Huddleston-Berry
Engineering & Testing, LLC

GEOTECHNICAL AND GEOLOGIC HAZARDS INVESTIGATION
MONUMENT ROAD TRAIL
GRAND JUNCTION, COLORADO
PROJECT#00208-0087

CITY OF GRAND JUNCTION
333 WEST AVENUE, BUILDING E
GRAND JUNCTION, COLORADO 81501

OCTOBER 15, 2018

Huddleston-Berry Engineering and Testing, LLC
640 White Avenue,
Grand Junction, Colorado 81501

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A geologic hazards and geotechnical investigation was conducted for the proposed Monument Road Trail project in Grand Junction, Colorado. The project location is shown on Figure 1 – Site Location Map. The purpose of the investigation was to evaluate the surface and subsurface conditions at the site with respect to geologic hazards, foundation design, pavement design, and earthwork for the proposed construction. This summary has been prepared to include the information required by civil engineers, structural engineers, and contractors involved in the project.

Subsurface Conditions (p. 2)

The subsurface investigation consisted of fourteen borings, drilled in August 2018. The borings generally encountered native sand and gravel soils. However, shallow bedrock was observed in the southern portion of the project area. Groundwater was only encountered in six of the borings at depths of between 2.0 and 14.0 feet at the time of the investigation. The native sand soils are non-plastic to slightly plastic and slightly collapsible. The claystone and bentonite bedrock materials were moderately to highly plastic and are anticipated to range from slightly to highly expansive.

Geologic Hazards and Constraints (p. 5)

No geologic hazards were identified which would preclude construction. However, construction should consider the risks of movement associated with the moisture sensitive soils and/or bedrock at the site. In addition, shallow groundwater and the potential for flooding could impact some portions of the trail.

Summary of Foundation Recommendations

Southern four Low-Flow Crossings (culverts)

- *Recommended Foundation Alternative* – Shallow Foundations. (p. 6)
- *Nominal Bearing Resistance at Strength Limit State* – q_{ult} = 1,450*Effective footing width + 10,000 psf. (p. 7)
- *Resistance Factor* – 0.45. (p. 7)
- *Nominal Bearing Resistance at Service Limit State* – See Appendix D.

Northern Low-Flow Crossing (culvert)

- *Recommended Foundation Alternative* – Shallow Foundations. (p. 7)
- *Nominal Bearing Resistance at Strength Limit State* – q_{ult} = 450*Effective footing width + 1,750 psf. (p. 7)
- *Resistance Factor* – 0.45. (p. 7)
- *Nominal Bearing Resistance at Service Limit State* – See Appendix D.

Pedestrian Bridge

H-Piles

- *Pile Type* – Minimum HP 10x57. (p. 8)
- *Nominal Axial Capacity* – 18 ksi times the pile bottom area for 36 ksi steel piles. 25 ksi times the pile bottom area for 50 ksi steel piles. (p. 8)
- *Resistance Factor* – 0.65 where PDA used to establish field driving criteria (p.8)

Micro Piles

- *Anticipated Length* – up to 40 feet. (p. 8)
- *Unit Side Resistance* – 5,250 psf. (p. 9)
- *Resistance Factor* – 0.5 (p. 9)

Shade Structures

- *Recommended Foundation Alternative* – Shallow Foundations. (p. 9)
- *Nominal Bearing Resistance at Strength Limit State* – q_{ult} = 450*Effective footing width + 1,750 psf. (p. 9)
- *Resistance Factor* – 0.45. (p. 9)
- *Nominal Bearing Resistance at Service Limit State* – See Appendix D.

Summary of Pavement Recommendations (p. 11)

It is recommended that the path consist a minimum of 4-inches of concrete. It is recommended that the path in areas where automobile traffic may use and/or cross the path consist of a minimum of 6-inches of concrete. All concrete should be constructed above a minimum of 6-inches of CDOT Class 6 base course.

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

As part of improvements to infrastructure in Western Colorado, the City of Grand Junction proposes to construct a new pedestrian path along Monument Road from D Road to the Lunch Loops parking lot. As part of the design development process, Huddleston-Berry Engineering and Testing, LLC (HBET) was retained by the City of Grand Junction to conduct a geologic hazards and geotechnical investigation at the site.

1.1 Scope

As discussed above, a geologic hazards and geotechnical investigation was conducted for the proposed Monument Road Trail in Grand Junction, Colorado. The scope of the investigation included the following components:

- Conducting a subsurface investigation to evaluate the subsurface conditions at the site.
- Collecting soil and bedrock samples and conducting laboratory testing to determine the engineering properties of the soils and bedrock at the site.
- Providing recommendations for bridge and culvert foundations.
- Providing recommendations for subgrade preparation.
- Providing recommendations for drainage, grading, and general earthwork.
- Providing recommendations for pavements.
- Evaluating potential geologic hazards at the site.

The investigation and report were completed by a Colorado registered professional engineer in accordance with generally accepted geotechnical and geological engineering practices. This report has been prepared for the exclusive use of the City of Grand Junction.

1.2 Site Location

The project is located on the southeast side of Monument Road between D Road and the Lunch Loops parking lot. The project location is shown on Figure 1 – Site Location Map.

1.3 Proposed Construction

The proposed construction is anticipated to consist of a new pedestrian path. The construction is also anticipated to include one bridge and five culverts. In addition, new shade structures are proposed at the Lunch Loops parking lot. Significant earthwork is also likely.

2.0 GEOLOGIC SETTING

2.1 Soils

Soils data was obtained from the USDA Natural Resource Conservation Service Web Soil Survey. The data indicates that the several soil types are present at the site. Soil survey data is included in Appendix A.

Path and trail construction in the site soils is indicated to range from somewhat limited to very limited due to sand content, large stones content, slope, dust, and/or water erosion. The site soils are indicated to have a low to moderate potential for frost action, moderate to high risk of corrosion of uncoated steel, and low to high risk of corrosion of concrete.

2.2 Geology

According to the *Geologic Map of the Grand Junction Quadrangle, Mesa County, Colorado* (2002), several geologic units are present along the trail alignment. The north end of the trail alignment is mapped as being underlain by young fan alluvium and debris flow deposits. The area of the northern bridge structure is mapped as being underlain by the Dakota formation, alluvium deposited by tributary streams, and/or local gravel deposits over terrace alluvium 30 of the Colorado River. The remainder of the trail area is mapped as being underlain by alluvium deposited by tributary streams and/or eolian sand and sheetwash deposits. A geologic map is included as Figure 2.

2.3 Groundwater

Groundwater was only encountered in Borings B-7 and B-10 through B-15 at depths of between 2.0 and 14.0 feet at the time of the investigation.

3.0 SUBSURFACE INVESTIGATION

The subsurface investigation was conducted between August 3rd and August 7th, 2018. Fifteen boring locations were proposed for the project area; however, only fourteen of the borings were drilled. The location of Boring B-12 was inaccessible to the track mounted drill rig. In addition to the borings, a hand sample was collected at the north end of the project area that was inaccessible to the drill rig. Another hand sample was collected at a proposed borrow area on the west side of Monument Road.

The borings were drilled to depths of between 5.5 and 30.5 feet below the existing ground surface. The locations of the borings and hand samples are shown on Figures 3 through 7. Typed boring logs are included in Appendix B. Samples of the native soils and bedrock were collected during Standard Penetration Testing (SPT) and using bulk sampling methods at the locations shown on the logs. In addition, a bulk sample was collected from the proposed borrow area. A second bulk sample was collected at the north end of the project that was inaccessible to the drilling equipment.

As shown on the logs, the subsurface conditions along the trail alignment were variable. Boring B-1, conducted near where the new trail will intersect the Lunch Loops parking lot, encountered red, moist, dense cobbles and boulders in a silty sand with gravel matrix from the ground surface to the bottom of the boring. Groundwater was not encountered in B-1 at the time of the investigation.

Boring B-2, conducted at the southernmost No Thoroughfare Canyon crossing, encountered 0.5 feet of red, moist, loose silty sand with gravel above white to green, soft, highly weathered bentonite to the bottom of the boring. Groundwater was not encountered in B-2 at the time of the investigation.

Borings B-3 and B-4, conducted along a trail section between creek crossings, encountered tan, moist, loose to medium dense silty sand with gravel soils at the ground surface. In B-3, the sand extended to a depth of 7.0 feet and was underlain by ran, moist, dense to very dense cobbles and boulders in a silty sand with gravel matrix to the bottom of the boring. In B-4, the sand extended to a depth of 6.0 feet where sandstone bedrock was encountered. Groundwater was not encountered in B-3 or B-4 at the time of the investigation.

Borings B-5 through B-7, conducted at the next three crossings of No Thoroughfare Canyon, encountered tan, moist to wet, medium dense to very dense silty sand with gravel or cobbles and boulders in a silty sand with gravel matrix from the ground surface to depths of between 3.5 and 5.5 feet. In B-5, the sand was underlain by tan, hard, moderately weathered sandstone bedrock to the bottom of the boring. In B-6, the sand was underlain by gray to green, medium hard, highly weathered bentonite to the bottom of the boring where sandstone bedrock was encountered. In B-7, the granular soils were underlain by red, medium hard, highly weathered claystone bedrock to the bottom of the boring. Groundwater was only encountered in B-7 at a depth of 2.0 feet at the time of the investigation.

Borings B-8 through B-10, conducted along a trail section north of the three crossings, encountered tan, moist to wet, very loose to medium dense silty sand soils from the ground surface to depths of between 5.0 and 7.5 feet. In B-8, the sand was underlain by gray to green, medium hard, highly weathered bentonite to the bottom of the boring. In B-9, the sand extended to the bottom of the boring where sandstone bedrock was encountered. In B-10, the sand was underlain by brown, wet, medium dense sandy gravel to the bottom of the boring where sandstone bedrock was encountered. Groundwater was only encountered in B-10 at a depth of 2.0 feet at the time of the investigation.

Boring B-11, conducted at the northernmost culvert crossing of No Thoroughfare Canyon, encountered 12.0 feet of tan, moist to wet, loose to medium dense silty sand with gravel above brown, wet, very dense sandy gravel to a depth of 17.0 feet. The gravel was underlain by brown, wet, loose silty sand with gravel to a depth of 22.0 feet. Below the sand, tan, hard, moderately weathered sandstone bedrock extended to the bottom of the boring. Groundwater was encountered in B-11 at a depth of 3.0 feet at the time of the investigation.

Boring B-13, conducted along a trail section south of the pedestrian bridge, encountered 7.0 feet of tan, moist to wet, very loose silty sand above tan, wet, medium dense to loose sandy gravel with trace cobbles to the bottom of the boring. Groundwater was encountered in B-13 at a depth of 3.5 feet at the time of the investigation.

Boring B-14, conducted at the south abutment of the pedestrian bridge, encountered brown, moist to wet, medium dense to dense sandy gravel soils from the ground surface to a depth of 29.0 feet where sandstone bedrock was encountered. Boring B-15, conducted at the north abutment of the pedestrian bridge, encountered 6.0 feet of dense fill materials above brown, moist to wet, dense to very dense silty clayey sand with trace cobbles and boulders to a depth of 15.5 feet. The sand was underlain by tan, wet, medium dense to dense sandy gravel to the bottom of the boring where sandstone bedrock was encountered. Groundwater was encountered in B-14 at a depth of 14.0 feet and in B-15 at a depth of 7.0 feet.

Bulk samples HS-1 and HS-2, collected from the proposed borrow area and north end of the project, respectively, encountered silty gravel with sand soils.

4.0 LABORATORY TESTING

Selected native soil and bedrock samples collected from the borings were tested in the Huddleston-Berry Engineering and Testing LLC geotechnical laboratory for natural moisture content and density determination, grain size analysis, Atterberg limits determination, maximum dry density and optimum moisture (Proctor) determination, swell/consolidation testing, and soluble sulfates content determination. The laboratory testing results are included in Appendix C.

The laboratory testing results indicate that the native sand soils are non-plastic to slightly plastic. In addition, the sand soils were shown to be slightly collapsible at their existing density with up to approximately 1.6% collapse measured in the laboratory. Water soluble sulfates were detected in the sand soils in a concentration of 0.04%.

The bentonite materials encountered in some of the borings were indicated to be highly plastic. Based upon the Atterberg limits of these materials and upon our experience with bentonite in the vicinity of the subject site, the bentonite is anticipated to be highly expansive.

The claystone bedrock was determined to be moderately plastic. Based upon the Atterberg limits of the material and upon our experience with claystone in the vicinity of the subject site, the claystone bedrock at this site is anticipated to be slightly to moderately expansive.

The native silty, clayey gravel with sand soils encountered at the bulk sampling locations were indicated to be slightly plastic.

5.0 GEOLOGIC INTERPRETATION

5.1 Geologic Hazards

The primary geologic hazard at the site is the potential for flooding of No Thoroughfare Canyon. However, moisture sensitive soils and bedrock were also encountered at the site.

5.2 Geologic Constraints

The primary geologic constraint to construction is the presence of moisture sensitive soils and bedrock. However, shallow groundwater may also impact construction in some areas of the site.

