

GEOTECHNICAL DESIGN REPORT

**ARROYO CROSSING
TRACT E &
LOTS 20, 26, 29, 30, 37, 46 & 47
GRAND COUNTY, UTAH**

August 6, 2023





August 6, 2023

Mr. Ben Riley
Housing Authority of Southeastern Utah
321 E Center St.
Moab, UT 84532

Mr. Riley,

We prepared this design-level geotechnical report for Tract E and Lots 20, 26, 29, 30, 37, 46, and 47 of the Arroyo Crossing development in Grand County, Utah in general conformance with the 2021 International Building Council (IBC). The following design recommendations and construction considerations were prepared based on findings from the field studies and subsequent laboratory testing. Based on our findings, the proposed development is feasible provided the following recommendations and considerations are followed.

We appreciate the opportunity of providing this service for you. If there are any questions or comments related to the information contained within, please call and we will be glad to discuss them with you.

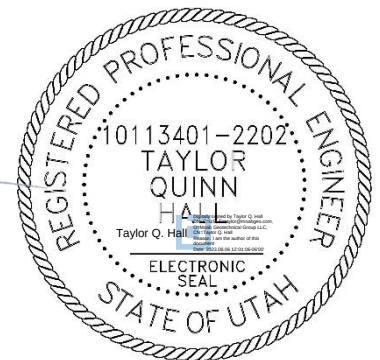
Sincerely,

A handwritten signature in purple ink that reads "Charlotte Van Voast".

Charlotte Van Voast, PE
Project Engineer

A handwritten signature in blue ink that reads "Taylor Hall".

Taylor Hall, PE
Principal



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1 INTRODUCTION

This report provides design recommendations and construction considerations for Tract E and Lots 20, 26, 29, 30, 37, 46, and 47 of the Arroyo Crossing development (the Project) located in Grand County, Utah. The recommendations are based on the findings from the field investigation and subsequent laboratory testing. Additionally, to support this effort, we utilized studies that have been performed for nearby lots at the Arroyo Crossing development. Should the structures and proposed site development change from what has been detailed in this report, Moab Geotechnical Group (MGG) should be contacted immediately to determine the relevance of the following recommendations and considerations.

1.1 Scope of Services

The following scope of services were performed in accordance with the Professional Services Agreement, signed and dated May 23, 2023.

- Retain the services of an excavation subcontractor to dig test pits throughout the property,
- A licensed Professional Engineer logged the test pits, classified soil samples in the field, and collected representative soil samples for supplemental testing,
- Representative soil samples were delivered to an independent geotechnical engineering laboratory for further testing and classification,
- Findings from the field investigation and laboratory testing were used to quantify potential geological hazards that may exist at the site, and
- This report was prepared to summarize the recommendations and construction considerations for the Project.

Additional services to support the construction of the project are discussed later in this report for your consideration. Experience has shown these additional services help ensure the following recommendations are consistent with findings during construction. Subsurface conditions are inherently heterogenous and often change over short distances.

1.2 Project Description

Based on plans provided (Architectural Squared, 2023) and discussions with the client, the development of Tract E will include 26 townhome lots, specifically three 6-plexes and two 4-plexes. Plans indicate that the townhouses will be 2 stories with a covered carport at grade and living space above. Additionally, single family residences are planned for Lots 20, 26, 29, 30, 37, 46 and 47. The single-family residences are assumed to be 1- to 2-stories with an at-grade first floor (i.e., no basement), with attached garages planned for some residences.

A site map of the lots explored is included in Figures 2a and 2b. Parcel IDs and Address correlated to each lot are listed in Exhibit 1-1.

Exhibit 1-1 Summary of Lots

Lot #	Parcel ID	Address
Tract E	02-0ARR-0204	2097 Golden Eagle Way
Lot 20	02-0ARR-0020	2120 Golden Eagle Way
Lot 26	02-0ARR-0026	2145 Nighthawk Ln
Lot 29	02-0ARR-0029	2113 Nighthawk Ln
Lot 30	02-0ARR-0030	2103 Nighthawk Ln
Lot 37	02-0ARR-0037	2043 Nighthawk Ln
Lot 46	02-0ARR-0046	2126 Bonnies Way
Lot 47	02-0ARR-0047	2136 Bonnies Way

1.3 Existing and Historic Information

Historic aerials of the area dating as far back as 1944 were reviewed (www.historicaerials.com). Figures 3 and 4 illustrate the boundary of the Project with 1953 and 1997 historic aerial overlays.

The 1953 historic aerial shows several drainages running northeast across the property, toward Pack Creek which is located northeast of the property. In the 1997 imagery, the site appears mostly free of vegetation, except along the drainages. A few dirt roads/trails running northwest are visible. Since 1997, the site appears to have remained unattended based on the uncontrolled growth of shrubs throughout the property. In reviewing Google Earth imagery, a portion of Arroyo Crossing, in the area of the Project, appears to have been over lot graded, and developed with roads and sidewalks between 2019 and 2022.

One of the drainages (visible in 1953 and 1997 historic aerials) runs through Lot 26, Lot 20, and near the middle of Tract E. Another drainage runs through the southeast corner of Tract E. It appears that these drainages were leveled with the adjacent grade during mass grading.

Several geotechnical investigations have previously been prepared for the Arroyo Crossing Development. The previous investigations were used as a reference for this investigation. TB-7 and TB-9 from Trautner Geotech's, *Feasibility Level Geotechnical Engineering Study / Design Level Pavement Recommendations – Arroyo Crossing Project*, are located within the project boundary. Relevant bore logs and laboratory testing are attached in Appendix C. Boring and test pit locations from previous investigations are marked in Figure 2a. The referenced reports include:

- Trautner Geotech LLC, April 26, 2019, *Feasibility Level Geotechnical Engineering Study / Design Level Pavement Recommendations – Arroyo Crossing Project*
- Trautner Geotech LLC, March 8, 2021, *Geotechnical Engineering Study Proposed Housing Authority of Southeast Utah, Lots 3, 8, 13, and 48, Arroyo Crossing*
- Trautner Geotech LLC, March 8, 2021, *Geotechnical Engineering Study Proposed Community Rebuilds Lots A1-A4, 14, 31, 38, 39 Arroyo Crossing*

- Geotechnical Testing Services Inc. [GTS], June 21, 2021, *Geotechnical Investigation for Proposed Arroyo Crossing Subdivision Phases 3, 4, 5, and 6*
- Huddleston-Berry Engineering & Testing, LLC, July 20, 2021, *Lot 42 Arroyo Crossing*
- Moab Geotechnical Group, October 25, 2022, *Geotechnical Design Report, Arroyo Crossing Lots 1, 2, 4, 9, 11, 12, 18, 19, 21 & 43*

2 SITE CHARACTERIZATION

We performed a field exploration for the Project using exploratory test pits and by collecting representative soil samples using a variety of sampling techniques. Laboratory testing was performed to further characterize the subsurface soils following the field studies.

2.1 Exploratory Test Pits

We retained the services of AW Construction out of Moab, Utah to excavate a total of twelve (12) test pits across the site. Approximate test pit locations are marked in Figure 2a and 2b. The test pit locations were not surveyed at the time of this report being prepared and should be considered approximate. Reported latitude, longitude, and elevations on the test pit logs were sourced from Google Earth. A graphical summary of the test pit logs is provided in Appendix A.

The test pits were excavated using a Deere 50G Compact (Mini) Excavator to depths ranging between about 6½ and 10 feet below current site grade. Samples were collected using a combination of Shelby tubes, bulk, and grab samples. Test pits were backfilled with spoils generated during excavation activities.

2.2 Laboratory Testing

Laboratory testing was performed on select soil samples by Intermountain GeoEnvironmental Services, Inc. (IGES) of South Salt Lake City, Utah. Laboratory testing consisted of the following:

- Index Testing
 - Moisture Content (ASTM D2216a)
 - Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis (ASTM D6913)
 - Atterberg Limits (ASTM D4318)
 - Organic Content (ASTM D2974)
- Compaction Characteristics
 - Modified Proctor (ASTM D1557 B)
- Compressibility Tests
 - Percent Collapse/Swell (ASTM D4546 B)
- Corrosion and Resistivity Tests
 - Minimum Laboratory Soil Resistivity (AASHTO T 288)
 - Soil pH for Use in Corrosion Testing (AASHTO T 289)
 - Anions in Water by Suppressed Ion Chromatography (ASTM D4327)
 - Water-Soluble Sulfate in Soil (ASTM C1580)

Results of the laboratory tests are provided in Appendix B. Select properties are summarized on the test pit logs provided in Appendix A.

2.3 Surface Conditions

The site is relatively flat with a slight downward sloping gradient trending from the southwest to the northeast. At the time of our field exploration the property had been over lot graded, and streets, curbs and gutters had been developed, with utilities stubbed into each lot. Vegetation at the time of our field exploration consisted of sparse weeds and shrubs. Construction materials, equipment and debris were observed on some of the lots.

2.4 Subsurface Conditions

In general, subsurface conditions consisted primarily of silty sand, silty sand with gravel, and sand with silt and gravel, with partially cemented nodules, from the ground surface to terminal depths varying between about 6 ½ and 11 feet below the ground surface. Trace cobbles were encountered at various depths.

Several test pits included layers that were not primarily sand, including:

- In TP-07 gravel with sand, some cobbles and few boulders from about 2½ feet to a terminal depth of about 9½ feet below the ground surface.
- In TP-04 an approximately 1½-foot-thick layer of lean clay with sand from about seven (7) to 8½ feet below the ground surface.
- In TP-05 an approximately 1½-foot-thick layer of sandy silt from about 8½ to 10 feet below the ground surface.

Notable variations were observed in several test pits, including:

- Heavily cemented layers, that were able to be excavated with the equipment used, in TP-02 from about four (4) to seven (7) feet below the ground surface, and in TP-03 from about 2½ to 3½ feet below the ground surface.
- Heavily cemented layers, where practical refusal was reached, in TP-09 from about 7½ to eight (8) feet below the ground surface, and in TP-10 from about 4½ to 6½ feet below the ground surface.
- An approximately 1.5-foot-thick layer containing organics in TP-04 from about 2½ to four (4) feet below the ground surface and in TP-08 from about three (3) to 4½ feet below the ground surface.

Exhibit 2-1 Summary of Notable Variations

Characteristic	Test Pit ID	Depth Below the Ground Surface (ft)
Heavily Cemented Soil (excavatable)	TP-02	4 - 7
	TP-03	2.5 – 3.5
Heavily Cemented Soil (practical refusal)	TP-09	7.5 - 8
	TP-10	4.5 – 6.5
Organics	TP-04	2.5 – 4
	TP-08	3 – 4.5

2.5 Groundwater

Groundwater was not observed in any of the test pits.

Subsurface data from the Feasibility Level Geotechnical Engineering Study (Trautner, 2019) indicates that groundwater was encountered at depths ranging from about 27 to 37 feet below the ground surface in the portion of the Arroyo Crossing development located west of Spanish Valley Drive and at depths ranging from about 11 to 13 feet below the ground surface in the portion of the Arroyo Crossing development located east of Spanish Valley Drive.

It is possible for groundwater levels to fluctuate seasonally and from year to year. Changes in irrigation, runoff and precipitation can affect the groundwater level.

3 GEOLOGICAL AND GEOTECHNICAL HAZARDS AND FINDINGS

3.1 Geologic Setting

Moab is located within the Colorado Plateau geological province that is characterized as a broadly uplifted region of relatively undeformed “layer-cake” sedimentary strata (Castleton et. al., 2018). The project is located within the Moab-Spanish Valley that formed from a collapsed salt anticline. Figure 5 illustrates the Project relative to the most recent mapping performed by UGS (Doelling et. al., 2002). The entirety of the site is mapped within a unit defined as ‘Eolian Sand’ which is characterized by windblown, fine to medium grained sand with silt. This mapping is consistent with the findings from our field exploration program.

