Geotechnical Investigation Report
Odor Improvements Project
City of Grand Junction, Colorado

RockSol Project No. 599.27
May 19, 2021

Prepared for:

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

Attention: Kurt Carson, PE

Prepared by:

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

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COLORADO REGISTERED
DONALD GORDON HUNT
35249
5-19-21
PROFESSIONAL ENGINEER

Callen Hecker, P.E.
Civil Engineer Associate

Ryan Lepro
Engineering Geologist

Donald G. Hunt, P.E.
Senior Geotechnical Engineer

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ATTACHMENTS

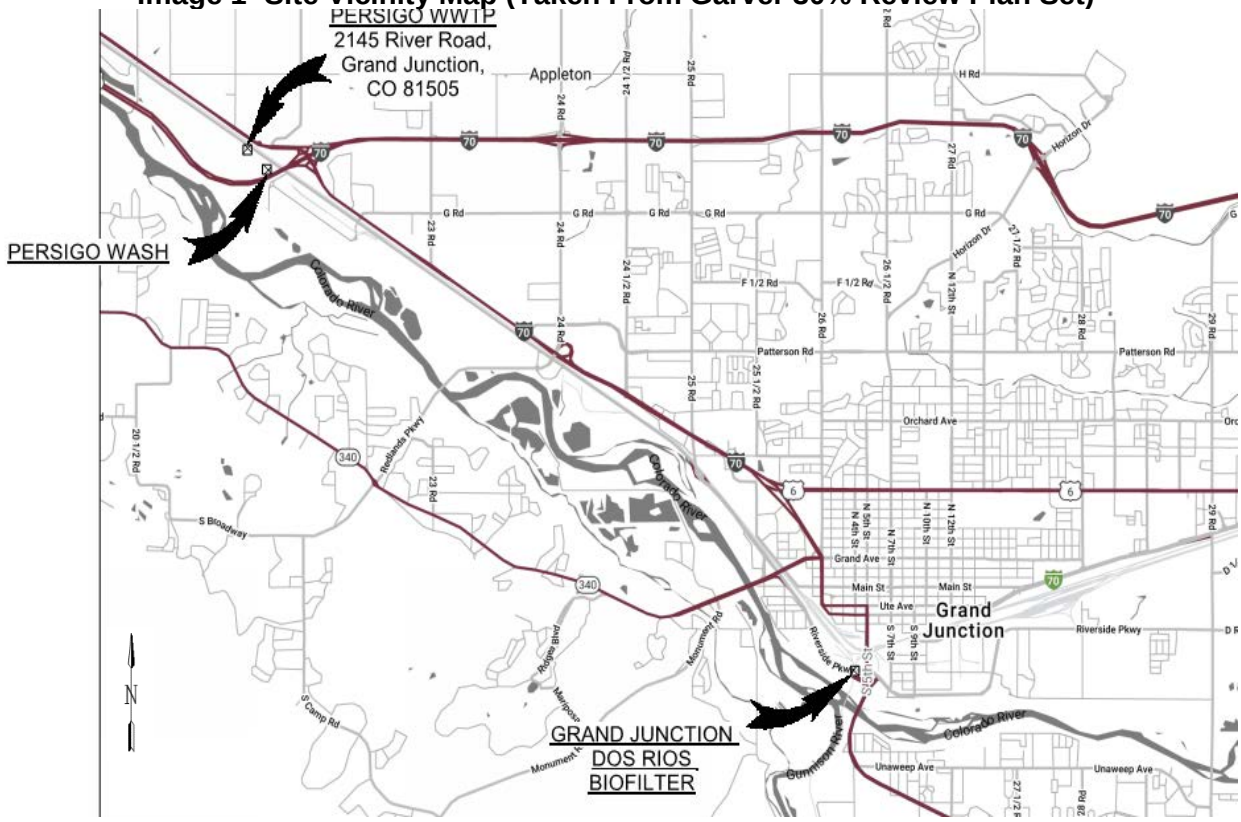
1.0 PROJECT PURPOSE AND DESCRIPTION

This report documents the Geotechnical Investigation performed by RockSol Consulting Group, Inc. (RockSol) to assist with design of proposed improvements to aid with odor control for existing City of Grand Junction wastewater infrastructure. For this investigation RockSol has designated two locations for proposed improvements, identified as Site One and Site Two.

Site One includes a proposed 40-foot by 50-foot Bio-Trickling Filter pad site at the Persigo Wastewater Treatment Plant (WWTP) located just north of the existing Headworks Building. Also included at this location are two concrete foundations to support a 24-inch aerial pipe spanning across Persigo Wash (See Image 1).

Site Two is labeled as the "Dos Rios" area in Image 1 and is located north of the US 50/Riverside Parkway On-Ramp. Site Two includes a 20-foot by 23-foot Bio-Trickling Filter pad site as well as a new 12-inch Duct to tie the new Bio-Filter into existing wastewater infrastructure. Two alternatives have been proposed for the new 12 inch duct line; however, the scope of this report will only include investigations for Alternative 2, which is the west location that will connect to a Manhole at the gore of Riverside Parkway Off-Ramp/US 50 (See Appendix A for 30% Design Layouts prepared and provided by Garver Consultants).

Image 1- Site Vicinity Map (Taken From Garver 30% Review Plan Set)



The scope of work for this geotechnical investigation included:

- Formulating a drilling pattern and performing the necessary subsurface investigation. Collecting samples as required.
- Performing appropriate laboratory tests and analyzing the data to determine strength, allowable bearing capacity, and corrosivity of foundation material.
- Evaluating potential geologic hazards at the site.

- Providing recommendations for foundation type and subgrade preparation.
- Providing recommendations for bearing capacity for recommended foundations.
- Providing recommendations for lateral earth pressures, where needed.
- Providing recommendations for pavement sections (flexible and rigid pavement types).
- Providing recommendations for drainage, grading, and general earthwork.
- Providing seismic site class in accordance with the 2018 International Building Code (IBC)
- Preparing 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

2.1 Site One

The site consists of two different areas in the vicinity of the City of Grand Junction Persigo Wastewater Treatment Facility (WWTF) located just south of River Road (See Image 2). The first area is the proposed location of a Bio-Trickling Filter Pad (designated as Bio-Trickling Filter No.1) and the second area is the proposed location of an aerial pipe crossing over Persigo Wash. Directly to the south, the Colorado River flows approximately 1000 feet away from the Persigo WWTF locale whole the north and east edges of the site are surrounded by industrial and commercial developments. Topography of the general area consists of flat to mild slopes trending toward the river. See Appendix A for more details on layout of the proposed improvements.

Image 2- Site Map—Site One (Google Maps)

2.2 Site Two

Site Two is in the downtown area of Grand Junction and is due south of the Union Pacific Train Yard. The overall condition of the area is considered commercial/industrial. Furthermore, the

Colorado River flows a few hundred feet to the south. The existing conditions of the site is landscaped and engineered for drainage. Included in this location is a second proposed Bio-Trickling Filter Pad (designated as Bio-Trickling Filter No.2) anticipated to be installed in open space between the Riverside Parkway On-Ramp, South 4th Street, and South 5th Street (See Image 3). Additionally, a new 12 Inch duct line is proposed to run from an existing manhole to the southeast of the area (designated as Manhole No.1), to the new Bio-Trickling Filter, and then to the southwest of the pad to another existing manhole (designated as Manhole No.2). See Appendix A for the proposed layout of these improvements.

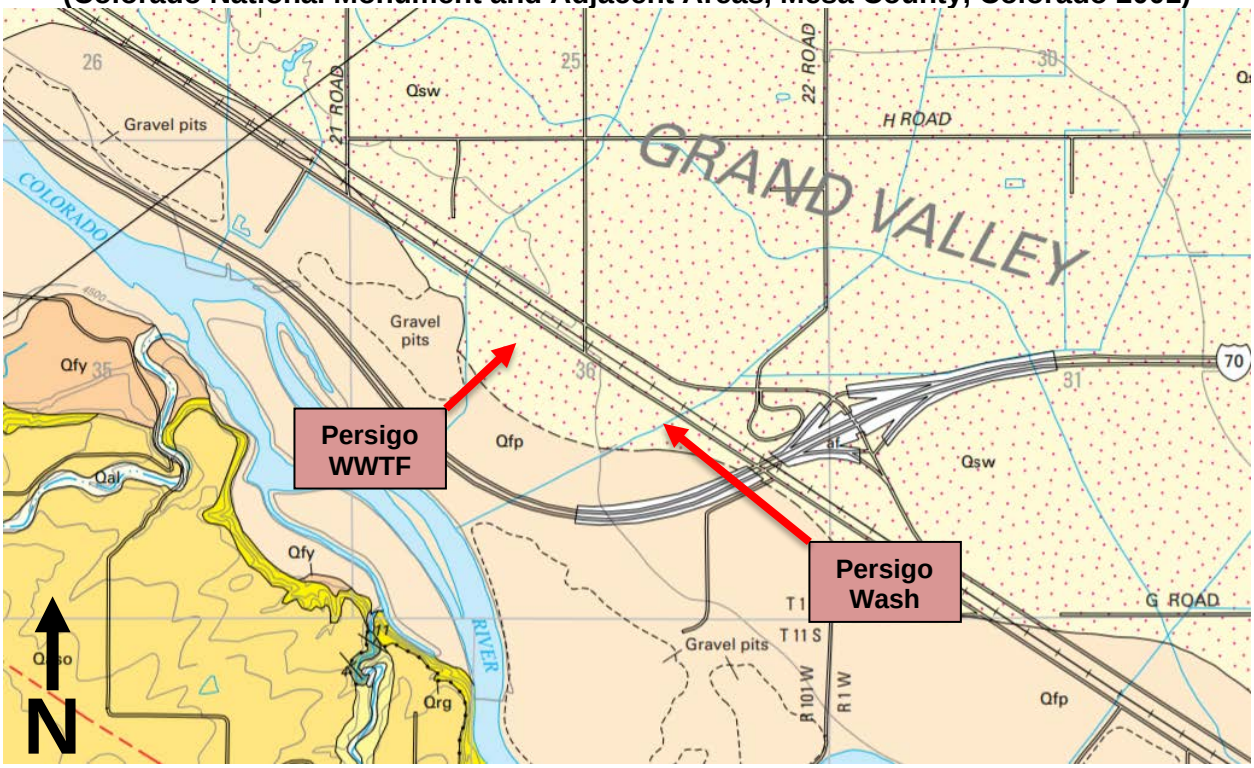
Image 3- Site Map—Site Two (Google Maps)

3.0 GEOLOGICAL CONDITIONS

3.1 Geologic Setting—Site One

Based on information presented in the United States Geological Survey (USGS) Geologic Map (See Image 4, *Site Geology Map*) of Colorado National Monument and Adjacent Areas, Mesa County, Colorado, dated 2001, the Persigo Wastewater Treatment Facility spreads two different classifications of surficial deposits. Sheetwash Deposits (Qsw) and Flood-Plain and Stream-Channel Deposits (Qfp) are both mapped at the project site. Sheetwash generally consists of light-gray sandy clay and silty clay deposited on very gentle slopes north of the Colorado River, derived from Mancos Shale. Conversely, the flood-plain deposits consist of chiefly gravel in a sand matrix. The materials identified by the USGS mapping were generally consistent with native soils encountered during our geotechnical investigation.

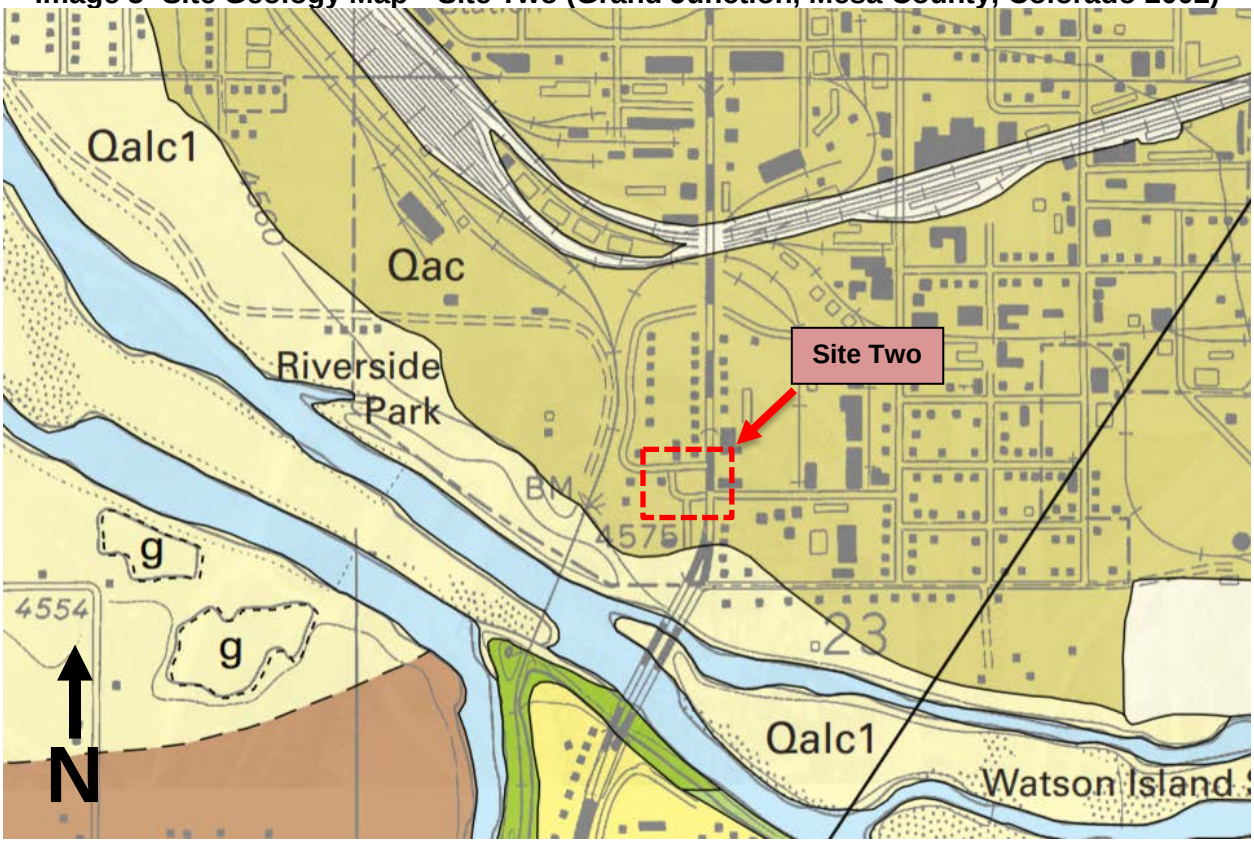
Image 4- Site Geology Map—Site One
(Colorado National Monument and Adjacent Areas, Mesa County, Colorado 2001)



3.2 Geologic Setting—Site Two

The United States Geological Survey (USGS) Geologic Map (See Image 5, *Site Geology Map*) of the Grand Junction Quadrangle, Mesa County, Colorado, by Roger B. Scott, Paul E. Carrara, William C. Hood, and Kyle E. Murray, dated 2002, indicates interbedded layers/deposits of alluvium and colluvium (Qac) soils are mapped at or near the surface within project Site Two. Alluvium generally consists of silt, sand and gravels and the colluvium generally consists of sandy silt, silty to clayey sand, and sandy clay. The materials identified by the USGS mapping were generally consistent with native soils encountered during our geotechnical investigation.

Image 5- Site Geology Map—Site Two (Grand Junction, Mesa County, Colorado 2002)



3.3 Geologic Hazards Discussion

Based on our laboratory results and understanding of the site geologic conditions, expansive soils were not encountered at this site that would impact the proposed development. Native clays with low bearing resistance have been identified and they present a risk of potential settlement for heavily loaded structural elements.

Due to the topography of Sites One and Two, slope instability is not considered a site geologic hazard; however, site excavations must consider potential shoring and stabilization requirements due to soft, very moist to wet clay soils and groundwater noted at depths varying between 8 feet and 12 feet below existing grades.

Due to the proximity of the Colorado River to both sites, flooding may pose a risk to structures and infrastructure within and adjacent to flood plains. In addition, scour conditions may pose a risk to the Persigo Wash slope banks during high intensity flows and flood events.