5.3 Water Resources

No water supply wells were observed in the project area. However, shallow groundwater was encountered in several of the borings. In addition, the site runs along No Thoroughfare Canyon. In general, with proper grading and stormwater management, the proposed construction at the site is not anticipated to adversely affect surface water or groundwater.

5.4 Mineral Resources

Potential mineral resources in Western Colorado generally include gravel, uranium ore, and commercial rock products such as flagstone. As discussed previously, sands and gravels were encountered in the subsurface along the trail alignment. However, based upon the location of the proposed trail along No Thoroughfare Canyon, HBET does not believe that the existing sands and gravels represent an economically recoverable resource.

6.0 CONCLUSIONS

Based upon the available data sources, field investigation, and nature of the proposed construction, HBET does not believe that there are any geologic conditions which should preclude construction of the new trail, culvert crossings, and bridges in the project area. However, the presence of shallow groundwater, moisture sensitive soils and bedrock, and/or potential for flooding may impact the design and/or construction.

7.0 RECOMMENDATIONS

7.1 Foundations

As discussed previously, five culvert crossings and one bridge crossing are proposed along the trail alignment. Also, as discussed previously, bedrock materials were encountered fairly shallow at the southern four culvert crossings (Borings B-2, 5, 6, 7). As a result, shallow foundation design will likely be appropriate for these culverts.

At the next culvert crossing (Boring B-11), at the elevation of the proposed culvert, silty sand soils were encountered. As discussed previously, the native sand soils are collapsible. However, the foundation loading is not anticipated to be large. As a result, shallow foundations are anticipated to be appropriate at this location.

At the pedestrian bridge (B-14 and B-15), sand and gravel soils were encountered above sandstone bedrock. Due to the variable density of the granular soils, deep foundations to competent bedrock should be considered. Driven piles may be appropriate; however, driven piles may have difficulties penetrating the dense clayey sand layer encountered in B-15. An alternative to driven piles is micro-piles.

As indicated previously, Boring B-1, conducted near the Lunch Loops parking lot encountered dense granular materials in the subsurface. In general, HBET anticipates similar soil conditions at the locations of the proposed shade structures. Therefore, HBET anticipates that shallow foundations will be appropriate for the shade structures.

7.1.1. Shallow Foundations for Southern Four Culverts (B-2, 5, 6, 7)

As discussed previously, expansive claystone and bentonite bedrock materials were encountered in borings at three of the crossings. However, claystone and bentonite are common to the geology in the area and even though they were not encountered in the fourth boring, it is likely that they are present in the bedrock below all of the crossings. Due to the high likelihood of moisture fluctuations in the subgrade at the culverts, volume changes in the claystone and/or bentonite are likely. Unfortunately, there is no cost effective way to limit the potential for movement of culverts. The only way to limit the potential for movement would be to construct micro-pile supported bridges at the crossings. However, this would likely be cost prohibitive. Therefore, HBET generally recommends that the culverts be constructed above competent bedrock materials or structural fill extending to bedrock.

Structural fill should consist of granular, non-free draining, non-expansive material such as ¼-inch minus crusher fines or CDOT Class 6 Base course. Controlled Low Strength Material (CLSM/Flowable Fill) is also acceptable below the culverts down to bedrock. However, unless it can be demonstrated that they are not free-draining, pit-run materials are not suitable for use as structural fill.

In accordance with LRFD design methodology, for culverts constructed/placed above competent weathered bedrock, a nominal bearing resistance for the strength limit state of q_{ult} = 1,450*Effective footing width + 10,000 psf may be used. A resistance factor of 0.45 is recommended. Nominal bearing resistance for the service limit state should be in accordance with the attached plot of Bearing Stress versus Effective Footing Width for a maximum total settlement of 1.0-inch included in Appendix D.

7.1.2. Shallow Foundations for Fifth Culvert (B-11)

As discussed previously, collapsible sand soils were encountered in the subsurface at the elevation of the proposed culvert base. Therefore, HBET recommends that the culvert(s) be constructed above a minimum of 24-inches of structural fill consisting of the proposed borrow materials or imported granular material such as crusher fines or CDOT Class 6 base course.

Prior to placement of structural fill, it is recommended that the bottom of the foundation excavation be scarified to a depth of 6 to 9 inches, moisture conditioned, and compacted to a minimum of 95% of the standard Proctor maximum dry density, within ± 2% of the optimum moisture content as determined in accordance with ASTM D698. However, soft, wet conditions may exist at the bottom of the foundation excavation and this may make compaction of the subgrade difficult. It may be necessary to utilize geotextile and/or geogrid in conjunction with up to 30-inches of granular fill to stabilize the subgrade. HBET should be contacted to provide specific recommendations for subgrade stabilization based upon the actual conditions in the bottom of the foundation excavation.

Structural fill should be moisture conditioned, placed in maximum 8-inch loose lifts, and compacted to a minimum of 95% of the standard Proctor maximum dry density for fine grained soils and modified Proctor maximum dry density for coarse grained soils, within ± 2% of the optimum moisture content as determined in accordance with ASTM D698 and D1557, respectively. Structural fill should extend laterally beyond the edges of the culvert(s) a distance equal to the thickness of structural fill.

In accordance with LRFD design methodology, for foundation preparation as recommended, a nominal bearing resistance for the strength limit state of q_{ult} = 450*Effective footing width + 1,750 psf may be used. A resistance factor of 0.45 is recommended. Nominal bearing resistance for the service limit state should be in accordance with the attached plot of Bearing Stress versus Effective Footing Width for a maximum total settlement of 1.0-inch included in Appendix D. Foundations subject to frost should be at least 24-inches below the finished grade.

7.1.3. Driven Piles for Pedestrian Bridge

As discussed previously, driven steel H-piles may be appropriate for the pedestrian bridge. For driven piles, it is anticipated that most of the axial pile capacity will be developed in end bearing on sandstone bedrock. Based upon the anticipated working loads and pile driving conditions, piles should be a minimum of HP 10x57. However, if larger piles are proposed, it is important to ensure the pile driving contractor has a large enough hammer to achieve the design capacities.

The piles should penetrate the native sand and gravel soils and bear into the sandstone bedrock. The actual penetration of individual piles will be dependent upon driving conditions and size of pile used; however, it is anticipated that H-piles will reach refusal within 2 to 10 feet of the top of the bedrock. Therefore, pile lengths of up to approximately 39 feet may be possible (measured from existing grade). In order to protect the pile tip, pile tip reinforcement is recommended.

In accordance with LRFD design methodology, for Grade 36 steel H-piles, a nominal combined skin friction and end bearing capacity of 18 ksi times the cross sectional area of the pile is recommended. For Grade 50 steel H-piles, a nominal combined skin friction and end bearing capacity of 25 ksi times the cross sectional area of the pile is recommended. However, it is recommended that pile load testing be conducted to evaluate actual achievable capacities and pile lengths. In accordance with AASHTO LRFD bridge design specifications, where a pile driving analyzer is utilized to establish the field pile driving criteria, a resistance factor of 0.65 may be used.

To eliminate reductions in capacity from group effects, the minimum center-to-center spacing of piles should be 3 pile diameters. Group effects should be considered for piles grouped less than 3 diameters apart.

In general, for properly installed H-piles refused on bedrock, HBET anticipates that total settlements will be 1.0-inch or less. However, this should be verified during pile load testing. A reduction in capacity may be necessary where pile load tests indicate excessive deflection.

7.1.4. Micro Piles for Pedestrian Bridge

As discussed previously, micro-piles are an appropriate foundation alternative for the pedestrian bridge. In general, micro-piles should be designed as unbonded elements in the overburden sand and gravel soils with bearing capacity developing from side shear in the sandstone bedrock. Due to the granular nature of the overburden soils, conventional micro-piles will likely require casing to maintain an open hole. However, injection grouted piles may also be considered.

For a micro pile foundation, it is recommended that micro piles extend into competent bedrock a minimum of 10 feet. Therefore, pile lengths of up to approximately 40 feet are anticipated (as measured from existing grade).

Side resistance should be ignored along the portion of the piles in the overburden soils. Assuming a weighted load factor of 1.5, a unit side resistance (q_s) value of 5,250 psf may be used for the sandstone bedrock. The side resistance is applicable in both compression and uplift. A resistance factor of 0.5 is recommended. However, where a different load factor is used, the load factor should be divided by 3 to determine the corresponding resistance factor. To ensure friction capacity, pile load testing is strongly recommended. Grout used in the bond zone of the micro piles should have a minimum 28 day compressive strength of 3,000 psi.

In general, micro piles should be installed with a center-to-center spacing of greater than 3 feet. However, to the extent practical, smaller numbers of longer micro piles should be used in lieu of larger numbers of shorter piles. The longer the piles and larger the loads on the piles, the lower the risk of movement.

For properly installed micro-piles, HBET anticipates that total settlements will be 1.0-inch or less. However, this should be verified during pile load testing. A reduction in capacity may be necessary where pile load tests indicate excessive deflection.

7.1.5. Shallow Foundations for Shade Structures

As discussed previously, dense granular materials were encountered at the south end of the trail. It is anticipated that similar conditions will be present at the proposed shade structure locations. Therefore, spread footing type foundations are appropriate for these structures. However, to provide a uniform bearing stratum and limit the potential for excessive differential settlements, it is recommended that the shade structure foundations be constructed above a minimum of 18-inches of structural fill consisting of the proposed borrow materials or imported granular material such as crusher fines or CDOT Class 6 base course.

Prior to placement of structural fill, it is recommended that the bottom of the foundation excavation be scarified to a depth of 6 to 9 inches, moisture conditioned, and proofrolled to the Engineer's satisfaction. Structural fill should be moisture conditioned, placed in maximum 8-inch loose lifts, and compacted to a minimum of 95% of the standard Proctor maximum dry density for fine grained soils and modified Proctor maximum dry density for coarse grained soils, within ± 2% of the optimum moisture content as determined in accordance with ASTM D698 and D1557, respectively. Structural fill should extend laterally beyond the edges of the foundations a distance equal to the thickness of structural fill.

In accordance with LRFD design methodology, for foundation preparation as recommended, a nominal bearing resistance for the strength limit state of q_{ult} = 450*Effective footing width + 1,750 psf may be used. A resistance factor of 0.45 is recommended. Nominal bearing resistance for the service limit state should be in accordance with the attached plot of Bearing Stress versus Effective Footing Width for a maximum total settlement of 1.0-inch included in Appendix D. Foundations subject to frost should be at least 24-inches below the finished grade

7.2 Lateral Pile Capacity

Based upon the results of the subsurface investigation, the following soil parameters are recommended for use in lateral capacity analyses utilizing the LPile software program:

Depth from Grade (in).	Above Water Table	Below Water Table
Soil Type	Sand	Sand
Density (pci)	0.0637	0.0275
Cohesion (psi)	0	0
Friction Angle (ϕ)	28	28
ε_{50} (in/in)	-	-
K_h (pci)	90	60

7.3 Corrosion of Steel and Concrete

The Soil Survey data suggest that the native soils have a moderate to high potential for corrosion of steel. The risk of corrosion may be increased where flooding or groundwater fluctuations result in periods of wetting and drying. Therefore, it is recommended that the structural engineer consider corrosion in the design of H-piles.

With regard to soil corrosivity to concrete, as discussed previously, water soluble sulfates were detected in the site soils in a concentration of 0.04%. This concentration of sulfates represents a negligible degree of sulfate attack on concrete exposed to the native soils. However, the Soil Survey data suggest that the native soils have lot to high potential for corrosion of concrete. Therefore, at a minimum, Type I-II sulfate resistant cement is recommended for construction at this site.

7.4 Borrow Materials

As indicated in the attached laboratory testing data, the proposed borrow materials consist of silty, clayey gravel with sand. In general, these materials are suitable for use as structural fill, embankment fill, etc.

7.5 Lateral Earth Pressures

The structures should be designed to resist lateral earth pressures. HBET recommends that the structures be designed using the following earth pressure coefficients:

<u>Native Sand Soils</u>

- $K_o = 0.53$
- $K_a = 0.36$
- $K_p = 2.77$

Native Gravels / Cobbles and Boulders and Gravel Borrow

- $K_o = 0.44$
- $K_a = 0.31$
- $K_p = 3.26$

The earth pressure coefficients above assume horizontal backslope and should be increased where the backslope is not level. Computed lateral earth pressures on the structures should consider surcharge loading from vehicular traffic on the trail, where applicable.

7.6 Seismic Site Classification

At the four southern culverts, shallow bedrock was present. As a result, Seismic Site Class C is recommended for these structures.

At the northern low-flow crossing, loose sand soils are present below the water table and some of these soils are potentially liquefiable. In general, HBET does not believe that there is a significant risk of structural damage, loss of life, etc. associated with a concrete culvert structure at this location. However, in accordance with the International Building Code (IBC), the northern crossing area technically classifies as Seismic Site Class F.

At the pedestrian bridge crossing, sand and gravel soils were present in the shallow subsurface. While some of these soils were below the water table, based upon the SPT blow counts of these materials, HBET does not believe that these soils are liquefiable. In addition, deep foundations are proposed for this structure. Therefore, HBET recommends that Seismic Site Class D be used for the pedestrian bridge.