3.2 Geologic and Geotechnical Hazards

The site is in an area having several identified geologic and geotechnical hazards. In 2018, the Utah Geological Survey (UGS) published a report on the Geologic Hazards of the Moab Quadrangle, Grand County, Utah (Castleton, et. al, 2018). In this report, a total of thirteen (13) geologic hazards were identified in the Moab area. The UGS report recommended the mapped hazards be used to aid design professionals, planners, building officials, developers, and the public and guide site-specific geotechnical and geologic hazard investigations for all developments. Guidance for investigating and reporting on these hazards are detailed in UGS Circular 128 (Bowman and Lund, 2020).

The site has been mapped relative to the 13 geologic and geotechnical hazards (see Figures 6 through 18) and we have prepared recommendations and considerations to address each hazard following the general guidelines in UGS Circular 128 (Bowman and Lund, 2020) and experience. Exhibit 3-1, below, includes a list of the 13 hazards and their mapped category for the Project.

One should note that the hazards mapped in the Moab Quadrangle Report are based on regional mapping, small samples of geotechnical test results, and various empirical relationships correlated with inferred soil types. Therefore, the maps may not directly reflect the appropriate level of risk for each geologic or geotechnical hazard.

Exhibit 3-1 Summary of Hazards

Hazard	Category
Shallow Groundwater Potential	Shallow Groundwater Unit 1
Salt Tectonics-Related Ground Deformation	Potential Valley Floor Subsidence
Flood Hazard	Low
Landslide Susceptibility	Not Mapped
Rockfall Hazard	Not Mapped
Radon Hazard	High
Collapsible Soil Susceptibility	Collapsible Soil C
Expansive Soil Susceptibility	Moderately Susceptible Soil
Soluble Soil and Rock Susceptibility	Gypsiferous Soil
Corrosive Soil and Rock Susceptibility	Corrosive Soil C
Piping and Erosion Susceptibility	Susceptible Soil
Wind Blow Sand Susceptibility	High
Shallow Bedrock	Deep

3.2.1 Groundwater

The site is mapped as SGW1 by UGS (Castleton et al., 2018), see Figure 6. This zone is identified as having the potential for shallow groundwater or the possibility of developing shallow groundwater.

Groundwater was not encountered in any of the test pits for this Project. Previous investigations by others found groundwater to be as shallow as 27 feet (Trautner, 2019). The addition of water to previously dry areas, as a result of landscape irrigation and poor surface drainage management may cause groundwater levels to raise. Additionally, partially to heavily cemented silty sand was observed in several of the test pits and there is a potential for perched groundwater to develop.

Other than the partially cemented layers, the soil observed in the test pits generally has good drainage characteristics. Additionally, given that no below grade finished space (i.e. basements) are planned, shallow groundwater is unlikely to impact the project. If water is encountered during the excavation and development of the site, MGG should be contacted immediately.

3.2.2 Salt-Tectonics Related Ground Deformations

The Moab-Spanish Valley is a graben formed by the collapse of a salt-cored anticline that was created by diapirism in the salt-rich Paradox Formation (Castleton et. al., 2018). The upward movement, or salt dissolution, has resulted in the formation of several fractures, folds, and faults along the valley margins. Given the nature of the mechanisms related to this phenomenon, the hazard and resulting affects are very difficult to evaluate.

This phenomenon can be quantified as a potential seismic source and is considered in the United States Geological Survey (USGS) Fault and Fold Database (USGS, 2021). This USGS database models the Moab fault and the associated deformation zones as a Class B fault, meaning the fault is well constrained but there isn't enough information available to demonstrate it is active (signs of deformation in the last ~11,000 years), the fault might not extend deep enough to be a potential source of a significant earthquake, or the information currently available is too weak to confidently assign a less or more significant risk category.

The site is mapped entirely within the zone identified as Potential Valley Floor Subsidence by the UGS (Castleton et. al., 2018), see Figure 7. The site is not located on the Moab Fault or associated deformation zones, therefore the risk for fault rupture for the development is low. Although the site is not located on a fault, the structure will be subject to seismic shaking during an earthquake event. The proposed structure should be designed using the seismic design parameters in Section 4.1 of this report.

3.2.3 Flooding

On an annual basis, the most common and damaging geologic hazard in Utah, and the Moab quadrangle, is flooding (Castleton, et. al., 2018). Figure 8 illustrates the site relative to the Flood Hazards developed by UGS. The Project is mapped entirely within the zone identified as having a low hazard rating based on mapping by UGS.

Despite the mapping, cloudburst storms have the potential to impact any development in the region. It is crucial to manage drainage within the development and around individual structures to reduce the risk of flooding. Reference Section 4.5 for drainage and landscaping recommendations.

3.2.4 Landslide

Landslides, the movement of soil down a slope, can be triggered by either an increase in stress or a decrease in soil strength. The site is mapped relative to landslide risks identified by the UGS (Castleton, et. al., 2018) in Figure 9. The Project is in an area mapped as having no significant landslide hazard. The site grade is not steeply sloping near any of the proposed structures. The landside risk is negligible for the Project.

3.2.5 Rockfall

Where a rock source exists above a slope steep enough to allow for rapid downslope movement of dislodged rocks, a rockfall hazard exists. The site is mapped relative to rockfall risks identified by UGS (Castleton, et. al., 2018) in Figure 10. The site is not mapped in a rockfall hazard zone. The risk for rockfall is considered negligible for the Project.

3.2.6 Radon

Radon is the most significant geologic risk to Utah residents and represents nearly 93 percent of all known geologic-related fatalities in the state (Bowman and Lund, 2020). The Project is mapped within a zone identified as having a high radon hazard potential (Castleton, et. al., 2018), see Figure 11. Radon is a common hazard found throughout the Southwest and Colorado Plateau regions. This gas is often a result of particle decay associated with naturally occurring radioactive elements within bedrock and alluvial soils.

New home construction should consider the current EPA Standard of Practice which addresses radon in new construction. The American National Standards Institute (ANSI) published a new standard in 2020 (ANSI, 2020) to provide guidance and resources on how to address potential radon sources. Recommendations to address Radon can be provided at your request.

3.2.7 Collapsible Soil

Collapsible soils are soils that have the potential to undergo significant volumetric change once loaded or wetted. Generally, the soil is deposited during flood, debris flow, or landslides and can become cemented from naturally occurring processes. Once wetted, or loaded beyond the compressive strength of the soil, the soils can break down and collapse. Often this does not occur uniformly, and differential settlement can occur. The site is mapped in a Collapsible Soil C area by UGS (Castleton, et. al., 2018), see Figure 12, which indicates the geologic units are susceptible to collapse but historic geotechnical data are lacking. Exhibit 3-2 summarizes the testing performed on select undisturbed samples.

Exhibit 3-2 Summary of Collapse Test Results

Test Pit	Location	Sample Designation	Depth Below Surface (ft)	Inundation Load (psf)	Percent Collapse (%)
TP-01		ST-01	3 – 4	1,000	5.1
				1,500	4.6
TP-05		ST-02	3 – 4	500	2.7
				1,500	6.2
TP-09		ST-02	3.5 – 4.5	1,000	3.2
				1,500	2.4
TP-10		ST-01	2 – 2.5	1,500	4.2
TP-11		ST-02	3.5 – 4.5	1,000	1.1
				1,500	3.7

Collapse testing indicates a significant risk of differential settlement to the proposed structures due to collapsible subsurface soils. This risk can be reduced by removal and replacement efforts or by supporting future structures on deep foundations. Recommendations to address this risk are detailed in Section 4 of this report.

3.2.8 Expansive Soil

Expansive soils generally occur when cohesive soils or weathered shales become wet. The plate-like nature of the material and its mineralogy determines how expansive these materials are. Wetting due to irrigation practices, site drainage, precipitation, and utilities often occurs irregularly around structures and can lead to differential movement of expansive soils. This differential settlement is often presented by ‘heaving’ flatwork, cracking foundations, jamming windows and doors, and inoperable utilities.

Figure 13 illustrates the site relative to the hazard mapping by UGS (Castleton, et. al., 2018). The entirety of the site is located within the moderately susceptible soil hazard zones. This zone is characterized by UGS as having the potential to undergo significant volumetric strain when exposed to a water source. Several samples tested by Trautner Geotech on nearby lots (specifically Lot A1 and A3) within the Arroyo Crossing Development were found to be highly expansive (Trautner, 2021).

MGG did not observe any potentially expansive soils in the test pits for this Project. However, this does not completely preclude the potential for there being high-risk soils onsite. A Geotechnical Engineer should observe the subgrade prior to fill placement to verify that the soil is consistent with the findings of the subsurface exploration.

3.2.9 Soluble Soil and Rock

Soluble soil and rock are a hazard of known significance in Moab. Soluble soil and rock are a result of prehistoric ocean environments that have resulted in numerous soluble minerals that have been transported, accumulated, and redistributed throughout the area. Evaporites throughout the Moab Valley are often carried long distances from their parent formation, the Paradox Formation which borders the valley and contains several outcrops throughout. These minerals are chaotically transported up to surficial soils through springs, flooding events, and fluctuations in the groundwater. Given the depositional nature of the minerals, the hazard is difficult to address due to its unpredictable presence in the subsurface.

The Project is located within an area identified by UGS (Castleton, et. al., 2018) as being susceptible to gypsum-bearing soils, see Figure 14. Gypsum crystals were observed in TP-06 at a depth of nine feet below the ground surface. Provided the recommendations in Section 4 and 5 are followed, the risk of evaporites to the future project is considered low.

3.2.10 Corrosive Soil and Rock

Potentially corrosive environments exist in nearly every soil and rock regime. Corrosion can damage unprotected steel and concrete. The Project is mapped within a zone identified as having Corrosive Soil C, classified as having the potential for buried or embedded corrosive soil and rock (Castleton, et. al., 2018), see Figure 15. Corrosion and resistivity testing was performed on a bulk sample collected at the time of our field investigation. Corrosion test results are included in Appendix B and summarized below.

Exhibit 3-3 Summary of Corrosion and Resistivity Test Results

Sample Location	pH	Sulfate (SO ₄) in water (ppm)	Sulfate Exposure Class	Minimum Resistivity (ohm-cm)	Corrosive Rating
TP-05 @ 4' – 4.5'	8.7	470	S1- Moderate	892	Extremely Corrosive

Resistivity values measured to be a minimum of 892 ohm-cm. These results indicate an extremely corrosive rating (Roberge, 2008) for unprotected steel elements. All steel to be in direct contact with soil is recommended to be designed for an extremely corrosive rating. The use of non-metallic piping is preferred where pipes will be in contact with soil.

Sulfates within the native onsite soils were measured to be 470 parts per million. In accordance with the American Concrete Institute (ACI) recommendations (ACI, 2019), an exposure class of S1 is recommended for the Project. Based on the exposure class, Type II cement and a maximum water to cement ratio of 0.50 is recommended for all concrete in contact with soil.

We recommend that future imported fill material have corrosion testing performed on the soils to determine their potential for corrosion towards concrete and unexposed steel.

3.2.11 Piping and Erosion

Erosional gullies can form when slope runoff, especially from heavy rains, becomes channelized. Piping, or tunnel erosion, is subsurface erosion that moves through permeable soil layers and exits at a free face. Piping requires a hydraulic gradient to exist for the phenomenon to take place. Soil and bedrock with high silt and clay content and soluble soil are highly susceptible to piping and erosion.

The Project is mapped within a zone identified as having soil that is susceptible to piping and erosion (Castleton, et. al., 2018), see Figure 16. Soils will be susceptible to erosion where left unprotected. Recommendations to mitigate these risks are discussed in Section 4.5 Drainage and Landscaping.

3.2.12 Wind-Blown Sand

The Project is mapped as having a high susceptibility to the wind-blown sand hazard by UGS (Castleton, et. al., 2018), see Figure 17. This hazard can result in the accumulation of fine-grained sand and silt transported by wind. The accumulation can create driving hazards, can clog storm drains and batter future structures. This hazard is often addressed through the development of neighborhoods such as this project by way of reducing the area of exposed soils. Fences, vegetation, structures, flatwork, and other features of the project will help reduce this hazard.