4.0 SUBSURFACE EXPLORATION SUMMARY

For this investigation, on February 25, 2021, RockSol drilled a total of 7 boreholes identified as Boreholes B-1 through B-7, respectively (See Appendix A).

Boreholes B-1 through B-4 were drilled at Site One. Boreholes B-1 and B-2 were drilled for the foundation recommendations of Bio-Filter Pad Number 1. Borehole B-1 was drilled to a depth of 27 feet after encountering very hard sedimentary bedrock. Boreholes B-3 and B-4 were drilled on both sides of Persigo Wash for the foundation study of the aerial pipe crossing.

Boreholes B-5 through B-7 were drilled at Site Two. Borehole B-5 was drilled for the foundation study of Bio-Filter Pad Number 2. Boreholes B-6 and B-7 were drilled for the west alternative of the 12" Duct location.

Boreholes were advanced with a CME 55 track mounted drill rig using 6.25-inch outside diameter hollow stem auger and 5.25-inch outside diameter ODEX drilling methods at Borehole Locations B-1 and B-5. The boreholes were logged in the field by a representative of RockSol with the depth to groundwater, if encountered, noted at the time of drilling. The boreholes were backfilled at the completion of drilling.

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).

Each borehole location was surveyed by the City of Grand Junction and ground surface elevation and location (easting and northing) was provided to RockSol.

5.0 LABORATORY TESTING

Soil samples retrieved from the borehole locations were examined by the project geotechnical engineer in the RockSol laboratory. 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 D 6913)
- Water-Soluble Sulfates (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)
- Soil Classification (ASTM D-2487, ASTM D-2488, and AASHTO M145)

- Swell Test (ASTM D-4546)
- Resistance Value (R-Value) (AASHTO T-190)

R-Values (Resistance Values) were tested by Cesare, Inc. All other laboratory tests were performed by RockSol. Laboratory test results are presented in Appendix C and are also summarized on the Borehole Logs presented in Appendix B.

6.0 SUBGRADE CHARACTERIZATION

Laboratory test results were used to characterize the engineering properties of the subsurface material encountered. 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.

6.1 Site One, Bio-Filter Pad Number 1 Subsurface Conditions

Boreholes B-1 and B-2 were drilled to investigate the existing conditions for Bio-Filter Pad Number 1. Subsurface conditions generally consisted of approximately 10 to 12 feet of soft silty to sandy clay overlying a layer of dense to very dense gravelly sand with cobbles. Borehole B-1 was drilled into sedimentary bedrock, which was encountered at a depth of 26 feet below the existing surface grade. The bedrock encountered consisted of gray to dark gray, very hard claystone and shale.

The sedimentary bedrock encountered is believed to be Mancos Shale, identified beneath the native overburden soils in the Grand Valley region, and is anticipated to remain at a relatively constant elevation beneath the project location. Groundwater was encountered at the time of drilling at a depth of 12 feet below existing grade at Borehole B-1 and 8 feet below existing grade at Borehole B-2 (See Table 6A below for elevation summaries for Boreholes B-1 and B-2).

6.2 Site One, Aerial Pipe Crossing Subsurface Conditions

Boreholes B-3 and B-4 were drilled on either side of the Persigo Wash, which will be spanned with the proposed pipeline. Subsurface conditions generally consisted of approximately 17 feet to 18 feet of very loose to loose silty to clayey sand and soft to stiff sandy to silty clay overlying dense to very dense gravelly sand with cobbles. Bedrock was not encountered in Boreholes B-3 and B-4. Groundwater was noted in both boreholes at approximate depths of 9.5 feet (Borehole B-3) and 17 feet (Borehole B-4) below existing grades. The boreholes were drilled to a maximum depth of approximately 20 feet below existing grades into the gravelly sand with cobbles layer.

6.3 Site Two, Bio-Filter Pad Number 2 Subsurface Conditions

Borehole B-5 was drilled for Bio-Filter Pad Number 2 on the southeast corner of the anticipated new pad footprint. Native soil consisting of loose clayey sand was encountered to an approximate depth of 10 feet below grade overlying a medium dense to very dense gravelly sand with cobble layer (cobble diameters of approximately 8 to 10 inches). ODEX drilling was performed through the gravelly sand and cobble layer into sedimentary bedrock encountered at an approximate depth of 19 feet below existing grade. The sedimentary bedrock encountered consisted of gray to dark gray, very hard claystone and shale, as described in Section 6.1. Groundwater was encountered during drilling operations at an approximate depth of 10 feet below existing grade (See Table 6A for the summary of bedrock and groundwater elevations).

6.4 Site Two, Proposed 12 Inch Duct Subsurface Conditions

Boreholes B-6 and B-7 were taken for the subsurface investigation for the proposed new 12" Duct. B-6 was drilled at the toe of the existing embankment and B-7 was drilled in the gore area between the Riverside Drive Off Ramp and South 5th Street (See Appendix A). Fill was encountered in the upper 3 feet and generally consisted of medium dense clayey sand overlying native soils that consist of very stiff to hard sandy clay and medium dense to very dense silty to clayey sand with gravel and cobbles. Black organic material was noted within the bulk sample obtained from an approximate depth ranging from 2 to 5 feet below the existing grade.

Table 6A - Approximate Ground Surface and Groundwater Elevations

Borehole No.	Ground Surface Elevation (ft)	Borehole Bottom Elevation (ft)	Groundwater Depth (ft)	Groundwater Elevation (ft)	Bedrock Elevation (ft)
B-1	4518.3	4491.0	12.0	4506.3	4492.3
B-2	4518.4	4498.9	8.0	4510.4	--
B-3	4523.1	4503.6	9.5	4513.6	--
B-4	4522.8	4502.3	17.0	4505.8	--
B-5	4566.2	4545.7	10.0	4556.2	4547.2
B-6	4568.2	4555.7	10.0	4,558.2	--
B-7	4569.1	4553.6	9.0	4,560.1	--

6.5 Subgrade Bulk Soil Classifications

Subgrade bulk samples were obtained at each borehole at various depths and were classified according to AASHTO M145 procedures. A summary of the subgrade bulk soil classifications is presented in Table 6B.

Table 6B – Subgrade Bulk Soil Classification Summary

Borehole Location	Depth (feet)	AASHTO Classification
B-1	0 - 5'	A-6 (12)
B-2	0 - 5'	A-6 (12)
B-3	0 - 5'	A-4
B-4	0 - 5'	A-4
B-5	0 - 5'	A-6
B-5	14 - 19'	A-1-a
B-6	0 - 2'	A-4
B-6	2 - 5'	A-4
B-7	0 - 4'	A-4

6.6 Swell/Consolidation Potential of Subgrade Soils

Based on swell test results and plasticity index (PI) testing, the subgrade soils encountered within the upper 10 feet of the existing surface elevation exhibit nil to low swell potential and low to moderate consolidation potential (-0.3 percent to -3.5 percent consolidation). Six swell/consolidation tests were performed on samples obtained from Boreholes B-1 to B-5 at approximate depths of 3 feet, 7 feet, and 8 feet below existing grades.

Based on consolidation and penetration data obtained from the boreholes drilled, special mitigation is recommended for design and construction of shallow foundation systems being considered (See Section 8.0 Geotechnical Analysis and Recommendations) due to settlement potential and constructability. Recommended mitigation consists of over excavation and replacement with CDOT Class 1 Structure Backfill material.

6.7 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 6D and in the Building Code Requirements for Structural Concrete (ACI 318-14) (ACI Tables 19.3.1.1 & 19.3.2.1).

Table 6D - Requirements to for Concrete by Sulfate Exposure Class

Exposure Class	Water-soluble sulfate (SO_4), in dry soil, percent	Water Cementitious Ratio, maximum	Cementitious Material Requirements (ASTM C150)	Minimum Compressive Strength (psi)
S0	0.00 to <0.10	Not Applicable	No Restriction	2500
S1	0.10 to < 0.20	0.50	Type II	4000
S2	0.20 to 2.0	0.45	Type V	4500
S3	2.01 or greater	0.45	Type V plus pozzolan	4500

The concentration of water-soluble sulfates measured in soil samples obtained from RockSol's exploratory boreholes varied from 0.00 percent to 1.02 percent (See Appendix B and C). 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. A compressive concrete strength of 4,500 psi is also recommended for the S2 Exposure Class.

6.8 Corrosion Resistance Discussion

To determine the existing corrosivity conditions of the in-situ soil, water- soluble sulfate, chloride content, pH and electrical resistivity tests were performed and compared to *Table 1 - Guidelines for Selection of Corrosion Resistance Levels* as presented in the *CDOT Pipe Materials Selection Guide,* dated April 30, 2015. Table 6E summarizes the accumulated data.

Table 6E - Corrosion Resistance Summary

Borehole Location	Sample Depth (ft)	Water-Soluble Chloride (%)	Water-Soluble Sulfate (% by weight)	pH	CR Level
B-2	0 - 5'	0.12	**0.96**	8.51	CR4
B-5	0 - 5'	0.04	**0.24**	8.06	CR3
B-6	2 - 5'	0.02	**0.18**	7.85	CR2

Additional testing at each location may be performed to provide structure specific corrosion resistance recommendations. In Table 6E, we have used "bold" text to identify the test result variable that is contributing to the Corrosion Resistance Level above 0. It should be noted that the presence of sulfates in the soils are the driving factor for increase in Corrosion Resistance Level and based on the available data.

Due to elevated sulfate content, careful consideration for material type should be accounted for when selecting construction materials and it should be noted that there is higher potential for metallic materials to experience corrosion.

In addition, electrical resistivity analyses were performed in the RockSol laboratory using the soil box method (ASTM G-187). The test results were referenced against *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. See Table 6F below for recommendations. Additional testing should be performed to provide structure specific recommendations.

Table 6F - Minimum Thickness Recommendations for Metal Pipes

Borehole No.	Sample Depth (ft)	Saturated Resistivity (ohm-cm) at Moisture Content (%)	pH	Minimum Required Gauge Thickness for Metal Pipe Material
B-2	0 - 5	1,400 Ohm-cm @ 5.6%	8.51	18-gauge Polymer Coated
B-5	0 - 5	2,500 Ohm-cm @ 9.8%	8.06	18-gauge Aluminized Type 2
B-6	2 - 5	2,800 Ohm-cm @ 8.9%	7.85	18-gauge Aluminized Type 2

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. 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.

7.1 Seismic Design Parameters

Based on the Standard Penetration Resistance encountered for the onsite subsurface conditions, it is our opinion that the Bio-Filter Pads at both Site One and Site Two meet criteria for Seismic Site Class D. Shear wave velocity testing was not performed by RockSol. The IBC classifies water treatment facilities and wastewater treatment facilities as Risk Category III structures (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 7A

Table 7A – Seismic Acceleration Coefficients (IBC 2018)

Location	Peak Ground Acceleration (PGA)	Spectral Acceleration Coefficient - S_s (Period 0.2 sec)	Spectral Acceleration Coefficient - S_1 (Period 1.0 sec)
Bio-Filter Pad No. 1 (Latitude°/Longitude°) (39° 6’ 54.82" N/ 108° 39' 25.14 "W)	0.129	0.235	0.065
Bio-Filter Pad No. 2 (Latitude°/Longitude°) (39° 3’ 28.72" N/ 108° 33' 54.89 "W)	0.130	0.237	0.065

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 7B.

Table 7B – Seismic Site Factor Values

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)
Bio-Filter Pad No. 1	1.542	1.6	2.4
Bio-Filter Pad No. 2	1.539	1.6	2.4

Table 7C summarizes the Seismic Zone determination and horizontal response spectral Acceleration Coefficients (S_{D1}) and (S_{DS}) obtained for the proposed structures. 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 7A and 7B, 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 F.

Table 7C – Seismic Performance Zone

Location	Acceleration Coefficient at 1.0 seconds (S_{D1})	Acceleration Coefficient at 0.2 seconds (S_{DS})	Seismic Design Category (1)
Bio-Filter Pad No. 1	0.105	0.251	B
Bio-Filter Pad No. 2	0.105	0.253	B

Note (1): Seismic Design Category B (for Risk Category III) is assigned when
$0.067g \leq S_{D1} < 0.133g$ *and* $0.167g \leq S_{DS} < 0.330g$

8.0 GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS

A 40-foot by 50-foot Bio-Trickling Filter Pad (anticipated weight of 45,000 lbs) is proposed just north of the existing Headworks Building at the Persigo WWTP and two concrete foundations to support a 24-inch aerial pipe spanning across Persigo Wash. In addition, a 20-foot by 23-foot Bio-Trickling Filter Pad (anticipated weight of 6,000 lbs and 2,000 lbs carbon) is proposed at the "Dos Rios" area located north of the US 50/Riverside Parkway On-Ramp. A new 12-inch Duct to tie the new Bio-Filter into existing wastewater infrastructure is also proposed at the Dos Rios area (See Appendix A for 30% Design Layouts prepared and provided by Garver Consultants). A brief discussion of anticipated soil conditions at the 12-inch Duct bore location under Riverside Parkway Ramp is presented in Section 8.4.

Our boreholes encountered relatively soft to loose, compressible soils to depths on the order of 11 feet at Persigo WWTP, 18 feet at the Persigo Wash crossing, and 10 feet at the Dos Rios site. As a result of the soft to loose soil conditions, shallow foundation systems require limited allowable bearing pressures and consideration of supporting subgrade soil improvement. A discussion of shallow foundation geotechnical parameters is presented in Sections 8.1 and 8.2.

As an alternative to shallow foundation systems, a deep foundation alternative using helical piers is feasible. The helical piers would be required to bear on and into the deep, underlying

sand/gravel/cobble layer that is present at each site. The advantage of the helical pier system is the relative ease of installation and with little to no waste soil generated. This system does require special structural design. A discussion of helical pier geotechnical parameters is presented in Section 8.3.

8.1 Shallow Foundation System (Persigo WWTP Filter Pad)

Due to the presence of soft clay soils, a very low allowable bearing pressure for shallow foundations is recommended at the proposed Persigo WWTP Filter Pad site to limit potential settlement. For the existing site soils, a maximum allowable bearing pressure of 750 pounds per square foot (psf) is recommended.

Ground improvement is recommended to achieve a service bearing resistance greater than 750 psf at this site. At a minimum, RockSol recommends ground improvement consisting of overexcavation of subgrade soils to a minimum depth of 2 feet below the bottom of shallow foundations (footings) and replacement with at least 2-feet of a material meeting CDOT Class 1 Structure Backfill requirements. The Class 1 Structure Backfill material shall also extend a minimum of 2 feet horizontally beyond the limits of the footing perimeter.

Placement of the backfill material should be in horizonal lifts with a maximum lift thickness of 6 inches. Compaction of each lift with vibratory methods using lightweight equipment is recommended.

With two feet (vertically) of Structural Backfill materials, RockSol considers an allowable bearing resistance of 1.0 ksf appropriate. If greater allowable bearing resistance is required, additional thickness of replaced subgrade soil is required and RockSol should be contacted to provide additional recommendations.

Allowable bearing resistance is estimated to correspond to a total settlement of less than 1-inch. The bottom of the pad should be a minimum of 3 feet below finished grade for frost considerations.

A representative of the geotechnical engineer should observe all foundation excavations prior to placement of the subgrade improvement material.

8.2 Shallow Foundation System (Persigo Wash Crossing and Dos Rios Filter Pad)

Due to the presence of loose to very loose sand soils, a low allowable bearing pressure for shallow foundations is recommended at the proposed Persigo Wash Crossing and Dos Rios Filter Pad sites to limit potential settlement. For the existing site soils, a maximum allowable bearing pressure of 1,000 pounds per square foot (psf) is recommended.

Ground improvement is recommended to achieve a service bearing resistance greater than 1,000 psf at both sites, if required. At a minimum, RockSol recommends ground improvement consisting of overexcavation of subgrade soils to a minimum depth of 2 feet below the bottom of shallow foundations (footings) and replacement with at least 2-feet of a material meeting CDOT Class 1 Structure Backfill requirements. The Class 1 Structure Backfill material shall also extend a minimum of 2 feet horizontally beyond the limits of the footing or pad perimeter.

