052 inches (18 Gauge) Polymer Coated*. Additional testing at specific structure locations should be performed to provide structure specific recommendations.

6.0 GEOLOGICAL SETTING

Based on information presented in the *Geologic Map of the Clifton Quadrangle, Mesa County, Colorado* by Paul E. Carrara dated 2001 (See Image 1 – Site Geology Map), the site is underlain by Alluvium and Colluvium, undivided (Holocene and late Pleistocene) (Qac) which contains a combination of alluvium, sheetwash, and debris flow deposits and typically consists of light-gray and light-olive-gray, fine sandy silt and clayey silt. South of the site, much of the soil surrounding the Colorado River is Alluvium deposited by the Colorado River (Holocene) (Qalc1) which consists of light-yellowish-brown, silty fine sand to medium sand that locally contains minor amounts of pebbles and cobbles in lenses generally less than several feet in thickness. Also, towards the south and surrounding the Colorado River are gravel pits.

Image 1 – Site Geology Map (USGS)



7.0 SEISMICITY DISCUSSION

The City of Grand Junction uses the 2018 International Building Code (IBC-2018) for development of seismic design parameters. The IBC-2018 references the American Society of Civil Engineers 7-16 (ASCE 7-16) seismic design code. Based on the subsurface conditions encountered, it is our opinion that the subject site meets criteria for Seismic Site Class E. Shear wave velocity testing was not performed by RockSol. Seismic design parameters for Seismic Site Class E are discussed below.

7.1 Seismic Design Parameters

Seismic design parameters were obtained from the United States Geological Survey (USGS) Earthquake Design Maps using the 2018 International Building Code specifications which reference ASCE 7-16. Values were obtained using the USGS site: https://seismicmaps.org. The proposed fire station or emergency structure qualifies as risk category IV per Table 1604.5 of the *IBC-2018*. 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 site. The seismic acceleration coefficients obtained (data based on 0.05-degree grid spacing) are presented in Table 7.1.

Table 7.1 – Seismic Acceleration Coefficients (IBC 2018)

Proposed Pear Park Fire Station (Latitude°/Longitude°) (39° 4'7.12"N/ 108°28'42.92"W)	Peak Ground Acceleration (PGA)	Spectral Acceleration Coefficient - S_s (Period 0.2 sec)	Spectral Acceleration Coefficient - S_1 (Period 1.0 sec)
IBC 2018 (ASCE 7-16)	0.136	0.244	0.066

The acceleration coefficients are then used to obtain Site Factors F_a, and F_v based on the defined Site Class as shown in Tables 1613.2.3(1) and 1613.2.3(2) of the *IBC-2018*. A summary of the Site Factor values obtained are shown in Table 7.2.

Table 7.2 – Seismic Site Factor Values

Proposed Pear Park Fire Station (Latitude°/Longitude°) (39° 4'7.12"N/ 108°28'42.92"W)	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)
IBC 2018 (ASCE 7-16)	2.222	2.4	4.2

Table 7.3 summarizes the Seismic Zone determination and horizontal response spectral Acceleration Coefficients (S_{D1}) and (S_{DS}) obtained for the proposed structure. Seismic Performance Zone determination is based on the value of the horizontal response spectral Acceleration Coefficient at 1.0 Seconds, S_{D1}, as determined by *Eq. 16-39* of the IBC-2018 and the horizontal response spectral Acceleration Coefficient at 0.2 Seconds, S_{DS}, as determined by *Eq. 16-38.* Values for S_1 and F_v are presented in Tables 7.1 and 7.2, shown above. The seismic performance zone was determined *IBC-2018* Tables 1613.2.5(1) and (2). Seismic Design output sheets are summarized in Appendix D.

Table 7.3 – Seismic Performance Zone

Proposed Pear Park Fire Station (Latitude°/Longitude°) (39° 4'7.12"N/ 108°28'42.92"W)	Acceleration Coefficient at 1.0 seconds (S_{D1})	Acceleration Coefficient at 0.2 seconds (S_{DS})	Seismic Design Category (1)
IBC 2018 (ASCE 7-16)	0.185	0.39	D

Note (1): Seismic Design Category C (For Risk Categories I, II or III) is assigned when *$0.133g \le$ **S_{D1}** $< 0.20g$ and $0.33g \le$ **S_{DS}** $< 0.50g$*

8.0 GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS

Based on the subsurface conditions encountered, a shallow foundation system (footing) is feasible for the proposed foundation structure. As an alternative to footings, driven H-piles or drilled shafts socketed into bedrock may also be considered. Discussion of the foundation alternatives is presented in Sections 8.1, 8.2, and 8.3.

8.1 Shallow Footing Foundation Recommendations

Based on conditions encountered in the boreholes, bearing resistances are presented in Table 8.1 for shallow (footing) foundations for the proposed fire station structure. Values for AASHTO LRFD strength limit state, service limit state, and Allowable Bearing Resistance (ASD) methodologies are presented. A resistance factor of 0.45 is used to determine the factored bearing resistance for LRFD strength limit state evaluation.

Table 8.1 – Recommended Bearing Resistances (Shallow Foundation)

Bearing Material	Strength Limit State (LRFD)		Service Limit State (LRFD) or Allowable Bearing Resistance (ASD)
	Ultimate (Nominal) Resistance (ksf)	Factored Resistance (ksf)	Service Bearing Resistance (LRFD) (ksf)
CLAY (Native)	2.9	1.3	1.0

If additional bearing resistance is needed, subgrade improvement using a geotextile separation and strength fabric/geogrid material and placement of an aggregate base course layer will be required.

A minimum embedment of 30 inches below finished exterior grade is recommended for a shallow concrete footing foundation system. RockSol estimates total movement for footings designed and constructed as discussed in this section will be less than 1-inch. Differential movements are estimated to be less than ½-inch. A representative of the geotechnical engineer should observe all footing excavations prior to concrete placement.

<u>Lateral Earth Pressure Parameters (Stem Walls)</u>

To assist with design of stem walls, lateral earth pressure parameters are presented in Table 8.2 for the existing soils encountered. Also included are parameters for CDOT Class 1 Structure backfill material.

8.2 Preliminary Driven Pile Recommendations

Alternatively, the Pear Park Fire Station structure may be supported on driven steel H-piles (Grade 50 steel). RockSol recommends the piles be driven to practical refusal in bedrock. Estimated pile lengths on the order of 35 feet to 40 feet are anticipated. If significant penetration into bedrock (greater than 5 feet) is necessary for lateral resistance requirements, pre-drilling may be required.

For the LRFD method, a nominal (ultimate) geotechnical capacity of 36 ksi, based on the cross-section area of the pile, can be used for Grade 50 steel.

During construction, pile driving is recommended to be monitored per CDOT requirements per Section 502 of the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), 2019". Monitoring shall be conducted using a Pile Driving Analyzer (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. A resistance factor of 0.65 is recommended for LRFD strength limit state design for axial compression provided PDA testing is performed.

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 is recommended to follow the guidelines specified in "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 502, 2019".

(b) Lateral load parameters presented in Table 8.4 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 3 to 5 feet of pile penetration into bedrock will be required to achieve capacity. 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) Pile tips should be protected against damage using driving shoes during penetration into the sedimentary bedrock.

(f) Potential damage to adjacent properties or structures during pile installation due to noise and vibrations should be considered and evaluated, if necessary.

Table 8.2: Lateral Earth Pressure Parameters

Soil Type	Total Unit Weight (γ) pcf	Effective Friction Angle, ϕ′ (degrees)	Undrained Shear Strength (psf)	Lateral Earth Pressure Coefficients (Notes 1 and 2)		
				Active (k_a)	At-Rest (k_o)	Passive (k_p) (Note 3)
CDOT Class 1 Structure Backfill (CDOT Section 703.08)	125	34	0	0.28	0.44	3.54
CLAY, silty to sandy	125	0	350	0.46	0.63	2.20

Note 1: Based on Coloumb Theory of earth pressure
Note 2: For horizontal backslope and foreslope.
Note 3: Full value, no reduction applied.

8.3 Preliminary Drilled Shafts Recommendations

Alternatively, the Pear Park Fire Station structure may be supported on drilled shafts. Drilled shafts will provide support by embedment into Mancos Shale bedrock. Bedrock is anticipated to be encountered around 30 to 35 feet below the ground surface based on experience from local (Grand Junction area) geotechnical drilling personnel. For axial bearing, a minimum shaft penetration into competent bedrock of 10 feet is recommended. If required, the embedment length should be increased to provide additional resistance to lateral loads and to provide additional axial capacity with increased side resistance. Anticipated drilled shaft length is 40 to 45 feet.

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 8.3 for use with Load and Resistance Factor Design (LRFD) methods.

Table 8.3 - Base and Side Resistance Values for Drilled Shafts

Location	Estimated Competent Bedrock Elevation (feet)	Nominal (unfactored)		Service Limit or Allowable Bearing Resistance	
		Base Resistance (ksf)	Side Resistance (ksf)	Bearing Resistance (ksf)	Side Resistance (ksf)
Proposed Pear Park Fire Station	4,602 – 4,607	92	7.5	30	2.0

Due to the depth to bedrock at this site, 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 0.55 is recommended for base/ tip resistance and a resistance factor of 0.60 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 (8th 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, 2019," and subsequent revisions.

(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 4,622 to 4,629 feet, approximately 15 to 27 feet above the estimated bedrock surface. 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 ensure 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 Table 8.4.

(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.

8.4 Lateral Resistance Parameters (Driven Pile and Drilled Shaft Foundations)

Recommended preliminary lateral resistance parameters for driven piles constructed are presented in Table 8.4. The parameters listed are for use with LPILE® or equivalent software.

Table 8.4: Drilled Shaft and Driven Pile Lateral Resistance Parameters

Borehole Material	L-Pile Soil Type	Undrained Shear Strength (psf)	Angle of Internal Friction (degrees)	Subgrade Reaction Coefficient, (pci)	Strain Factor ε_{50} (%)	Unit Weight (pcf)
CLAY, with sand, above water table	Stiff clay w/o free water	360	0	250	0.020	125 (Total)
CLAY, with sand, Below water table	Stiff clay w/ free water	360	0	100	0.025	63 (Submerged)
SAND, gravelly to GRAVEL, sandy, Below water table	Sand	0	36	60	--	63 (Submerged)
Claystone/Shale Bedrock	Stiff clay w/o free water	8,000	0	2,000	0.004	125 (Total)

Total unit weight indicated in the table above includes soil plus moisture content. Depths at which groundwater were encountered are indicated on the attached borehole logs.

9.0 INTERIOR FLOOR SLAB AND SUBGRADE SUPPORT DISCUSSION

Based on consolidation and penetration data obtained from the boreholes drilled, special mitigation is recommended for design and construction of interior slab-on-grade flatwork, parking and drive lane pavements, and fire truck garage interior concrete pavement due to settlement potential and constructability. Mitigation may consist of over excavation and replacement with coarse, granular material with geosynthetic fabrics or geogrids to help stabilize subgrade soils.

To provide stable subgrade support within the interior limits of the building, remove and dispose the full extents of saturated or unstable existing subgrade soil (including topsoil material) down to stable subgrade or to a minimum depth of 18-inches below elevation of the bottom of final subgrade elevations. Place a layer of Mirafi RS 380i, Hanes TerraTex HPG HM28, or approved woven geotextile in accordance with the manufacturer's installation recommendations. Place and compact 6-inches of coarse, granular material on top of the geotextile. Proof roll the section and add additional geotextile with coarse, granular material layers (maximum of 6-inch lifts) as needed to pass proof rolling at finished subgrade elevations. If necessary, add Tensar triaxial geogrid, or approved equal.