Additionally, insitu wind-blown sand can result in reduced bearing capacities. Indications of insitu wind-blown sands were found in other lots in the Arroyo Crossing Development (specifically lot A2). This material is often difficult to address and is generally best treated by removal and replacement. The material is generally suitable for reuse onsite once mixed with other onsite soils. Observation and coordination during construction will help mitigate the risk of windblown sands impacting the Project.

3.2.13 Shallow Bedrock

The primary concern with shallow bedrock is difficulty of excavation for this project. Additionally shallow bedrock can cause areas of perched groundwater and create problems for wastewater disposal. The Project is mapped within a zone identified as having deep bedrock, likely greater than 10 feet beneath the surface (Castleton, et. al., 2018), see Figure 18. Bedrock was not encountered in any of the test pits, which reached total depths ranging from 6.5 to 11 feet below the ground surface.

While bedrock was not encountered, practical refusal with the Deere 50G Compact (Mini) Excavator was reached at eight (8) and 6.5 feet in TP-09 and TP-10 respectively, on cemented soil layers. Cemented soil layers, that were able to be excavated with the Deere 50G, were encountered at depths of four (4) and 2.5 feet in TP-02 and TP-03 respectively. Adequately sized equipment is recommended for foundation excavations that may encounter cemented soil layers. Given the planned foundation depths, the cemented soils are not expected to be encountered in the majority of the excavations.

4 GEOTECHNICAL DESIGN RECOMMENDATIONS

The following geotechnical design recommendations have been developed based on the results of the field studies, laboratory testing, review of publicly available information, knowledge of the proposed structures, and experience. The performance of the planned structures and infrastructure is dependent on conformance with the following recommendations.

The following recommendations and design criteria are based on the Project description in Section 1.2 of this report. If changes are made to the Project, Moab Geotechnical Group should be contacted immediately to determine the validity of the following recommendations.

4.1 Seismic Design Parameters

The site is located within a seismically active area. Although the Paradox basin possesses a low level of seismic hazard, it is possible that background earthquakes as large as M_w could occur, albeit infrequently (Wong et. al., 1996). In general accordance with IBC 2021 and ASCE 7-16, seismic design parameters for the structure have been developed using online Seismic Design Map Tool by the Structural Engineers Association of California (SEAOCC, 2021). Following Section 11.4.3 of ASCE 7-16, site Class D was calculated for the Project. This assumption is appropriate provided the structural period of the structure is less than 0.5 seconds. Exhibit 4-1 provides a summary of the Seismic Design Parameters for use in the design of the structures.

Exhibit 4-1 Seismic Design Parameters

Period (seconds)	Spectral Acceleration (g)
Site Modified Peak Ground Acceleration, PGA_M	0.163
MCE_R Spectral Response Acceleration at Short Periods, S_{MS} (g)	0.314
MCE_R Spectral Response Acceleration at 1-second Period, S_{M1} (g)	0.151
Design Spectral Response Acceleration at Short Period, S_{DS} (g)	0.209
Design Spectral Response Acceleration at 1-second Period, S_{D1} (g)	0.101

Note: Based on assumed site location of Latitude: 38.5421274 & Longitude: -109.5081416

4.2 Lateral Earth Pressures

Lateral earth pressures will impart loads onto structures retaining earth loads. Exhibit 4-2 provides a summary of the lateral earth pressures for use in the design of walls, buried structures and other elements of the project.

Active earth pressures are the earth pressures to be used for conditions where movements greater than $0.003H$ (H is the height of the wall in feet) are allowed for the structure. At rest pressures should otherwise be used as the earth pressures in the design of structures.

Passive earth pressures are to be used to resist the lateral earth pressures. Passive earth pressures should be ignored in the upper 20 inches of the ground surface due to the potential for frost to impact these soils. Passive earth pressures can be assumed to increase linearly in the frost susceptible zone. Exhibit 4-2 provides a summary for both native and imported structural fill soils.

Exhibit 4-2 Summary of Lateral Earth Pressures

Soil Type	Standard						Seismic ²					
	Earth Pressure Coefficient			Earth Pressure (psf/ft)			Earth Pressure Coefficient			Earth Pressure (psf/ft)		
	At			At			At			At		
	Active	Rest	Passive ¹	Active	Rest	Passive ¹	Active ³	Rest ³	Passive ⁴	Active ³	Rest ³	Passive ⁴
Native Soil	0.29	0.48	3.12	35	55	340	0.05	0.16	2.98	5	18	325
Imported Structural Fill ⁵	0.25	0.44	3.54	35	60	460	0.05	0.16	3.38	5	21	435

Note: psf – pounds per square foot.

1. The static passive resistance can be increased by 1/3 to address other extreme events due to wind or snow loading.
2. The seismic earth pressures were calculated using the Mononobe Okabe methodology (Mononobe, 1929) (Okabe, 1926).
3. The seismic active and at rest earth pressure coefficients should be added to their respective static term.
4. The seismic passive earth pressure coefficient is the discounted static term and does not require any further factoring.
5. Based on Imported Structural Fill in accordance with Section 5.3.1.

4.3 Foundations

It is understood the planned structures will be supported by either a monolithic thickened edge slab or by continuous spread footings with independent slab-on-grade floors. The following section provides recommendations based on the findings from the subsurface exploration, laboratory testing and our analyses. Should the planned structures not be able to be supported by the following recommendations, additional recommendations can be made at the Owner and Design Team's request.

4.3.1 Footings

A shallow foundation system is applicable to support the planned structures. Given the presence of undocumented fill and collapsible soils onsite, over-excavation below structural elements is needed. The soil should be replaced with properly compacted fill in accordance with Section 5.3 of this report. The over-excavation requirements vary across the site, recommendations by lot are included in Exhibit 4-3.

Exhibit 4-3 Summary of Over-Excavation Recommendations

Lot	Recommendation
Tract E	Over-excavate and replace two feet of soil below structural elements. Additional over-excavation may be required in historic drainage locations.
Lot 20	Over-excavate and replace two feet of soil below structural elements. Additional over-excavation may be required in historic drainage locations.
Lot 26	Over-excavate and replace two feet of soil below structural elements. Additional over-excavation may be required in historic drainage locations.
Lot 29	Over-excavate and replace two feet of soil below structural elements
Lot 30	Over-excavate and replace two feet of soil below structural elements
Lot 37	Over-excavate and replace two feet of soil below structural elements
Lot 46	Lower structural elements to gravel layer, approximately 2½ feet below ground surface, or over-excavate to the gravel layer and replace
Lot 47	Lower structural elements to gravel layer, approximately 2½ feet below ground surface, or over-excavate to the gravel layer and replace

Footings bearing on native subgrade or properly compacted fill can be designed for an allowable bearing resistance of 1,800 pounds per square foot (psf), provided the following:

- Foundations should be protected from frost. Grand County design criteria specifies a frost depth of 20 inches below proposed finish grade.
- Over-excavation
 - a. For continuous spread footings, the over-excavation should extend 12 inches on either side of the footing. For isolated footings the over-excavation should extend 12 inches beyond the edge of the footing, on all sides. For monolithic, thickened-edge, slabs, the over-excavation should include the entire area below the slab and extend an additional 12 inches on all sides.
 - b. The over-excavated soils are applicable for reuse so long as they meet the requirements outlined in Section 5.3.
 - c. Subgrade, considered the lowest excavation below the footings, should be prepared in accordance with Section 5.2 and observed to be in a dense and unyielding condition prior to the placement of engineered fill.
- Continuous spread footings should be at least 1.5 feet wide, and no more than four (4) feet wide. Isolated footings should be no more than six (6) feet square.
- The foundation system should be reinforced to span an unsupported length of 10 feet.
- The allowable bearing resistance may be increased by 1/3 for temporary (seismic and wind) loading conditions.
- Footings designed following these recommendations are expected to settle less than one inch. We recommend the structure be designed to accommodate up to 1-inch of differential settlement over 30 feet.

4.3.2 Slab on Grade

Slabs should be designed and constructed in accordance with ACI 302.1 Guide to Concrete Floor and Slab Construction (ACI, 2015). Independent slabs on grade should be separated from all bearing walls and columns with isolation joints that allow for unrestrained vertical movement. Control joints should also be provided throughout the slab. Where plumbing lines enter through the slab, positive breaks should be provided. Connections to mechanical equipment should be flexible.

Slab-on-grades cast directly onto properly prepared subgrade, see Section 5.2, can be designed assuming a modulus of subgrade reaction of between 5 to 9 pounds per square inch per inch. Where additional support is required, over-excavation of the native soils and replacement with structural fill can increase this modulus. For an over-excavation and replacement of 12-inches of native soils with Structural Fill, the modulus of subgrade reaction can be increased to 25 to 30 pounds per square in per inch.

4.3.3 Sliding Resistance

For footings and slabs on grade founded on properly prepared native soils, a coefficient of friction of 0.30 for the silty sand and 0.50 for the gravel can be used. These values can be increased by 1/3 for temporary loading conditions. Additional lateral support can be accommodated by utilizing the passive lateral earth pressures provided in Section 4.2. Note that the local frost depth should be considered when utilizing lateral earth pressures.

4.4 Vapor Reduction

Water from beneath the slab will migrate through the slab into the building over time. This water vapor can be reduced but not stopped. Vapor transmission can negatively affect floor coverings and lead to increased moisture within a building. We recommend the following to reduce, but not stop, water vapor transmission upward through the slab-on-grade.

- Install a vapor retarder membrane directly beneath the slab. Seal the vapor retarder at all seams and pipe penetrations. Vapor retarders should conform to class A vapor retarder per ASTM E 1745-11 “Standard Specification for Plastic Water Vapor Retarders used in Contact with Soil or Granular Fill under Concrete Slabs”.
- Place 4-inches of clean, crushed rock below the vapor retarder membrane. Crushed rock should have 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 Sieve.
- Concrete should have a concrete water-cement ratio of no more than 0.50.
- Provide inspection and testing during concrete placement to check that the proper concrete and water-cement ratio are used.
- Moist cure slabs for a minimum of 3 days or use the equivalent curing specified by the structural engineer.

4.5 Drainage and Landscaping

Excessive wetting of the foundation subgrade and sub-floor soils should be avoided. Roof downspouts should discharge well beyond foundation wall backfill zones. Local best practices are for all drains from the structures be directed directly to the storm drain system or have the outfall directed away from the structure to appropriate drainage swales. We recommend the outfall be at least 10 feet away from the closest foundation element.

Water should not be allowed to pond near foundations, pavements, or exterior flatwork. Landscaping adjacent to the structures should consist of dry-scaping or consist of vegetation that does not require frequent watering. Finished grade and flatwork should be designed to drain away from the structure in accordance with 2021 IBC where a minimum of 5 percent is specified.

Where lot lines or surface improvements restrict meeting these requirements, we recommend that specific drainage requirements be developed.

Homeowners must maintain the surface grading and drainage recommended in this report to help prevent water from being directed toward and/or ponding near the foundations. Any settling of foundation backfill should be re-graded to maintain the slopes noted above. Failure to maintain positive surface drainage away from the structure may result in localized differential vertical movement of foundations and slabs.

4.6 Concrete Flatwork

Concrete flatwork includes exterior walkways, driveways, and steps. Concrete flatwork should be designed specifically for their intended use and loading requirements. Cracking of the exterior flatwork is normal as it is part of the concrete curing process and should be expected. Frequent control joints should be provided during slab construction for control of cracking. We recommend that concrete flatwork meet the minimum requirements set forth in the current Utah APWA Standards and Specifications.

5 CONSTRUCTION CONSIDERATIONS

The construction of the Project will require removal and replacement of soil below foundation elements, as discussed in Section 4.3 Foundations. The success of the project and the recommendations provided in the report have been prepared assuming the following construction considerations are incorporated into the development of the Project. Where the recommendations cannot be followed, or alternative construction methods are to be employed to construct the Project, (MGG) should be notified.

5.1 Site Preparation

We understand that over-lot grading was performed prior to our involvement in the Project. Prior to individual lot development, undocumented fill, weeds and organic material should be cleaned to a firm, undisturbed soil surface determined by a Geotechnical Engineer.