Placement of the backfill material should be in horizonal lifts with a maximum lift thickness of 6 inches. Compaction of each lift with vibratory methods using lightweight equipment is recommended.

With two feet (vertically) of Structural Backfill materials, RockSol considers an allowable bearing resistance of 1.5 ksf appropriate. If greater allowable bearing resistance is required, additional

thickness of replaced subgrade soil is required and RockSol should be contacted to provide additional recommendations.

Allowable bearing resistance is estimated to correspond to a total settlement of less than 1-inch. The bottom of all footings shall be a minimum of 3 feet below finished grade for frost considerations.

A representative of the geotechnical engineer should observe all foundation excavations prior to placement of the subgrade improvement material.

8.3 Helical Pier Foundation System

Helical piers are a feasible alternative to shallow foundations, especially if greater bearing resistance is required. The helical piers would need to bear in the dense gravelly sand with cobble layer encountered in our boreholes. The depth to the sand/gravel/cobble layer may vary slightly across each site (See Table 8.1) and therefore some allowance for variations in the total length of the helical piers must be considered.

Table 8.1 - Approximate Groundwater and Sand, Gravel, Cobble Layer Elevations

Site Location	Borehole No.	Ground Surface Elevation (ft)	Groundwater Elevation (ft)	Approximate Sand, Gravel,Cobble Layer Elevation (ft)
Persigo WWTP	B-1	4,518.3	4,506.3	4,506
	B-2	4,518.4	4,510.4	4,507
Persigo Wash Crossing	B-3	4,523.1	4,513.6	4,505
	B-4	4,522.8	4,505.8	4,505
Dos Rios	B-5	4,566.2	4,556.2	4,555
	B-6	4,568.2	4,558.2	4,563
	B-7	4,569.1	4,560.1	4,562

For helical pier capacity estimating, RockSol recommends the bearing stratum of gravelly sand with cobbles be modeled as a cohesionless material at all three structure locations. A summary of minimum helical pier requirements for each of the three structure locations is presented below.

Persigo WWTP Site

The structure pad at this site will support a 45-kip load. Based on the subsurface conditions encountered at this site the following parameters were used to estimate the minimum number of helical piers required to support the proposed pad and structure load.

Persigo WWTP Helical Pier Input Parameter	Value
Undrained Shear Strength of Bearing Soil	0 psf
Friction Angle of Bearing Soil	40 degrees
Total Unit Weight of Bearing Soil	140 pcf
Total Unit Weight of Overburden Soil	115 pcf
Depth to Water Table	8 feet
Depth to Helical Plate	12 feet
Foundation Load	45 kips
Helical Plate Diameter	10 inches
Number of Plates	1
Projected Plate Area	0.51 square feet
Helical Shaft Size	2¼ inch square bar

Using the input parameters shown above, the following output values were obtained.

Persigo WWTP Output Parameter	Value
Soil Overburden Pressure	1130.4 psf
Bearing Capacity Factor, Nq	64
Bearing Capacity Factor, Nc	75
Ultimate Theoretical Capacity	37 kips
Allowable Capacity	19 kips
Estimated Helical Installation Torque	3364 foot-pounds
Maximum Allowable Torque	11500 foot-pounds
Minimum Required Piers	3 piers

RockSol anticipates that a single plate for each helical pier will be needed with a minimum plate diameter of 10-inches recommended. The minimum number of piers is listed for bearing requirements. Final structural design may require additional piers to satisfy other structural design requirements.

Persigo Wash Crossing Site

The structure pads at this site will support lightly loaded pipes over Persigo Wash. For loading RockSol has assumed a conservative load of 5 kips for each pad. Based on the subsurface conditions encountered at this site the following parameters were used to estimate the minimum number of helical piers required to support the proposed pad and structure load.

Persigo Wash Crossing Site Helical Pier Input Parameter	Value
Undrained Shear Strength of Bearing Soil	0 psf
Friction Angle of Bearing Soil	40 degrees
Total Unit Weight of Bearing Soil	140 pcf
Total Unit Weight of Overburden Soil	115 pcf
Depth to Water Table	9 feet
Depth to Helical Plate	18 feet
Foundation Load	5 kips
Helical Plate Diameter	8 inches
Number of Plates	1
Projected Plate Area	0.328 square feet
Helical Shaft Size	1¾ inch square bar

Using the input parameters shown above, the following output values were obtained.

Persigo Wash Crossing Site Output Parameter	Value
Soil Overburden Pressure	1508.4 psf
Bearing Capacity Factor, Nq	64
Bearing Capacity Factor, Nc	75
Ultimate Theoretical Capacity	32 kips
Allowable Capacity	16 kips
Estimated Helical Installation Torque	3176 foot-pounds
Maximum Allowable Torque	5500 foot-pounds
Minimum Required Piers	1 pier

RockSol anticipates that a single plate for each helical pier will be needed with a minimum plate diameter of 8-inches recommended. The minimum number of piers is listed for bearing requirements. Final structural design may require additional piers to satisfy other structural design requirements.

Dos Rios Site

The structure pad at this site will support a total load of 8 kips. Based on the subsurface conditions encountered at this site the following parameters were used to estimate the minimum number of helical piers required to support the proposed pad and structure load.

Dos Rios Site Helical Pier Input Parameter	Value
Undrained Shear Strength of Bearing Soil	0 psf
Friction Angle of Bearing Soil	40 degrees
Total Unit Weight of Bearing Soil	140 pcf
Total Unit Weight of Overburden Soil	125 pcf
Depth to Water Table	10 feet
Depth to Helical Plate	11 feet
Foundation Load	8 kips
Helical Plate Diameter	8 inches
Number of Plates	1
Projected Plate Area	0.328 square feet
Helical Shaft Size	1¾ inch square bar

Using the input parameters shown above, the following output values were obtained.

Dos Rios Site Output Parameter	Value
Soil Overburden Pressure	1312.6 psf
Bearing Capacity Factor, Nq	64
Bearing Capacity Factor, Nc	75
Ultimate Theoretical Capacity	28 kips
Allowable Capacity	14 kips
Estimated Helical Installation Torque	2764 foot-pounds
Maximum Allowable Torque	5500 foot-pounds
Minimum Required Piers	1 pier

RockSol anticipates that a single plate for each helical pier will be needed with a minimum plate diameter of 8-inches recommended. The minimum number of piers is listed for bearing requirements. Final structural design may require additional piers to satisfy other structural design requirements.

8.4 12” Duct Subsurface Soil Conditions Discussion

A new 12-inch Duct to tie the new Bio-Filter into existing wastewater infrastructure is proposed at the Dos Rios area (See Appendix A for 30% Design Layouts prepared and provided by Garver Consultants). A bore and jack operation is proposed to construct the new Duct under the existing Riverside Parkway Ramp. Borehole B-6 was located at the base of the ramp and Borehole B-7 located to the south to provide information about the type of materials that may be encountered. General subsurface information for Boreholes B-6 and B-7 is presented in Section 6.4 of this report. Of particular note is the presence of a very stiff to hard layer of sandy clay noted in both boreholes overlying a dense gravelly sand layer that contains cobbles. Above elevation 4560 feet the gravelly sand layer appears to have fewer cobbles and below elevation 4560 feet the presence of cobbles increases. Groundwater was encountered between elevations 4558 to 4560 feet.

9.0 PAVEMENT DESIGN RECOMMENDATIONS

New, relatively short access roads are planned where the City of Grand Junction will be installing two new of Bio-Filter Systems. The first site is at Persigo Water Treatment Facility where the

access road is proposed to run from the plant entrance north of the existing Headworks building approximately 60 feet east to the Bio-Filter pad. The second site is north of the Riverside Parkway/US 50 on ramp where the access road is proposed to run from 4th Street approximately 140 feet east to the Bio-Filter pad.

Pavement thickness evaluation for development of flexible and rigid pavement design recommendations within the City of Grand Junction right of way was performed in accordance with *Chapter 29.32 – Pavements and Truck Routes* (April 21, 2004) in the City of Grand Junction Transportation Engineering Design Standards (TEDS), *AASHTO Guide for the Design of Pavements* (1993 with the 1998 update for rigid pavement), *Guideline for the Design and Use of Asphalt Pavements for Colorado Roadways* (January, 2006) published by the Colorado Asphalt Pavement Association (CAPA).

9.1 Traffic Loading

The average daily traffic (ADT) for each site was estimated to be one H20 AASHTO classified truck per day which was supplied to RockSol by Garver Consultants. This data along with an annual growth factor of 1% was used to estimate the number of 18-kip equivalent single axle loads (ESALs) for flexible and rigid pavements in accordance with TEDS Subsection 29.32.030. Pavement design 18k ESALs calculations for flexible and rigid pavements are available in Appendix E.

9.2 Pavement Subgrade Characterization

Subgrade samples were obtained from each site and were tested for AASHTO soil classification. The subgrade soils tested in the top four feet classified as A-4 and A-6 AASHTO soil types (See Table 6B) with group indices from 0 to 12. RockSol assigned two R-Value tests based on the results of the soil classifications and are shown in Table 9A.

Table 9A - R-Value Summary

Sample Type	Borehole(s) at Sample Depths And AASHTO Classification	R-Value	Resilient Modulus, (psi) (see Note 1)
Individual	B-2 at 2' ---- A-6 (12)	13	3,904
Individual	B-5 at 3' ---- A-6 (2)	11	3,729

Note 1. CAPA *Guideline for the Design and Use of Asphalt Pavements for Colorado Roadways* equation 3-2 as shown in the January 2006 edition.

A conservative R-Value of 10 was used for the subgrade support for the pavement designs at Sites 1 and 2. Using CAPA's equation, the subgrade resilient modulus value of 3,562 psi was determined.

9.3 Pavement Section Recommendations

A structural coefficient of 0.44 was used for new HMA and 0.12 was used for Class 6 ABC.

Pavement thickness evaluations for development of flexible and rigid design recommendations conformed to the minimum design standards set forth in Chapter 29 of TEDS and Mesa County Standard Specifications for Road and Bridge Construction.

For the pavement designs, RockSol is providing pavement thickness recommendations based on AASHTO 1993 for construction of new flexible pavements along with AASHTO 1998 for construction of new rigid pavements.

Based on the 30-year traffic loads, the AASHTO 1998 equation does not allow for calculation of a thickness less than 7 inches. AASHTO and Mesa County Standards Specifications for Road

and Bridge Construction do not recommend using less than 6 inches of PCCP for the reconstruction of any roadway.

A summary of the recommended flexible pavement thickness along with the reconditioning thickness is presented in Table 9B and the flexible pavement design is included in Appendix F. The rigid pavement design information is included in Appendix G.

Table 9B – Pavement Section in Recommendations

Roadway	HMA Thickness (inches)	PCCP Thickness (inches)	ABC Thickness (inches)	Reconditioning Thickness (inches)
Site 1: Persigo WWTF	4.5	6.0	6.0	6.0
Site 2: Riverside/US 50	4.5	6.0	6.0	6.0

HMA or PCCP pavement shall consist of CDOT approved mix designs. The new HMA should consist of CDOT grading SX(75) PG 64-22 placed in two lifts. The first lift (bottom) should be 2.5 inches thick, and the second lift (top) should be 2.0 inches thick. If PCCP is selected, CDOT Class P mix should be used. Approximately 150 pounds per cubic yard of steel fibers should be used in lieu of dowel and tie bars. The panel dimensions should be 12' x 12'.

9.4 Base Preparation (Prior to Pavement Construction)

Prior to construction of new pavements on base materials, the underlying base 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 recompacting. The minimum depth of scarification, moisture conditioning and re-compaction in all cases shall be 6 inches. Cobbles greater than 6 inches in diameter, if encountered, should be removed from the scarification zone.

Prior to pavement section construction, base proof rolling with pneumatic tire equipment shall be performed using a minimum axle load of 18 kips per axle after specified subgrade compaction has been obtained. Areas found to be weak and those areas which exhibit soft spots, non-uniform deflection or excessive deflection as determined by the project engineer shall be ripped, scarified, wetted or dried if necessary, and re-compacted to the requirements for density and moisture. Complete coverage of the proof roller will be required.

All pavement base preparation, including final proof-rolling, pavement materials, and pavement construction shall conform to the latest edition of the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction as stated in Subsection 5.1.1 of Mesa County Standards and Specifications for Road and Bridge Construction. At a minimum, roadway base moisture conditioning and compaction should meet the compaction specifications outlined in Subsection 5.1.5 of Mesa County Standards and Specifications for Road and Bridge Construction and restated in Table 9C.

Table 9C –Roadway Base 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 T99	-3 to +3
A-2-6, A-2-7	95% of AASHTO T99	-2 to +2
A-4, A-5, A-6 and A-7	95% of AASHTO T99	-2 to +2

MDD = Maximum Dry Density; OMC = Optimum Moisture Content

Based on the results of our field and laboratory tests, A-1-a, A-1-b, A-4 and A-6 soils are anticipated to be encountered at existing pavement subgrade elevations within the project limits.

10.0 EARTHWORK

Materials used to construct structure backfill and aggregate base course materials should meet the material and moisture density control requirements specified in Article IV of the Mesa County Standard Specifications for Road and Bridge Construction and City of Grand Junction Transportation Engineering Design Standards (current editions).

Prior to construction of new concrete flatwork or asphalt surfaces on subgrade soils, the underlying subgrade should be properly prepared by removal of all organic matter (topsoil), debris, loose material, and any deleterious material followed by scarification, moisture conditioning and recompaction. The minimum depth of scarification, moisture conditioning and re-compaction in all cases shall be 6 inches. Cobbles greater than 6 inches in diameter, if encountered, should be removed from the scarification zone.

Broken concrete, broken asphalt, or other solid materials more than 6 inches in greatest dimension shall not be placed within subgrade areas supporting concrete flatwork and pavement structures. Material excavated from utility trenches may be used for backfilling provided it does not contain unsuitable material or particles larger than 3 inches. Unsuitable material includes, but is limited to, topsoil, vegetation, brush, sod, trash, and other deleterious substances.

11.0 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

Proper construction practices, in accordance with City of Grand Junction Transportation Engineering Design Standards and Mesa County Standard Specifications for Road and Bridge Construction (current editions), should be followed during site preparation, structure and earthwork excavations 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.

Surface drainage patterns may be altered during construction and local landscape irrigation (if any) must be controlled to prevent excessive moisture infiltration into the subgrade soils during and after construction. 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.

12.0 LIMITATIONS

This geotechnical investigation was conducted in general accordance with the scope of work. RockSol's geotechnical practices are similar to those used in Colorado with similar soil conditions and based on our understanding of the proposed work. This report has been prepared for use by the City of Grand Junction for the project described in this report. The report is based on our exploratory boreholes and does not consider 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.