7.7 Excavations

Excavations in the soils at the site may stand for short periods of time but should not be considered to be stable. The native sand soils generally classify as Type C soil with regard to OSHA's *Construction Standards for Excavations*. In general, for Type C soils, the maximum allowable slope in temporary cuts is 1.5H:1V.

In general, for bedrock excavation in the southern portion of the project area, HBET recommends that the materials be classified as Type A soil. For Type A soil, the maximum allowable slope in temporary cuts is 0.75H:1V. However, HBET should be contacted to further evaluate bedrock materials exposed during construction.

7.8 Path Pavements

The proposed construction is anticipated to include a new concrete path. The subgrade materials along the path will consist of native sand and gravel soils or gravel soils from the borrow area.

In general, the native sand soils will be critical for the pavement section design as any fills will consist of suitable controlled materials. Due to the collapse potential of the native sand soils, the recommended minimum Resilient Modulus of 3,000 psi was used for the pavement design.

In general, HBET recommends that the concrete path be a minimum of 4-inches in thickness in accordance with Mesa County standards. In addition, in areas where automobile traffic may use and/or cross the path, a minimum thickness of 6-inches of concrete is recommended. For all areas of the path, a minimum of 6-inches of CDOT Class 6 base course is recommended below the concrete.

Prior to new pavement placement, areas to be paved should be stripped of all topsoil, uncontrolled fill, or other unsuitable materials. It is recommended that the subgrade soils be scarified to a depth of 12-inches; moisture conditioned, and recompacted to a minimum of 95% of the standard Proctor maximum dry density, within ±2% of optimum moisture content as determined by AASHTO T-99.

Aggregate base course should be placed in maximum 9-inch loose lifts, moisture conditioned, and compacted to a minimum of 95% of the maximum dry density, at -2% to +3% of optimum moisture content as determined by AASHTO T-180. In addition to density testing, base course should be proofrolled to verify subgrade stability.

The long-term performance of the pavements is dependent on positive drainage away from the pavements. Ditches, culverts, and inlet structures in the vicinity of paved areas must be maintained to prevent ponding of water on the pavement.

8.0 GENERAL

The recommendations included above are based upon the results of the subsurface investigation and on our local experience. These conclusions and recommendations are valid only for the proposed construction.

As discussed previously, the subsurface conditions at the site were variable. Although HBET believes that the investigation was sufficient to adequately characterize the range of subsurface conditions at the site, the precise nature and extent of subsurface variability may not become evident until construction. Therefore, it is recommended that a representative of HBET be retained to provide engineering oversight and construction materials testing services during the construction. This is to verify compliance with the recommendations included in this report or permit identification of significant variations in the subsurface conditions which may require modification of the recommendations.

It is important to note that moisture sensitive soils and bedrock were encountered at the site. In general, with proper design and construction, HBET believes that the risk of excessive differential movements is low. However, where significant changes in the subsurface moisture conditions occur either during or after construction, significant differential movements of the sidewalks are possible.

Huddleston-Berry Engineering and Testing, LLC is pleased to be of service to your project. Please contact us if you have any questions or comments regarding the contents of this report.

Respectfully Submitted:
Huddleston-Berry Engineering and Testing, LLC

Michael A. Berry, P.E.
Vice President of Engineering

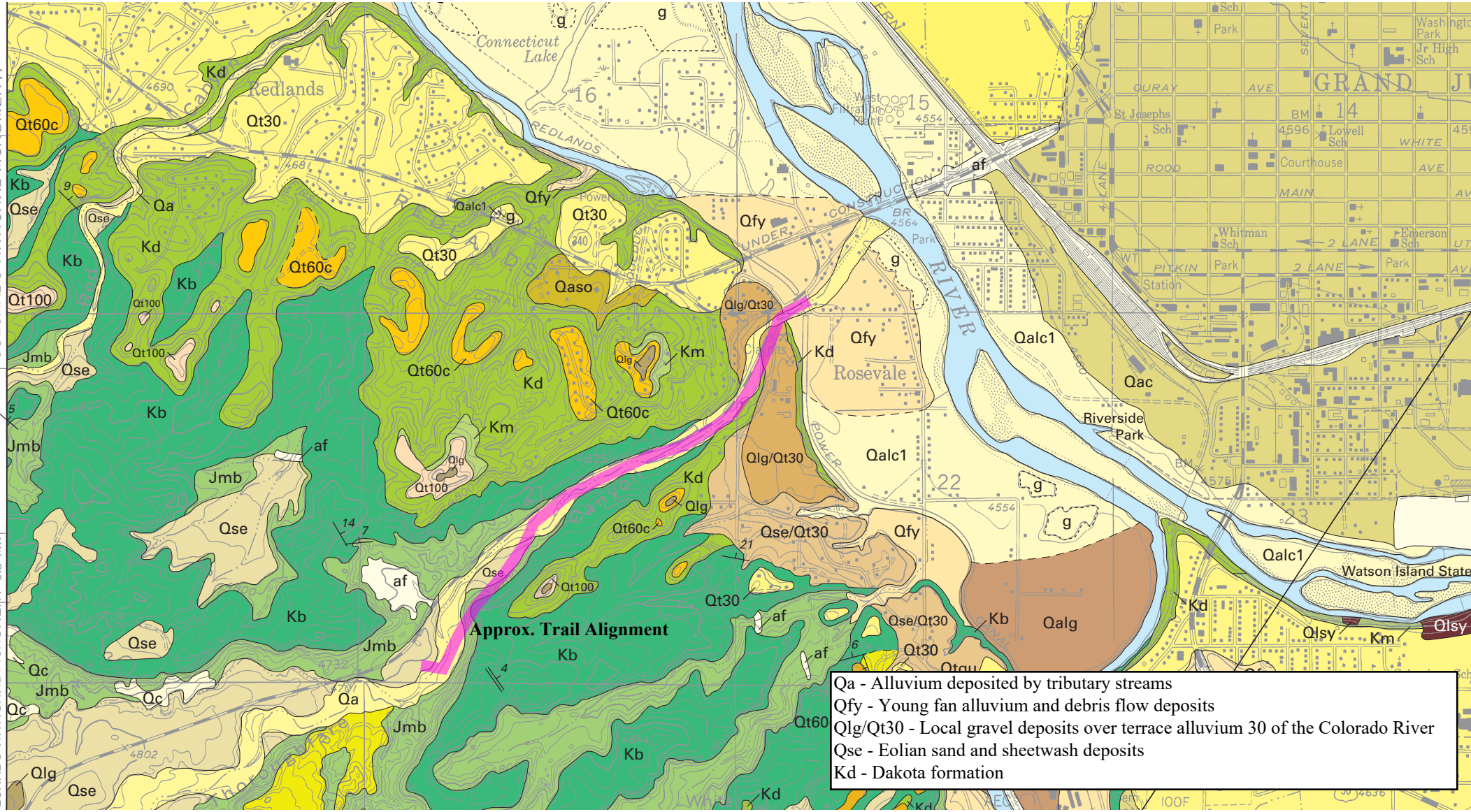
FIGURES

Mesa County Map

0 0.125 0.25 0.5 mi
0 0.15 0.3 0.6 km

Print Date: October 15, 2018

Mesa County, Colorado
GIS/IT Department
gis.mesacounty.us



Printed portion of map titled G*eologic Map of the Grand Junction Quadrangle, Mesa County, Colorado* by Scott, Carrara, Hood, and Murray (2002)

FIGURE 2
Geologic Map

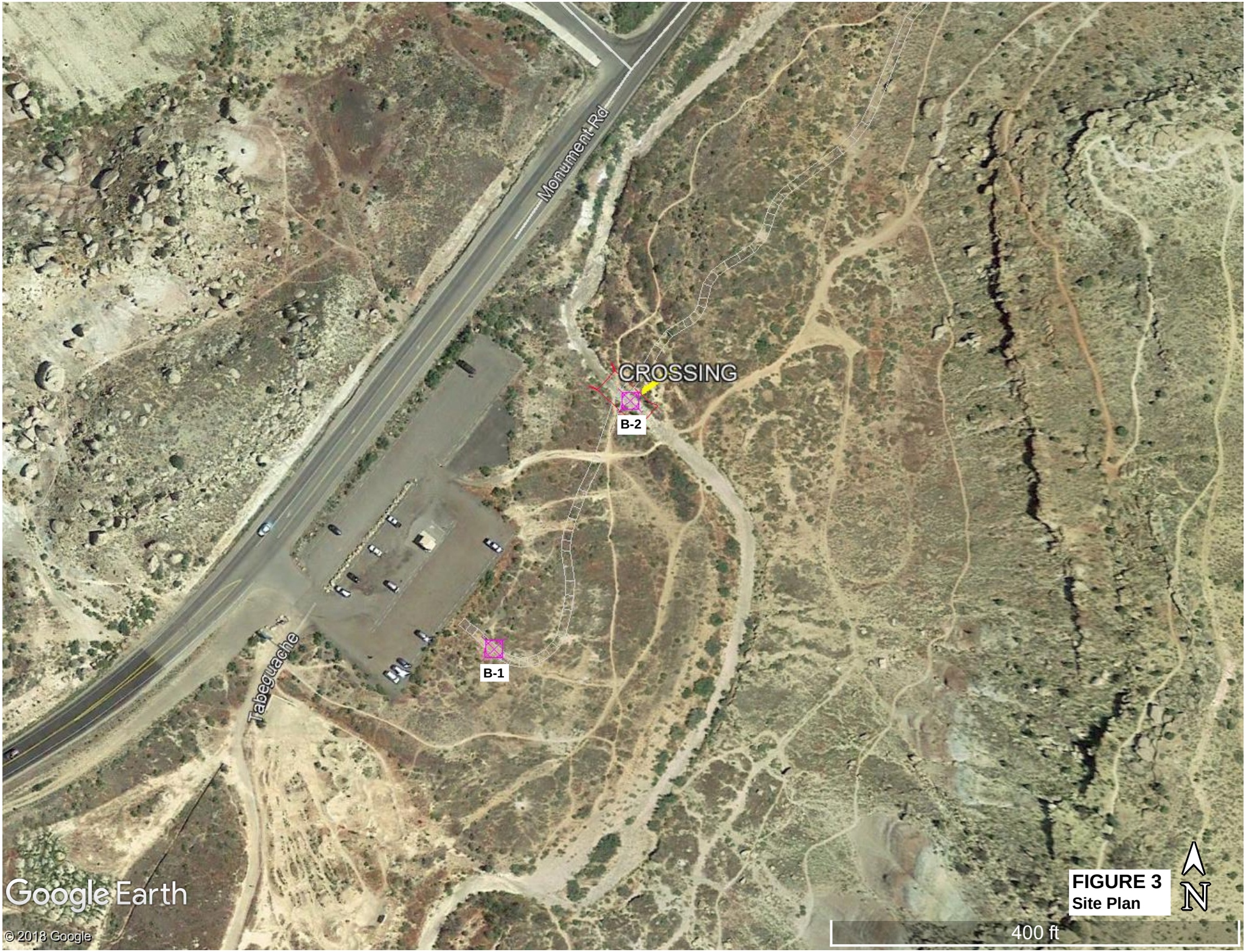


FIGURE 3
Site Plan

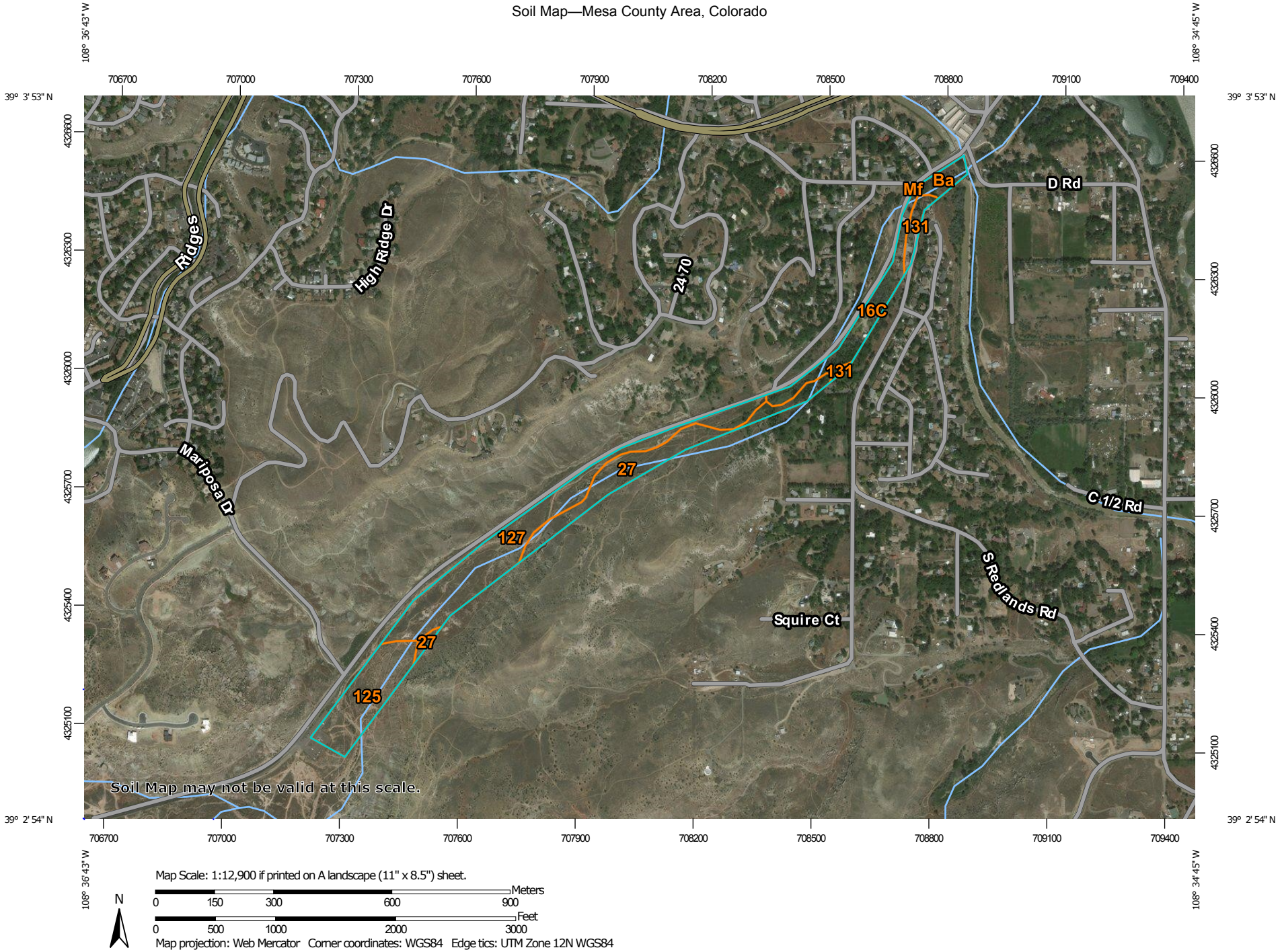
FIGURE 4
Site Plan

FIGURE 5
Site Plan

FIGURE 6
Site Plan

FIGURE 7
Site Plan

APPENDIX A
Soil Survey Data



Map Scale: 1:12,900 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 150 300 600 900