5.2 Subgrade Preparation

Over-excavation below structural elements should be performed in accordance with Section 4.3. Subgrade, the lowest depth to which soil is excavated, will vary across the site, and expected to consist of native silty sand under structural elements.

Once excavated, subgrade preparation should consist of scarifying the upper 8 to 12 inches of soil, moisture conditioning, and compacting the material in place. The scarification can generally be performed using an excavator bucket with teeth.

A Geotechnical Engineer should observe the subgrade prior to fill placement to verify that the subgrade is firm, unyielding and that the soil is consistent with the findings of the subsurface investigation. At the historic drainage locations, mentioned previously in Section 1.3 of this report and visible in the 1997 historic aerial (see Figure 4), additional over-excavation may be required to reach native soil. The depth of

fill noted in the test pit logs (TP-04 and TP-08) is approximate and the test pits may not be located at the lowest part of the historic drainage.

Where soft or loose zones are identified, additional excavation or installation of a geotextile reinforcing material can be used. Over-excavation should extend at least one foot laterally from any areas identified as being soft or loose. If the over-excavation required becomes too large, the geotextile reinforcing material can help limit the required over-excavation volume. A Mirafi HP270 or an MGG approved equivalent is recommended to reinforce soft or loose material.

5.3 Fill Placement

Fill placement will be required to replace over-excavated soil, to backfill foundation elements, and may be required to accomplish site grading and to balance earth work for the project. Onsite soils are suitable for reuse provided they meet the criteria in the following subsections. All fill material that will be used should be placed at 95% of the modified proctor and within one percentage point of the optimum moisture content. Proctor results are provided in Appendix B.

The height of the loose lifts to be used as the fill material is placed is dependent on the machinery used to compact the soils. Where hand-held jumping jacks or walk-behind compactors are used, we recommend that loose lifts not exceed 8 inches. For excavators outfitted with a wheel compactor, 10-inch loose lifts should be used. For large sheep foot or drum rollers, 12-inch loose lifts can be used. Larger lift thicknesses can be used provided that the contractor can demonstrate adequate compaction through the compacted lift.

Fill material should be free of frozen material or free water. Where free water is present, we recommend you blend the material with dry material to reach the required moisture content. Frozen soils should be set aside and not utilized until they are unfrozen.

not utilized until they are unfrozen.

5.3.1 Structural Fill

Structural Fill should consist of a 3-inch minus material with no more than 15 percent fines. The Atterberg Limit (ASTM 4318) of the material should result in a Plasticity Index less than 7. The material should not be open graded or well-rounded and free of organic and deleterious materials. We recommend that any imported fill material be approved by a geotechnical engineer familiar with the project prior to use.

5.3.2 Recycled Onsite Materials

Onsite soils are suitable for reuse provided that they are screened of particles greater than 3 inches in nominal diameter, organics greater than 1-inch in diameter and 5 percent by volume, concrete or asphaltic concrete debris, and deleterious materials. Where clay-dominated materials are sourced onsite for fill, we recommend the material be blended with onsite sand, gravel, and non-plastic fine-grained material. Gypsum crystals and nodules of evaporites greater than one inch in nominal diameter should be removed from the site.

5.4 Utilities

Utilities should be designed and installed in accordance with the City of Moab approved Resolution #46-2017. These resolutions detail the design and installation methods required for culinary water, wastewater and stormwater design. In addition to these resolutions, utilities should be installed in accordance with the Utah APWA Standards and Specifications.

Onsite soils are suitable for reuse as backfill within utility trenches provided, they meet the required specifications detailed in the current Utah APWA Standards and Specifications manual.

5.5 Excavations

Trench and excavation safety is the requirement of the contractor installing the utilities and performing excavations. We recommend the contractor be familiar with the necessary OSHA 1926 standards and have a person onsite who can perform the necessary duties of the Competent Person as defined by OSHA. Soil conditions can vary from those explored as part of this investigation and therefore soil types, in accordance with OSHA, should be assessed by the onsite Competent Person.

6 Additional Services

Moab Geotechnical Group (MGG) strongly encourages our continued involvement with the project leading up to and during construction. The additional services we can provide will help ensure the recommendations and construction considerations are followed and that adverse conditions encountered during construction are properly addressed.

6.1 Project Progression

As the design of the project advances, we recommend we be informed of changes that differ from those assumed or detailed in this report. Successful performance of the future structures and infrastructure are dependent on the findings used to prepare this report. This report can be revised from its current state with subsequent changes and evolution of the project.

6.2 Plan and Specification Review

It is recommended that MGG review the final plans and specifications for the project. The adherence to the recommendations and construction considerations will help the long-term performance of the proposed structures and associated improvements. The review can also check if any changes in the nature, design or location of the proposed improvements and provide opportunity to prepare a written response with updated recommendations, if needed.

6.3 Testing and Observation Services

Testing and observation services can be performed by moisture / density testing and by onsite observation and testing. These services should be considered in the future construction costs of the project. **All earthwork operations should be performed under the fulltime to temporary observation of our representative to check that the site properly prepared, the selected fill materials are satisfactory, and that placement and compaction of the fills have been performed in accordance with our recommendations and project specifications.** Site observations also aid in addressing potentially problematic soils that were not found during the site characterization and field investigation phase.

7 LIMITATIONS

This report is issued with the understanding that it is the responsibility of the owner to transmit the information and recommendations of this report to developers, contractors, buyers, architects, engineers, and designers for the project so that the necessary states can be taken by the contractors and subcontractors to carry out such recommendations in the field.

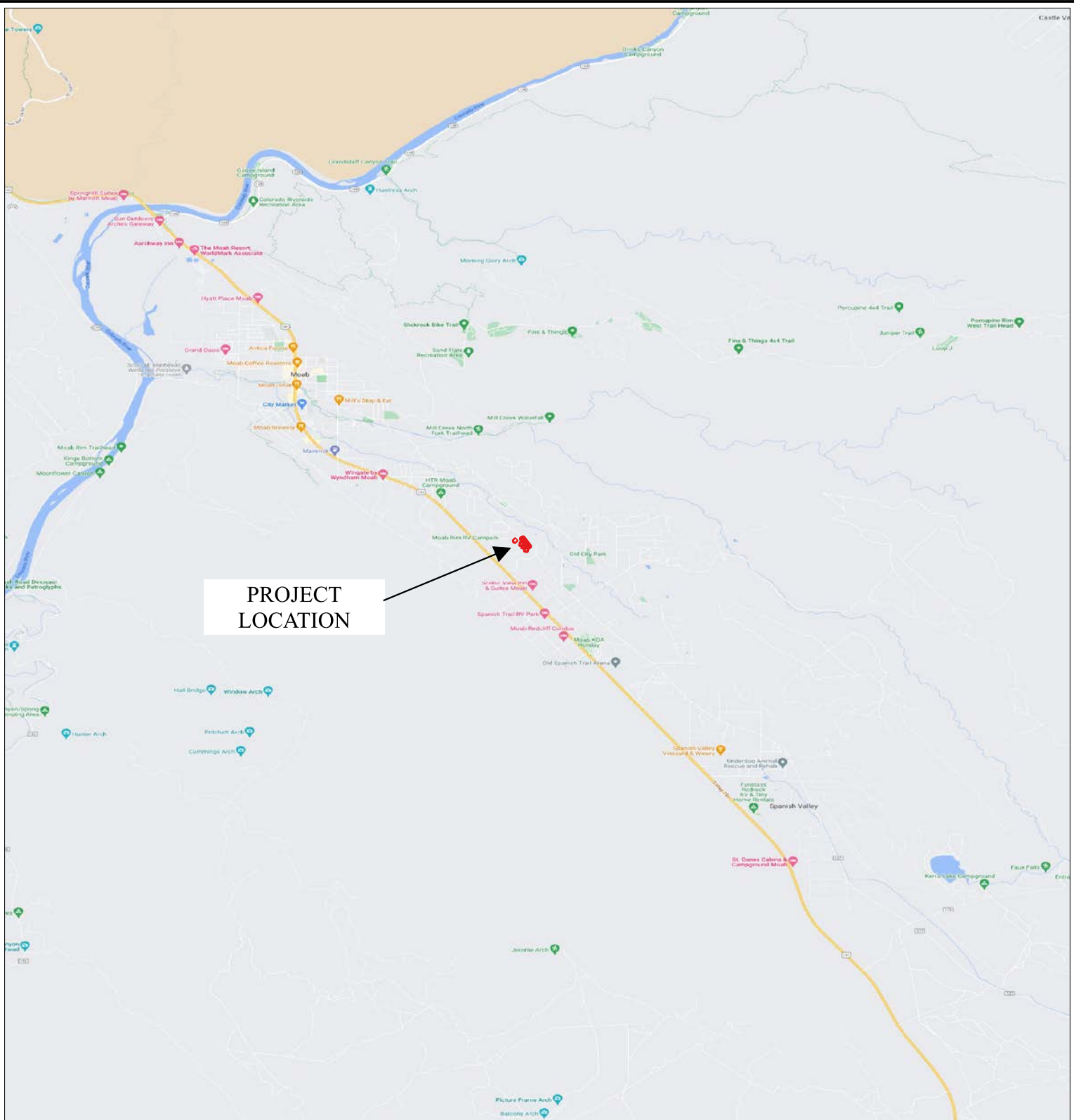
Moab Geotechnical Group (MGG) strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied. There are risks of earth movement and property damages inherent in land development. MGG is unable to eliminate all risks or provide insurance; therefore, MGG is unable to guarantee or warrant the results of the work.

This report is based upon field and other conditions discovered at the time of preparation of our work. This document must not be subject to unauthorized reuse, that is, reuse without our written authorization. Such authorization is essential because it requires us to evaluate the document's applicability given new circumstances, not the least of which is passage of time.

Actual field or other conditions will necessitate clarifications, adjustments, modifications, to other changes to our work. Therefore, we must be engaged to prepare the necessary clarifications, adjustment modifications, or other changes before construction activities commence or further activity proceeds.

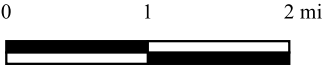
REFERENCES

- American Concrete Institute [ACI], 2019, Building Code Requirements for Structural Concrete, ACI 318
- American Concrete Institute [ACI], 2015, Guide to Concrete Floor and Slab Construction, ACI 302.1R-15
- American National Standard [ANSI], 2020, *Reducing Radon in New Construction of 1 & 2 Family Dwellings and Townhouses*, AARST Consortium on National Radon Standards
- American Society of Civil Engineers [ASCE], 2017, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE 7-16)*
- Bowman and Lund, 2020, *Guidelines for Investigating Geologic Hazards and Preparing Engineering-Geology Reports, with a Suggested Approach to Geologic-Hazard Ordinances in Utah*, Second Edition, Utah Geological Survey Circular 128
- Castleton, et. al., 2018, *Geologic Hazards of the Moab Quadrangle, Grand County, Utah*, Special Study 162, Utah Geological Survey
- Doelling, et. al., 2002, *Geologic Map of the Moab 7.5' Quadrangle, Grand County, Utah*, Utah Geological Survey Map 181
- International Code Council, 2021, *International Building Code*. Falls Church, Va. :International Code Council
- Mononobe, N. and H. Matsuo, 1929, *On the Determination of earth Pressures During Earthquakes*, Proceedings of the World Engineering Congress
- Okabe, S., 1926, *General Theory of Earth Pressure*, Journal of Japan Society of Civil Engineering Vol. 12, No. 1
- Roberge, Pierre R., 2000, *Handbook of Corrosion Engineering*, McGraw-Hill