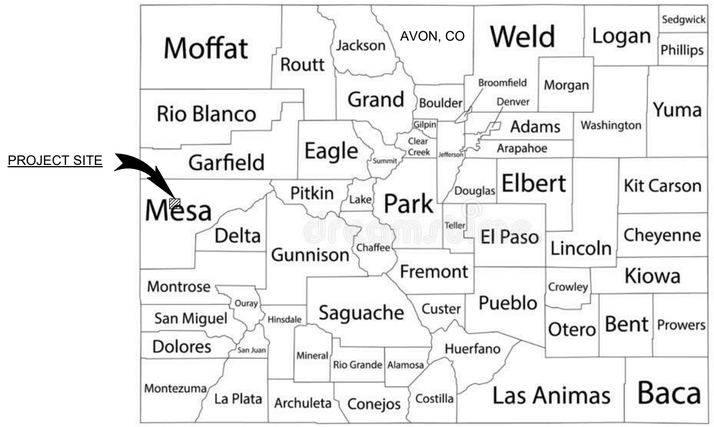
GRAND JUNCTION ODOR CONTROL IMPROVEMENTS

CITY OF Grand Junction COLORADO

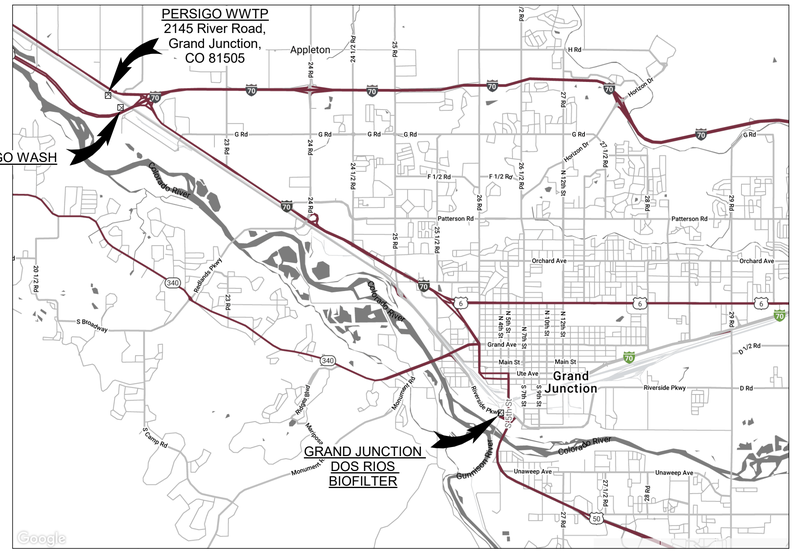
CITY OF GRAND JUNCTION

PROJECT NO. 20W23045

30% REVIEW - NOT FOR CONSTRUCTION



AREA MAP
NO SCALE



VICINITY MAP
NO SCALE

GARVER PROJECT NO. 20W23045

JAN. 2021

GARVER

One Denver Technology Center
5251 DTC Parkway, Suite 420
Greenwood Village, CO 80111
Phone: 303-721-6932

REGISTRATION NO.
20171218008

30% REVIEW - NOT FOR CONSTRUCTION

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW UNDER THE AUTHORITY OF RICHARD G. HUGGINS, PE # 52412, ON JANUARY 2021. IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING, OR PERMITTING PURPOSES.

REV	DATE	DESCRIPTION	BY

CITY OF GRAND JUNCTION
GRAND JUNCTION, COLORADO
GRAND JUNCTION
ODOR CONTROL IMPROVEMENTS

COVER

JOB NO.: 20W23045
DATE: JAN. 2021
DESIGNED BY: RGH
DRAWN BY: EGB

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
01-G001

SHEET NUMBER **001**

Revit File: BIM 360://20W23045 - Grand Junction Persigo Biotrickling Des/20W23045 GJPBD.rvt
Plot Date: 1/4/2021 12:10:54 PM

NOTE: Plan modified by RockSol to show approximate Borehole Locations.

REGISTRATION NO.
20171218008

30% REVIEW - NOT FOR CONSTRUCTION

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REV.	DATE	DESCRIPTION	BY

CITY OF GRAND JUNCTION
GRAND JUNCTION, COLORADO
CITY OF Grand Junction COLORADO
GRAND JUNCTION ODOR CONTROL IMPROVEMENTS

SITE PLAN

JOB NO.: 20W23045
DATE: JAN. 2021
DESIGNED BY: TNP
DRAWN BY: TNP

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
10-C101

SHEET NUMBER
007

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Last plotted by: Pipher, Tanner N. Plot Style: ---- Plot Scale: 1:1 Plot Date: 1/4/2021 2:30 PM Plotter used: ----

NOTE: Plan modified by RockSol to show approximate Borehole Locations.

REGISTRATION NO.
20171218008

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REV.	DATE	DESCRIPTION	BY

CITY OF GRAND JUNCTION
GRAND JUNCTION, COLORADO
Grand Junction COLORADO

GRAND JUNCTION
ODOR CONTROL IMPROVEMENTS

SITE PLAN

JOB NO.: 20W23045
DATE: JAN. 2021
DESIGNED BY: TNP
DRAWN BY: TNP

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
20-C101

SHEET NUMBER 015

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Last plotted by: Pipher, Tanner N. Plot Style: ---- Plot Scale: 1:1 Plot Date: 1/4/2021 2:31 PM Plotter used: ----

NOTE: Plan modified by RockSol to show approximate Borehole Locations.

REGISTRATION NO.
20171218008

30% REVIEW - NOT FOR CONSTRUCTION

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REV.	DATE	DESCRIPTION	BY

CITY OF GRAND JUNCTION
GRAND JUNCTION, COLORADO
City of Grand Junction Colorado

GRAND JUNCTION
ODOR CONTROL IMPROVEMENTS

SITE PLAN

JOB NO.: 20W23045
DATE: JAN. 2021
DESIGNED BY: TNP
DRAWN BY: TNP

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
30-C101

SHEET NUMBER 016

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APPENDIX A

30% REVIEW PLAN SET – GRAND JUNCTION ODOR CONTROL IMPROVEMENTS PREPARED BY GARVER (JANUARY 2021)

RockSol Consulting Group, Inc.

LEGEND

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado

LITHOLOGY


Fill - SAND, gravelly


Fill - SAND, clayey to silty


LANDSCAPE GRAVEL


Native - SAND


Native - SAND, clayey


Native - CLAY


Native - CLAY, sandy


Native - SILT, sandy


Native - GRAVEL


Bedrock - SHALE/CLAYSTONE

SAMPLE TYPE


Bulk Sample (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

Fines Content indicates amount of material, by weight, passing the US No 200 Sieve (%)

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 1ST DEPTH

RockSol Consulting Group, Inc.

BORING : B-1

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado
DATE STARTED 2/25/21 **COMPLETED** 2/25/21
GROUND ELEVATION 4518.3 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith Drilling
NORTH 52895.4 **EAST** 65063.8
DRILLING METHOD Hollow Stem Auger/ ODEX **HOLE SIZE** 8.0"
BORING LOCATION: S.E. corner, Persigo Biotrickling Filter Pad
LOGGED BY Compton **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 12.0 ft on 2/25/21

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 (%)
4518.3	0		(Native) CLAY, moist, brown, soft	BULK			1.02			33	19	14	91.4
			Approximate Bulk Depth 0-5 Liquid Limit= 33 Plastic Limit= 19 Plasticity Index= 14 Fines Content= 91.4 Sulfate= 1.02										
4513.3	5		(native) CLAY, sandy, very moist, brown, soft										
				MC	2/12	-1.5		90.7	27.1				
4508.3	10												
			(Native) SAND, gravelly with cobbles, wet, brown, dense	SS	50/4		0.43						
4503.3	15												
4498.3	20												
			Approximate Bulk Depth 22' Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 2.2	BULK						NP	NP	NP	2.2
4493.3	25												
			(Beddrock) SHALE/CLAYSTONE, slightly silty to sandy in parts, moist, dark gray, very hard	BULK									
				SS	50/4								
			Bottom of hole at 27.3 feet.										

LOG - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ 3/17/21

RockSol Consulting Group, Inc.

BORING : B-2

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado
DATE STARTED 2/25/21 **COMPLETED** 2/25/21
GROUND ELEVATION 4518.4 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith Drilling
NORTH 52927.8 **EAST** 65018.6
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: N.W. corner, Persigo Biotrickling Filter Pad
LOGGED BY Compton **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 8.0 ft on 2/25/21

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 (%)
4518.4	0		(Native) CLAY, with sand, moist to very moist, brown, soft	BULK			0.96			32	16	16	85.1
			Approximate Bulk Depth 0-5 Liquid Limit= 32 Plastic Limit= 16 Plasticity Index= 16 Fines Content= 85.1 Sulfate= 0.96										
				MC	3/12	-3.5		94.8	25.6				
4513.4	5												
			(Native) CLAY, sandy, wet, brown and gray, soft										
				MC	2/12	-0.5		92.0	34.3				
4508.4	10												
			(Native) GRAVEL, with sand and cobbles, wet, medium dense										
			(Native) SAND, gravelly with clay, wet, brown, medium dense to dense	SS	8/18/25					17	16	1	13.6
4503.4	15												
			(Native) GRAVEL, with cobbles, wet, dense										
			(Native) SAND, clayey with gravel, wet, dense										
				SS	26/32/37		0.18						
			Bottom of hole at 19.5 feet.										

LOG - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ 3/19/21

RockSol Consulting Group, Inc.

BORING : B-3

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado
DATE STARTED 2/25/21 **COMPLETED** 2/25/21
GROUND ELEVATION 4523.1 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith Drilling
NORTH 52227.6 **EAST** 66652.9
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: Air Jumper site, west side Persigo Wash
LOGGED BY B. Duff **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 9.5 ft on 2/25/21

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 (%)
4523.1	0		(Native) CLAY, sandy, moist to slightly moist, brown, medium stiff, rock fragments in parts	BULK			0.22			25	17	8	65.5
			(Native) SAND, clayey with gravel, slightly moist, light brown, loose	MC	8/12	-1.3		112.7	12.5				
4518.1	5		**Approximate Bulk Depth 0-5** Liquid Limit= 25 Plastic Limit= 17 Plasticity Index= 8 Fines Content= 65.5 Sulfate= 0.22										
			(Native) SAND, clayey, wet, brown, loose	MC	4/12			100.5	25.5				
4513.1	10												
			(Native) CLAY, sandy, wet, brown, soft	SS	1/1/1								
4508.1	15												
			(Native) GRAVEL, sandy, wet, dense	SS	15/25/30								
			Bottom of hole at 19.5 feet.										

LOG - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ 3/16/21

RockSol Consulting Group, Inc.

BORING : B-4

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado
DATE STARTED 2/25/21 **COMPLETED** 2/25/21
GROUND ELEVATION 4522.8 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith Drilling
NORTH 52179.9 **EAST** 66727.9
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: Air Jumper site, east side of Persigo Wash
LOGGED BY Compton **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 17.0 ft on 2/25/21

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 (%)
4522.8	0		(Native) SILT, sandy with trace gravel, moist, brown, stiff **Approximate Bulk Depth 0-5** Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 62.0 Sulfate= 0.01	BULK			0.01			NP	NP	NP	62.0
				MC	13/12	-0.7		95.7	11.4				
4517.8	5		(Native) SAND, clayey, wet, brown, very loose										
								92.4	23.8				
4512.8	10												
				SS	1/1/1		0.00						36.9
4507.8	15		(Native) SAND, clayey with cobbles, wet, brown, dense										
				SS	19/23/27								
4502.8	20		Bottom of hole at 20.5 feet.										

LOG - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ 3/15/21

RockSol Consulting Group, Inc.

BORING : B-5

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado
DATE STARTED 2/25/21 **COMPLETED** 2/25/21
GROUND ELEVATION 4566.2 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith Drilling
NORTH 32403.4 **EAST** 91051.4
DRILLING METHOD Hollow Stem Auger/ ODEX **HOLE SIZE** 8.0"
BORING LOCATION: Southeast corner of pad site, Site #2
LOGGED BY B. Duff **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 10.0 ft on 2/25/21

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 (%)
4566.2	0		(Native) SAND, clayey, moist, brown, loose	BULK			0.24			34	21	13	40.4
			Approximate Bulk Depth 0-5 Liquid Limit= 34 Plastic Limit= 21 Plasticity Index= 13 Fines Content= 40.4 Sulfate= 0.24										
				MC	9/12	-0.3		103.0	21.8				
4561.2	5		(Native) SAND, clayey with gravel, very moist, brown, loose										
				MC	9/12								
4556.2	10		**Approximate Bulk Depth 10-14** Sulfate= 0.23	BULK			0.23						
			(Native) GRAVEL, sandy with cobbles, wet, brown										
			Approximate Bulk Depth 14-19 Liquid Limit= NP Plastic Limit= NP Plasticity Index= NP Fines Content= 4.9	BULK						NP	NP	NP	4.9
4551.2	15												
4546.2	20		(Bedrock) SHALE/CLAYSTONE, slightly silty, moist, gray to dark gray, very hard	SS	50/4/6								
			Bottom of hole at 20.5 feet.										

RockSol Consulting Group, Inc.

BORING : B-6

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado
DATE STARTED 2/25/21 **COMPLETED** 2/25/21
GROUND ELEVATION 4568.2 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith Drilling
NORTH 32356.9 **EAST** 91086.2
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION: Potential bore/jack location, site #2
LOGGED BY L. Basler **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 10.0 ft on 2/25/21

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 (%)
4568.2	0.0		(Fill) SAND, clayey with gravel in parts, slightly moist, light brown to brown with black, medium dense	BULK						21	19	2	48.3
			Approximate Bulk Depth 0-2 Liquid Limit= 21 Plastic Limit= 19 Plasticity Index= 2 Fines Content= 48.3	MC	24/12								
4565.7	2.5			BULK			0.18	93.3	22.7	23	18	5	55.5
			(Native) CLAY, sandy, very moist, brown, very stiff to hard **Approximate Bulk Depth 2-5** Liquid Limit= 23 Plastic Limit= 18 Plasticity Index= 5 Fines Content= 55.5 Sulfate= 0.18										
4563.2	5.0		(Native) SAND, silty to clayey, gravelly with cobbles in parts, dense to very dense, very moist to wet										
4560.7	7.5			MC	32/12								
4558.2	10.0		▼										
4555.7	12.5		Bottom of hole at 12.5 feet.										

LOG - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ 3/19/21

RockSol Consulting Group, Inc.

BORING : B-7

CLIENT City of Grand Junction
PROJECT NAME Grand Junction Odor Control Improvements Project
PROJECT NUMBER 599.27
PROJECT LOCATION Grand Junction, Colorado
DATE STARTED 2/25/21 **COMPLETED** 2/25/21
GROUND ELEVATION 4569.1 ft **STATION NO.**
DRILLING CONTRACTOR DA Smith Drilling
NORTH 32009.7 **EAST** 91226.3
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8.0"
BORING LOCATION:
LOGGED BY L. Basler **HAMMER TYPE** Automatic
GROUND WATER LEVELS:
NOTES
WATER DEPTH 9.0 ft on 2/25/21

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 (%)
4569.1	0.0		Landscape gravel, approximately 6 inches thick	BULK			0.32			22	15	7	37.5
			(Fill) SAND, clayey, moist, brown, medium dense **Approximate Bulk Depth 0-4** Liquid Limit= 22 Plastic Limit= 15 Plasticity Index= 7 Fines Content= 37.5 Sulfate= 0.32										
4566.6	2.5		(Native) CLAY, sandy, moist, brown, hard										
				MC	36/12			111.6	14.7				
4564.1	5.0												
4561.6	7.5		(Native) SAND, silty to clayey with gravel and cobbles in parts, wet, brown, dense to very dense										
				SS	36/12		0.07						
4559.1	10.0												
4556.6	12.5												
				SS	24/26/28					NP	NP	NP	13.7
4554.1	15.0												
			Bottom of hole at 15.5 feet.										