As an alternative to the mitigation through subexcavation and replacement with granular material and geotextile layers the interior floor system may be designed and constructed as a structurally supported floor system.

9.1 Compaction Specifications

All backfill placement and subgrade preparation shall be performed in accordance with City of Grand Junction requirements, or as specified by recommendations in this report. The minimum compaction recommended for all soil classifications for this project by RockSol is presented in Table 9.1.

Table 9.1 – Compaction Specifications

AASHTO Classification (AASHTO M 145)	Relative Compaction Percent of Maximum	Moisture Content Deviation from Optimum
Clay Soils A-6 and A-7	95% Min. ASTM D698 (Standard Proctor Method)	0% to +3%
Sands, Gravels and Silts A-1, A-2, A-3, A-4 and A-5	90% Min. ASTM D1557 (Modified Proctor Method)	-2% to +2%

A representative of the geotechnical engineer should observe and test fill placement operations.

9.2 Subgrade Preparation

At a minimum, the ground surface underlying exterior slab-on-grade flatwork (sidewalks and drive lanes) should be carefully prepared by removing all organic matter (topsoil), scarification to a minimum depth of 6 inches and recompacting to the requirements for maximum dry density and moisture content listed in Table 9.1 of this report prior to concrete placement.

10.0 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

Proper construction practices and adherence to project plans and specifications should be followed during site preparation, earthwork, excavations, and construction of utilities, pavements, and structures for the suitable long-term performance of the proposed fire station. 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 water ponding and excessive moisture infiltration into the subgrade soils during and after construction.

11.0 LIMITATIONS

This geotechnical investigation was conducted in general accordance with the scope of work. The geotechnical practices are similar to that used in Colorado with similar soil conditions and our understanding of the proposed work.

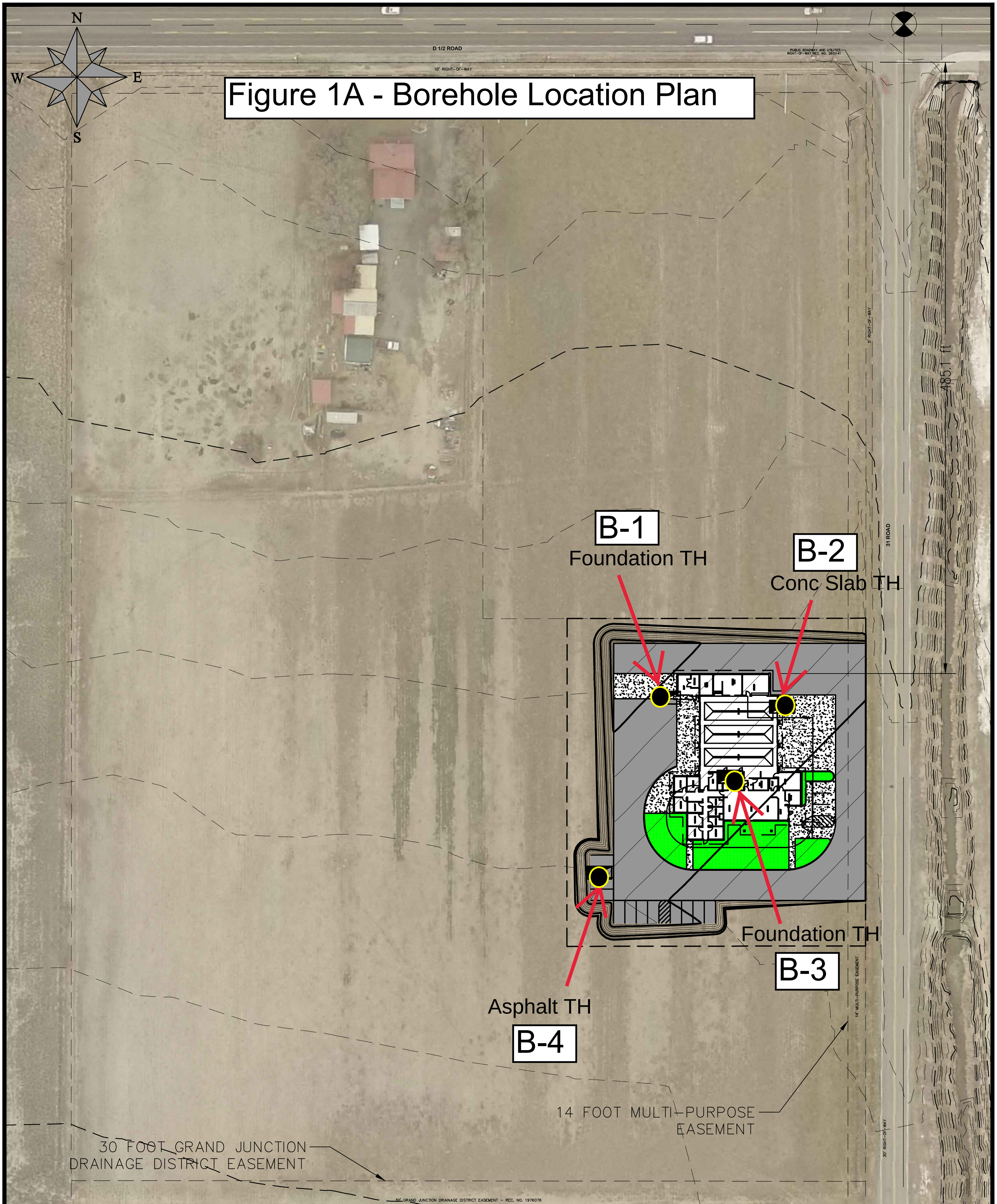
The subsurface investigation program was conducted to obtain information on the subsurface soil, groundwater, and bedrock conditions at the proposed Pear Park Fire Station site. Surface and groundwater hydrology, hydraulic engineering, and environmental studies including contaminant characterization were not included in RockSol's geotechnical scope of work

This report has been prepared by RockSol for the City of Grand Junction 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.

APPENDIX A

BOREHOLE LOCATION PLAN

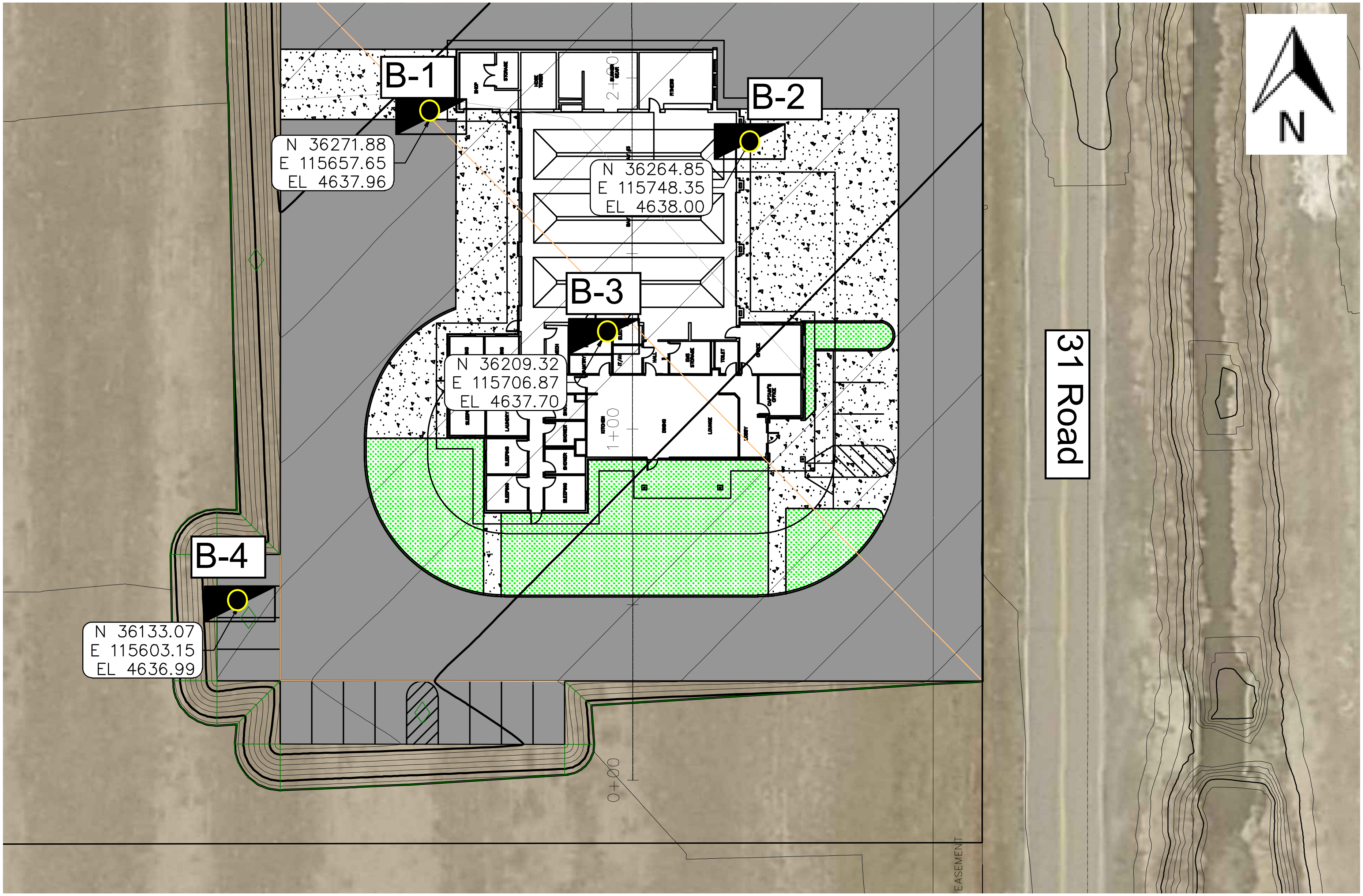
Figure 1A - Borehole Location Plan



DRAWN BY HMC DATE 2019 DESIGNED BY ____ DATE ______ HORIZONTAL: 1" = 100' 0 25 50 100	*PUBLIC WORKS* *ENGINEERING DIVISION* PEAR PARK FIRE STATION	CITY OF Grand Junction COLORADO

N:\Landproj\Pear Park Fire Station\dwg\PEAR PARK FIRE STATION.dwg

Figure 1B - Borehole Location Plan - Proposed Pear Park Fire Station



APPENDIX B

LEGEND AND INDIVIDUAL SOIL BOREHOLE LOGS

RockSol Consulting Group, Inc.