LEGEND

 Site Boundary



Source: Google Maps, 2023

	ARROYO CROSSING TRACT E & RESIDENTIAL LOTS GRAND COUNTY, UTAH	VICINITY MAP	Project No: 2021-003	
			August 2023	FIG. 1



LEGEND

Current Exploration

Site Boundary

HASU-MGG-061523

Previous Explorations

Tract I-MGG Test Pits

HASU-MGG-102522

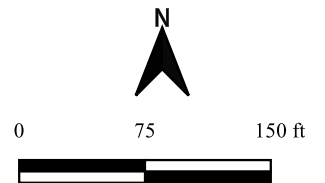
HBE&T-072021

GTS-062121

HASU-Trautner-032821

CR-Trautner-032821

Trautner-042619



Note: Exploration locations have been approximately located and do not reflect surveyed locations.
Map Source: Google Satellite, 2023



ARROYO CROSSING
TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

SITE & PREVIOUS EXPLORATIONS MAP

Project No: 2021-003

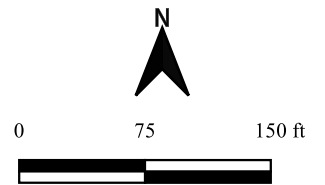
August 2023

FIG. 2a



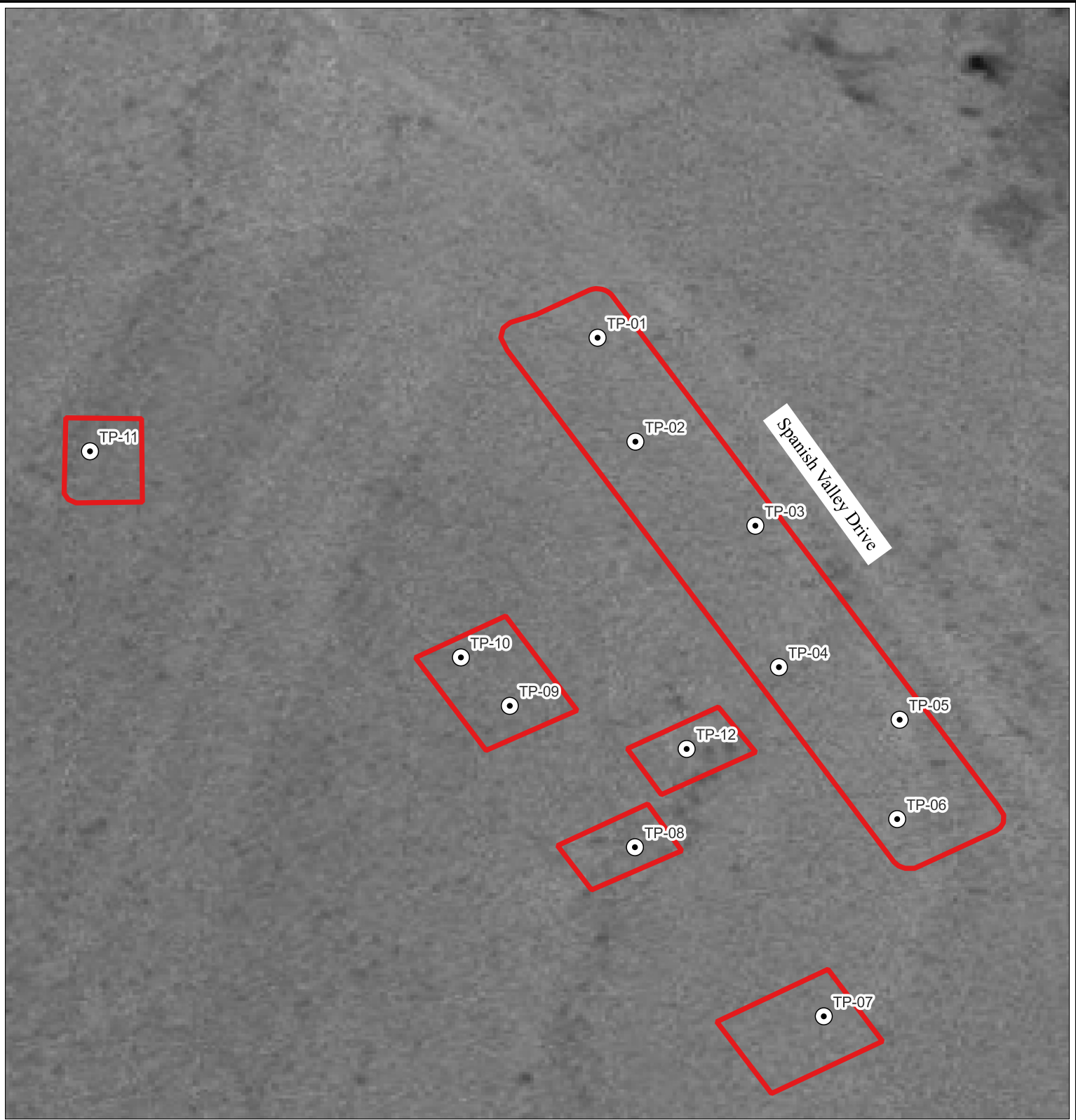
LEGEND

- Site Boundary
- Test Pits



Note: Exploration locations have been approximately located and do not reflect surveyed locations.
 Map Source: Google Satellite, 2023

	ARROYO CROSSING TRACT E & RESIDENTIAL LOTS GRAND COUNTY, UTAH	LOT IDENTIFICATION & EXPLORATIONS MAP	Project No: 2021-003	
			August 2023	FIG. 2b



LEGEND

 Site Boundary

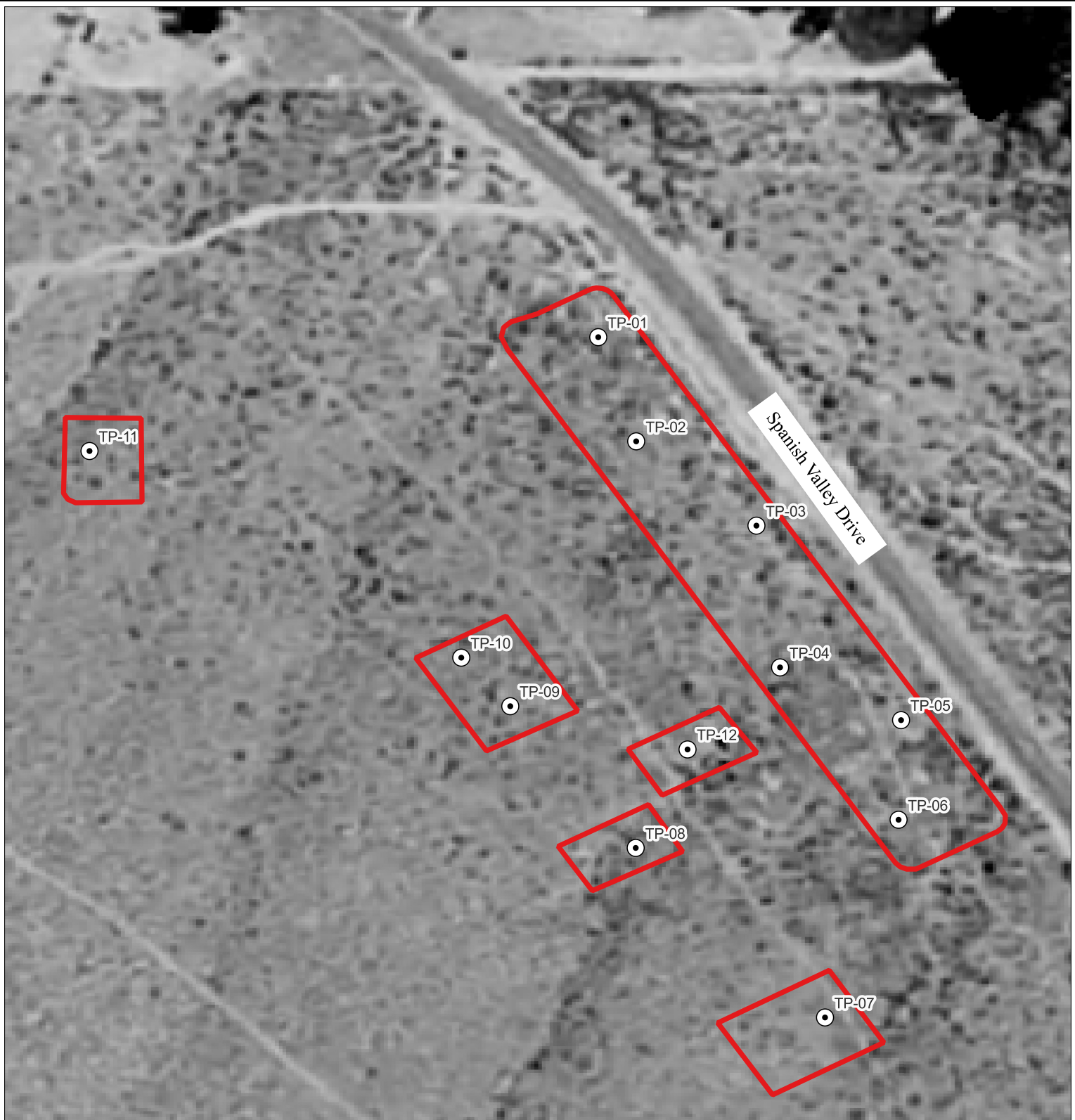
N

0 75 150 ft



Map Source: 1953 Historic Aerial, Nationwide Environmental Title Research, LLC

	ARROYO CROSSING TRACT E & RESIDENTIAL LOTS GRAND COUNTY, UTAH	1953 HISTORIC AERIAL	Project No: 2021-003	
			August 2023	FIG. 3



LEGEND

 Site Boundary

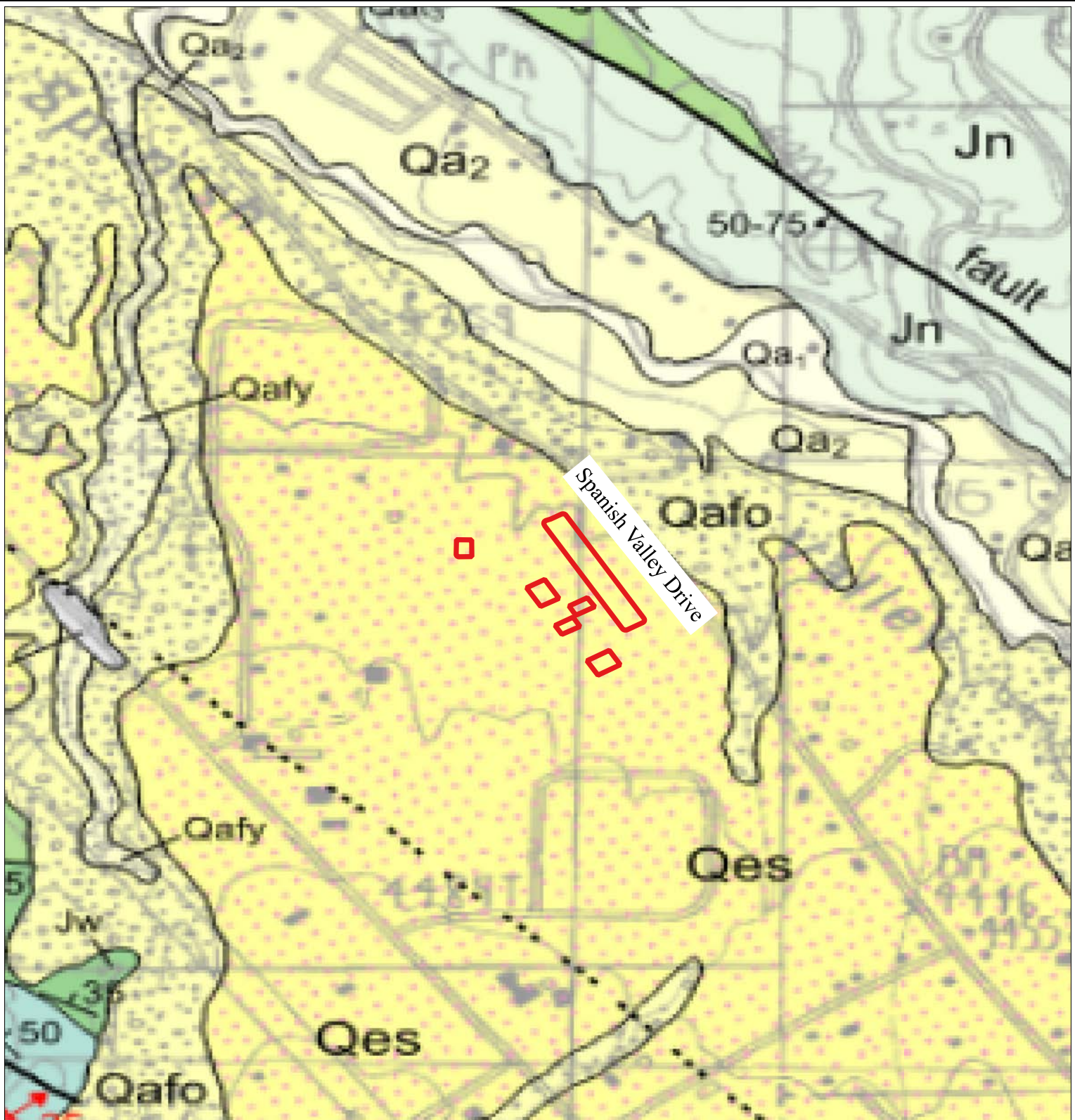
N

0 75 150 ft



Map Source: 1997 Historic Aerial, Nationwide Environmental Title Research, LLC

	ARROYO CROSSING TRACT E & RESIDENTIAL LOTS GRAND COUNTY, UTAH	1997 HISTORIC AERIAL		Project No: 2021-003	
				August 2023	FIG. 4



LEGEND

Site Boundary

Select Abbreviated Descriptions

Qes: Eolian-sand deposits (Holocene) - Well-sorted, fine- to medium-grained, quartzose sand with silt; typically form thin, discontinuous sheets and small dunes, and locally fill hollows; locally as much as 30 feet (9 m) thick.