LOG - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ 3/19/21

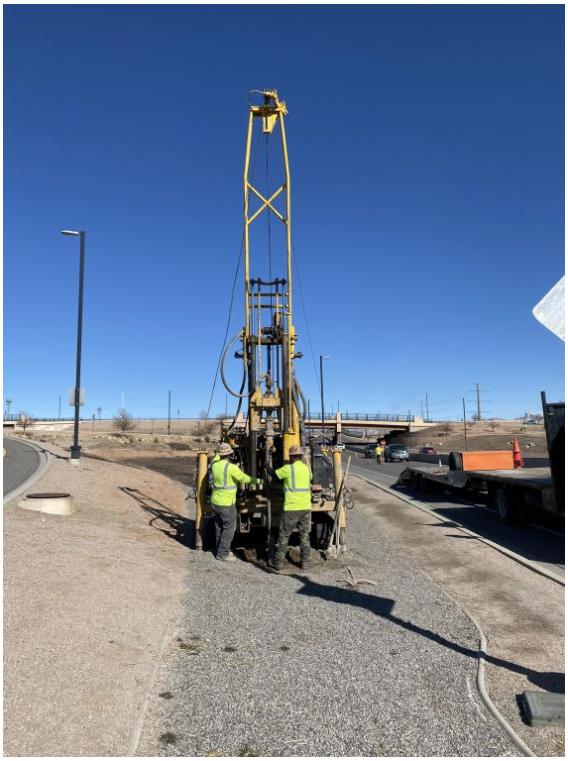
Borehole B-1
Site One Bio Filter Pad Number 1 SE

Borehole B-2
Site One Bio Filter Pad Number 2 NW

Borehole B-3 & B-4
General Location of Site One Aerial Pipe Crossing

Borehole B-5
Site Two Bio Filter Pad Number 2 (Dos Rios)

Borehole B-6
Site Two 12” Duct Toe of Embankment



Borehole B-7
Site Two 12” Duct near Manhole tie in

APPENDIX B

LEGEND AND INDIVIDUAL SOIL BOREHOLE LOGS

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT City of Grand Junction

PROJECT NAME Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27

PROJECT LOCATION Grand Junction, Colorado

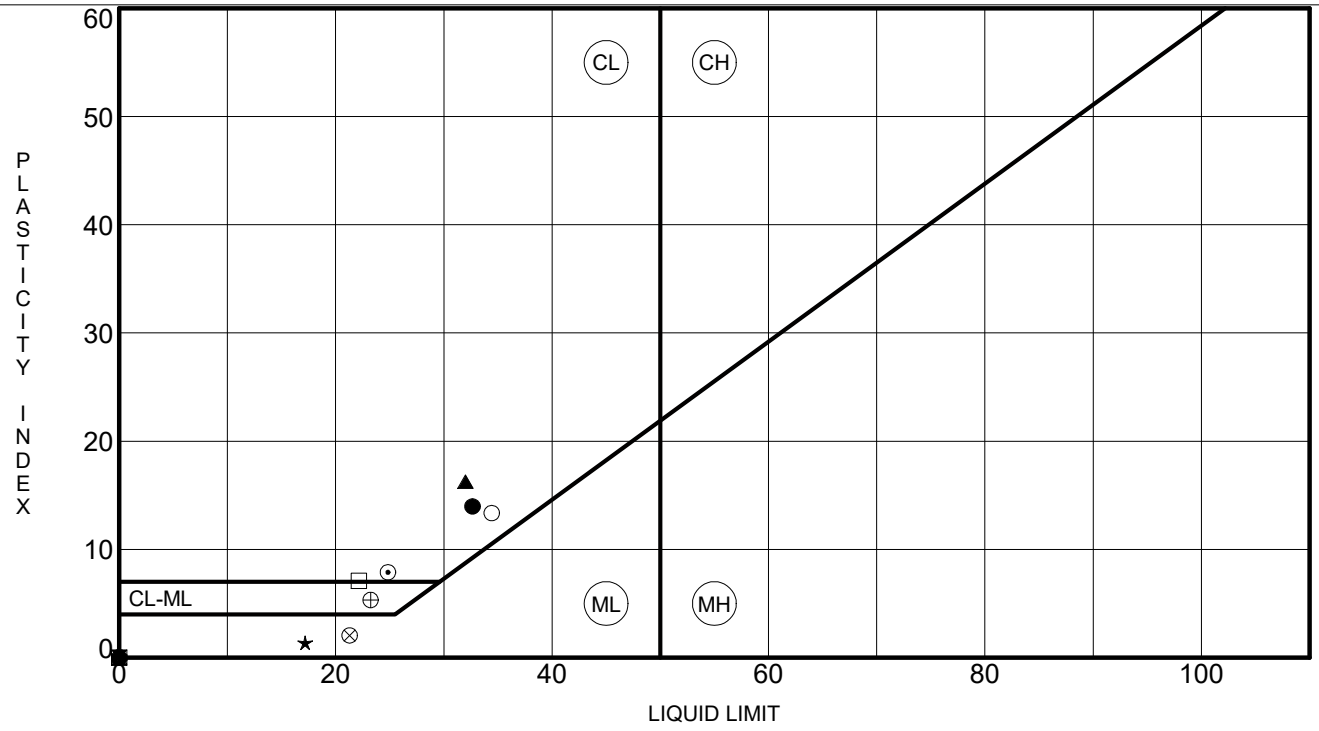
Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
B-1	0-5	33	19	14		91	CL	A-6 (12)				1.02						
B-1	7				-1.5				27.1	90.7								
B-1	12											0.43						
B-1	22	NP	NP	NP		2	SP	A-1-b (0)										
B-2	0-5	32	16	16		85	CL	A-6 (12)				0.96	590 @ 15.3%	8.5	0.1212			
B-2	3				-3.5				25.6	94.8								
B-2	8				-0.5				34.3	92.0								
B-2	13	17	16	1		14	GM	A-1-a (0)										
B-2	18											0.18						
B-3	0-5	25	17	8		66	CL	A-4 (3)				0.22						
B-3	3				-1.3				12.5	112.7								
B-3	8								25.5	100.5								
B-4	0-5	NP	NP	NP		62	ML	A-4 (0)				0.01						
B-4	3				-0.7				11.4	95.7								
B-4	8								23.8	92.4								
B-4	13					37						0.00						
B-5	0-5	34	21	13		40	SC	A-6 (2)				0.24	1600 @ 21.3%	8.1	0.0363			
B-5	3				-0.3				21.8	103.0								
B-5	10-14											0.23						
B-5	14-19	NP	NP	NP		5	GP	A-1-a (0)										
B-6	0-2	21	19	2		48	SM	A-4 (0)										
B-6	2-5	23	18	5		56	CL-ML	A-4 (0)	22.7	93.3		0.18	1700 @ 15.4%	7.9	0.0180			
B-6	7																	
B-7	0-4	22	15	7		38	SC-SM	A-4 (0)				0.32						
B-7	4								14.7	111.6								
B-7	10											0.07		8.2	0.0516			
B-7	14	NP	NP	NP		14	SM	A-1-b (0)										

ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



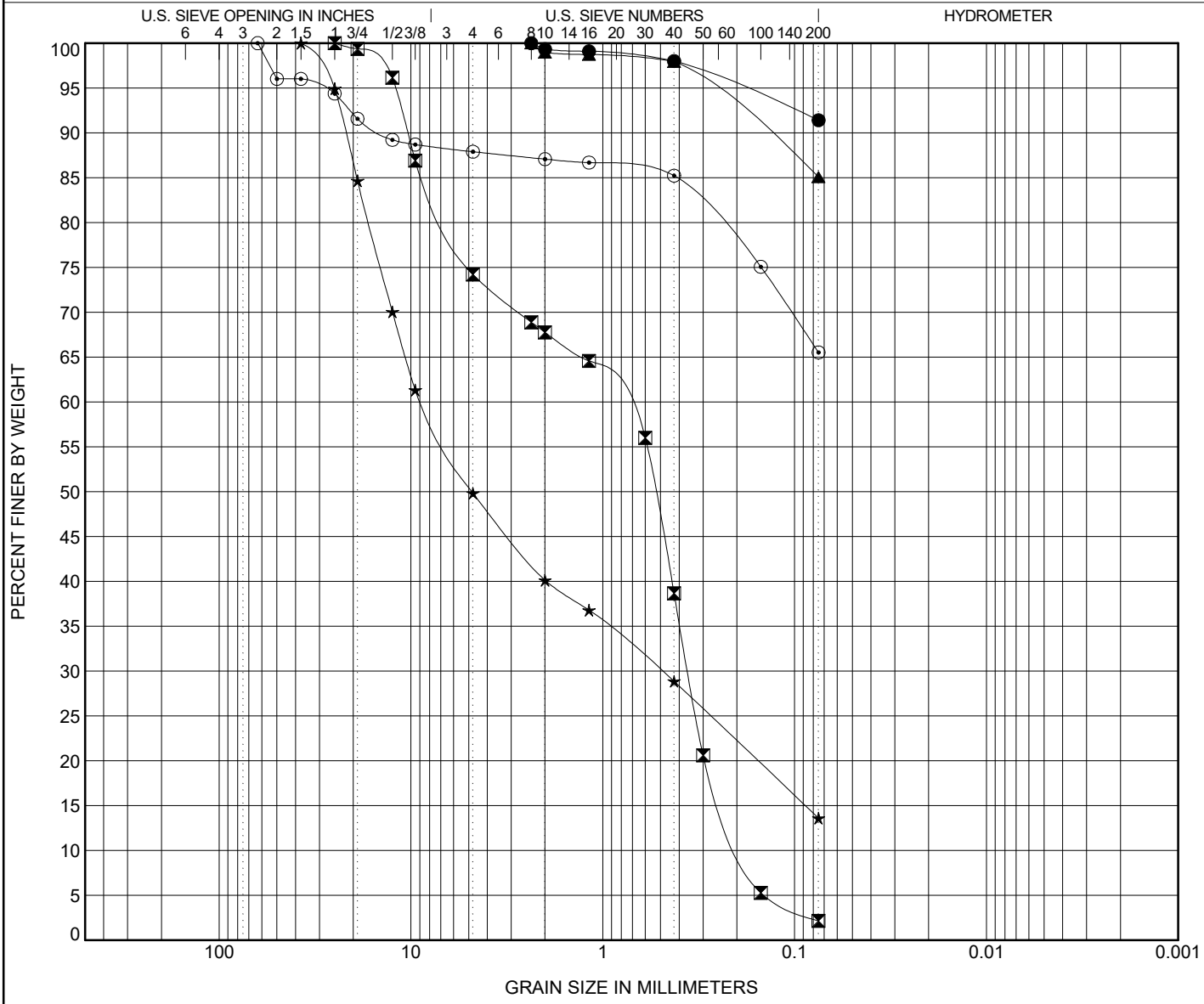
	Specimen Identification		LL	PL	PI	Fines	Classification
●	B-1	0.0-5.0	33	19	14	91.4	LEAN CLAY (CL) (A-6)
⧓	B-1	22.0	NP	NP	NP	2.2	POORLY GRADED SAND with GRAVEL (SP) (A-1-b)
▲	B-2	0.0-5.0	32	16	16	85.1	LEAN CLAY (CL) (A-6)
★	B-2	13.0	17	16	1	13.6	SILTY GRAVEL with SAND (GM) (A-1-a)
⊙	B-3	0.0-5.0	25	17	8	65.5	SANDY LEAN CLAY (CL) (A-4)
✿	B-4	0.0-5.0	NP	NP	NP	62.0	SANDY SILT with GRAVEL (ML) (A-4)
○	B-5	0.0-5.0	34	21	13	40.4	CLAYEY SAND with GRAVEL (SC) (A-6)
△	B-5	14.0-19.0	NP	NP	NP	4.9	POORLY GRADED GRAVEL with SAND (GP) (A-1-a)
⊗	B-6	0.0-2.0	21	19	2	48.3	SILTY SAND (SM) (A-4)
⊕	B-6	2.0-5.0	23	18	5	55.5	SANDY SILTY CLAY (CL-ML) (A-4)
□	B-7	0.0-4.0	22	15	7	37.5	SILTY, CLAYEY SAND with GRAVEL (SC-SM) (A-4)
⊛	B-7	14.0	NP	NP	NP	13.7	SILTY SAND with GRAVEL (SM) (A-1-b)

GRAIN SIZE DISTRIBUTION

Rocksol Consulting Group

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-1	0.0-5.0	LEAN CLAY (CL) (A-6)	33	19	14		
⊠	B-1	22.0	POORLY GRADED SAND with GRAVEL (SP) (A-1-b)	NP	NP	NP	0.85	4.42
▲	B-2	0.0-5.0	LEAN CLAY (CL) (A-6)	32	16	16		
★	B-2	13.0	SILTY GRAVEL with SAND (GM) (A-1-a)	17	16	1		
⊙	B-3	0.0-5.0	SANDY LEAN CLAY (CL) (A-4)	25	17	8		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-1	0.0-5.0	2.36				0.7	1.3	6.6	91.4	
⊠	B-1	22.0	25	0.822	0.36	0.186	32.2	29.1	36.5	2.2	
▲	B-2	0.0-5.0	2.36				1.0	1.0	12.9	85.1	
★	B-2	13.0	37.5	8.767	0.492		59.9	11.3	15.3	13.6	
⊙	B-3	0.0-5.0	63				12.9	1.8	19.7	65.5	

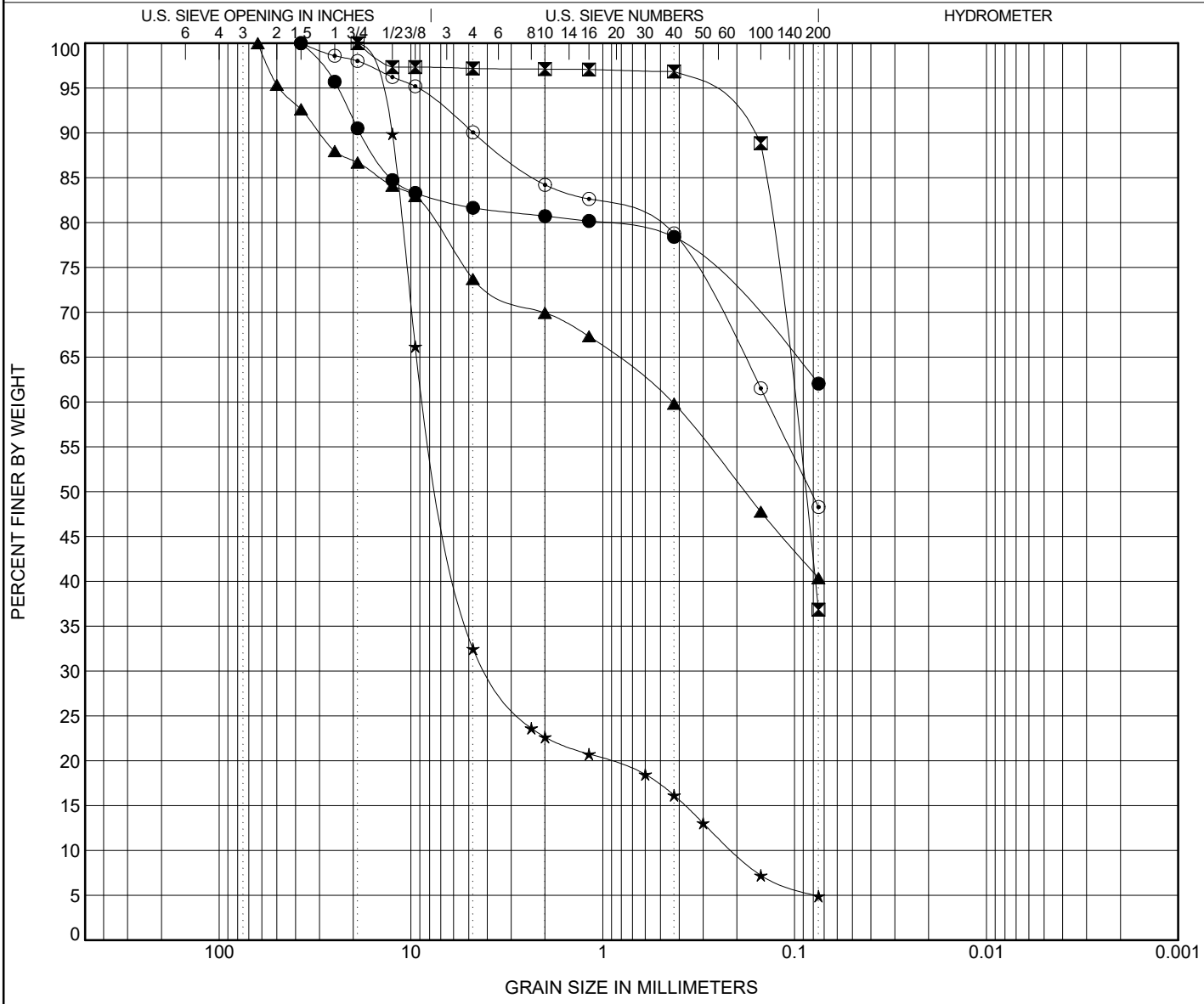
GRADATION - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ ROCKSOL TEMPLATE.GDT 3/19/21

GRAIN SIZE DISTRIBUTION

Rocksol Consulting Group

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-4	0.0-5.0	SANDY SILT with GRAVEL (ML) (A-4)	NP	NP	NP		
⊠	B-4	13.0	SAND, clayey					
▲	B-5	0.0-5.0	CLAYEY SAND with GRAVEL (SC) (A-6)	34	21	13		
★	B-5	14.0-19.0	POORLY GRADED GRAVEL with SAND (GP) (A-1-a)	NP	NP	NP	8.73	40.07
⊙	B-6	0.0-2.0	SILTY SAND (SM) (A-4)	21	19	2		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-4	0.0-5.0	37.5				19.3	2.3	16.3	62.0	
⊠	B-4	13.0	19	0.102			2.9	0.3	60.0	36.9	
▲	B-5	0.0-5.0	63	0.436			30.1	10.1	19.4	40.4	
★	B-5	14.0-19.0	19	8.365	3.904	0.209	77.4	6.5	11.2	4.9	
⊙	B-6	0.0-2.0	37.5	0.138			15.8	5.4	30.5	48.3	