Feet
0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 9, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Mar 2, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
16C	Luster loamy fine sand, 3 to 8 percent slopes	5.7	13.9%
27	Rock outcrop-Biedsaw complex, 25 to 65 percent slopes, extremely bouldery	8.8	21.5%
125	Moffat sandy loam, 2 to 6 percent slopes	8.0	19.4%
127	Rock outcrop-Persayo-Hostage complex, 25 to 65 percent slopes, extremely bouldery	15.1	37.0%
131	Mack-Gyprockmesa complex, 1 to 5 percent slopes	1.6	4.0%
Ba	Massadona silty clay loam, 0 to 2 percent slopes	1.6	4.0%
Mf	Gyprockmesa cobbly clay loam, 5 to 12 percent slopes	0.0	0.0%
Totals for Area of Interest		**40.9**	**100.0%**

Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named, soils that are similar to the named components, and some minor components that differ in use and management from the major soils.

Most of the soils similar to the major components have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Some minor components, however, have properties and behavior characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

Mesa County Area, Colorado

16C—Luster loamy fine sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: k06j
Elevation: 5,400 to 6,500 feet

Mean annual precipitation: 9 to 12 inches
Mean annual air temperature: 49 to 54 degrees F
Frost-free period: 120 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Luster and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Luster

Setting

Landform: Hillslopes
Landform position (two-dimensional): Footslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from sandstone

Typical profile

Ap1 - 0 to 3 inches: loamy fine sand
Ap2 - 3 to 8 inches: fine sandy loam
AB - 8 to 12 inches: fine sandy loam
Bk1 - 12 to 32 inches: loamy fine sand
Bk2 - 32 to 45 inches: loamy fine sand
Bk3 - 45 to 60 inches: loamy fine sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.13 to 7.09 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy Foothills (R036XY310CO)
Hydric soil rating: No

27—Rock outcrop-Biedsaw complex, 25 to 65 percent slopes, extremely bouldery

Map Unit Setting

National map unit symbol: k08s
Elevation: 5,800 to 8,000 feet
Mean annual precipitation: 9 to 12 inches
Mean annual air temperature: 49 to 54 degrees F
Frost-free period: 120 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 55 percent
Biedsaw, extremely bouldery, and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Biedsaw, Extremely Bouldery

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Colluvium derived from sandstone and shale over residuum weathered from clayey shale

Typical profile

A - 0 to 16 inches: very cobbly clay loam
2C1 - 16 to 32 inches: silty clay
2C2 - 32 to 60 inches: silty clay

Properties and qualities

Slope: 25 to 65 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.07 to 0.21 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent

Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Ecological site: Steep Shallow Clay Loam - (Pinyon-Utah Juniper) (R036XY111CO)
Hydric soil rating: No

125—Moffat sandy loam, 2 to 6 percent slopes

Map Unit Setting
National map unit symbol: k07l
Elevation: 4,400 to 5,000 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition
Moffat and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Moffat

Setting
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from sandstone

Typical profile
Ap - 0 to 2 inches: sandy loam
Bw1 - 2 to 7 inches: fine sandy loam
Bw2 - 7 to 16 inches: fine sandy loam
Bk1 - 16 to 24 inches: sandy loam
Bk2 - 24 to 32 inches: sandy loam
Bk3 - 32 to 44 inches: loamy sand
Bk4 - 44 to 61 inches: sandy loam

Properties and qualities
Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: B
Ecological site: Desert Sandy Loam (Indian Ricegrass) (R034BY115UT)
Hydric soil rating: No

127—Rock outcrop-Persayo-Hostage complex, 25 to 65 percent slopes, extremely bouldery

Map Unit Setting

National map unit symbol: k07k
Elevation: 4,700 to 5,400 feet
Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 35 percent
Persayo, extremely bouldery, and similar soils: 30 percent
Hostage, extremely bouldery, and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Persayo, Extremely Bouldery

Setting

Landform: Pediments
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Cretaceous source residuum weathered from clayey shale

Typical profile

A - 0 to 2 inches: very parachannery clay loam
C - 2 to 11 inches: very parachannery silty clay loam
Cr - 11 to 60 inches: bedrock

Properties and qualities

Slope: 25 to 65 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.00 to 0.28 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 0.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: D
Ecological site: Semidesert Very Steep Loam (Shadscale) (R034BY248UT)
Hydric soil rating: No

Description of Hostage, Extremely Bouldery

Setting

Landform: Pediments
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Colluvium derived from sandstone and shale over cretaceous source residuum weathered from clayey shale

Typical profile

A - 0 to 4 inches: clay loam
Bw - 4 to 25 inches: clay loam
C1 - 25 to 50 inches: silty clay loam
C2 - 50 to 55 inches: silty clay loam
Cr - 55 to 72 inches: bedrock

Properties and qualities

Slope: 25 to 50 percent
Percent of area covered with surface fragments: 10.0 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.00 to 0.28 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C
Ecological site: Semidesert Very Steep Loam (Shadscale) (R034BY248UT)
Hydric soil rating: No

131—Mack-Gyprockmesa complex, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: k0df
Elevation: 4,360 to 4,990 feet
Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Mack and similar soils: 50 percent
Gyprockmesa and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mack

Setting

Landform: Fan remnants
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Slope alluvium over alluvium derived from sandstone and shale

Typical profile

Ap - 0 to 6 inches: loam
Btk1 - 6 to 14 inches: clay loam
Btk2 - 14 to 20 inches: clay loam
Btk3 - 20 to 50 inches: gravelly clay loam
Bk - 50 to 80 inches: gravelly clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 35 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C
Ecological site: Desert Loam (Shadscale) (R034BY106UT)
Hydric soil rating: No

Description of Gyprockmesa

Setting

Landform: Fan remnants
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy slope alluvium derived from shale over cobbly alluvium derived from sandstone and shale

Typical profile

Ap - 0 to 5 inches: clay loam
Btk1 - 5 to 10 inches: clay loam
Btk2 - 10 to 15 inches: clay loam
Btk3 - 15 to 23 inches: cobbly clay loam
2Bky1 - 23 to 35 inches: very cobbly clay loam
2Bky2 - 35 to 44 inches: cobbly clay loam
2Bky3 - 44 to 70 inches: stony loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Gypsum, maximum in profile: 35 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0

Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C
Ecological site: Desert Loam (Shadscale) (R034BY106UT)
Hydric soil rating: No

Ba—Massadona silty clay loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: k06n
Elevation: 4,490 to 4,920 feet
Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Massadona and similar soils: 70 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Massadona

Setting

Landform: Fan remnants
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Cretaceous source alluvium derived from clayey shale

Typical profile

A - 0 to 2 inches: silty clay loam
Bw - 2 to 12 inches: silty clay
Bkyz - 12 to 24 inches: silty clay
BCkyz1 - 24 to 48 inches: fine sandy loam
BCkyz2 - 48 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.07 to 0.21 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 2 percent

Salinity, maximum in profile: Moderately saline to strongly saline (10.0 to 30.0 mmhos/cm)
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups
Land capability classification (irrigated): 7s
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C
Ecological site: Desert Clay (Castlevalley saltbush) (R034BY103UT)
Hydric soil rating: No

Mf—Gyprockmesa cobbly clay loam, 5 to 12 percent slopes

Map Unit Setting
National map unit symbol: k0ct
Elevation: 4,490 to 4,890 feet
Mean annual precipitation: 6 to 9 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition
Gyprockmesa and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gyprockmesa

Setting
Landform: Strath terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy slope alluvium derived from shale over cobbly alluvium derived from sandstone and shale

Typical profile
Ap - 0 to 5 inches: cobbly clay loam
Btk1 - 5 to 10 inches: clay loam
Btk2 - 10 to 15 inches: clay loam
Btk3 - 15 to 23 inches: cobbly clay loam
2Bky1 - 23 to 35 inches: very cobbly clay loam
2Bky2 - 35 to 44 inches: cobbly clay loam
2Bky3 - 44 to 70 inches: stony loam

Properties and qualities
Slope: 5 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Gypsum, maximum in profile: 35 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: C
Ecological site: Desert Loam (Shadscale) (R034BY106UT)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 9, Sep 10, 2018

Paths, Trails, and Golf Fairways

The soils of the survey area are rated in this table according to limitations that affect their suitability for paths, trails, and golf fairways. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

Paths and trails for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

Off-road motorcycle trails require little or no site preparation. They are not covered with surfacing material or vegetation. Considerable compaction of the soil material is likely. The ratings are based on the soil properties that influence erodibility, trafficability, dustiness, and the ease of revegetation. These properties are stoniness, slope, depth to a water table, ponding, flooding, and texture of the surface layer.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. Irrigation is not considered in the ratings. The ratings are based on the soil properties that affect plant growth and trafficability after vegetation is established. The properties that affect plant growth are reaction; depth to a water table; ponding; depth to bedrock or a cemented pan; the available water capacity in the upper 40 inches; the content of salts, sodium, or calcium carbonate; and sulfidic materials. The properties that affect trafficability are flooding, depth to a water table, ponding, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer. The suitability of the soil for traps, tees, roughs, and greens is not considered in the ratings.

Report—Paths, Trails, and Golf Fairways

[Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the potential limitation. The table shows only the top five limitations for any given soil. The soil may have additional limitations]

Paths, Trails, and Golf Fairways–Mesa County Area, Colorado							
Map symbol and soil name	Pct. of map unit	Golf fairways		Off-road motorcycle trails		Paths and trails	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
16C—Luster loamy fine sand, 3 to 8 percent slopes							
Luster	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Low exchange capacity	0.75	Too sandy	0.92	Too sandy	0.92
27—Rock outcrop-Biedsaw complex, 25 to 65 percent slopes, extremely bouldery							
Rock outcrop	55	Not rated		Not rated		Not rated	
Biedsaw, extremely bouldery	30	Very limited		Very limited		Very limited	
		Slope	1.00	Large stones content	1.00	Large stones content	1.00
		Large stones content	1.00	Slope	1.00	Slope	1.00
		Dusty	0.42	Dusty	0.42	Dusty	0.42
		Gravel content	0.13				

Paths, Trails, and Golf Fairways–Mesa County Area, Colorado							
Map symbol and soil name	Pct. of map unit	Golf fairways		Off-road motorcycle trails		Paths and trails	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
87—Persayo-Blackston complex, 6 to 45 percent slopes							
Persayo	65	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Water erosion	1.00	Slope	1.00
		Slope	1.00	Dusty	0.50	Water erosion	1.00
		Droughty	0.87	Slope	0.01	Dusty	0.50
		Dusty	0.50				
		Low exchange capacity	0.50				
Blackston	25	Very limited		Somewhat limited		Somewhat limited	
		Slope	1.00	Dusty	0.19	Dusty	0.19
		Droughty	0.75			Slope	0.02
		Gravel content	0.39				
		Dusty	0.19				
125—Moffat sandy loam, 2 to 6 percent slopes							
Moffat	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Low exchange capacity	0.50	Dusty	0.04	Dusty	0.04
		Dusty	0.04				
127—Rock outcrop-Persayo-Hostage complex, 25 to 65 percent slopes, extremely bouldery							
Rock outcrop	35	Not rated		Not rated		Not rated	
Persayo, extremely bouldery	30	Very limited		Very limited		Very limited	
		Slope	1.00	Large stones content	1.00	Large stones content	1.00
		Droughty	1.00	Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Dusty	0.50	Dusty	0.50
		Dusty	0.50				
Hostage, extremely bouldery	25	Very limited		Very limited		Very limited	
		Slope	1.00	Large stones content	1.00	Large stones content	1.00
		Dusty	0.36	Slope	0.92	Slope	1.00
				Dusty	0.36	Dusty	0.36