Source: Geologic Map of the Moab 7.5 Quadrangle, 2002, Original Scale: 1:24,000



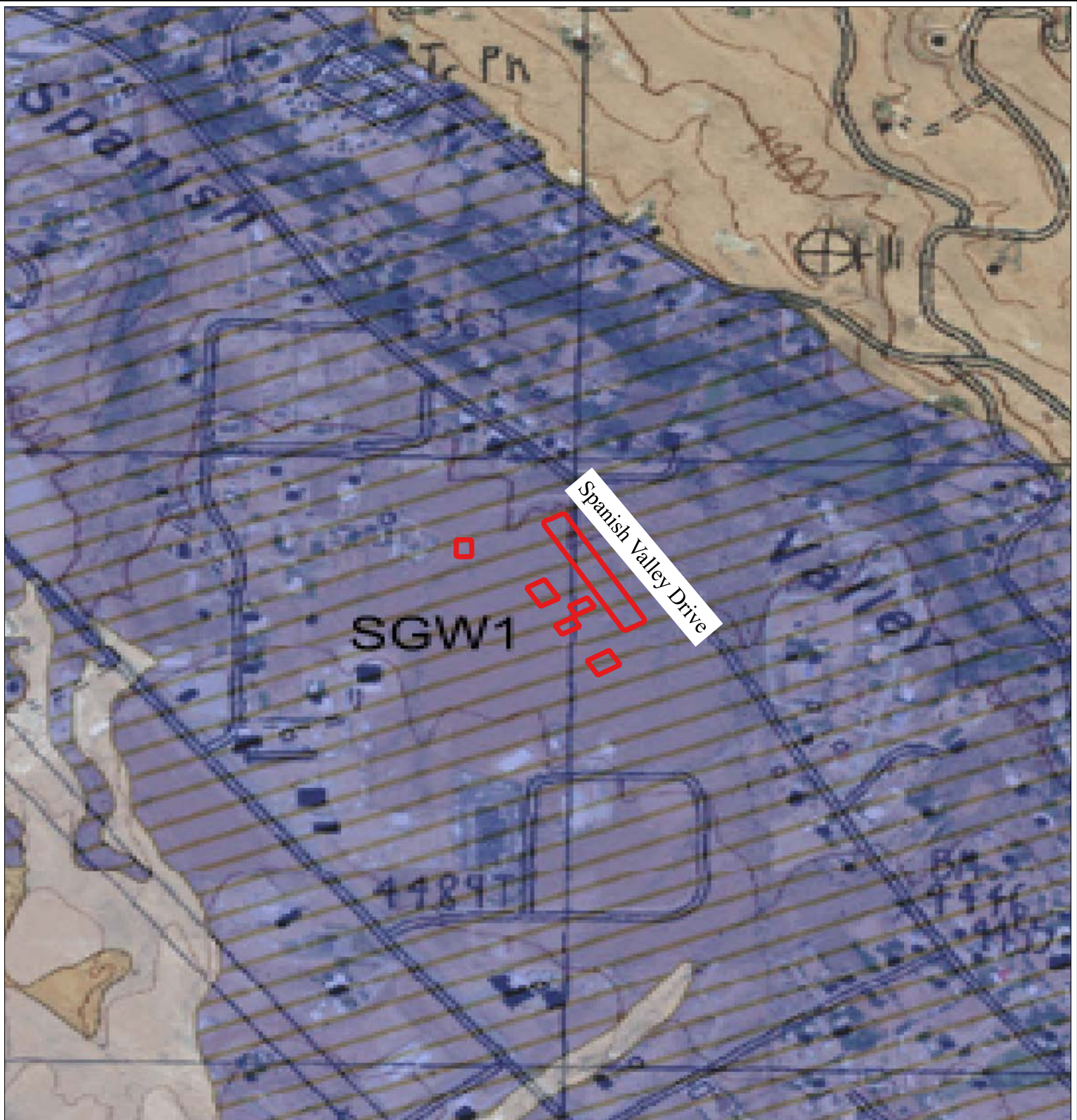
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GRAND COUNTY, UTAH

GEOLOGIC MAP

Project No: 2021-003

August 2023

FIG. 5



LEGEND

 Site Boundary

Select Abbreviated Descriptions

SGW1: Shallow Groundwater Unit 1 – Area identified as having potentially shallow groundwater, or the possibility of developing shallow groundwater.



Source: Plate 1 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



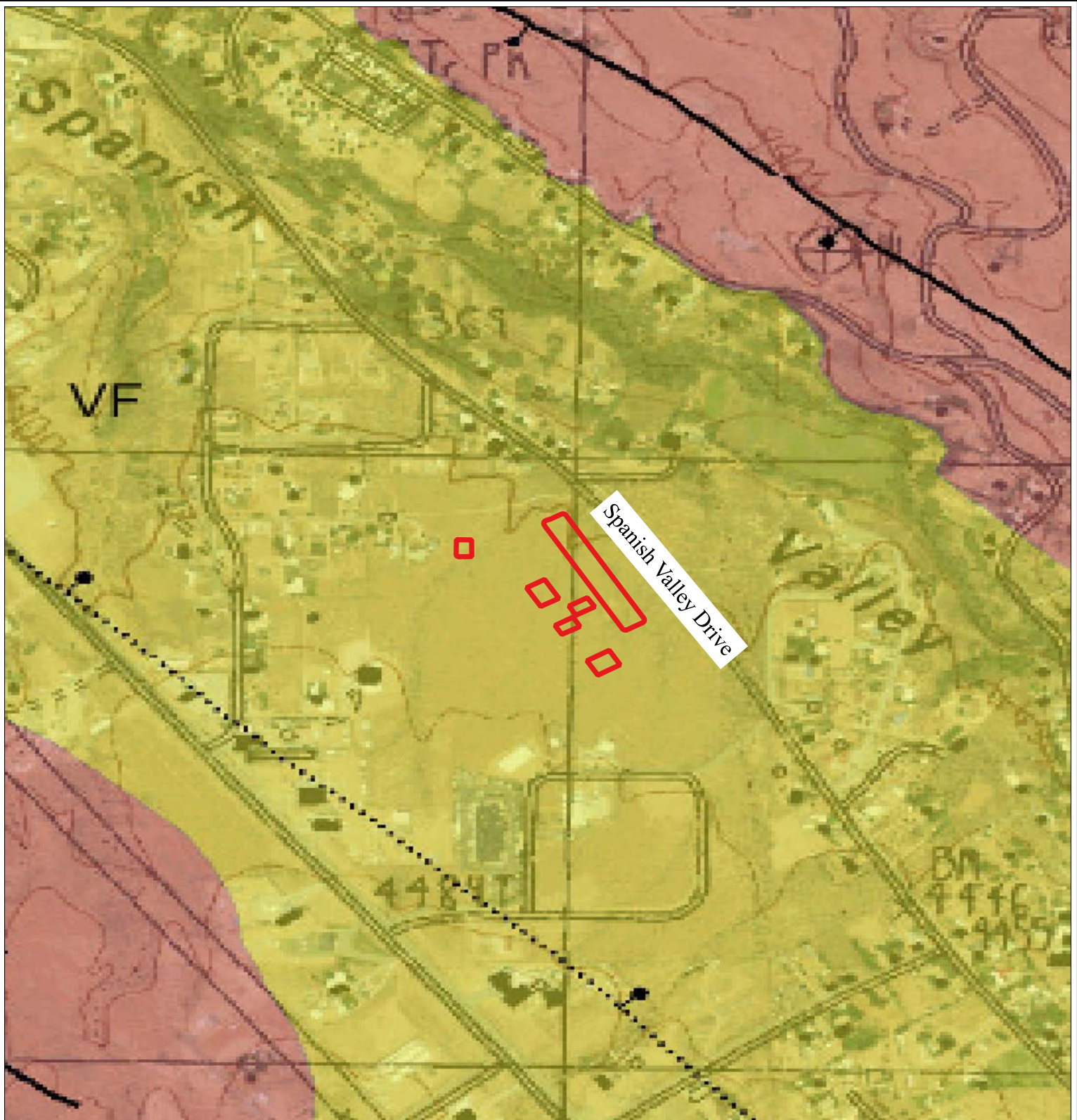
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GRAND COUNTY, UTAH

**SHALLOW GROUNDWATER
POTENTIAL MAP**

Project No: 2021-003

August 2023

FIG. 6



LEGEND

 Site Boundary

Select Abbreviated Descriptions

VF: Potential Valley Floor Subsidence – Potential ground subsidence causing tilting and/or damage to structures due to differential settlement, lateral earth pressures, ground cracks or displacements in fractured rock, and ground collapse, including sinkhole formation.