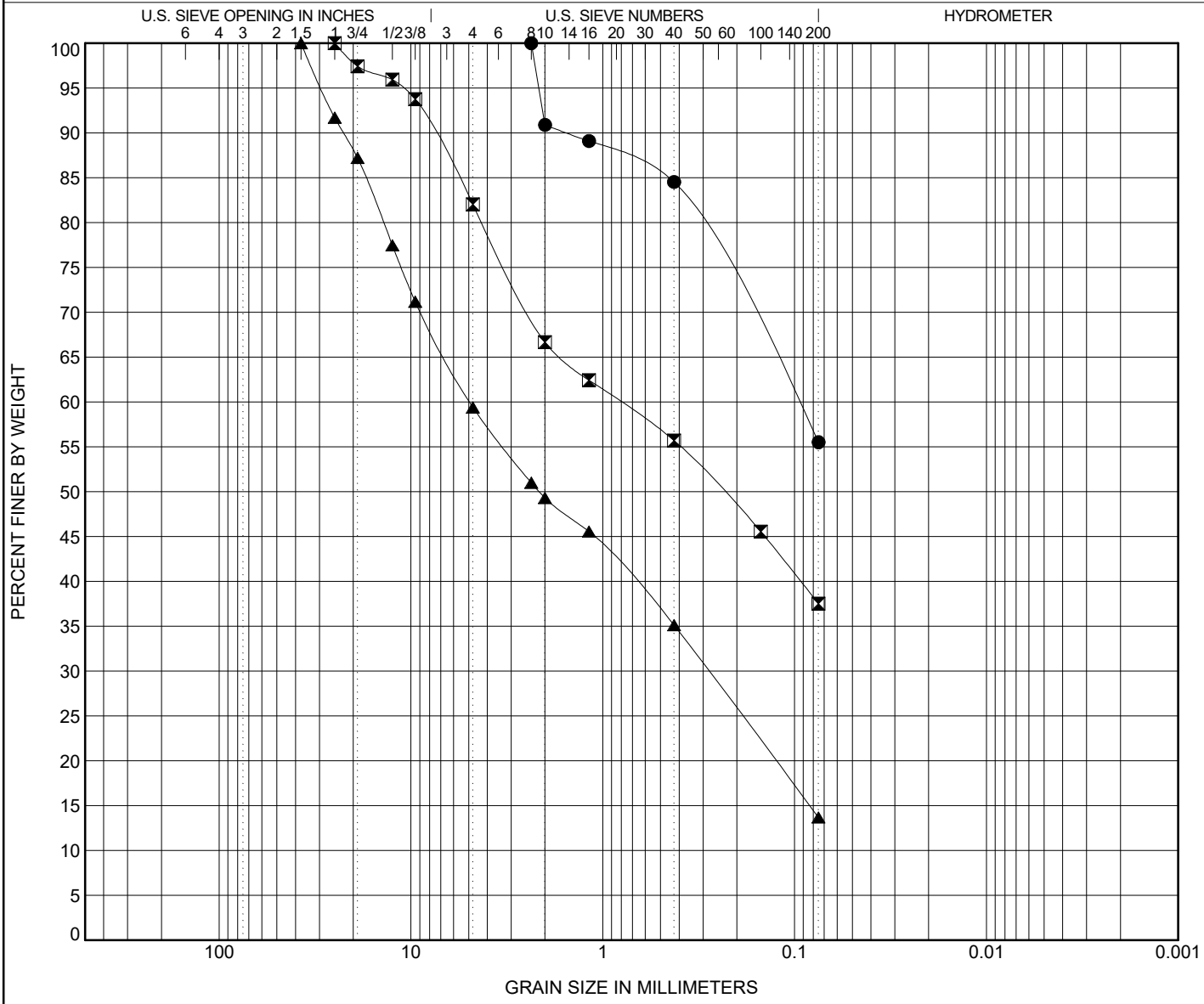
GRADATION - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ ROCKSOL TEMPLATE.GDT 3/19/21

GRAIN SIZE DISTRIBUTION

Rocksol Consulting Group

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-6	2.0-5.0	SANDY SILTY CLAY (CL-ML) (A-4)	23	18	5		
⊠	B-7	0.0-4.0	SILTY, CLAYEY SAND with GRAVEL (SC-SM) (A-4)	22	15	7		
▲	B-7	14.0	SILTY SAND with GRAVEL (SM) (A-1-b)	NP	NP	NP		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Coarse Sand	%Fine Sand	%Silt	%Clay
●	B-6	2.0-5.0	2.36	0.098			9.1	6.4	29.0	55.5	
⊠	B-7	0.0-4.0	25	0.817			33.3	11.0	18.2	37.5	
▲	B-7	14.0	37.5	4.921	0.281		50.7	14.2	21.5	13.7	

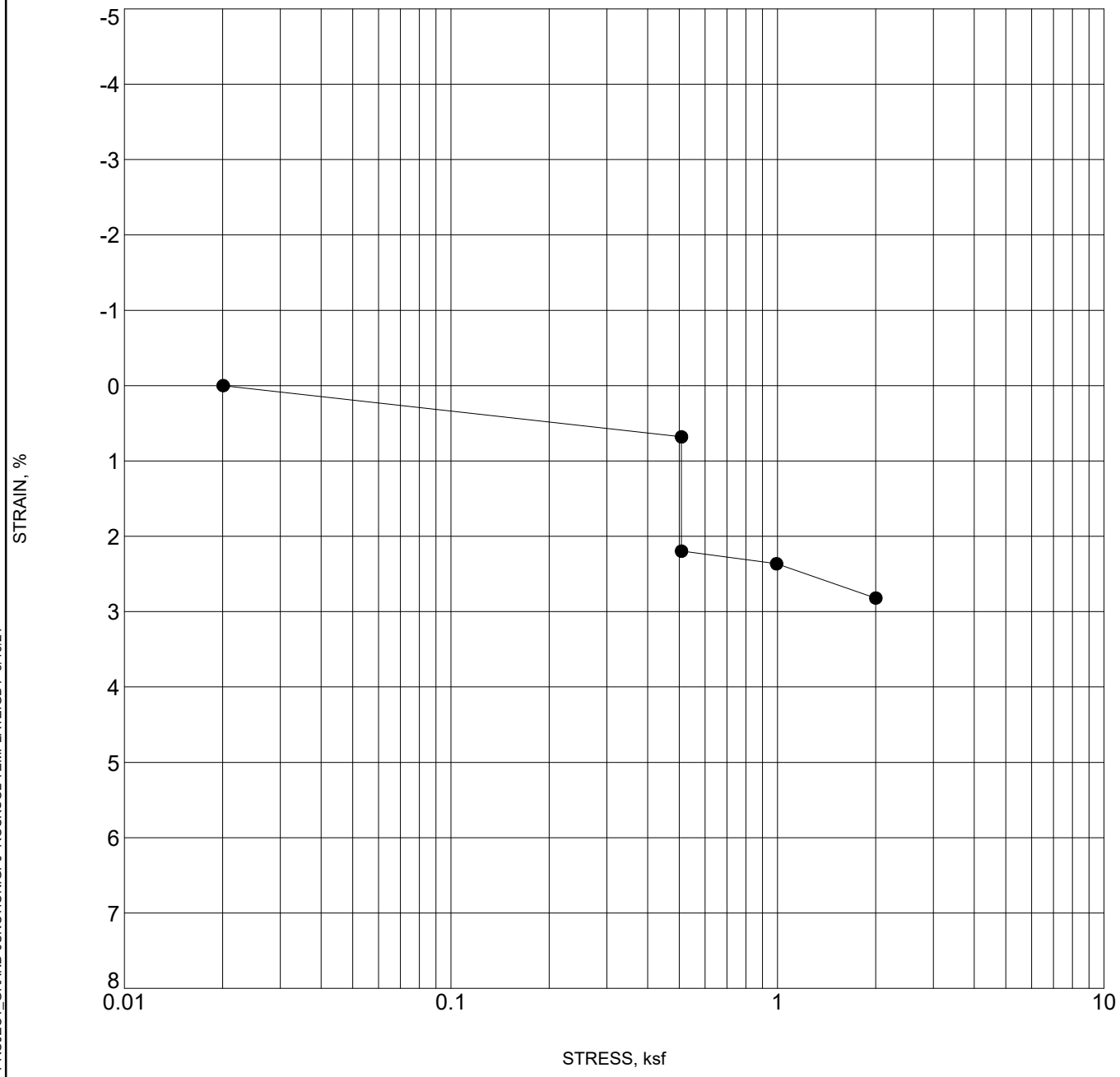
GRADATION - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ ROCKSOL TEMPLATE.GDT 3/19/21

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-1** **7**	**CLAY, sandy**	**-1.5**	**90.7**	**27.1**

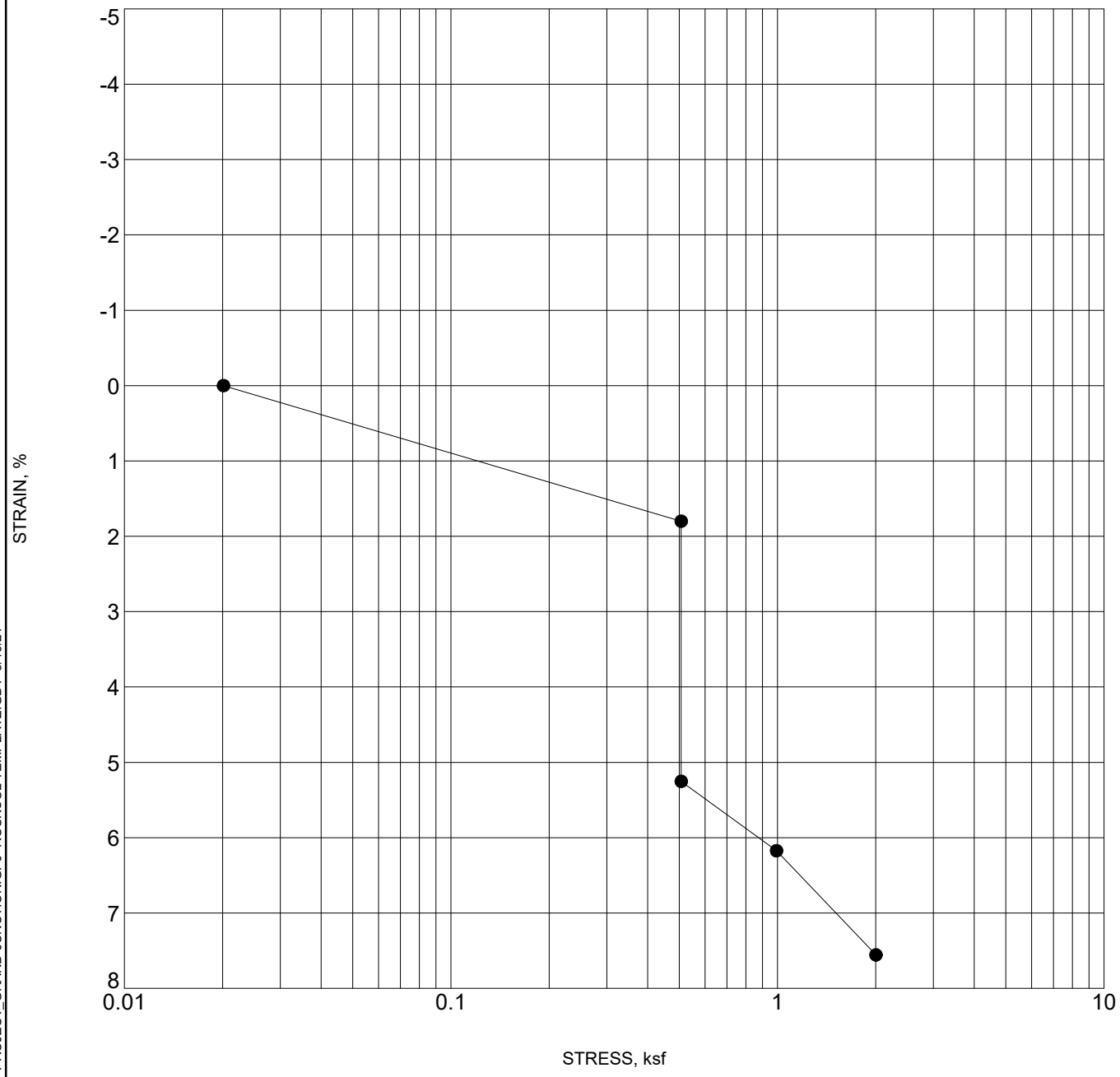
SWELL - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ ROCKSOL TEMPLATE.GDT 3/19/21

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



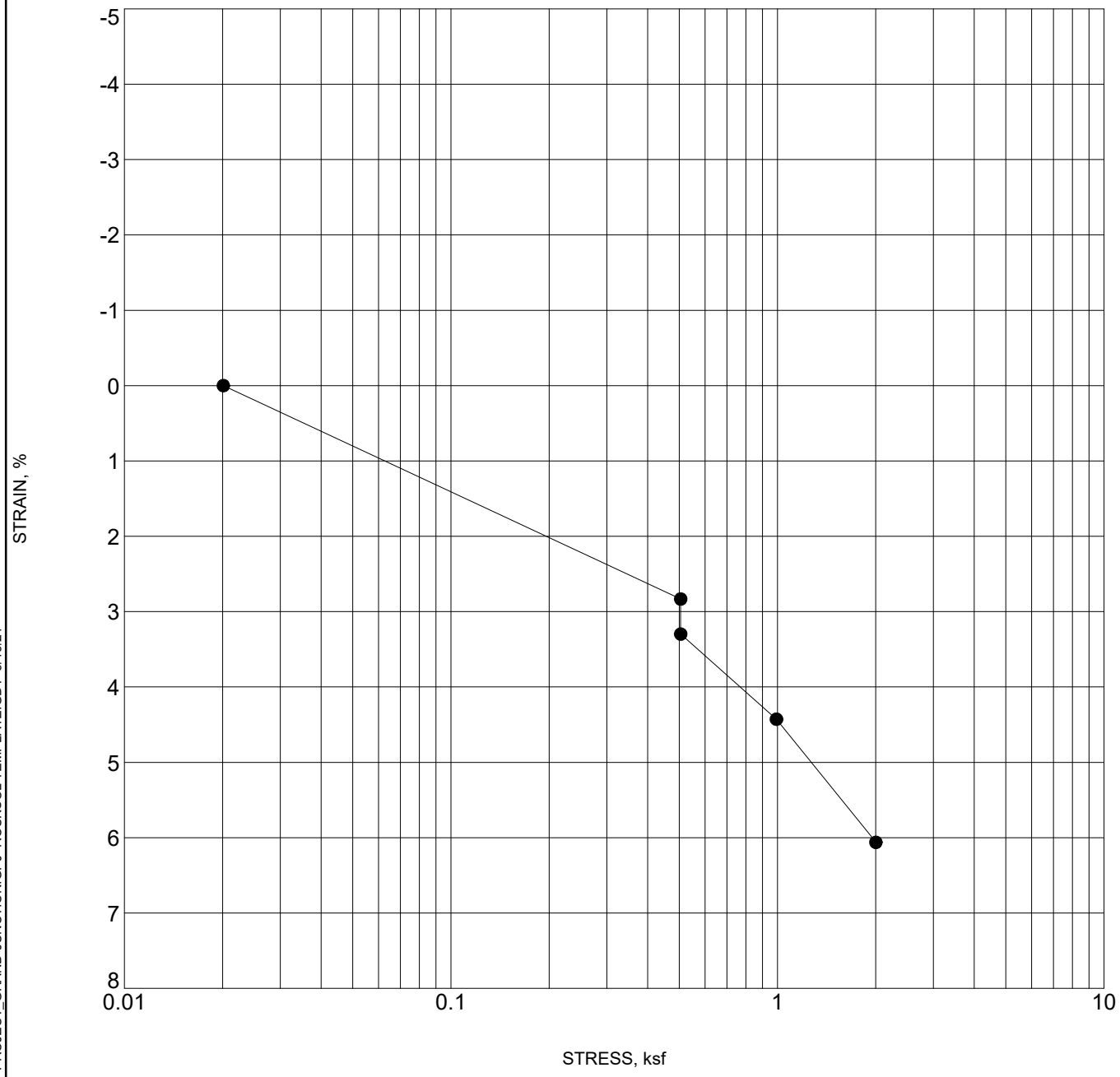
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-2 3**	**CLAY, with sand**	**-3.5**	**94.8**	**25.6**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