Paths, Trails, and Golf Fairways–Mesa County Area, Colorado							
Map symbol and soil name	Pct. of map unit	Golf fairways		Off-road motorcycle trails		Paths and trails	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
131—Mack-Gyprockmesa complex, 1 to 5 percent slopes							
Mack	50	Somewhat limited		Somewhat limited		Somewhat limited	
		Dusty	0.38	Dusty	0.38	Dusty	0.38
Gyprockmesa	35	Somewhat limited		Somewhat limited		Somewhat limited	
		Dusty	0.35	Dusty	0.35	Dusty	0.35
Ba—Massadona silty clay loam, 0 to 2 percent slopes							
Massadona	70	Somewhat limited		Somewhat limited		Somewhat limited	
		Dusty	0.50	Dusty	0.50	Dusty	0.50
Mf—Gyprockmesa cobbly clay loam, 5 to 12 percent slopes							
Gyprockmesa	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Large stones content	0.99	Dusty	0.35	Dusty	0.35
		Dusty	0.35	Large stones content	0.01	Large stones content	0.01
		Slope	0.04				

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 9, Sep 10, 2018

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Report—Soil Features

Soil Features–Mesa County Area, Colorado									
Map symbol and soil name	**Restrictive Layer**				**Subsidence**		**Potential for frost action**	**Risk of corrosion**	
	Kind	**Depth to top**	**Thickness**	**Hardness**	**Initial**	**Total**		**Uncoated steel**	**Concrete**
		Low-RV-High	*Range*		*Low-High*	*Low-High*			
		In	*In*		*In*	*In*			
16C—Luster loamy fine sand, 3 to 8 percent slopes									
Luster		—	—		0	0	Low	Moderate	Low
27—Rock outcrop-Biedsaw complex, 25 to 65 percent slopes, extremely bouldery									
Rock outcrop		—	—		—	—			
Biedsaw, extremely bouldery		—	—		0	0	Low	High	Moderate
125—Moffat sandy loam, 2 to 6 percent slopes									
Moffat		—	—		0	0	Moderate	Moderate	Low

Soil Features–Mesa County Area, Colorado									
Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		Low-RV-High	*Range*		*Low-High*	*Low-High*			
127—Rock outcrop-Persayo-Hostage complex, 25 to 65 percent slopes, extremely bouldery									
Rock outcrop		—	—		—	—			
Persayo, extremely bouldery	Paralithic bedrock	10-11-20	—	Weakly cemented	0	0	Moderate	High	High
Hostage, extremely bouldery	Paralithic bedrock	40-55-60	—	Weakly cemented	0	0	Moderate	Moderate	Low
131—Mack-Gyprockmesa complex, 1 to 5 percent slopes									
Mack		—	—		0	0	Moderate	Moderate	Low
Gyprockmesa		—	—		0	0	Moderate	Moderate	High
Ba—Massadona silty clay loam, 0 to 2 percent slopes									
Massadona		—	—		0	0	Low	High	High
Mf—Gyprockmesa cobbly clay loam, 5 to 12 percent slopes									
Gyprockmesa		—	—		0	0	Moderate	Moderate	High

Data Source Information

Soil Survey Area: Mesa County Area, Colorado
Survey Area Data: Version 9, Sep 10, 2018

APPENDIX B
Typed Boring Logs

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-1

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION _____ **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		COBBLES and BOULDERS in a Silty SAND with Gravel Matrix (SM), red, moist, dense										
2.5		*** Lab Classified SS1	SS 1	83	25-17-24 (41)			2	NP	NP	NP	13
5.0												
7.5												
			SS 2	61	24-27							
10.0												
12.5			SS 3	83	52							
15.0		Bottom of hole at 15.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-2

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND with GRAVEL (sm), red, moist, loose										
		BENTONITE, white to green, soft, highly weathered										
2.5			SS 1	0	6-6-10 (16)			34	108	34	**74**	
5.0												
7.5			SS 2	100	6-7-12 (19)							
10.0		Bottom of hole at 10.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-3

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION _____ **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND with Gravel (sm), tan, moist, medium dense										
2.5			SS 1	78	6-7-8 (15)							
5.0												
7.5		COBBLES and BOULDERS in a Silty SAND with Gravel Matrix (sm), tan, moist, dense to very dense	SS 2	58	24-26							
10.0		Bottom of hole at 10.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-4

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND with Gravel (sm), tan, moist, loose										
			SS 1	89 (39)	5-4							
2.5												
5.0		*** Auger refusal on SANSTONE bedrock										
		Bottom of hole at 6.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-5

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND with Gravel (sm), tan, moist, medium dense										
			SS 1	78	14-11-12 (23)							
2.5												
		SANDSTONE, tan, hard, moderately weathered										
5.0		*** Auger refusal										
		Bottom of hole at 5.5 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-6

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION _____ **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND with Gravel (sm), tan, moist, medium dense										
2.5			SS 1	83	21-12-8 (20)							
		BENTONITE, grey to green, medium hard, highly weathered										
5.0												
7.5			SS 2	100	25-13							
		*** Auger refusal on SANDSTONE bedrock										
		Bottom of hole at 9.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-7

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING 2.0 ft
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING 2.0 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		COBBLES and BOULDERS in a Silty SAND Matrix (sm), tan, moist to wet, very dense										
2.5												
5.0		CLAYSTONE, red, medium hard, highly weathered	SS 1	67	17-36			23	34	21	13	
7.5												
10.0		Bottom of hole at 10.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-8

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION _____ **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES _____
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND (sm), tan, moist, medium dense										
2.5			SS 1	78	8-8-6 (14)							
5.0												
7.5		BENTONITE, grey to green, medium hard, highly weathered	SS 2	100	50							
10.0		Bottom of hole at 10.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-9

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING dry
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING dry
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND (sm), tan, moist, medium dense										
2.5			MC 1	94	10-8-7 (15)		100	2				
5.0		*** Auger refusal on SANDSTONE bedrock										
		Bottom of hole at 6.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-10

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING 2.0 ft
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING 2.0 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND (sm), tan, moist to wet, very loose										
2.5			MC 1	83	1-1-1 (2)		98	19				
5.0		Sandy GRAVEL (gws), brown, wet, medium dense										
7.5			SS 1	72	21-14-16 (30)							
10.0												
12.5												
		*** Auger refusal on SANDSTONE bedrock										
		Bottom of hole at 14.5 feet.										

GEOTECH BH COLUMNS 00208-0087MONUMENT ROAD TRAIL.GPJ GINT US LAB.GDT 10/5/18

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-11

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING 3.0 ft
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING 3.0 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Silty SAND with Gravel (sm), tan, moist, loose to medium dense										
			SS 1	67	5-3-2 (5)							
5			SS 2	94	4-8-7 (15)							
10		Sandy GRAVEL (gws), brown, wet, very dense	SS 3	42	19-39							
15		Silty SAND with Gravel (gws), brown, wet, loose	SS 4	72	2-4-3 (7)							
20		SANDSTONE, tan, hard, moderately weathered										
		*** Auger refusal										
		Bottom of hole at 23.0 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-13

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING 3.5 ft
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING 3.5 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		Silty SAND (sm), tan, moist to wet, very loose										
2.5			SS 1	50	3-2-1 (3)							
5.0												
7.5		Sandy GRAVEL with tarec cobbles (gws), tan, wet, medium dense to loose	SS 2	89	4-13-15 (28)							
10.0												
12.5												
15.0			SS 3	72	5-3-5 (8)							
		Bottom of hole at 15.5 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-14

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING 14.0 ft
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING 14.0 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Sandy GRAVEL (gws), brown, moist to wet, medium dense to dense										
			SS 1	44	10-7-16 (23)							
5												
			SS 2	89	5-6-9 (15)							
10												
			SS 3	89	8-4-4 (8)							
15												
			SS 4	67	10-16-13 (29)							
20												
25												
30		SANDSTONE tan, hard, highly weathered *** Auger refusal Bottom of hole at 30.5 feet.										

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

BORING NUMBER B-15

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO
DATE STARTED 8/3/18 **COMPLETED** 8/7/18
GROUND ELEVATION ---- **HOLE SIZE** 4-inches
DRILLING CONTRACTOR S. McKracken
GROUND WATER LEVELS:
DRILLING METHOD Simco 2000 Track Rig
AT TIME OF DRILLING 7.0 ft
LOGGED BY SD **CHECKED BY** MAB
AT END OF DRILLING 7.0 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Silty SAND with trace Cobbles and Boulders (FILL), brown, moist, dense	SS 1	100	50/3"							
5		Silty Clayey SAND with trace Cobbles and Boulders (sc), brown, moist to wet,	SS 2	67	6-25-17 (42)							
10			SS 3	0	50/1"							
15		Sandy GRAVEL (gws), tan, wet, medium dense	SS 4	67	5-8-12 (20)							
20												
25		*** Auger refusal on SANDSTONE bedrock Bottom of hole at 27.0 feet.										

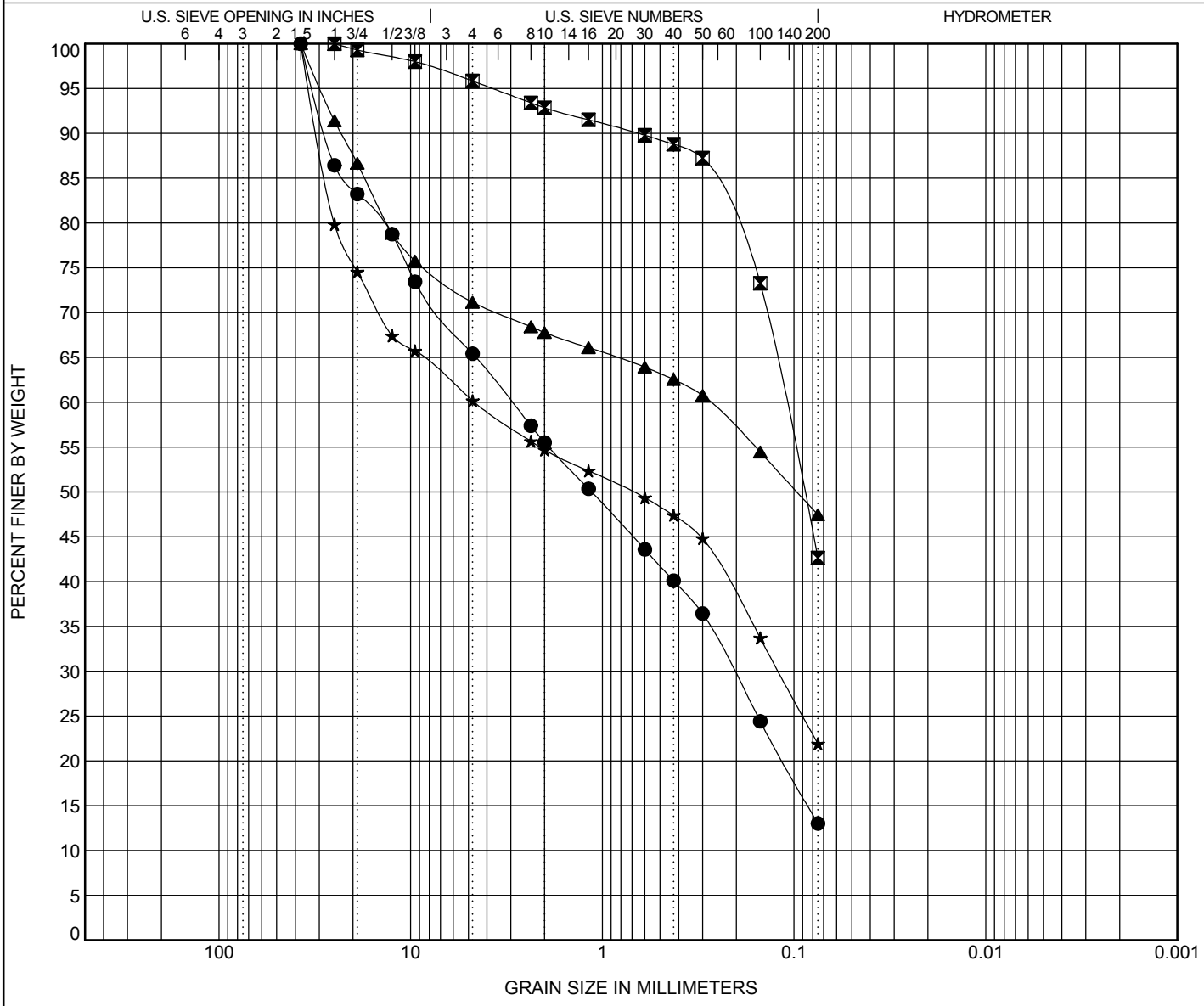
APPENDIX C
Laboratory Testing Results

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

GRAIN SIZE DISTRIBUTION

CLIENT City of Grand Junction **PROJECT NAME** Monument Road Trail

PROJECT NUMBER 00208-0087 **PROJECT LOCATION** Grand Junction, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-1, SS1	8/2018	SILTY SAND with GRAVEL(SM)	NP	NP	NP		
⊠	Composite	8/2018	SILTY SAND(SM)	22	21	1		
▲	HS-1, GB1	8/2018	SILTY, CLAYEY GRAVEL with SAND(GC-GM)	26	19	7		
★	HS-2, GB1	8/2018	SILTY, CLAYEY GRAVEL with SAND(GC-GM)	23	17	6		