Source: Plate 2 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



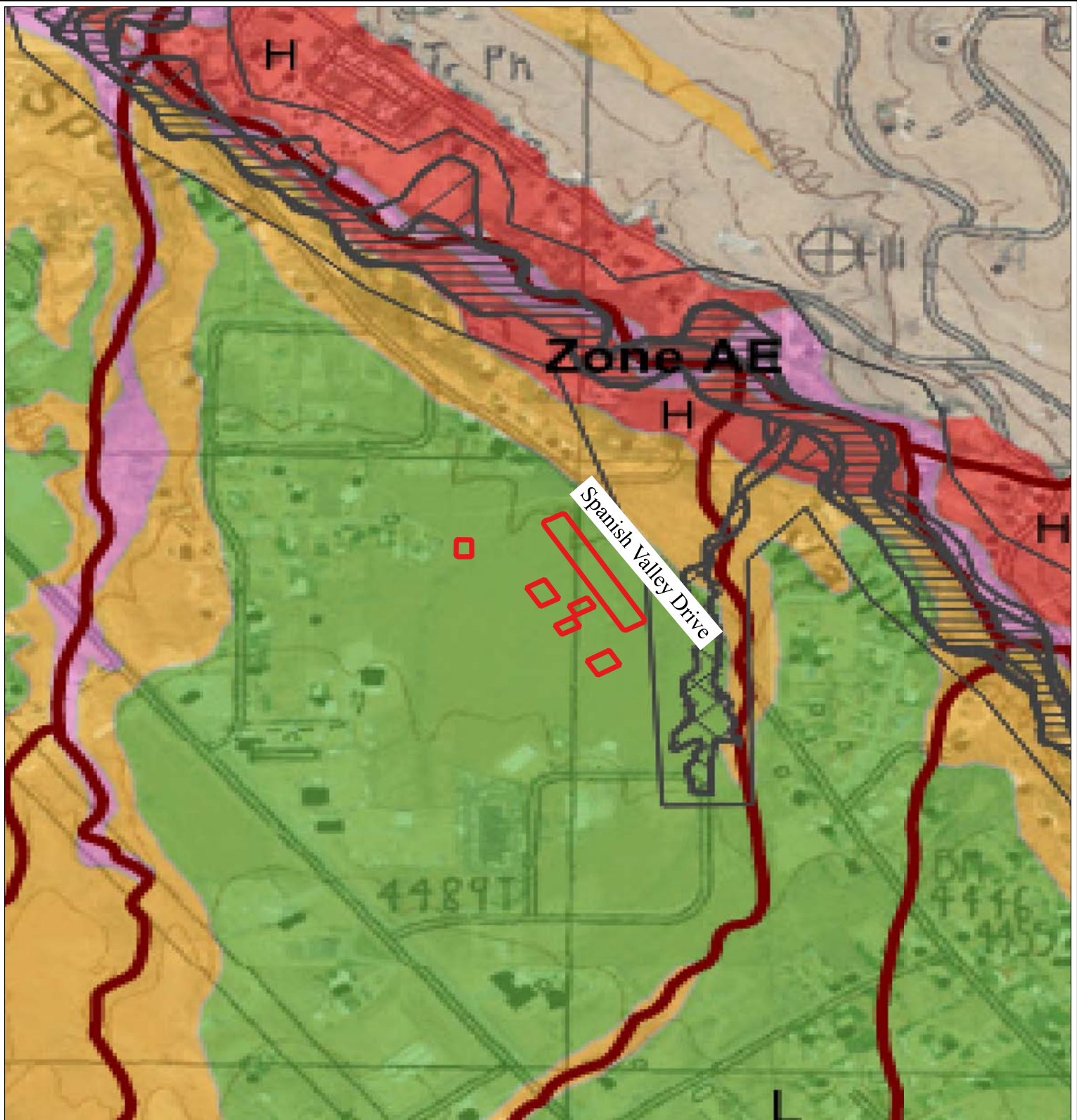
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GRAND COUNTY, UTAH

**SALT TECTONICS-RELATED
GROUND DEFORMATION
HAZARD MAP**

Project No: 2021-003

August 2023

FIG. 7



LEGEND

 Site Boundary

Select Abbreviated Descriptions

L: Low - Valley bottoms and minor ephemeral draina subject to possible sheetfloods and minor flashfloods from adjacent upland areas during cloudburst storms.



0 400 800 ft



Source: Plate 3 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



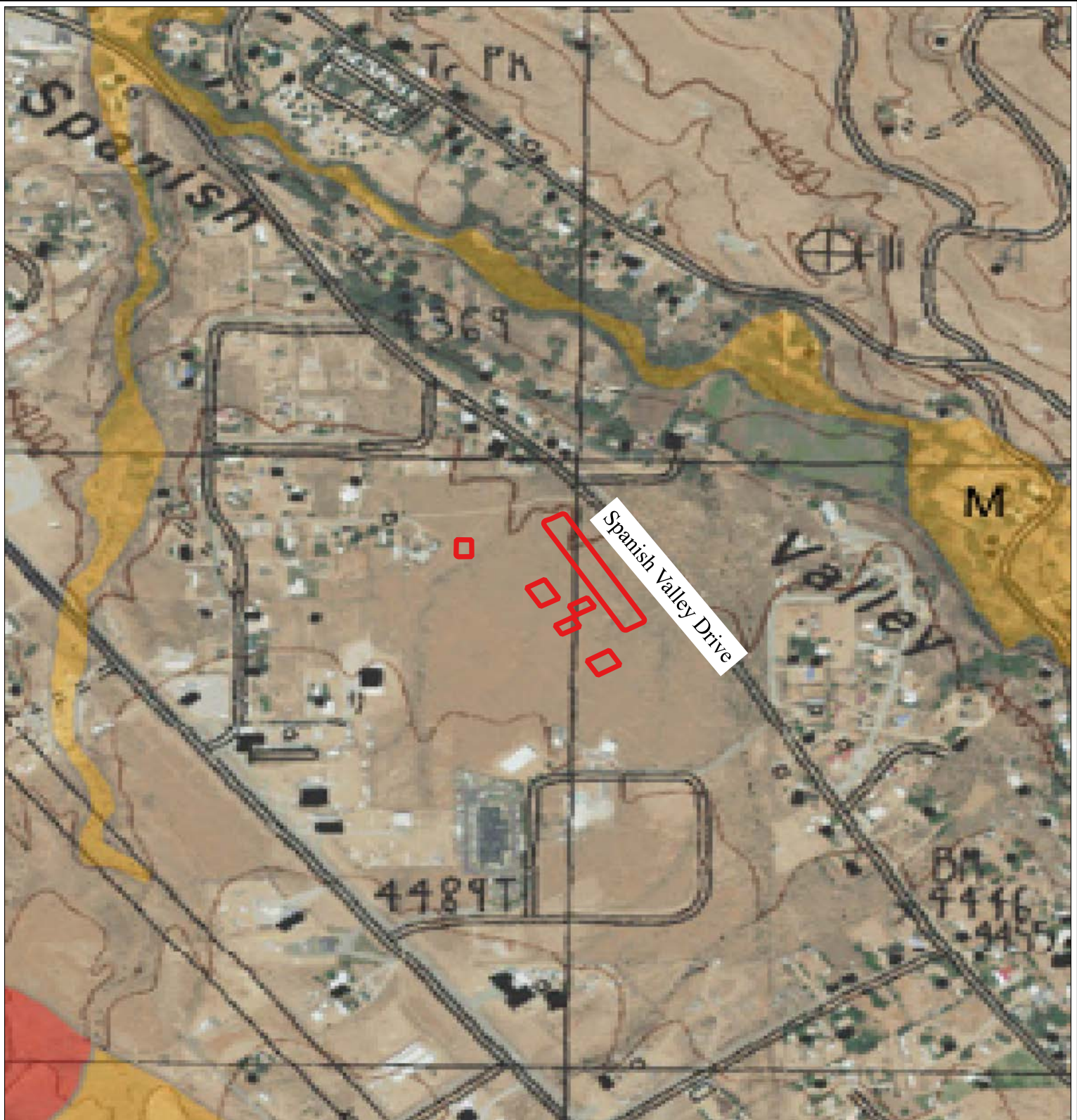
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LOTS
GRAND COUNTY, UTAH

FLOOD HAZARD MAP

Project No: 2021-003

August 2023

FIG. 8



LEGEND

 Site Boundary

Select Abbreviated Descriptions

Hazard is not mapped in the project vicinity.



Source: Plate 4 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



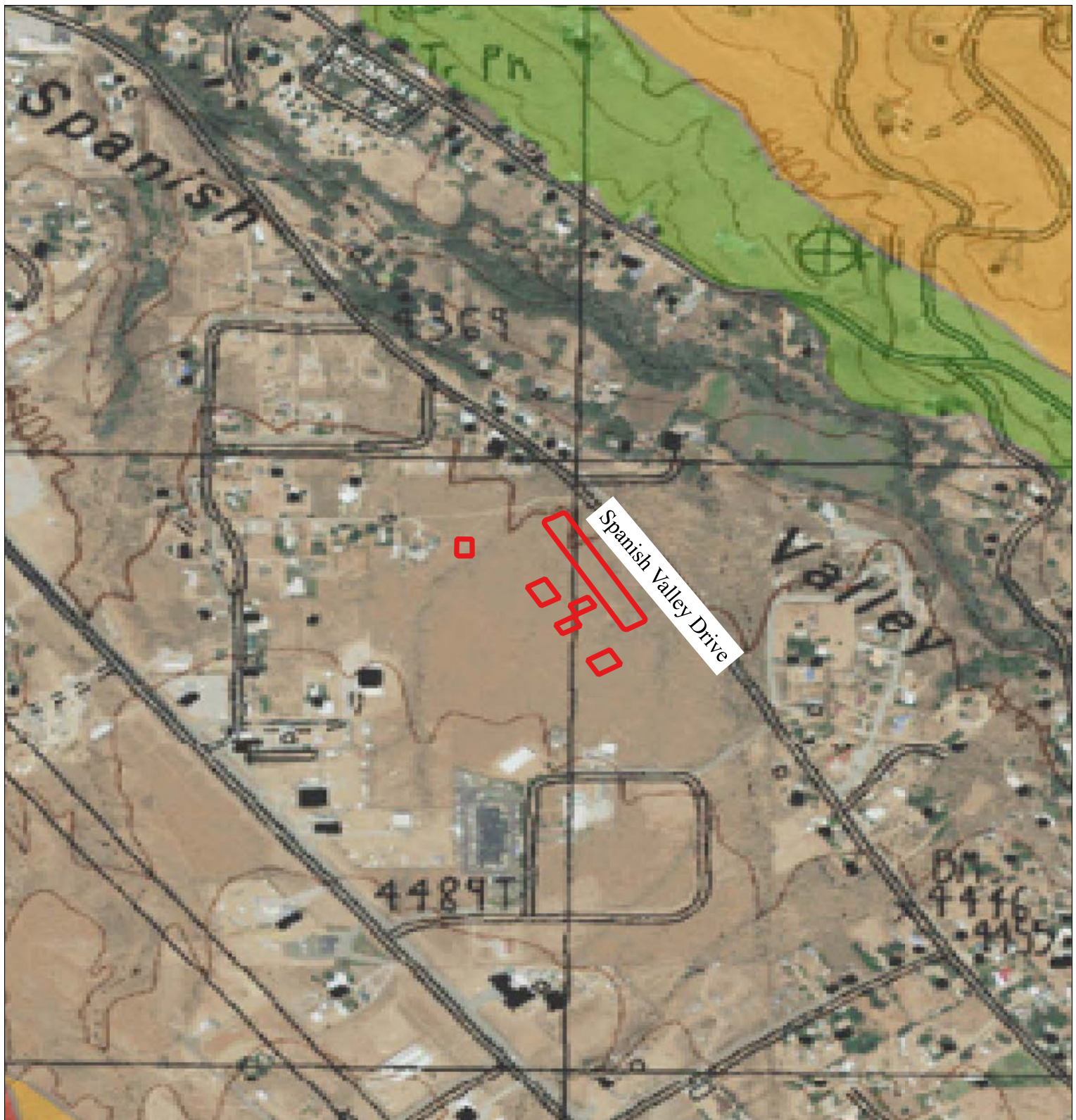
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LOTS
GRAND COUNTY, UTAH

LANDSLIDE
SUSCEPTIBILITY
MAP

Project No: 2021-003

August 2023

FIG. 9



LEGEND

 Site Boundary

Select Abbreviated Descriptions

Hazard is not mapped in the project vicinity.