LEGEND

CLIENT City of Grand Junction | **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 | **PROJECT LOCATION** Grand Junction, CO

LITHOLOGY

- **TOPSOIL**
- **Native - CLAY**
- **Native - GRAVEL, silty**
- **Native - SAND, with gravel to gravelly**
- **Native - CLAY, with sand to sandy**

SAMPLE TYPE

Auger Cuttings

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 : B-1

CLIENT City of Grand Junction
PROJECT NAME Pear Park Fire Station
PROJECT NUMBER 599.05
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/8/20 **COMPLETED** 6/8/20
GROUND ELEVATION 4638.0 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 36271.9 **EAST** 115657.7
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: NW corner of proposed fire station
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
▼ **WATER DEPTH** 15.3 ft on 6/8/20

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 (%)
4637.96	0		(Topsoil) SAND, clayey, approximately 3" thick										
			(Native) CLAY, slightly moist to moist, brown, medium stiff, slightly calcareous										
				MC	5/12	0.6		107.0	15.7				
				MC	5/12	-1.1	2.00	103.9	20.0				
4632.96	5												
			(Native) CLAY, moist, brown, very stiff, slightly calcareous										
				MC	15/12	2.8		117.5	10.0				
4627.96	10												
			(Native) CLAY, with sand to sandy, moist, brown, stiff, slightly calcareous										
				MC	12/12			108.2	17.3				
4622.96	15	▼											
			(Native) SAND, gravelly, wet, brown, dense										
				SS	17/21/19				8.5				12.3
4617.96	20												
			Bottom of hole at 20.5 feet.										

RockSol Consulting Group, Inc.

BORING : B-2

CLIENT City of Grand Junction
PROJECT NAME Pear Park Fire Station
PROJECT NUMBER 599.05
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/8/20 **COMPLETED** 6/8/20
GROUND ELEVATION 4638.0 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 36264.9 **EAST** 115748.4
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: NE corner of proposed fire station
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 8.7 ft on 6/8/20

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 (%)
4638.0	0.0		(Topsoil) SAND, clayey, approximately 3" thick	BULK			0.82			30	18	12	98.9
			(Native) CLAY, very moist, brown, soft, trace small plant roots **Approximate Bulk Depth 0-5** Liquid Limit= 30 Plastic Limit= 18 Plasticity Index= 12 Fines Content= 98.9 Sulfate= 0.82										
				MC	3/12	-1.1	0.03	100.9	22.8				
4635.5	2.5												
				MC	3/12	-2.3		95.3	26.6				99.3
4633.0	5.0												
			(Native) CLAY, with sand to sandy, very moist to wet, brown, soft to medium stiff										
4630.5	7.5												
				MC	3/12	-1.9		98.6	25.5				
4628.0	10.0												
4625.5	12.5												
				MC	4/12	-1.6		97.7	26.0				
4623.0	15.0												
			Bottom of hole at 15.0 feet.										

RockSol Consulting Group, Inc.

BORING : B-3

CLIENT City of Grand Junction
PROJECT NAME Pear Park Fire Station
PROJECT NUMBER 599.05
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/8/20 **COMPLETED** 6/8/20
GROUND ELEVATION 4637.7 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 36209.3 **EAST** 115706.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: Center of proposed fire station
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 8.5 ft on 6/8/20

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
4637.7	0	(Topsoil) SAND, clayey, approxiamtely 3" thick	BULK			0.86			30	17	13	97.0
		(Native) CLAY, moist, brownish gray to brown, soft, roots **Approximate Bulk Depth 0-10** Liquid Limit= 30 Plastic Limit= 17 Plasticity Index= 13 Fines Content= 97.0 Sulfate= 0.86	MC	3/12	-0.5		102.3	22.0				
			MC	3/12	-1.3		99.9	23.8				
4632.7	5											
		(Native) CLAY, with sand to sandy, very moist, brown and gray, soft to medium stiff	MC	4/12	-1.7	0.64	103.5	22.5				
4627.7	10											
			MC	5/12			99.5	24.0				
4622.7	15											
		(Native) SAND, with gravel to gravelly, wet, brown, medium dense	SS	26/12				6.4				
4617.7	20											
		(Native) GRAVEL, sandy, wet, brown to dark brown, very dense	SS	25/28/34				8.0	NP	NP	NP	8.7
4612.7	25											
		Bottom of hole at 25.5 feet.										

LOG - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ 7/24/20

BORING : B-4

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Pear Park Fire Station
PROJECT NUMBER 599.05
PROJECT LOCATION Grand Junction, CO
DATE STARTED 6/8/20 **COMPLETED** 6/8/20
GROUND ELEVATION 4637.0 ft **STATION NO.**
DRILLING CONTRACTOR McCracken Drilling
NORTH 36133.1 **EAST** 115603.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25"
BORING LOCATION: SW corner of proposed fire station
LOGGED BY R. Lepro **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 4.0 ft on 6/8/20

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 (%)
4636.99	0		(Topsoil) SAND, clayey, approximately 3" thick	BULK			0.16			25	17	8	92.6
			(Native) CLAY, very moist, brown, soft **Approximate Bulk Depth 0-5** Liquid Limit= 25 Plastic Limit= 17 Plasticity Index= 8 Fines Content= 92.6 Sulfate= 0.16										
4635.99	1												
4634.99	2			MC	3/12	-2.0		103.4	20.6				
4633.99	3												
4632.99	4			MC	3/12	-2.0		99.0	24.7				
4631.99	5		Bottom of hole at 5.0 feet.										

APPENDIX C

LABORATORY TEST RESULT SUMMARY

AND

TEST RESULT SHEETS

RockSol
Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NAME Pear Park Fire Station

PROJECT NUMBER 599.05

PROJECT LOCATION Grand Junction, 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
B-1	2				0.6				15.7	107.0								
B-1	4				-1.1				20.0	103.9		2.00						
B-1	9				2.8				10.0	117.5								
B-1	14								17.3	108.2								
B-1	19					12			8.5									
B-2	0-5	30	18	12		99	CL	A-6 (11)				0.82	300 @ 23%	7.9	0.0200			
B-2	2				-1.1				22.8	100.9		0.03						
B-2	4				-2.3	99			26.6	95.3								
B-2	9				-1.9				25.5	98.6								
B-2	14				-1.6				26.0	97.7								
B-3	0-10	30	17	13		97	CL	A-6 (12)				0.86	400 @ 20%	8.0	0.0200			
B-3	2				-0.5				22.0	102.3								
B-3	4				-1.3				23.8	99.9								
B-3	9				-1.7				22.5	103.5		0.64						
B-3	14								24.0	99.5								
B-3	19								6.4									
B-3	24	NP	NP	NP		9	GP-GM	A-1-a (0)	8.0									
B-4	0-5	25	17	8		93	CL	A-4 (6)				0.16	1000 @ 21%	7.9	0.0100			
B-4	2				-2.0				20.6	103.4								
B-4	4				-2.0				24.7	99.0								

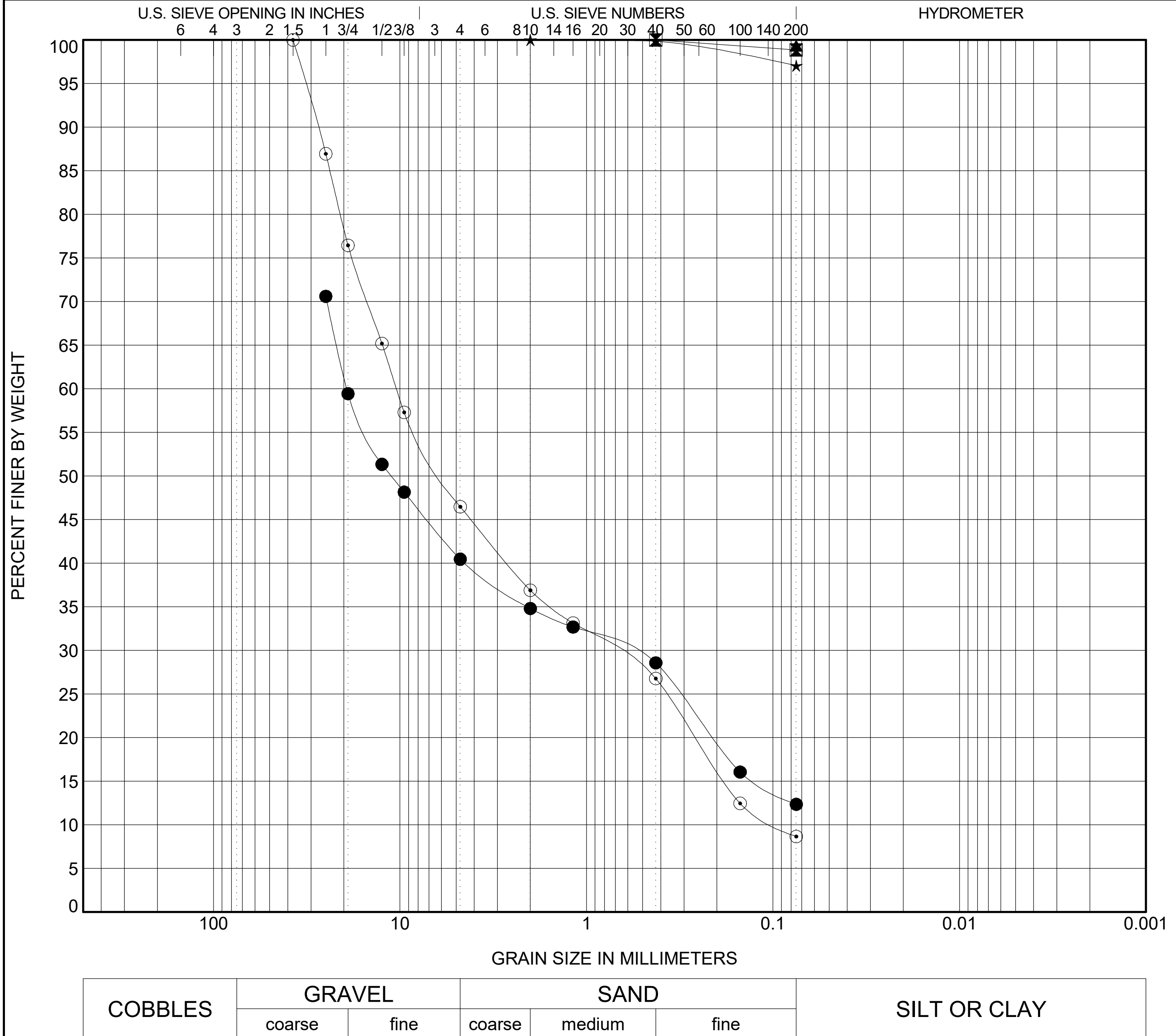
GRAIN SIZE DISTRIBUTION

RockSol Consulting Group, Inc.