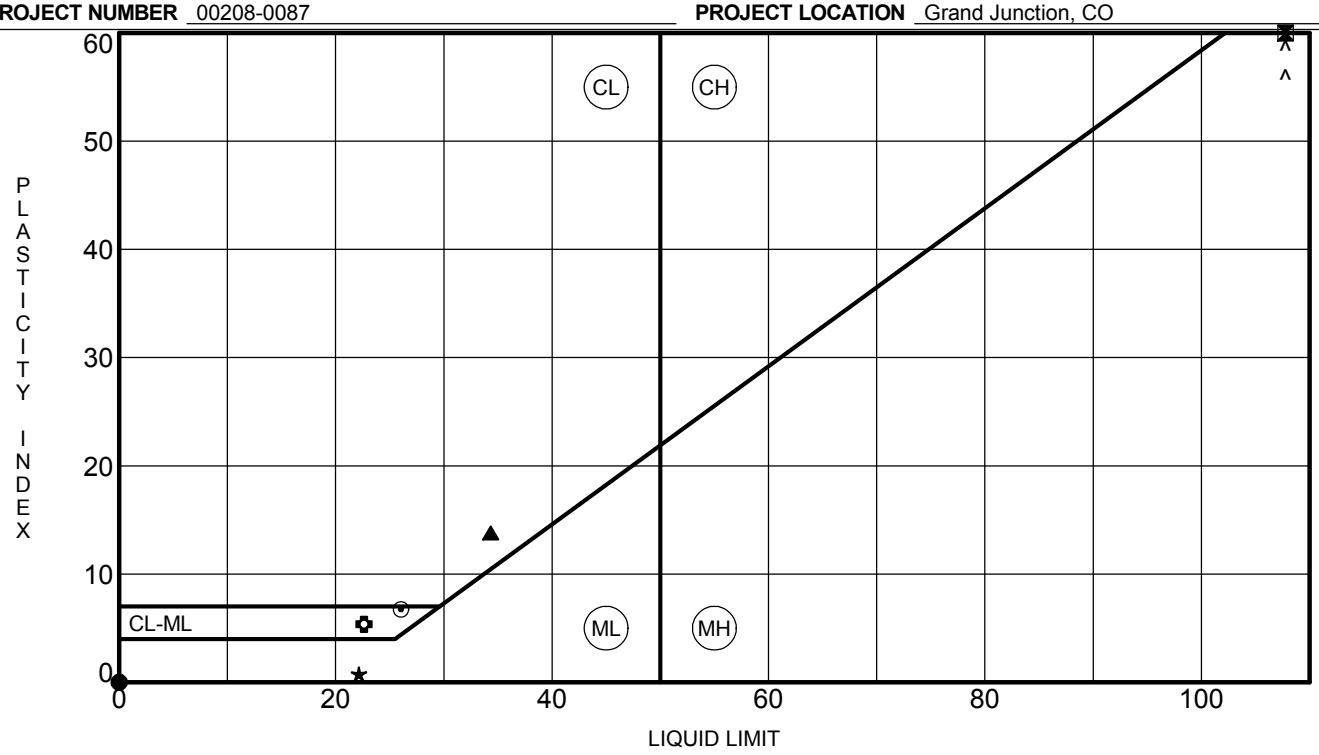
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1, SS1	8/2018	37.5	2.964	0.207		34.6	52.4	13.0	
⊠	Composite	8/2018	25	0.111			4.2	53.2	42.6	
▲	HS-1, GB1	8/2018	37.5	0.276			28.9	23.7	47.5	
★	HS-2, GB1	8/2018	37.5	4.629	0.121		39.8	38.3	21.9	

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

ATTERBERG LIMITS' RESULTS

CLIENT City of Grand Junction **PROJECT NAME** Monument Road Trail

PROJECT NUMBER 00208-0087 **PROJECT LOCATION** Grand Junction, CO



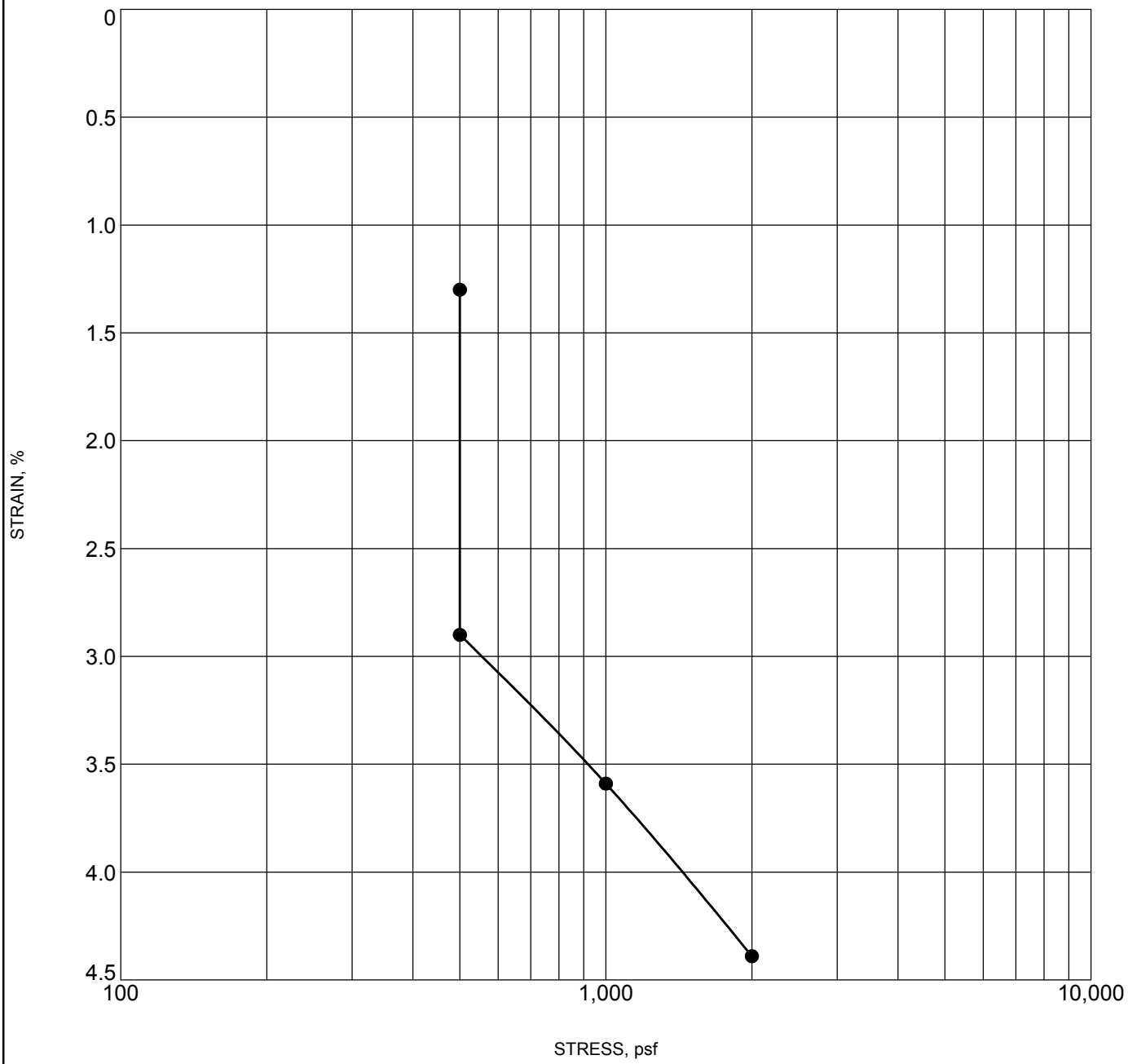
	Specimen Identification		LL	PL	PI	#200	Classification
●	B-1, SS1	8/2018	NP	NP	NP	13	SILTY SAND with GRAVEL(SM)
⧓	B-2, SS2	8/2018	108	34	74		
▲	B-7, SS1	8/2018	34	21	13		
★	Composite	8/2018	22	21	1	43	SILTY SAND(SM)
⊙	HS-1, GB1	8/2018	26	19	7	47	SILTY, CLAYEY GRAVEL with SAND(GC-GM)
✿	HS-2, GB1	8/2018	23	17	6	22	SILTY, CLAYEY GRAVEL with SAND(GC-GM)