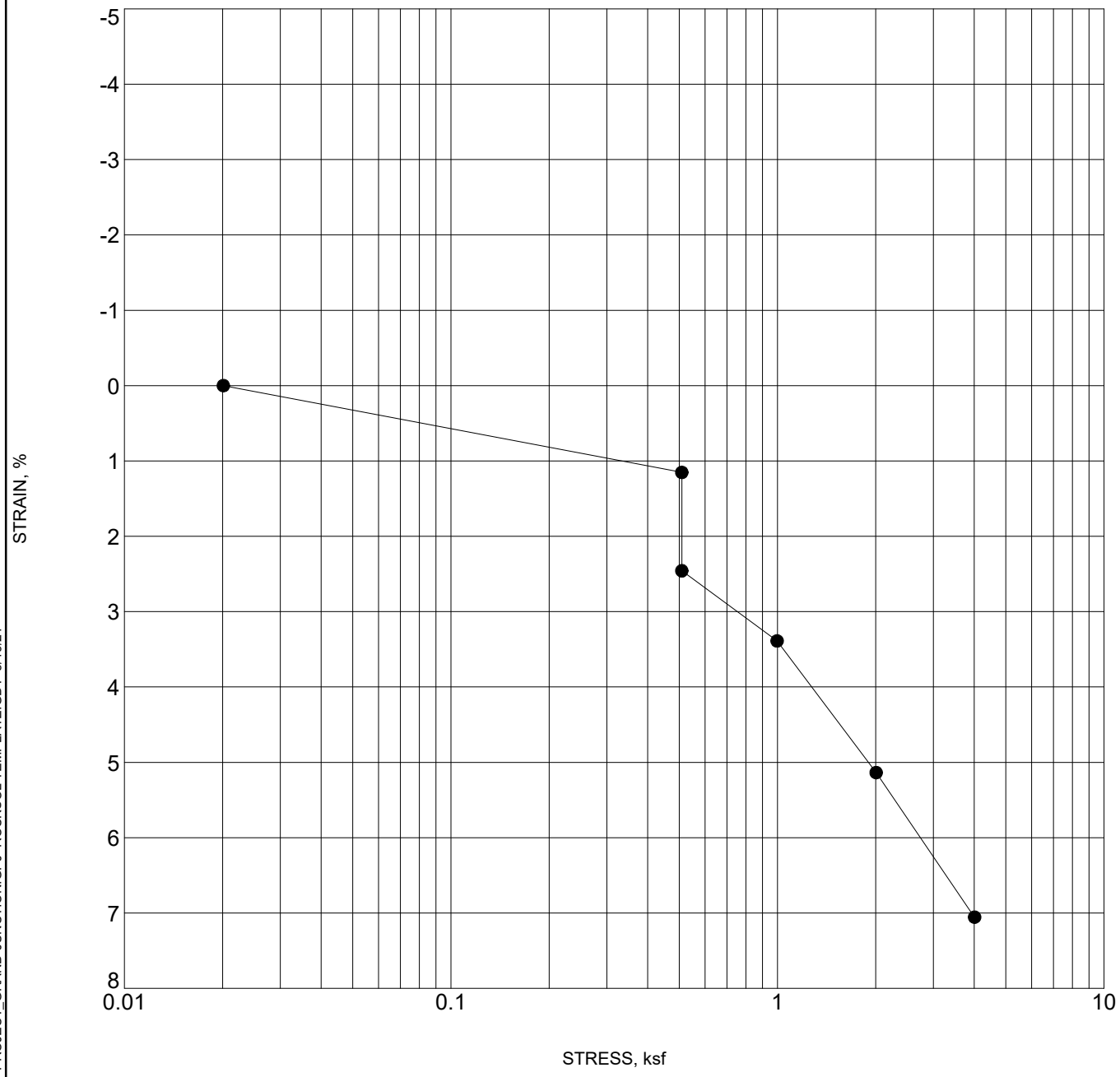
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-2**	**8**	**CLAY, sandy**	**-0.5**	**92.0**	**34.3**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-3 3**	**SAND, clayey with gravel**	**-1.3**	**112.7**	**12.5**

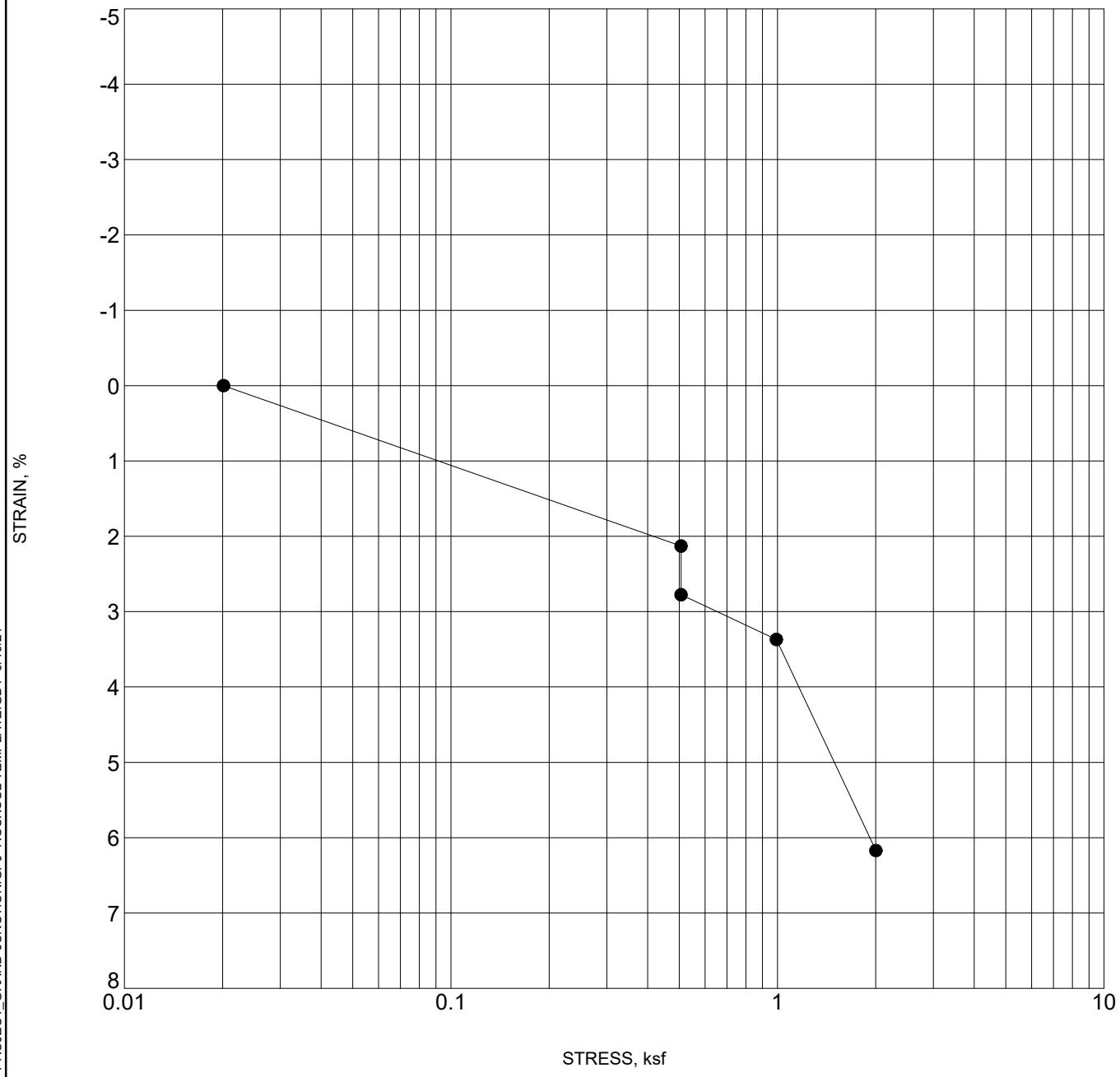
SWELL - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ ROCKSOL TEMPLATE.GDT 3/19/21

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● B-4 3	**SILT, sandy with trace gravel**	**-0.7**	**95.7**	**11.4**

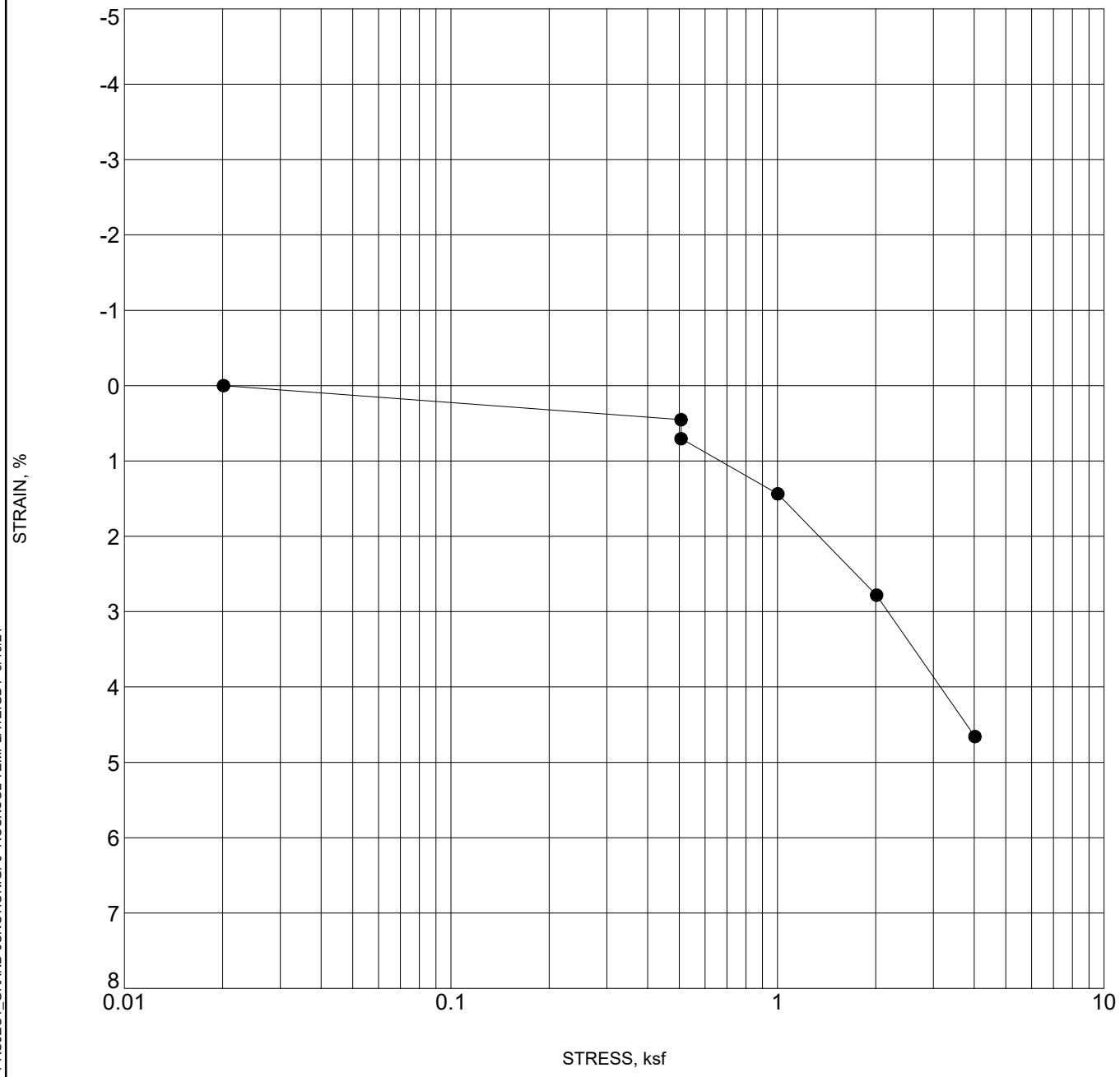
SWELL - STANDARD 599.27_ODOR IMPROVEMENT PROJECT_GRAND JUNCTION.GPJ ROCKSOL TEMPLATE.GDT 3/19/21

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT City of Grand Junction **PROJECT NAME** Grand Junction Odor Control Improvements Project

PROJECT NUMBER 599.27 **PROJECT LOCATION** Grand Junction, Colorado



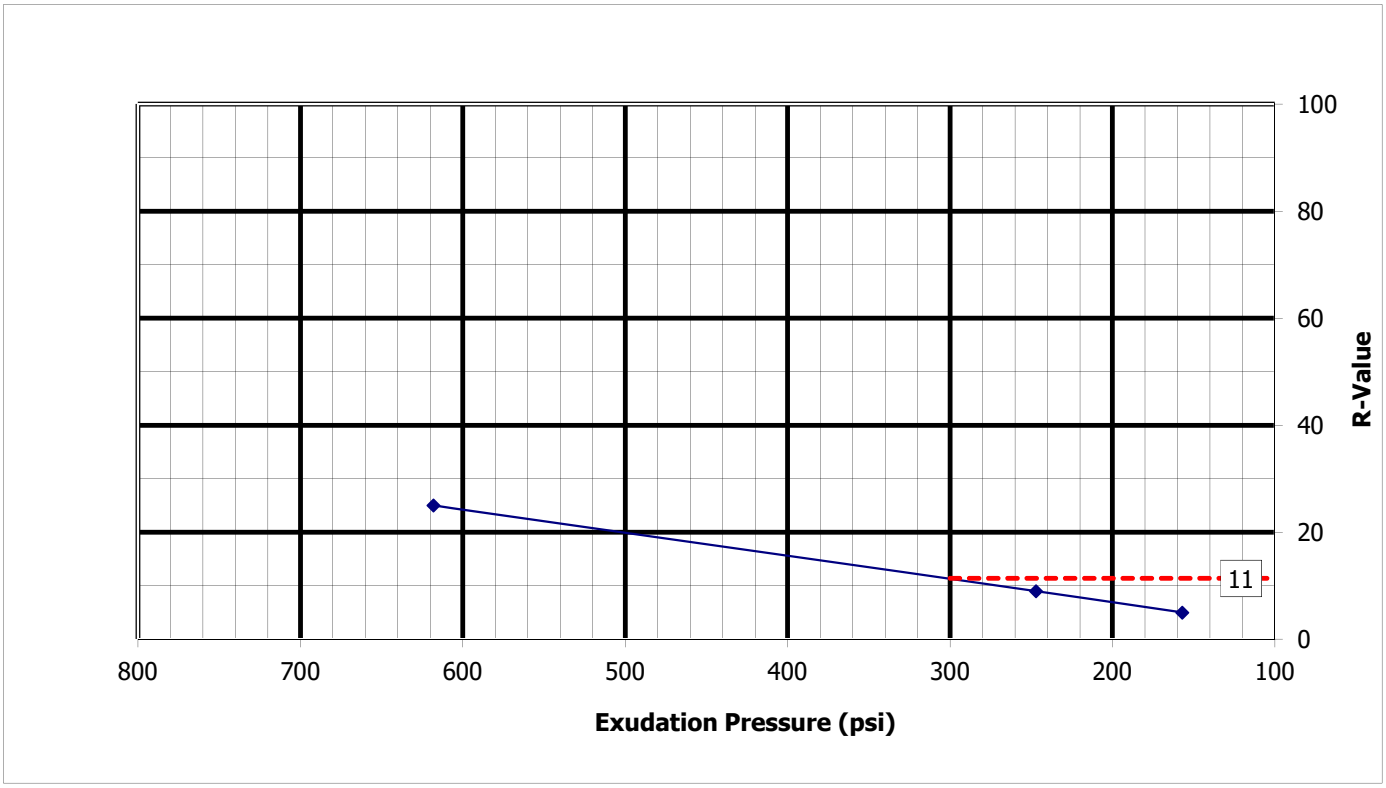
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **B-5 3**	**SAND, clayey**	**-0.3**	**103.0**	**21.8**