Rocksol Consulting Group

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-1	19.0	SAND, slightly silty to gravelly				0.40	398.48
⧗	B-2	0.0-5.0	LEAN CLAY (CL) (A-6)	30	18	12		
▲	B-2	4.0	CLAY					
★	B-3	0.0-10.0	LEAN CLAY (CL) (A-6)	30	17	13		
⊙	B-3	24.0	POORLY GRADED GRAVEL w SILT & SAND (GP-GM) (A-1-a)	NP	NP	NP	0.51	108.88

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	19.0	25	19.267	0.607		30.1	28.1	12.3	
⧗	B-2	0.0-5.0	0.425				0.0	1.1	98.9	
▲	B-2	4.0	0.075						99.3	
★	B-3	0.0-10.0	2				0.0	3.0	97.0	
⊙	B-3	24.0	37.5	10.437	0.714	0.096	53.5	37.8	8.7	

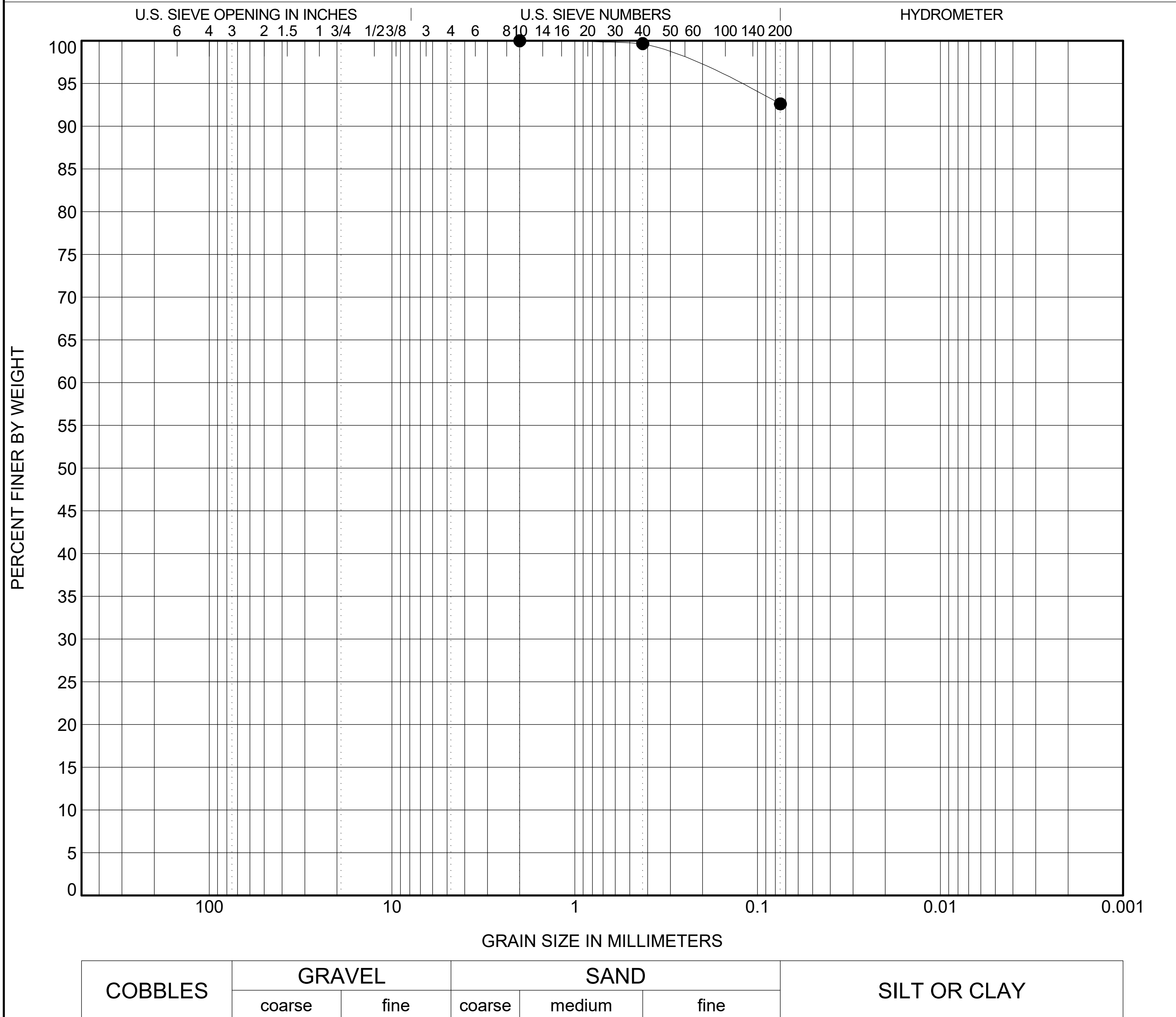
GRADATION - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

GRAIN SIZE DISTRIBUTION

Rocksol Consulting Group

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-4**	**0.0-5.0**	**LEAN CLAY (CL) (A-4)**	**25**	**17**	**8**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**0.0-5.0**	**2**				**0.0**	**7.4**	**92.6**	

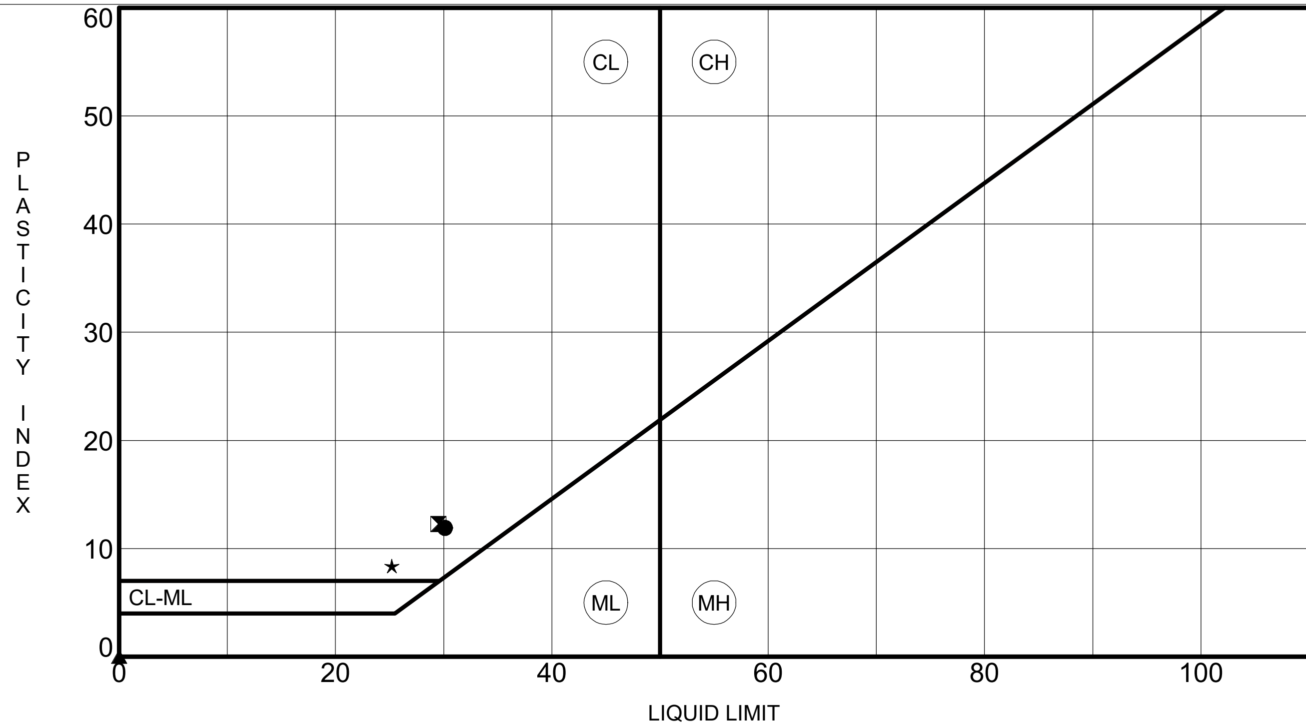
GRADATION - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction | **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 | **PROJECT LOCATION** Grand Junction, CO



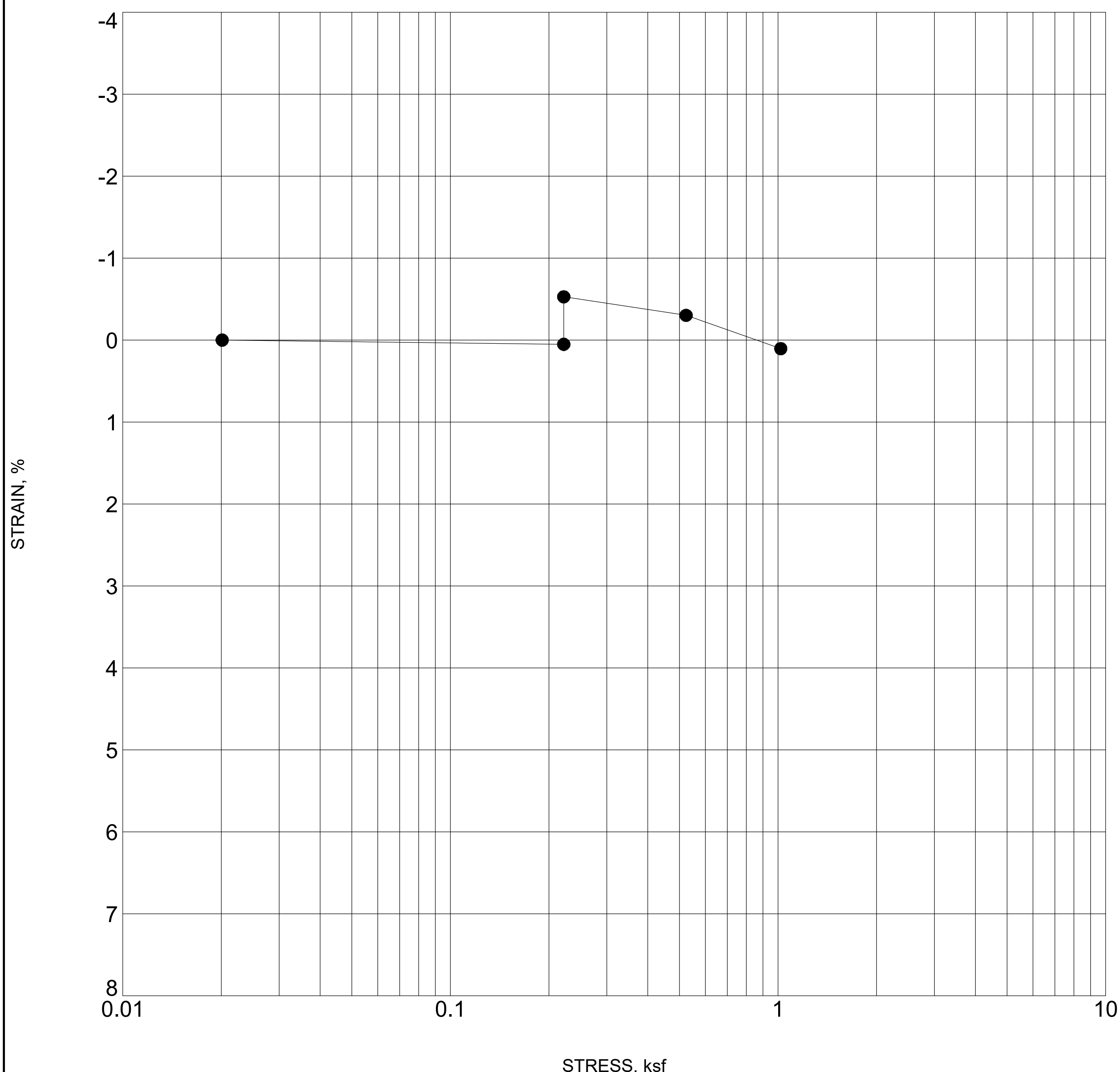
	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-2**	**0.0-5.0**	**30**	**18**	**12**	**98.9**	**LEAN CLAY (CL) (A-6)**
⧗	**B-3**	**0.0-10.0**	**30**	**17**	**13**	**97.0**	**LEAN CLAY (CL) (A-6)**
▲	**B-3**	**24.0**	**NP**	**NP**	**NP**	**8.7**	**POORLY GRADED GRAVEL with SILT and SAND (GP-GM) (A-1-a)**
★	**B-4**	**0.0-5.0**	**25**	**17**	**8**	**92.6**	**LEAN CLAY (CL) (A-4)**

RockSol
Consulting Group, Inc.