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

CONSOLIDATION TEST

CLIENT City of Grand Junction **PROJECT NAME** Monument Road Trail

PROJECT NUMBER 00208-0087 **PROJECT LOCATION** Grand Junction, CO



Specimen Identification		Classification	γ_d	MC%
● **B-9**	**2.0**		**97**	**2**

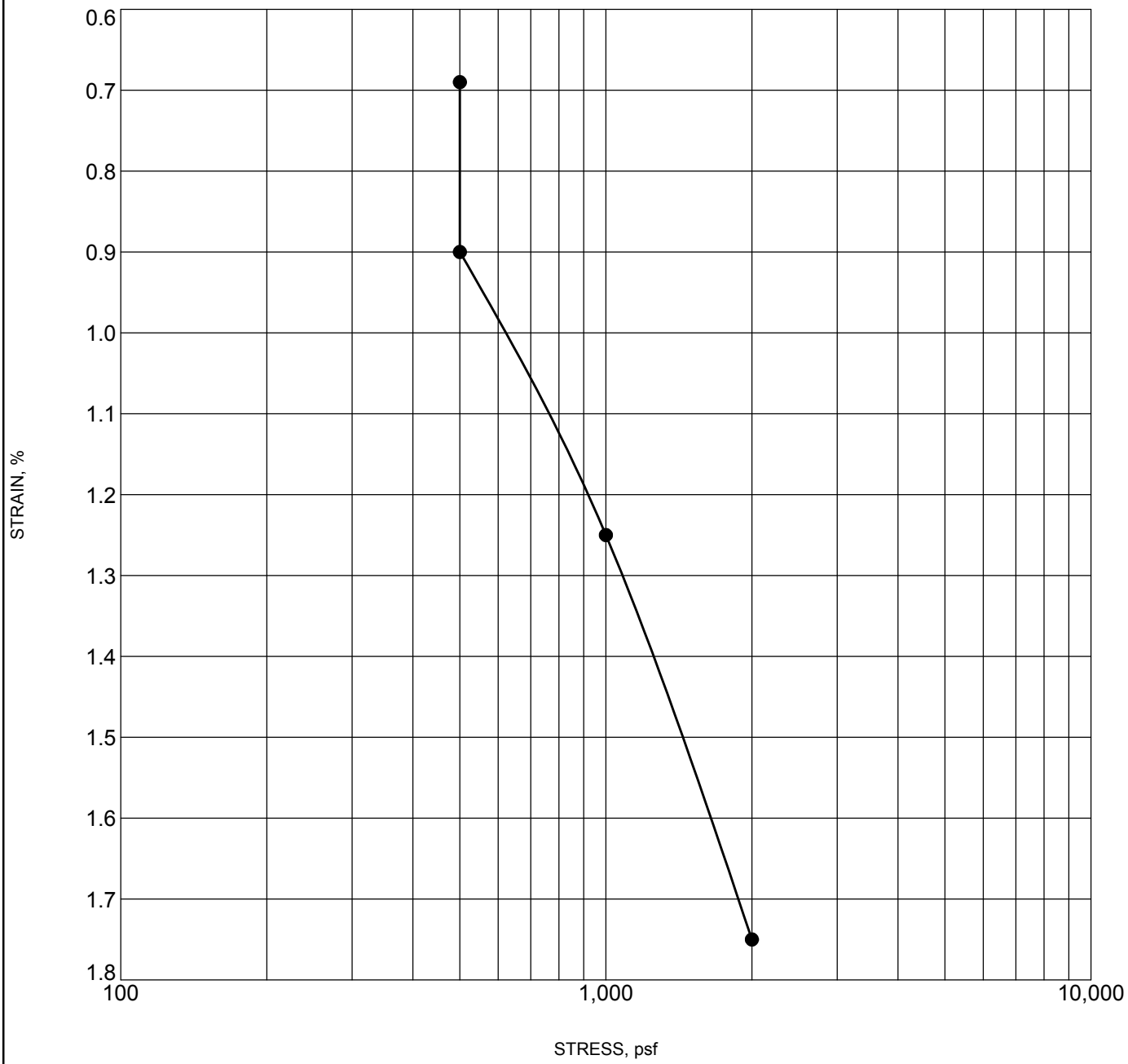
CONSOL STRAIN 00208-0087MONUMENT ROAD TRAIL.GPJ GINT US LAB.GDT 10/4/18

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

CONSOLIDATION TEST

CLIENT City of Grand Junction **PROJECT NAME** Monument Road Trail

PROJECT NUMBER 00208-0087 **PROJECT LOCATION** Grand Junction, CO



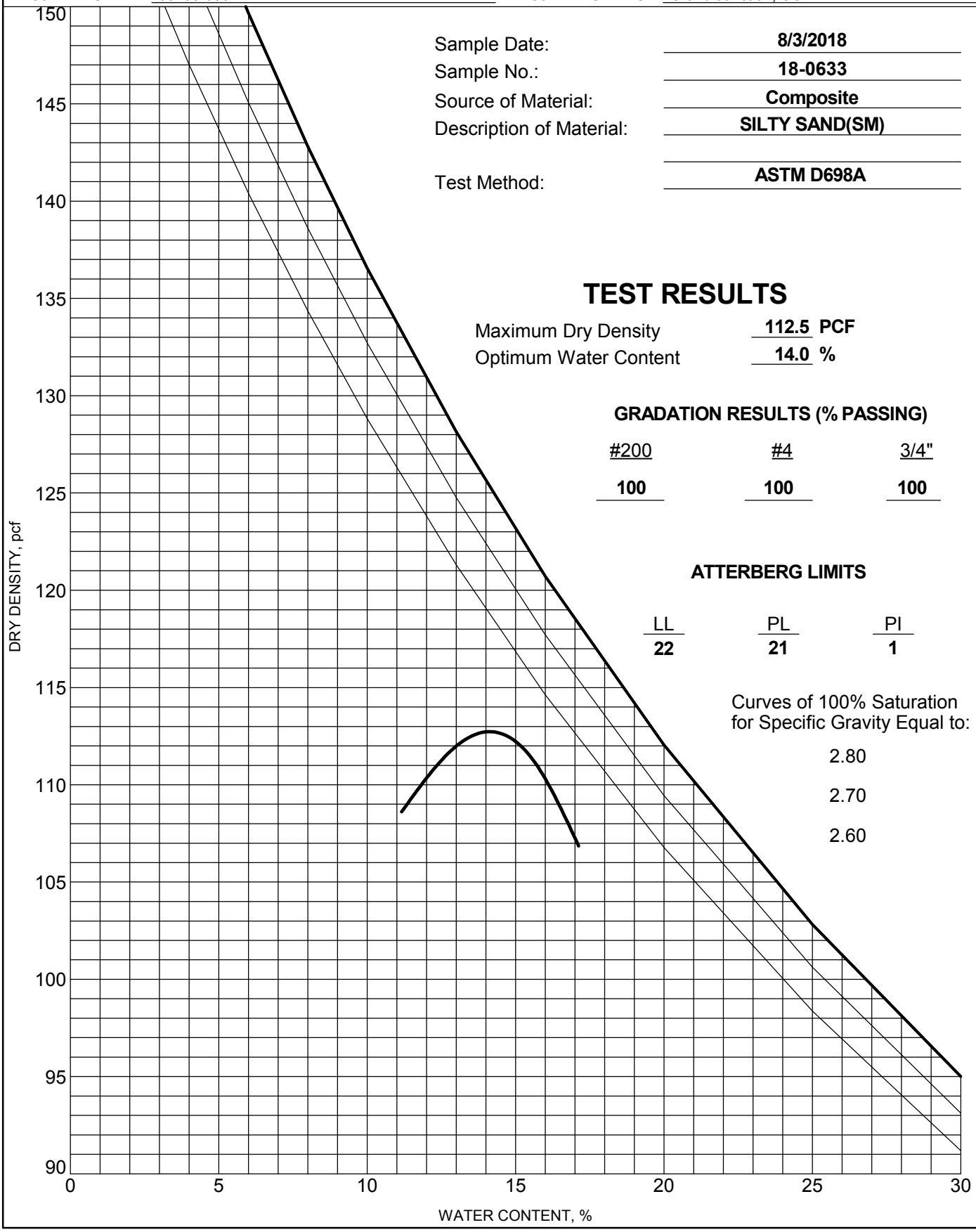
Specimen Identification		Classification	γ_d	MC%
● **B-10**	**2.0**		**98**	**19**

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

MOISTURE-DENSITY RELATIONSHIP

CLIENT City of Grand Junction **PROJECT NAME** Monument Road Trail

PROJECT NUMBER 00208-0087 **PROJECT LOCATION** Grand Junction, CO



Sample Date: **8/3/2018**

Sample No.: **18-0633**

Source of Material: **Composite**

Description of Material: **SILTY SAND(SM)**

Test Method: **ASTM D698A**

TEST RESULTS

Maximum Dry Density **112.5** PCF

Optimum Water Content **14.0** %

GRADATION RESULTS (% PASSING)

#200	#4	3/4"
100	100	100

ATTERBERG LIMITS

LL	PL	PI
22	21	1

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

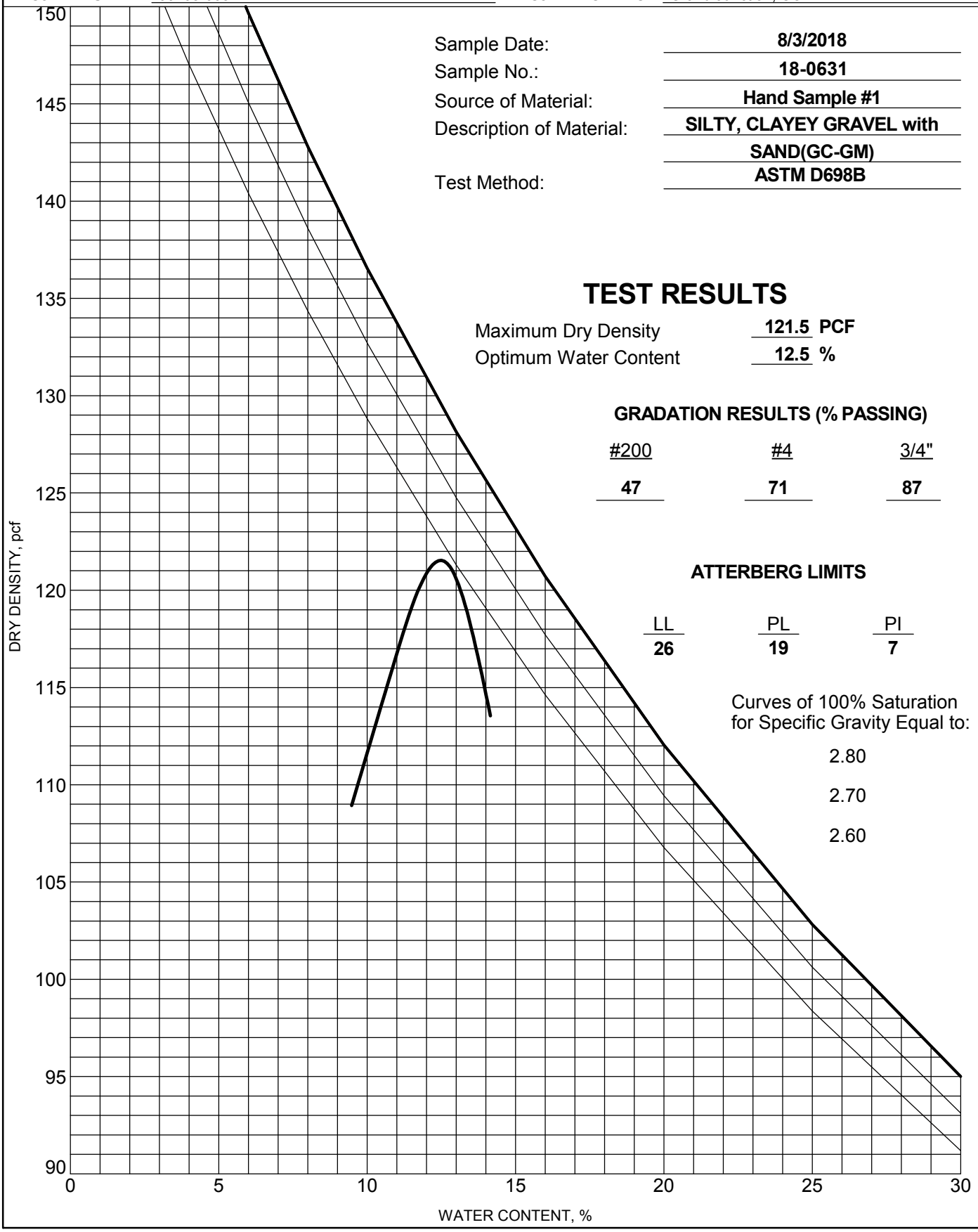
2.70

2.60

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

MOISTURE-DENSITY RELATIONSHIP

CLIENT City of Grand Junction
PROJECT NAME Monument Road Trail
PROJECT NUMBER 00208-0087
PROJECT LOCATION Grand Junction, CO



Sample Date: **8/3/2018**
Sample No.: **18-0631**
Source of Material: **Hand Sample #1**
Description of Material: **SILTY, CLAYEY GRAVEL with SAND(GC-GM)**
Test Method: **ASTM D698B**

TEST RESULTS

Maximum Dry Density **121.5** PCF
Optimum Water Content **12.5** %

GRADATION RESULTS (% PASSING)

#200	#4	3/4"
47	71	87

ATTERBERG LIMITS

LL	PL	PI
26	19	7

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

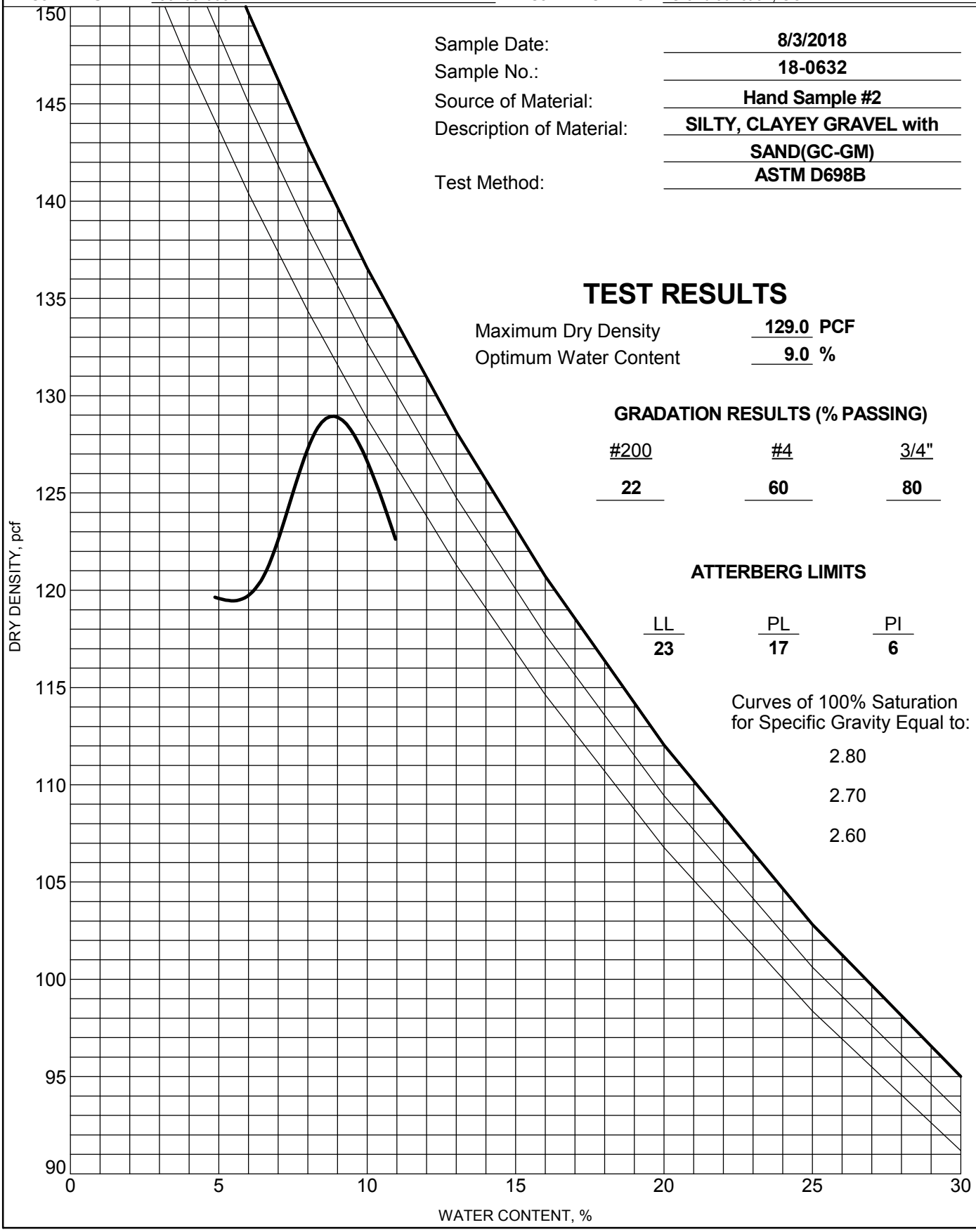
2.60

Huddleston-Berry Engineering & Testing, LLC
640 White Avenue, Unit B
Grand Junction, CO 81501
970-255-8005
970-255-6818