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

AASHTO ACCREDITED

R-VALUE TEST GRAPH (AASHTO T190)

Project Number:	21.022, RockSol Consulting	Date:	3-Mar-21
Project Name:	Odor Improvement Project - City of Grand Junction (RockSol Project No. 599.27)	Technician:	J. Holiman
Lab ID Number:	212344	Reviewer:	G. Hoyos
Sample Location:	SE corner pad Site 1 Riverside and US 50; B-5 at 3'		
Visual Description:	CLAY, sandy, brown		



R-Value @ Exudation Pressure 300 psi: 11

Specification:

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

$S_1 = [(R-5)/11.29]+3$ **S_1= 3.57**

$M_R = 10^{[(S_1+18.72)/6.24]}$ **M_R= 3,729**

M_R = Resilient Modulus, psi

S_1 = the Soil Support Value

R = the R-Value obtained

Test Specimen:	1	2	3
Moisture Content, %:	15.6	17.6	19.6
Expansion Pressure, psi:	0.45	0.36	0.06
Dry Density, pcf:	116.3	111.7	109.8
R-Value:	25	9	5
Exudation Pressure, psi:	618	247	157

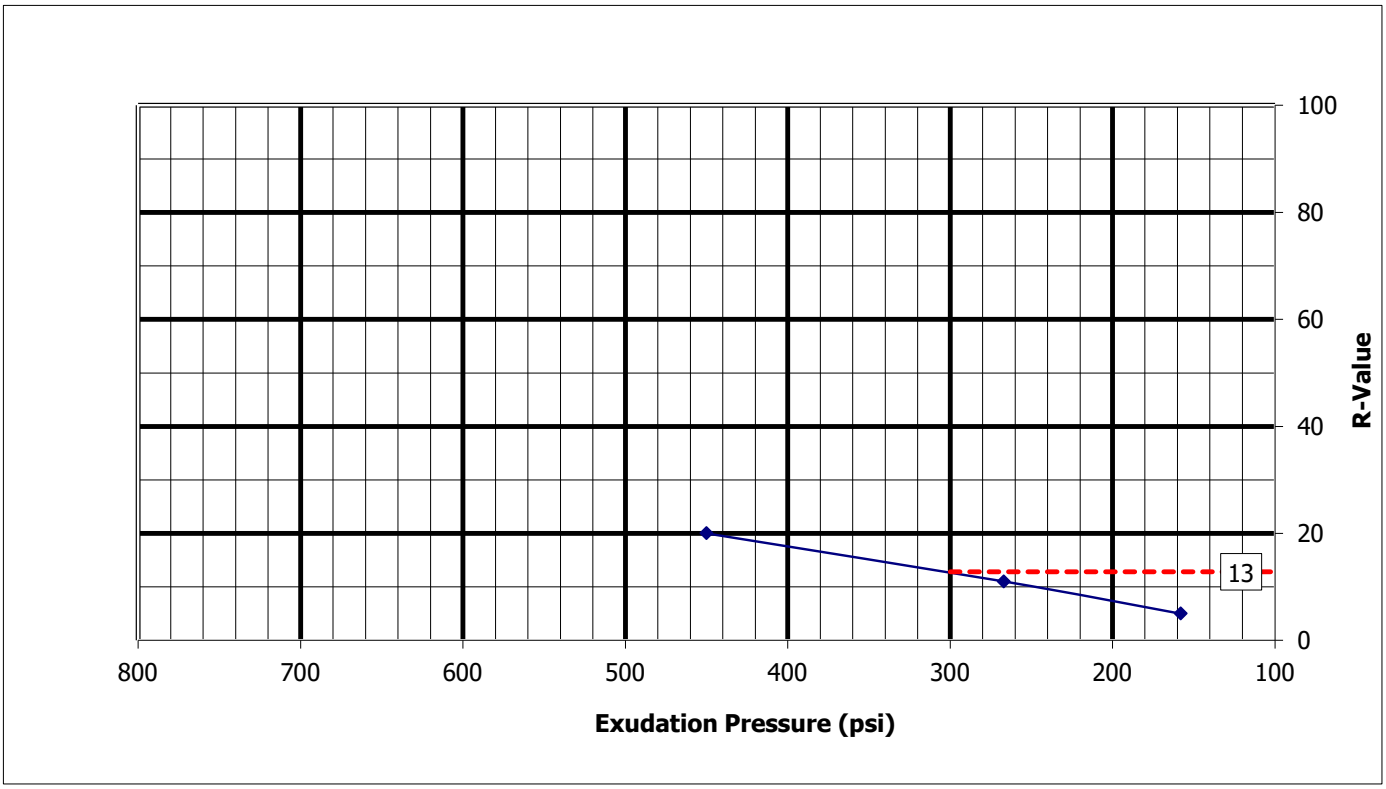
Note: The R-Value is measured; the M_R is an approximation from correlation formulas.

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

AASHTO ACCREDITED

R-VALUE TEST GRAPH (AASHTO T190)

Project Number:	21.022, RockSol Consulting	Date:	15-Mar-21
Project Name:	Odor Improvement Project - City of Grand Junction (RockSol Project No. 599.27)	Technician:	J. Holiman
Lab ID Number:	212345	Reviewer:	G. Hoyos
Sample Location:	NW corner pad Site 1 Persigo: B-2 at 2'		
Visual Description:	CLAY, sandy, brown		



R-Value @ Exudation Pressure 300 psi: **13**

Specification:

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

$S_1 = [(R-5)/11.29]+3$ **S_1= 3.69**

$M_R = 10^{[(S_1+18.72)/6.24]}$ **M_R= 3,904**

M_R = Resilient Modulus, psi

S_1 = the Soil Support Value

R = the R-Value obtained

Test Specimen:	1	2	3
Moisture Content, %:	14.9	17.3	19.0
Expansion Pressure, psi:	0.33	0.15	-0.06
Dry Density, pcf:	113.1	111.9	110.6
R-Value:	20	11	5
Exudation Pressure, psi:	450	267	158

Note: The R-Value is measured; the M_R is an approximation from correlation formulas.

APPENDIX D

SEISMIC DESIGN CRITERIA OUTPUT

Site One- Bio-Filter Pad No. 1

Persigo Water Treatment Plant, 2145 River Road, Grand Junction, CO 81505, USA

Latitude, Longitude: 39.1152279, -108.6569846

Date	3/4/2021, 11:32:13 AM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Default (See Section 11.4.3)

Type	Value	Description
S_S	0.235	MCE_R ground motion. (for 0.2 second period)
S_1	0.065	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.376	Site-modified spectral acceleration value
S_{M1}	0.157	Site-modified spectral acceleration value
S_{DS}	0.251	Numeric seismic design value at 0.2 second SA
S_{D1}	0.105	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	B	Seismic design category
F_a	1.6	Site amplification factor at 0.2 second
F_v	2.4	Site amplification factor at 1.0 second
PGA	0.129	MCE_G peak ground acceleration
F_{PGA}	1.542	Site amplification factor at PGA
PGA_M	0.199	Site modified peak ground acceleration
T_L	4	Long-period transition period in seconds
SsRT	0.235	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.249	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.065	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.07	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

Type	Value	Description
C_{R1}	0.932	Mapped value of the risk coefficient at a period of 1 s

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Site Two- Bio-Filter Pad No. 2

Latitude, Longitude: 39.05797770, -108.56524734

Date	3/4/2021, 11:33:01 AM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Default (See Section 11.4.3)

Type	Value	Description
S_S	0.237	MCE_R ground motion. (for 0.2 second period)
S_1	0.065	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.379	Site-modified spectral acceleration value
S_{M1}	0.157	Site-modified spectral acceleration value
S_{DS}	0.253	Numeric seismic design value at 0.2 second SA
S_{D1}	0.105	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	B	Seismic design category
F_a	1.6	Site amplification factor at 0.2 second
F_v	2.4	Site amplification factor at 1.0 second
PGA	0.13	MCE_G peak ground acceleration
F_{PGA}	1.539	Site amplification factor at PGA
PGA_M	0.201	Site modified peak ground acceleration
T_L	4	Long-period transition period in seconds
SsRT	0.237	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.251	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.065	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.07	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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APPENDIX E

FLEXIBLE AND RIGID 18K ESAL CALCULATIONS

FLEXIBLE ESAL CALCULATIONS

ADL = Average Daily Load

Design Period (in years) :	30
Growth Factor (as decimal):	0.01

Vehicle Classification	Base Year AADT (2-way)	Flexible ESAL Factors	Base Year ADL	Growth Factor	Design Year AADT (2 way)	Design ADL
Cars and pickups (Class 2 and 3)	0	0.0001	0	1.01	0	0
2 axle, 6 tire SU (Class 5)	2	0.864	2.5	1.01	3	2.592
3+ axle SU (Class 6)	1	2.499	11.6	1.01	1	2.499
3 axle TST (Class 7)	1	1.346	0.39	1.01	1	1.346
4 axle TST (Class 8)	0	2.793	0.51	1.01	0	0
5+ axle TST (Class 9)	0	2.322	16.95	1.01	0	0
Buses, trucks w/trailers (Class 4 and 10)	0	3.701	1.14	1.01	0	0
Twin trailers (Class 11, 12, and 13)	0	2.208	2.4	1.01	0	0
Total	4		35.49		5	6.437

Average ADL	20.9635
No. of days in design period	10950
Design lane factor	0.6
Cumulative design lane flexible ESAL	137,730

RIGID ESAL CALCULATIONS

ADL = Average Daily Load

Design Period (in years) :	30
Growth Factor (as decimal):	0.01

Vehicle Classification	Base Year AADT (2-way)	Rigid ESAL Factors	Base Year ADL	Growth Factor	Design Year AADT (2 way)	Design ADL
Cars and pickups (Class 2 and 3)	0	0.0002	0	1.01	0	0
2 axle, 6 tire SU (Class 5)	2	0.838	2.5	1.01	3	2.514
3+ axle SU (Class 6)	1	3.659	11.6	1.01	1	3.659
3 axle TST (Class 7)	1	1.63	0.39	1.01	1	1.63
4 axle TST (Class 8)	0	3.601	0.51	1.01	0	0
5+ axle TST (Class 9)	0	3.824	16.95	1.01	0	0
Buses, trucks w/trailers (Class 4 and 10)	0	4.804	1.14	1.01	0	0
Twin trailers (Class 11, 12, and 13)	0	2.467	2.4	1.01	0	0
Total	4		35.49		5	7.803

Average ADL	21.6465
No. of days in design period	10950
Design lane factor	0.6
Cumulative design lane flexible ESAL	142,218

APPENDIX F

PAVEMENT DESIGN OUTPUT SHEETS (FLEXIBLE PAVEMENT)

INITIAL VALUES

Initial Serviceability Index=	4.5
Final Serviceability Index=	2
Overall Standard Deviation, So=	0.44
Reliability, R (percent)=	75
Standard Normal Deviate (ZR)=	-0.674
Structural Coefficient of HMA=	0.44
Structural Coefficient of ABC=	0.12
Design Life ESALs=	140,000
R-Value=	**10**

INTERMEDIATE CALCULATIONS

Calculated Mr=	3562
Design Mr=	3562
Design Serviceability Loss (ΔPSI)=	2.5

FINAL CALCULATIONS

SN= **2.8670**

	Such That:	
$Log_{10}ESAL$	≤	**Thickness Equation**
5.1461	≤	5.1471

Full HMA:

Depth= **6.52** in

HMA over ABC:

Depth ABC=	**6**	in	
Depth HMA=	**4.88**	in	Use 5.0 inches

ESAL's = the number of Equivalent 18-kip axle loads for the appropriate design period

Mr = subgrade Resilient Modulus in pounds per square inch (psi)

THIS SHEET USES THE "OLD" CDOT R-VALUE TO RESILIENT MODULUS EQUATION

R-Value = 10

If Mr is based on R-Value ===> Mr = 3,562 psi For Pre-2015 CDOT Correlation

140,000 = Design Life ESALs

SN = 2.867 = Required SN when B equals (or slightly exceeds) A

$Log_{10}ESAL$ = A = 5.14613 Design Mr = 3,562 psi

=

Thickness Equation= B = 5.14706 with no drainage reduction

When A = B, ESAL's and SN agree, then calculate thickness

Take Calculated Thickness and round appropriately for design thickness

0.170041335	A	
3.87	B	
1118.077616	C	
1.378465166	D	
-0.02424708	E	
0.200000	F	Mr= 3,562 psi S_t= 3.44287
3.87	G	Exponent = 3.551742
5.497822251	H	
-0.29656	I	

Structural Coefficient of HMA = 0.44

Structural Coefficient of ABC = 0.12

Design Serviceability Loss (ΔPSI)= 2.5

Calculated thickness, inches = 6.52

FULL DEPTH HMA

Initial Serviceability Index= 4.5

Final Serviceability Index = 2.0

Overall Standard Deviation, So = 0.44

Reliability, R (percent) = 75

Standard Normal Deviate (ZR) = -0.674

(Use Table 1.4 from CDOT Pavement Design Manual)

Composite HMA over ABC

(using specified layer of ABC)

Inches of ABC = 6.0

Calculated Inches of HMA = 4.88

Table 1.4 Reliability and Standard Normal Deviate

Reliability, R (percent)	Standard Normal Deviate(Z_R)
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	-1.037
90	-1.282
91	-1.340
92	-1.405
93	-1.476
94	-1.555
95	-1.645
98	-2.054

APPENDIX G

PAVEMENT DESIGN OUTPUT SHEETS (RIGID PAVEMENT)

Rigid Pavement Design - Based on AASHTO Supplemental Guide

Reference: *LTPP DATA ANALYSIS - Phase I: Validation of Guidelines for k-Value Selection and Concrete Pavement Performance Prediction*

I. General

Agency:	RockSol Consulting Group, Inc.
Street Address:	12076 Grant Street
City:	Thornton
State:	Colorado
Project Number:	599.27
ID:	Odor Improvement Project
Description:	Odor Improvement Project
Location:	Grand Junction, CO

II. Design

Serviceability

Initial Serviceability, P1:	4.5	
Terminal Serviceability, P2:	2.0	

PCC Properties

28-day Mean Modulus of Rupture, $(S'_c)'$:	650	psi
Elastic Modulus of Slab, E_c:	3,400,000	psi
Poisson's Ratio for Concrete, m:	0.15	

Base Properties

Elastic Modulus of Base, E_b:	20,000	psi
Design Thickness of Base, H_b:	6.0	in
Slab-Base Friction Factor, f:	1.4	

Reliability and Standard Deviation

Reliability Level (R):	75.0	%
Overall Standard Deviation, S_0:	0.34	

Climatic Properties

Mean Annual Wind Speed, WIND:	8.8	mph
Mean Annual Air Temperature, TEMP:	50.3	°F
Mean Annual Precipitation, PRECIP:	8.3	in

Subgrade k-Value

100 psi/in

Design ESALs

0.2 million

Pavement Type, Joint Spacing (L)

- (•) JPCP
- ( ) JRCP
- ( ) CRCP

Joint Spacing: 12.0 ft

JPCP

Effective Joint Spacing: 144 in

Edge Support

- (•) Conventional 12-ft wide traffic lane
- ( ) Conventional 12-ft wide traffic lane + tied PCC
- ( ) 2-ft widened slab w/conventional 12-ft traffic lane

Edge Support Factor: 1.00

Sensitivity Analysis

Slab Thickness used for Sensitivity Analysis: ____ in

( ) Modulus of Rupture	( ) Elastic Modulus (Slab)
(•) Elastic Modulus (Base)	( ) Base Thickness
( ) k-Value	( ) Joint Spacing
( ) Reliability	( ) Standard Deviation

Calculated Slab Thickness for Above Inputs: **in**