SWELL - CONSOLIDATION TEST

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



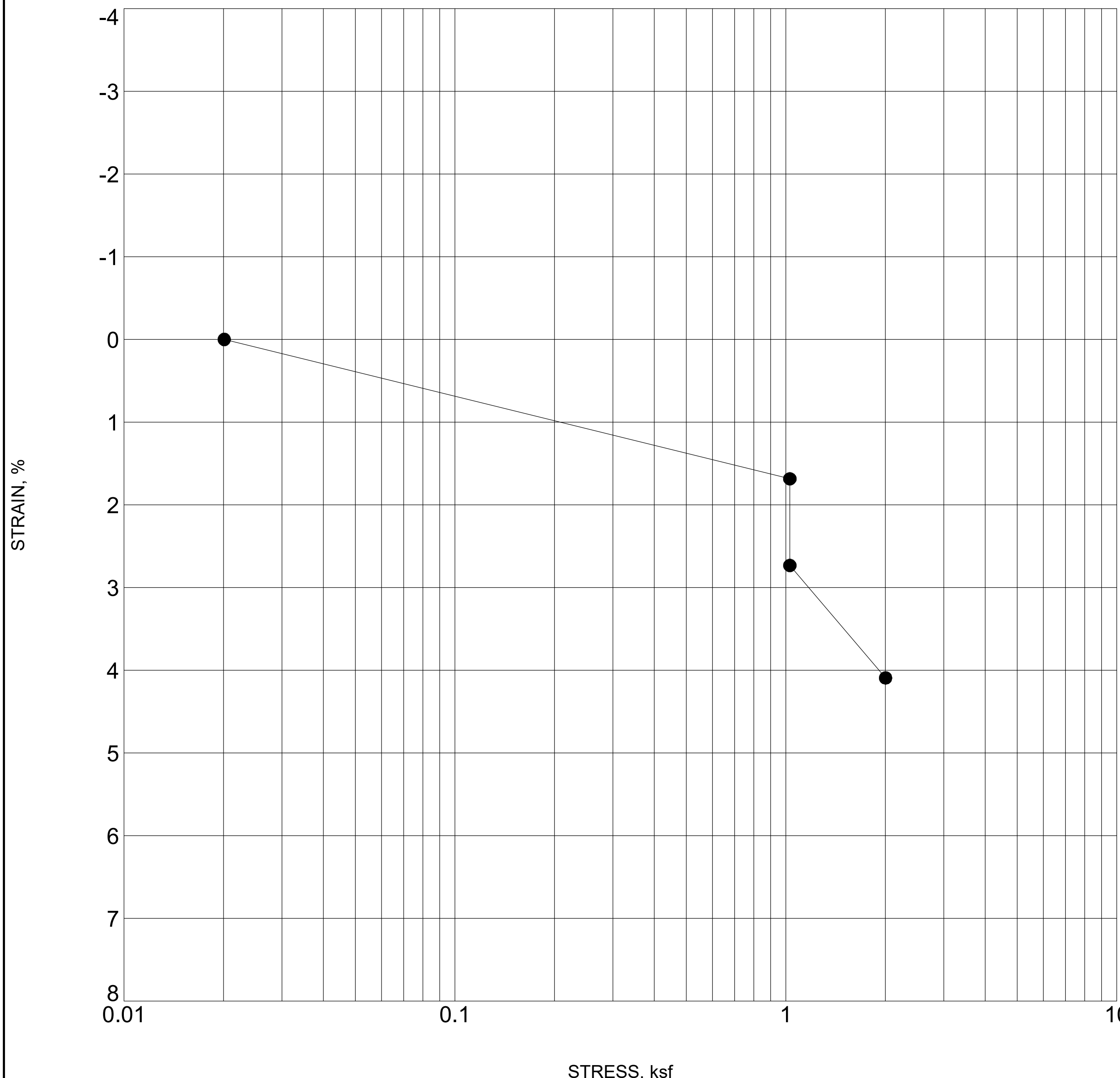
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-1**	**2**	**CLAY**	**0.6**	**107.0**	**15.7**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● B-1	4	**CLAY**	**-1.1**	**103.9**	**20.0**

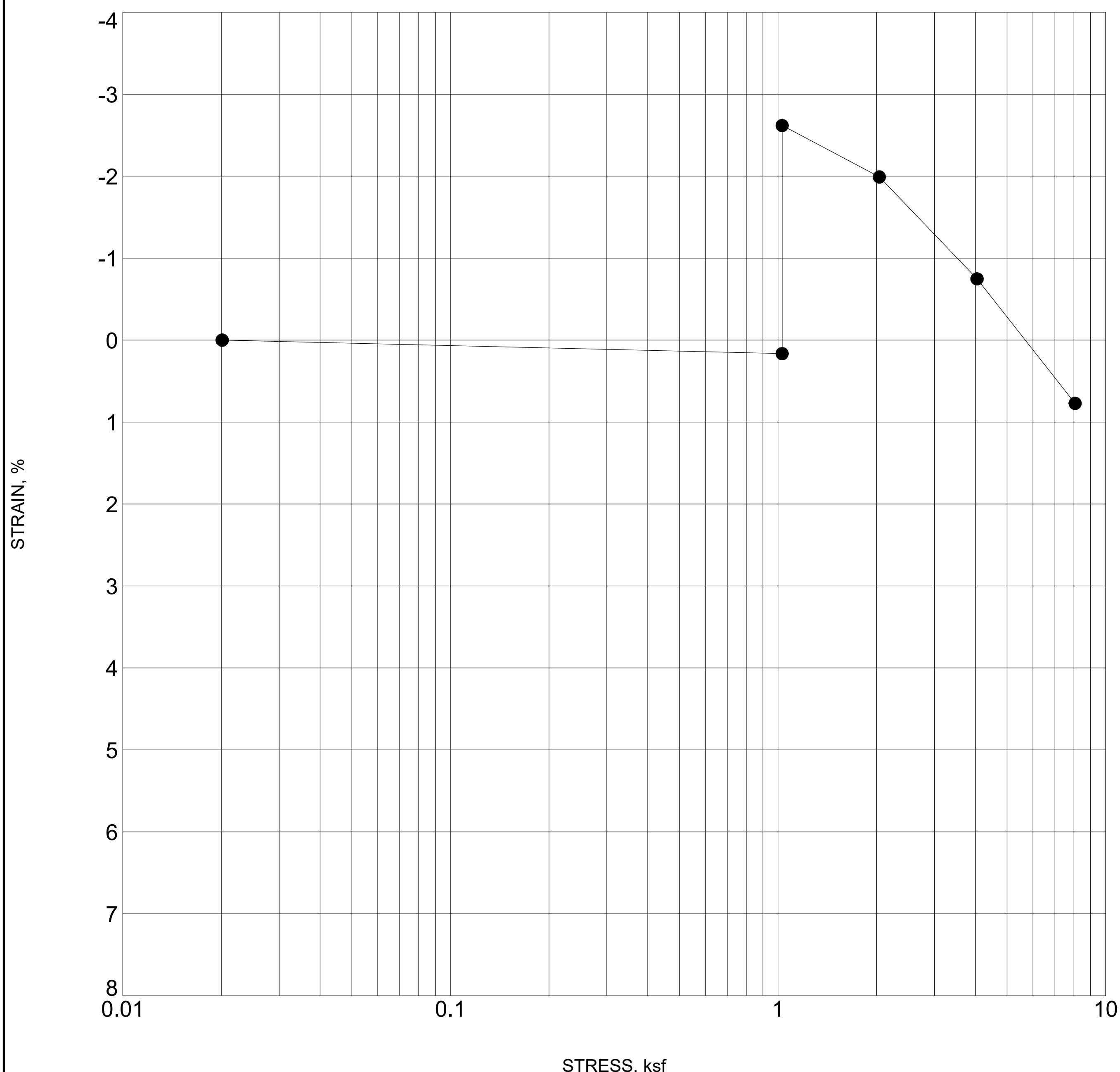
SWELL - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

RockSol Consulting Group, Inc.

SWELL - CONSOLIDATION TEST

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



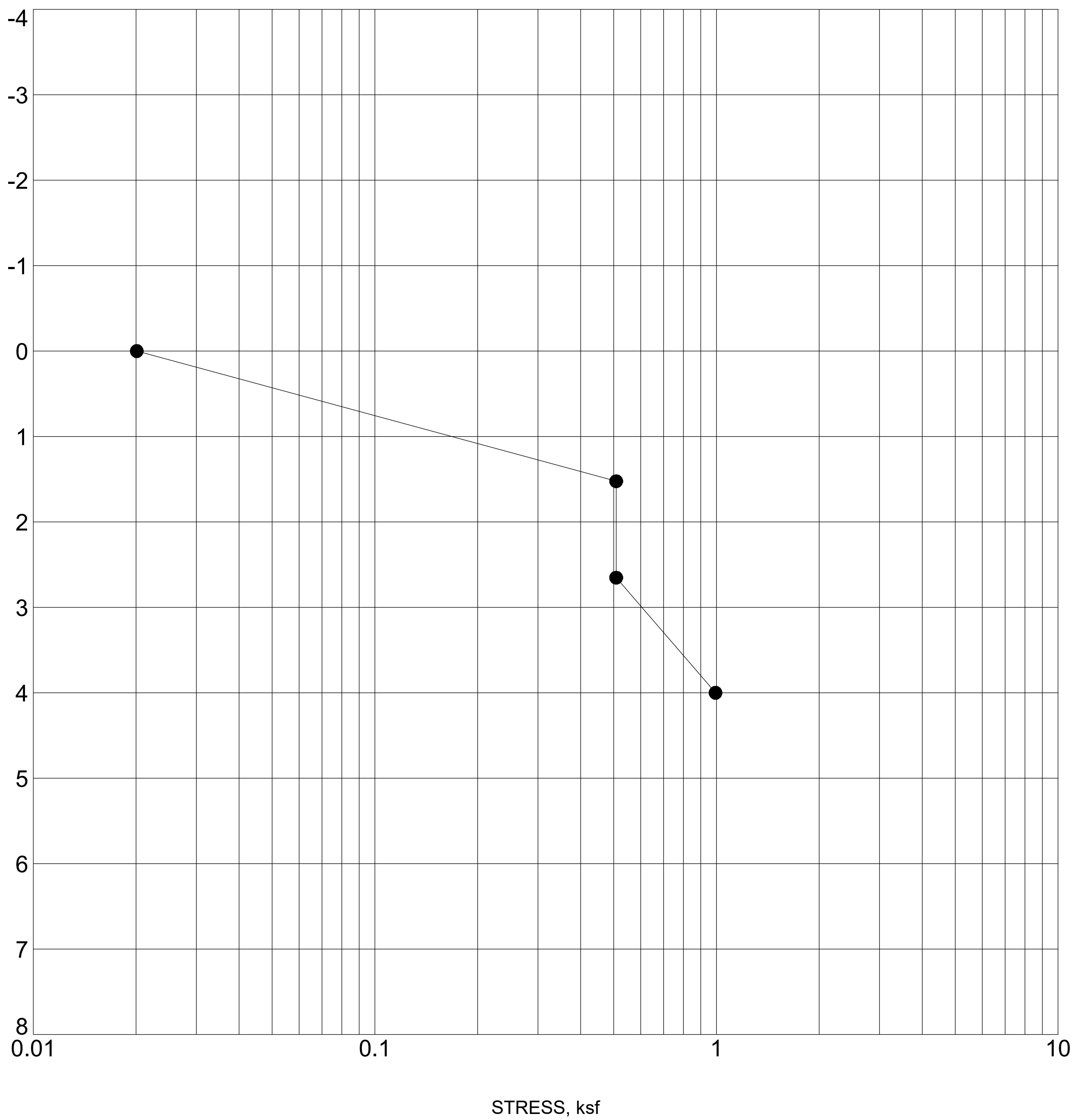
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-1**	**9**	**CLAY**	**2.8**	**117.5**	**10.0**