MOISTURE-DENSITY RELATIONSHIP

CLIENT City of Grand Junction **PROJECT NAME** Monument Road Trail

PROJECT NUMBER 00208-0087 **PROJECT LOCATION** Grand Junction, CO



Sample Date: **8/3/2018**

Sample No.: **18-0632**

Source of Material: **Hand Sample #2**

Description of Material: **SILTY, CLAYEY GRAVEL with SAND(GC-GM)**

Test Method: **ASTM D698B**

TEST RESULTS

Maximum Dry Density **129.0** PCF

Optimum Water Content **9.0** %

GRADATION RESULTS (% PASSING)

#200	#4	3/4"
22	60	80

ATTERBERG LIMITS

LL	PL	PI
23	17	6

Curves of 100% Saturation for Specific Gravity Equal to:

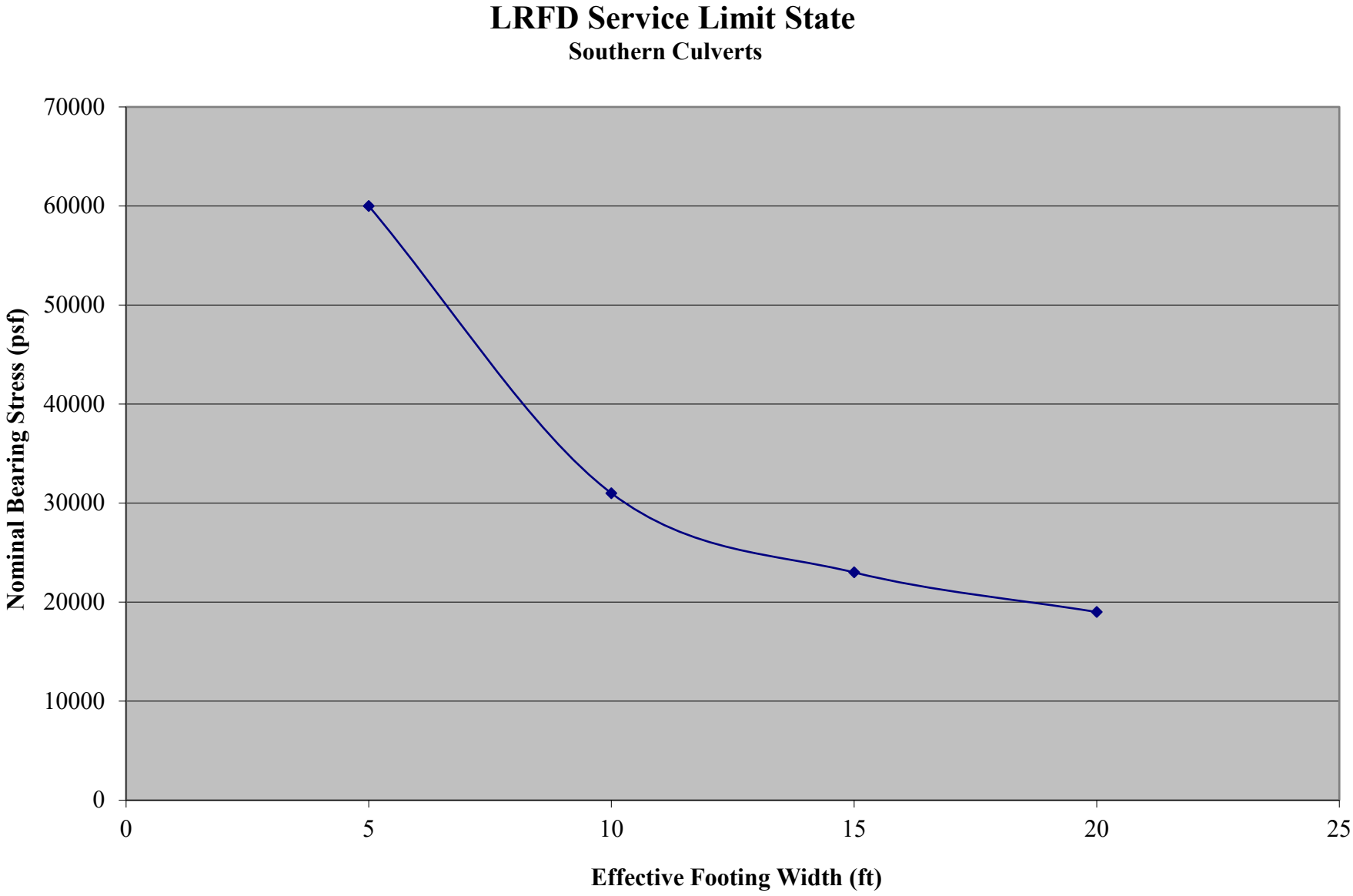
2.80

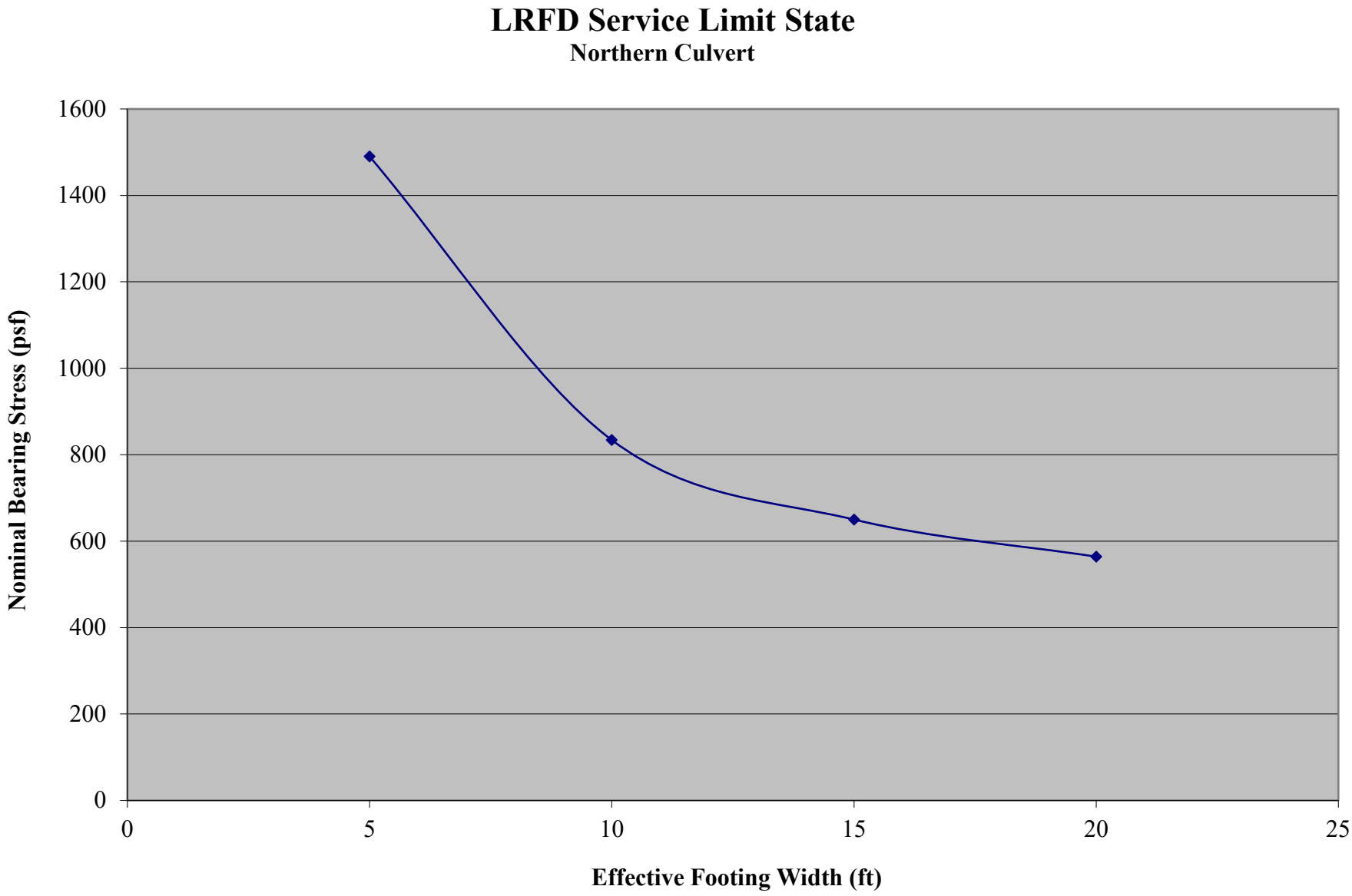
2.70

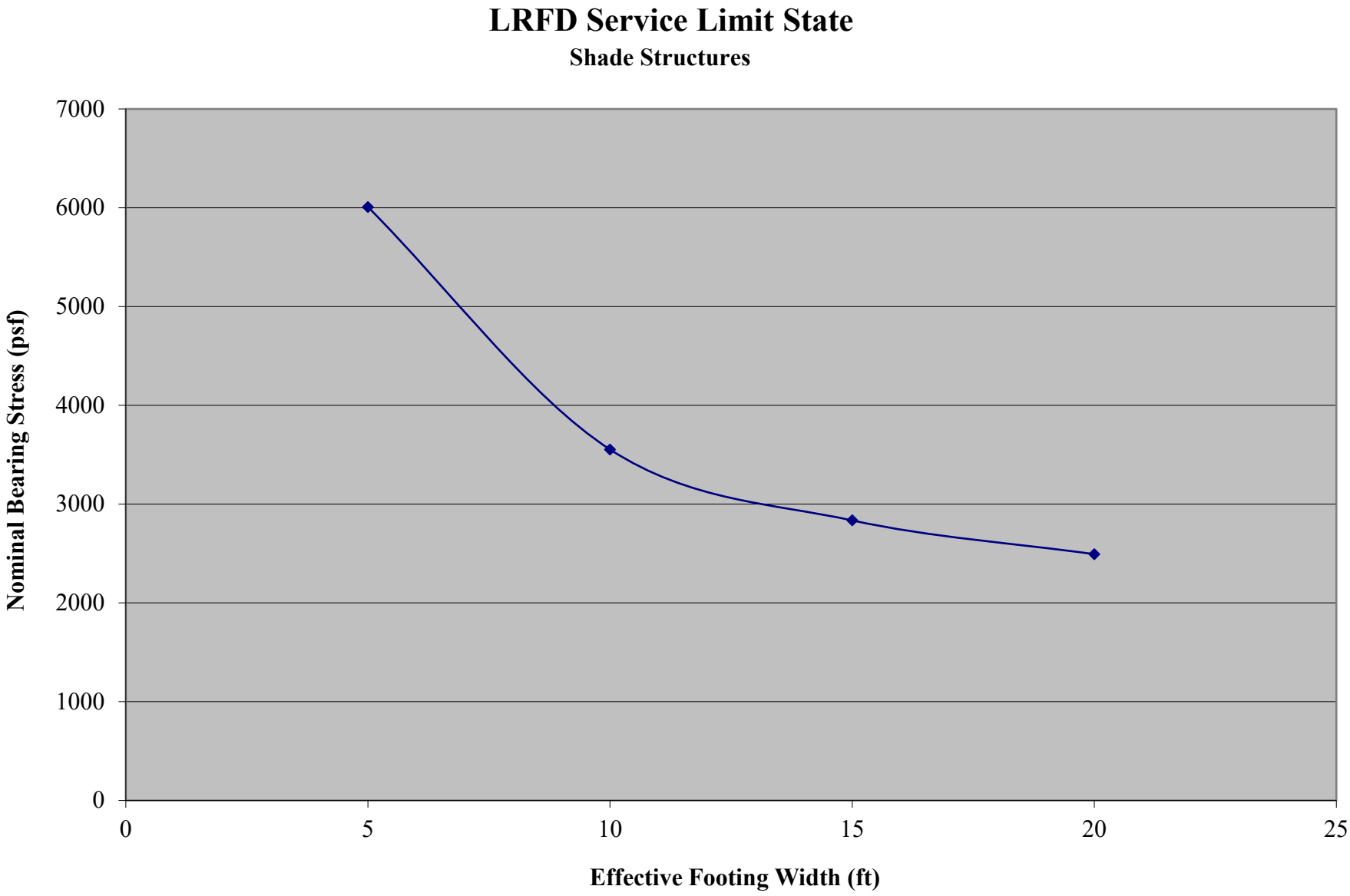
2.60

COMPACTION 00208-0087MONUMENT ROAD TRAIL.GPJ GINT US LAB.GDT 10/4/18

APPENDIX D
Bearing Resistance for Service Limit State


LRFD Service Limit State
Southern Culverts
70000
60000
50000
40000
30000
20000
10000
0
Nominal Bearing Stress (psf)
0
5
10
15
20
25
Effective Footing Width (ft)


LRFD Service Limit State
Northern Culvert
Nominal Bearing Stress (psf)
1600
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
Effective Footing Width (ft)


LRFD Service Limit State
Shade Structures
Nominal Bearing Stress (psf)
7000
6000
5000
4000
3000
2000
1000
0
0
5
10
15
20
25
Effective Footing Width (ft)