SWELL - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Pear Park Fire Station
PROJECT NUMBER 599.05
PROJECT LOCATION Grand Junction, CO



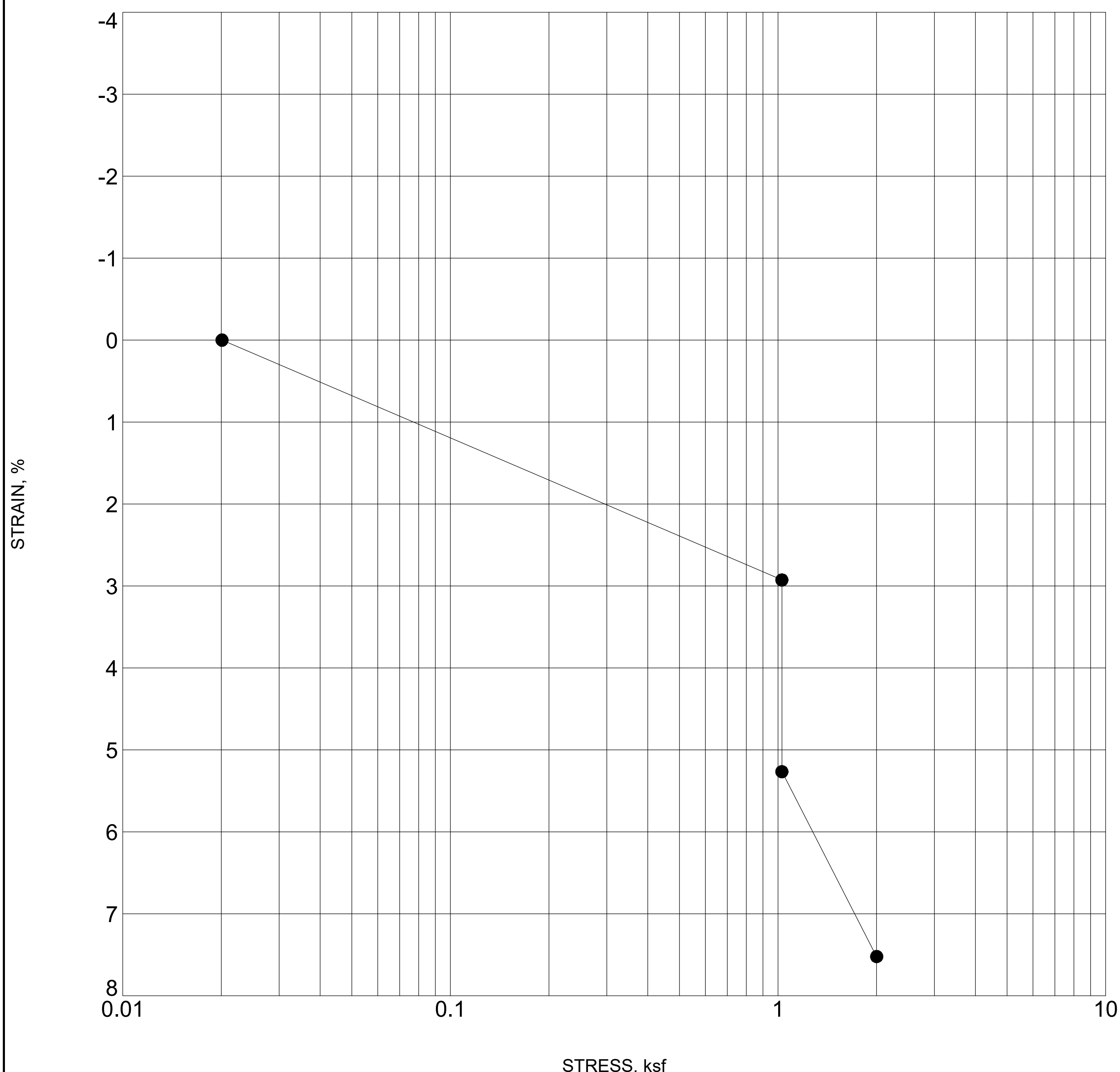
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-2**	**2**	**CLAY**	**-1.1**	**100.9**	**22.8**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



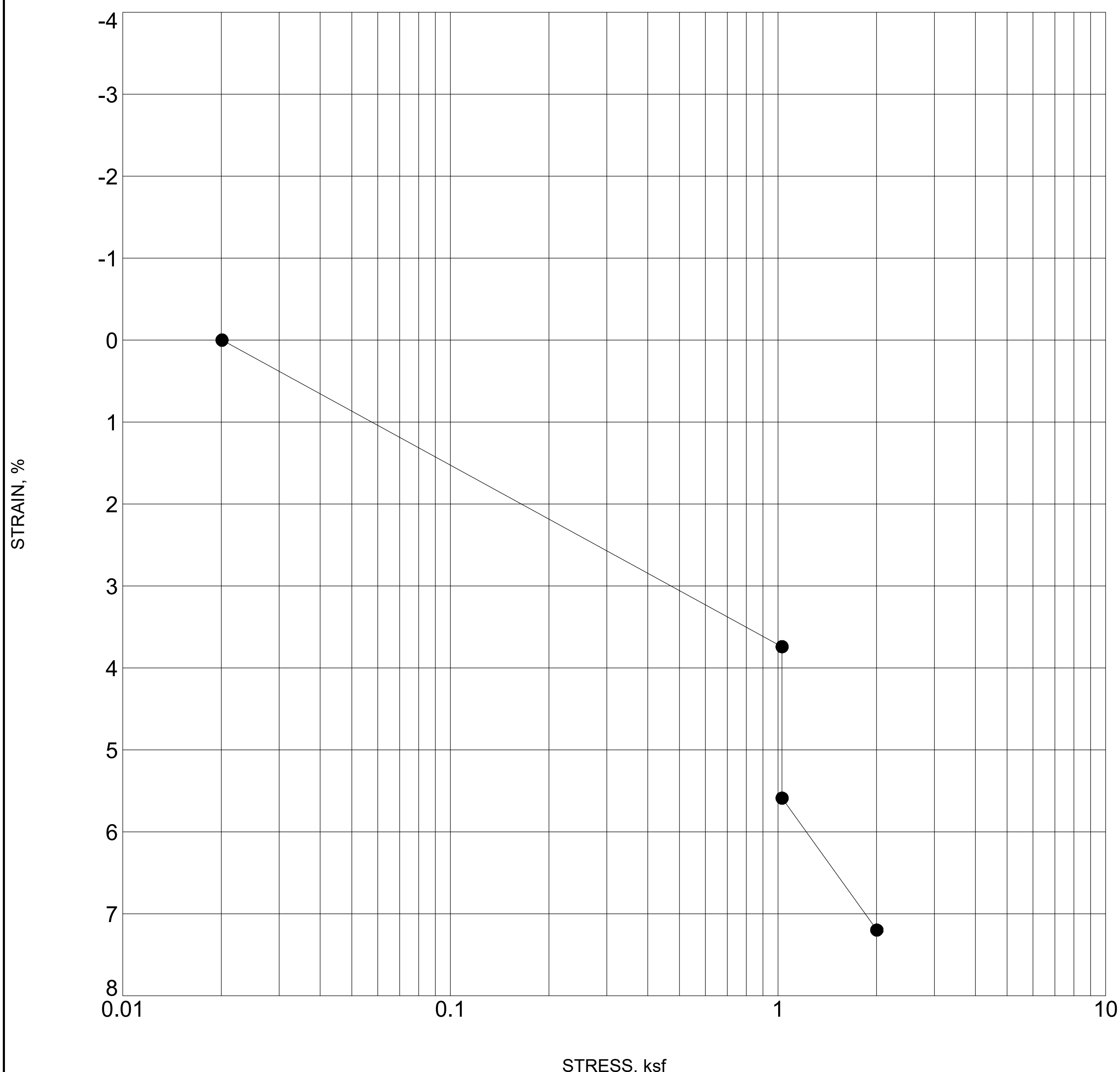
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● B-2	4	CLAY	-2.3	95.3	26.6

SWELL - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Pear Park Fire Station
PROJECT NUMBER 599.05
PROJECT LOCATION Grand Junction, CO



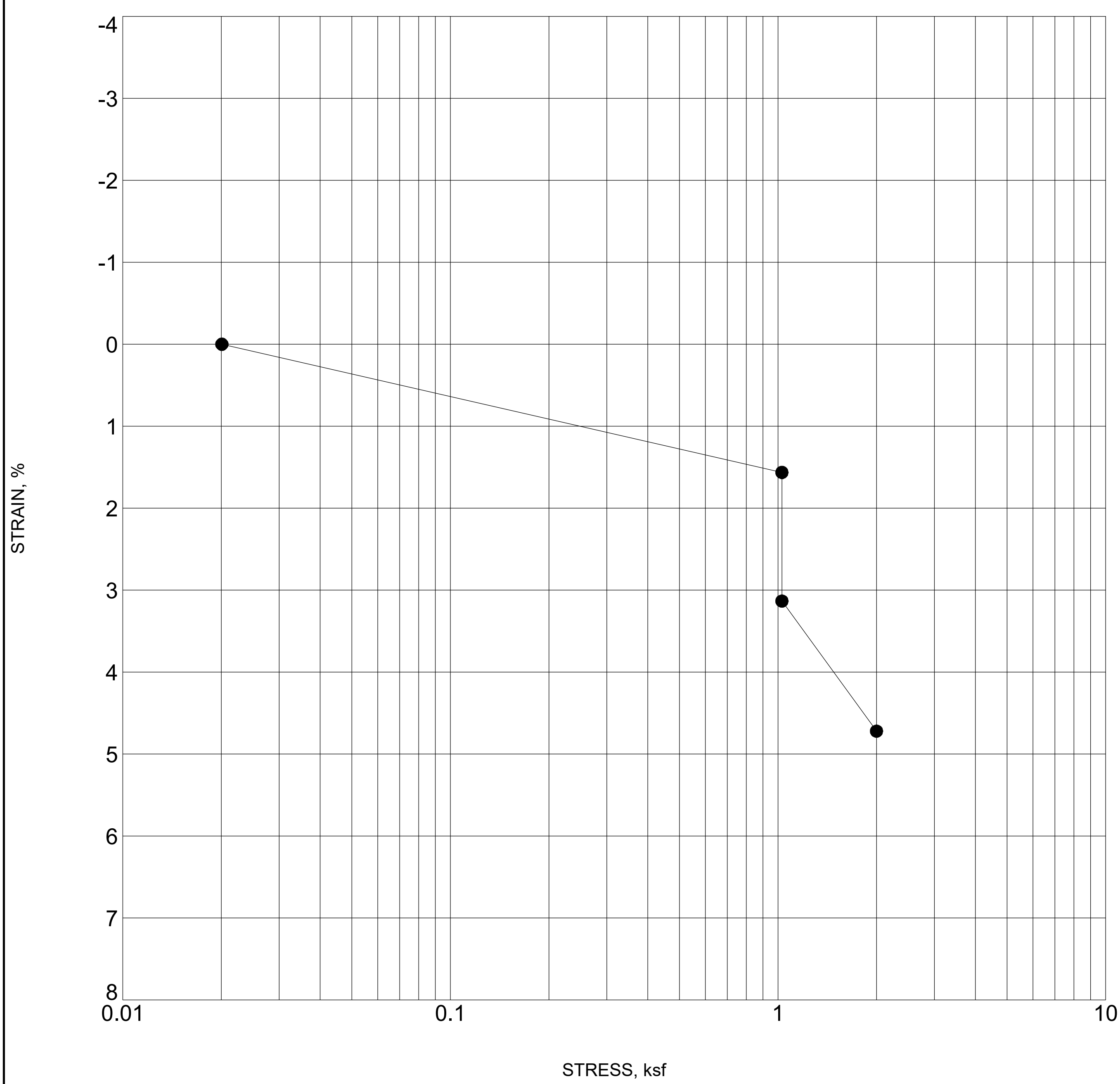
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-2**	**9**	**CLAY, sandy**	**-1.9**	**98.6**	**25.5**

RockSol Consulting Group, Inc.

SWELL - CONSOLIDATION TEST

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



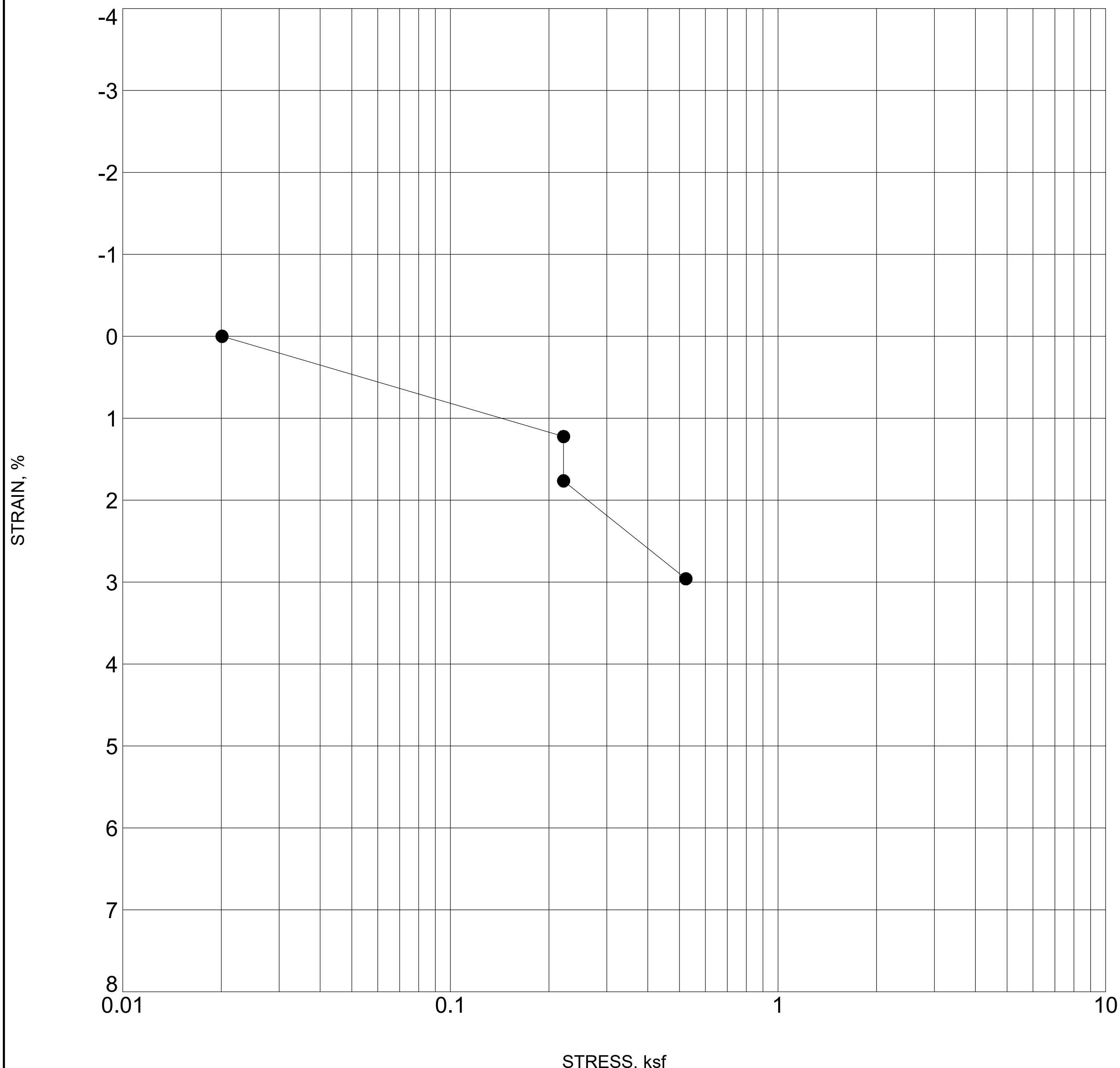
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-2**	**14**	**CLAY, sandy**	**-1.6**	**97.7**	**26.0**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● B-3	2	CLAY	-0.5	102.3	22.0

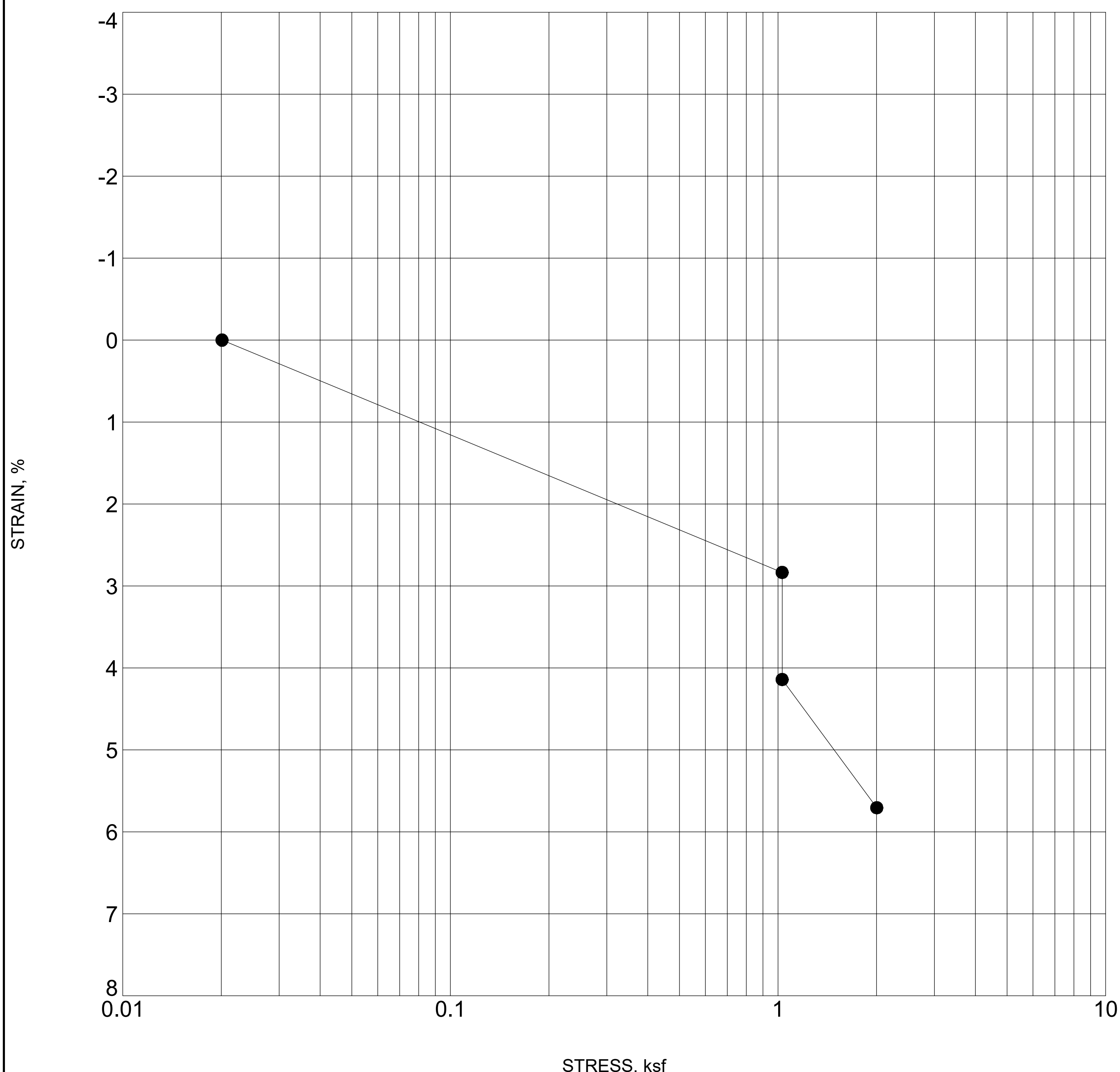
SWELL - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



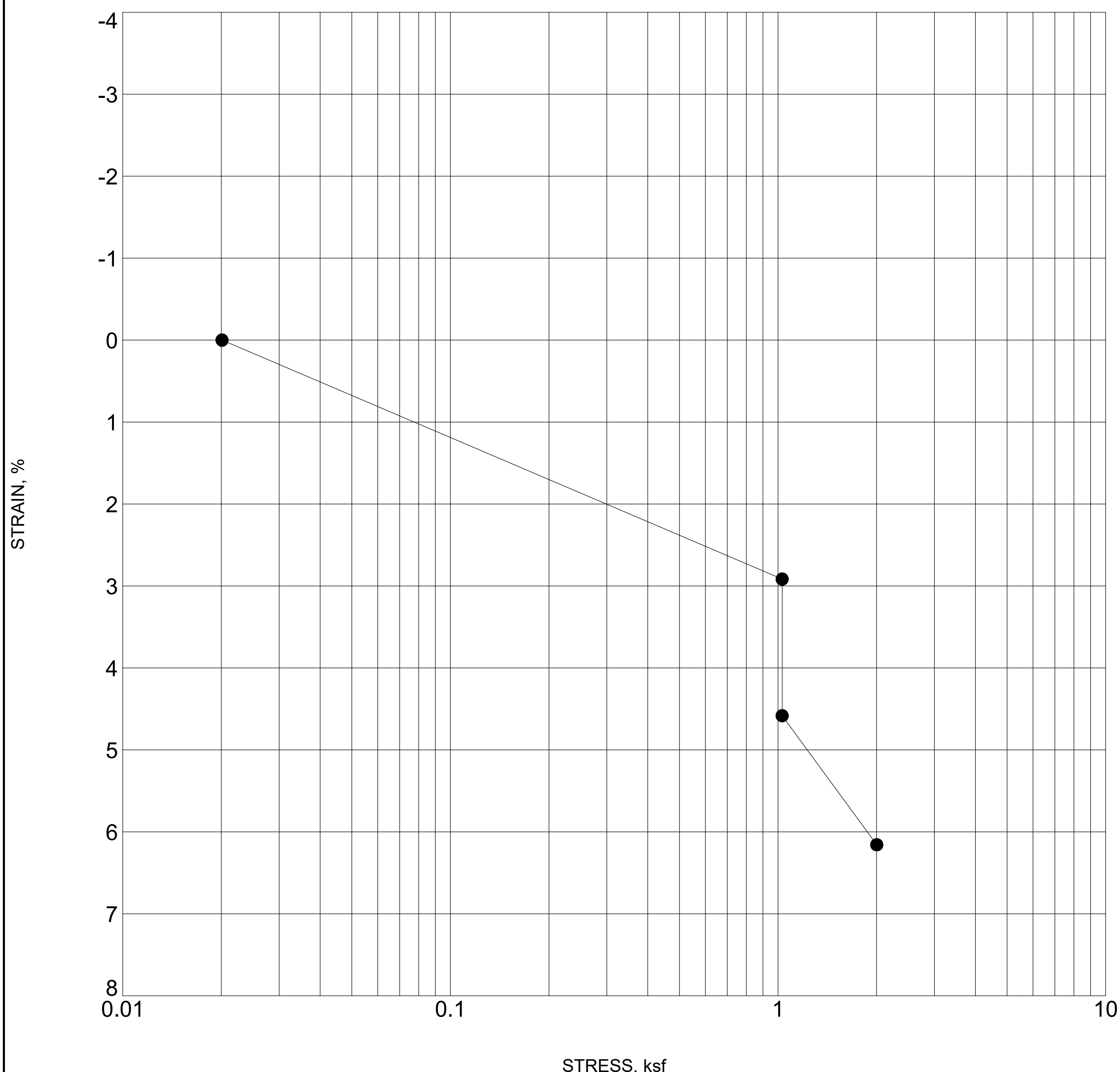
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-3**	**4**	**CLAY**	**-1.3**	**99.9**	**23.8**

SWELL - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction
PROJECT NAME Pear Park Fire Station
PROJECT NUMBER 599.05
PROJECT LOCATION Grand Junction, CO



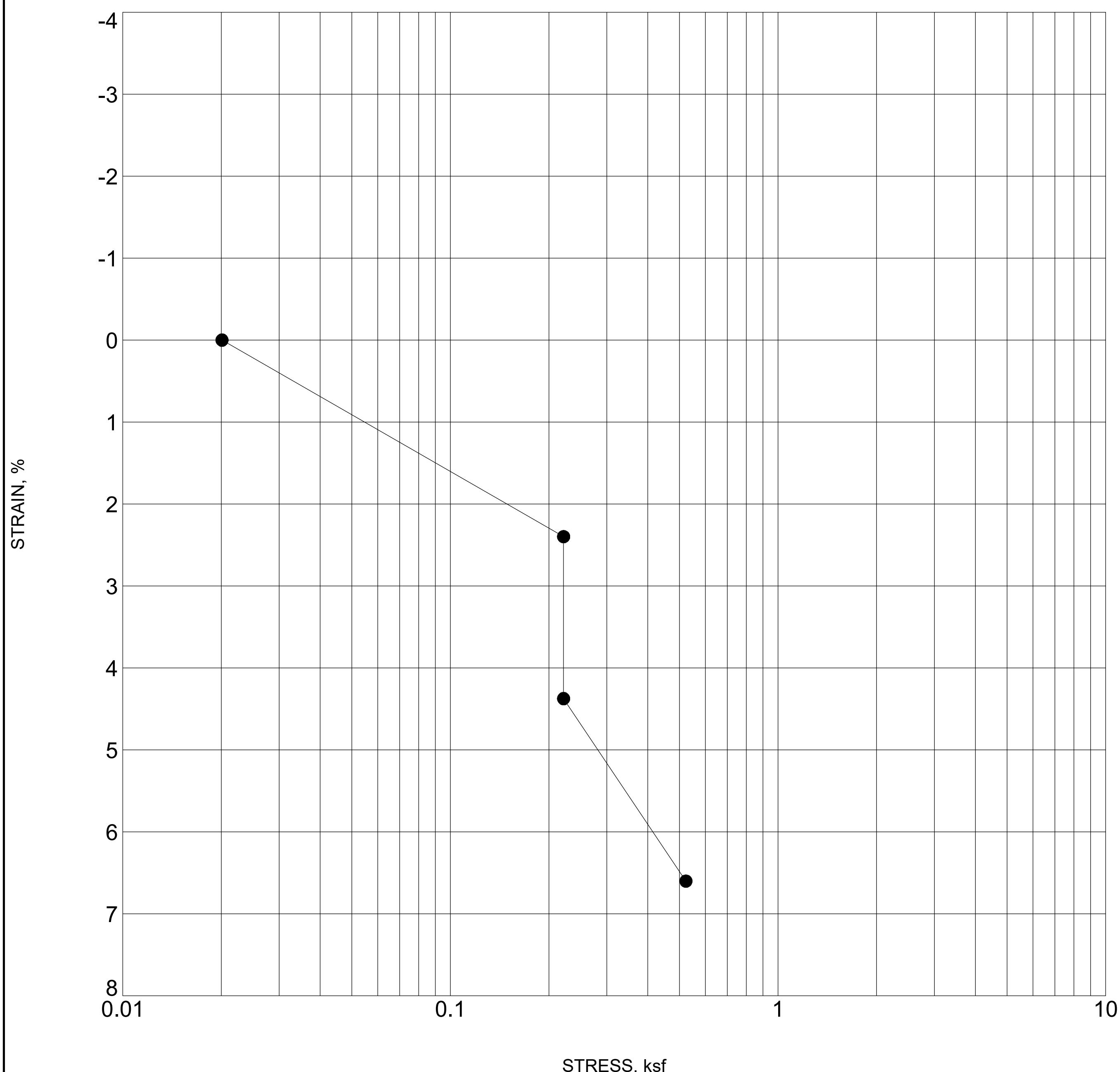
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-3**	**9**	**CLAY, with sand to sandy**	**-1.7**	**103.5**	**22.5**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction | **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 | **PROJECT LOCATION** Grand Junction, CO



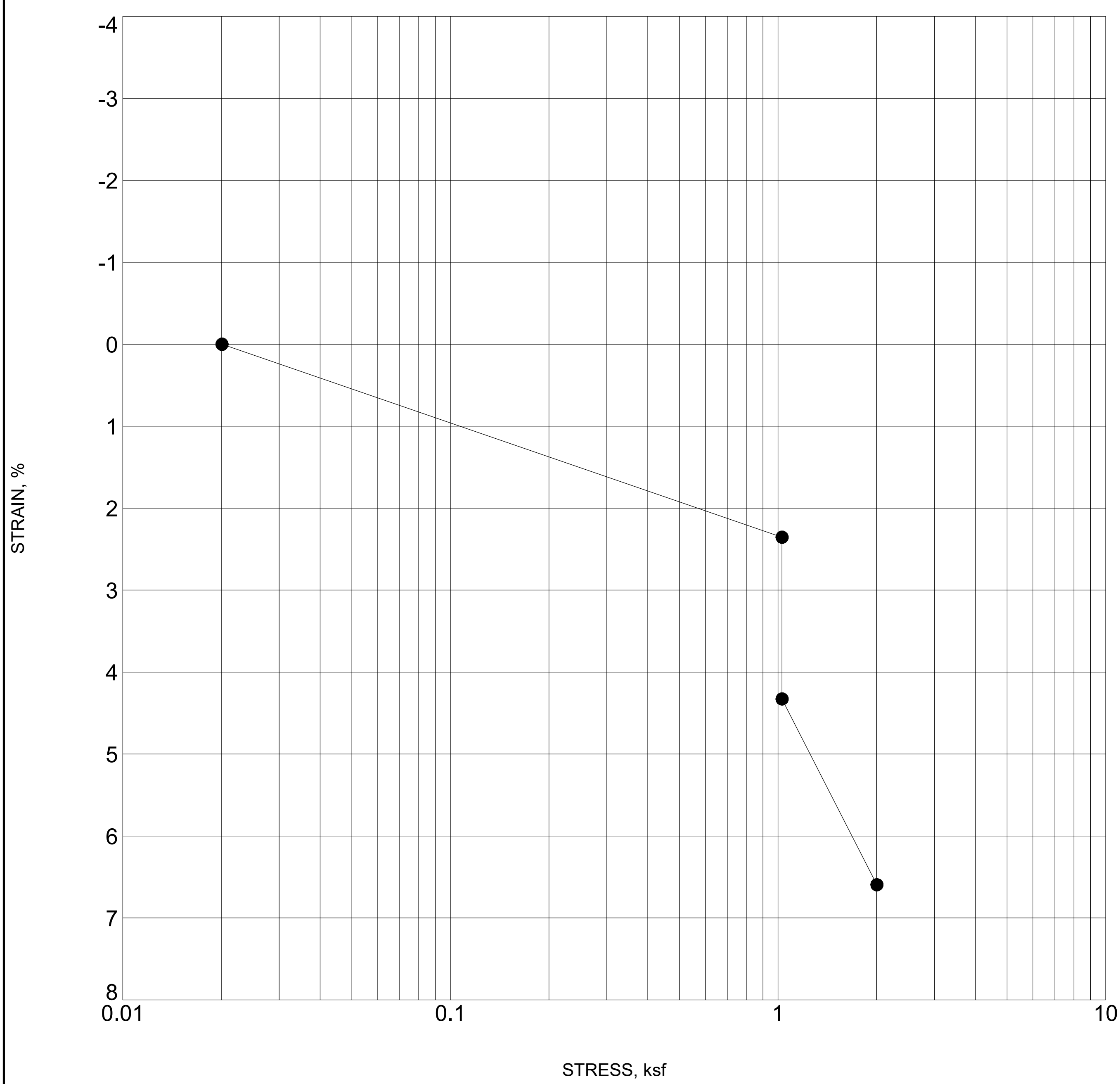
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-4**	**2**	**CLAY**	**-2.0**	**103.4**	**20.6**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Pear Park Fire Station

PROJECT NUMBER 599.05 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● B-4	4	**CLAY**	**-2.0**	**99.0**	**24.7**

SWELL - STANDARD 599.05_PEAR PARK FIRE STATION.GPJ ROCKSOL TEMPLATE.GDT 7/22/20

APPENDIX D

SEISMIC DESIGN CRITERIA OUTPUT SHEETS

OSHPD

Latitude, Longitude: 39.068572, -108.478439

Date	9/29/2020, 3:01:59 PM
Design Code Reference Document	ASCE7-16
Risk Category	IV
Site Class	E - Soft Clay Soil

Type	Value	Description
S_S	0.244	MCE_R ground motion. (for 0.2 second period)
S_1	0.066	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.585	Site-modified spectral acceleration value
S_{M1}	0.277	Site-modified spectral acceleration value
S_{DS}	0.39	Numeric seismic design value at 0.2 second SA
S_{D1}	0.185	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	2.4	Site amplification factor at 0.2 second
F_v	4.2	Site amplification factor at 1.0 second
PGA	0.136	MCE_G peak ground acceleration
F_{PGA}	2.222	Site amplification factor at PGA
PGA_M	0.301	Site modified peak ground acceleration
T_L	4	Long-period transition period in seconds
SsRT	0.244	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.258	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.066	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.071	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.946	Mapped value of the risk coefficient at short periods
C_{R1}	0.932	Mapped value of the risk coefficient at a period of 1 s

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