Source: Plate 5 of 13 from Utah Geological Survey Special Study 162,
Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



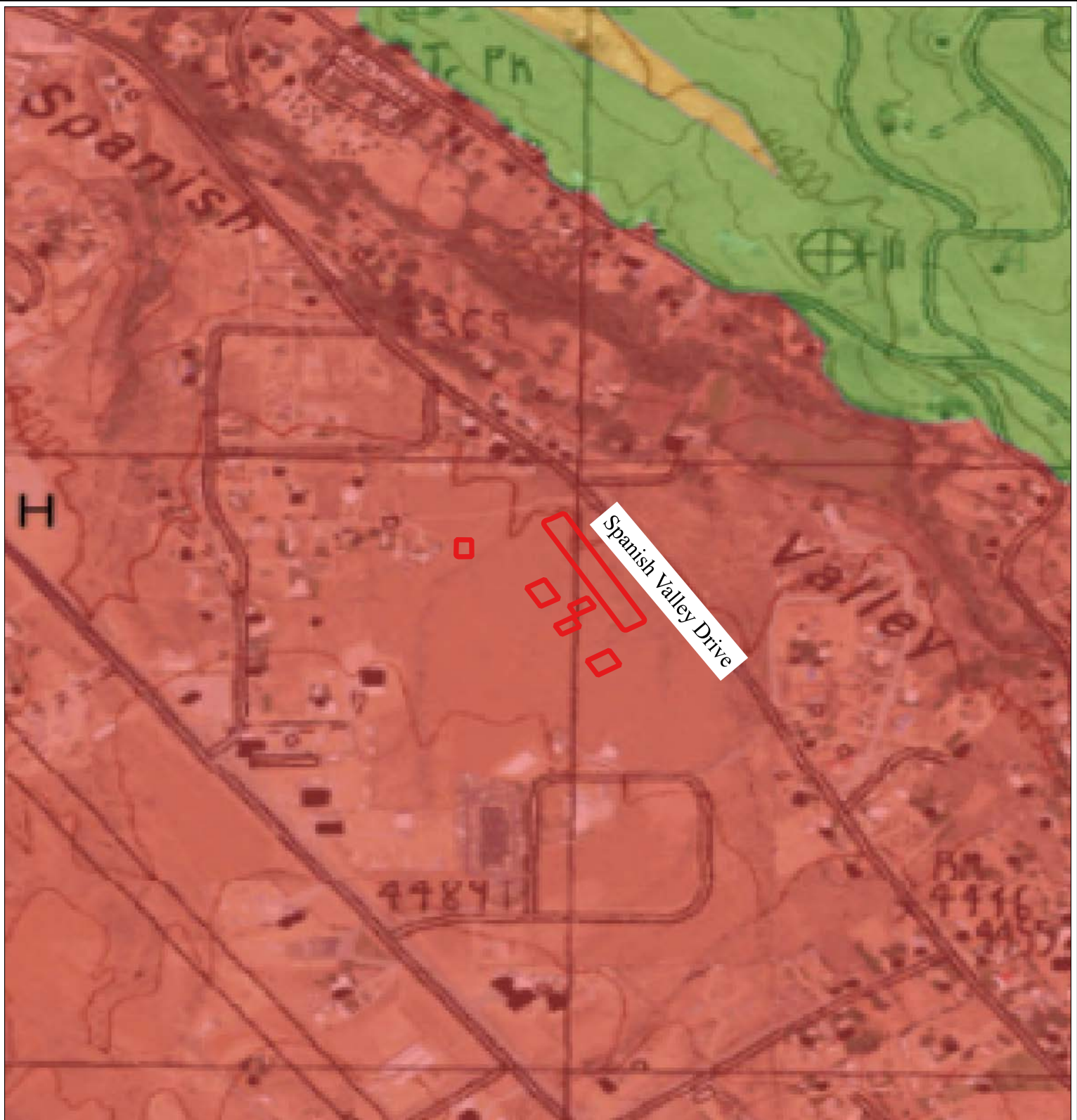
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GRAND COUNTY, UTAH

ROCKFALL HAZARD MAP

Project No: 2021-003

August 2023

FIG. 10



LEGEND

 Site Boundary

Select Abbreviated Descriptions

H: High – Area where probable soil uranium concentrations are greater than 3 parts per million (ppm); groundwater depth is greater than 30 feet below the surface and soil is highly permeable to moderately permeable. Indoor radon testing recommended.



0 400 800 ft



Source: Plate 6 of 13 from Utah Geological Survey Special Study 162,
Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



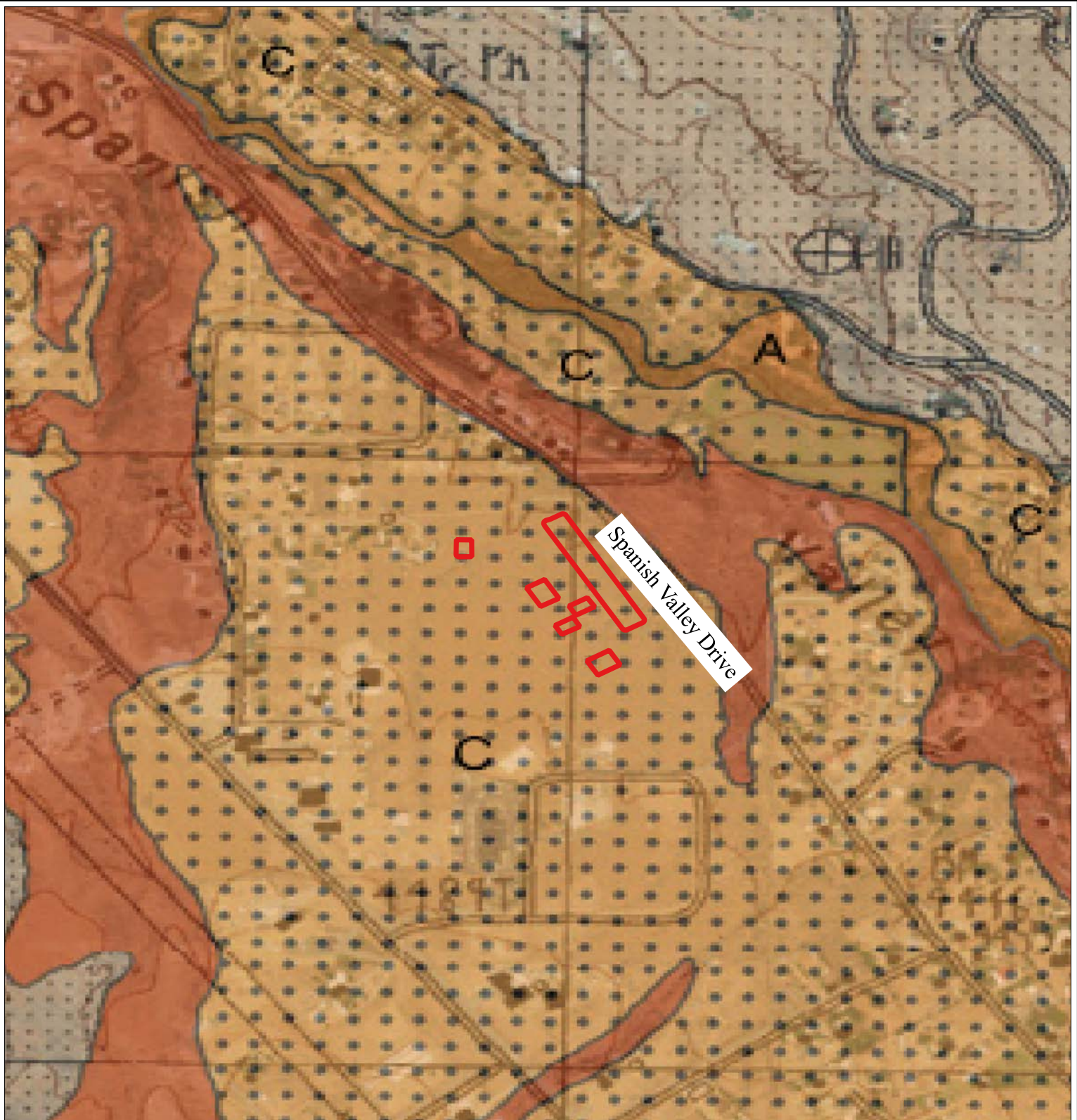
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TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

RADON HAZARD MAP

Project No: 2021-003

August 2023

FIG. 11



LEGEND

 Site Boundary

Select Abbreviated Descriptions

C: Collapsible Soil C – Unconsolidated, young geologic units (Holocene) for which no geotechnical data are available, but which have a genesis or texture susceptible to collapse. In areas continually subjected to saturation or flooding, collapsible soils are unlikely.



Source: Plate 7 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



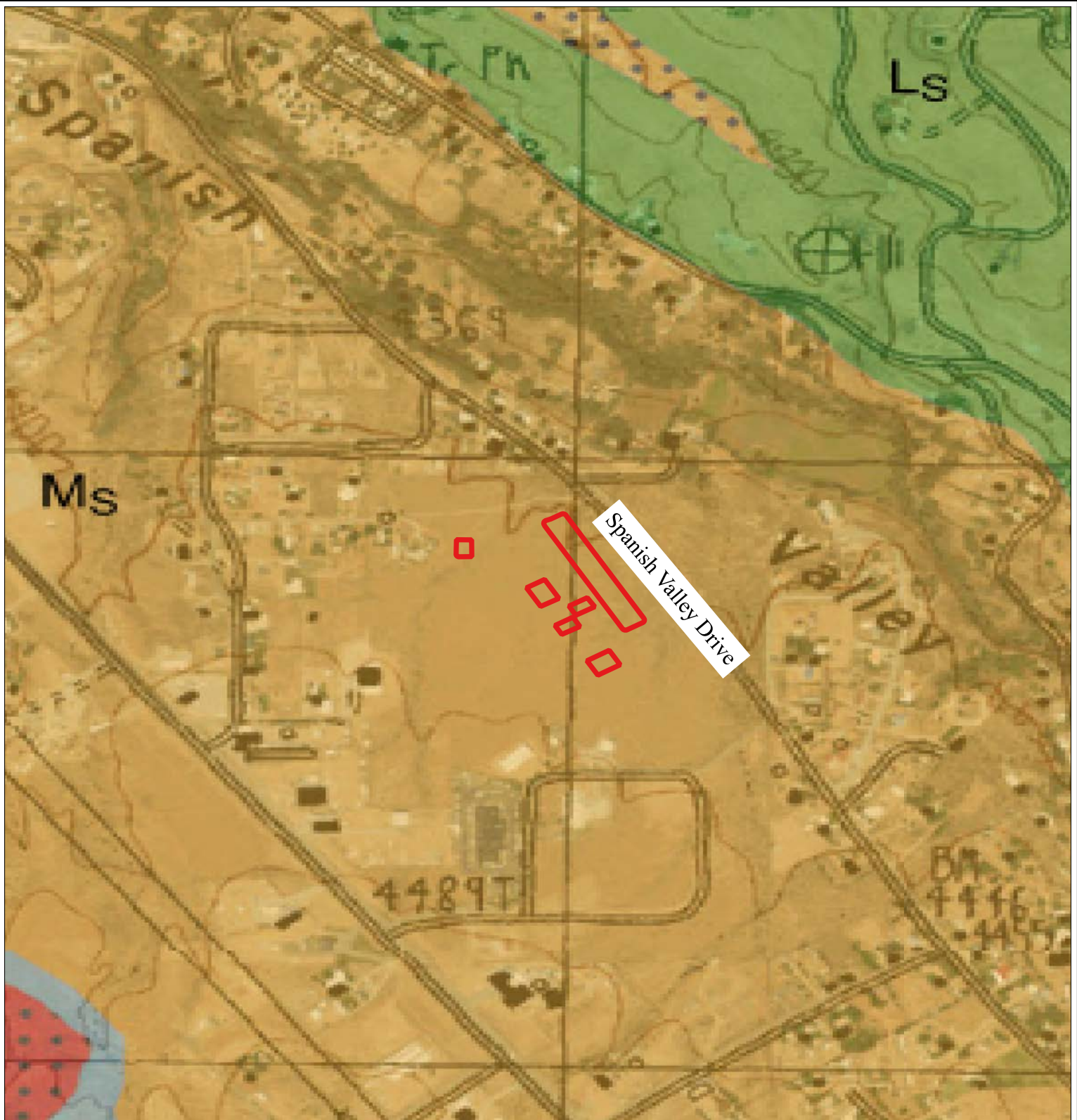
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TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

**COLLAPSIBLE SOIL
SUSCEPTIBILITY MAP**

Project No: 2021-003

August 2023

FIG. 12



LEGEND

 Site Boundary

Select Abbreviated Descriptions

Ms: Moderately susceptible soil (Ms) - Soil classified by the NRCS as having moderate susceptibility for volumetric change; includes concealed clay-rich deposits, including the Chinle Formation, mapped by Doelling and others (2002) in which geotechnical borehole logs indicate thick expansive clay layers are present. Includes geologic bedrock units mapped by Doelling and others (2002) that weather to clay.



Source: Plate 8 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



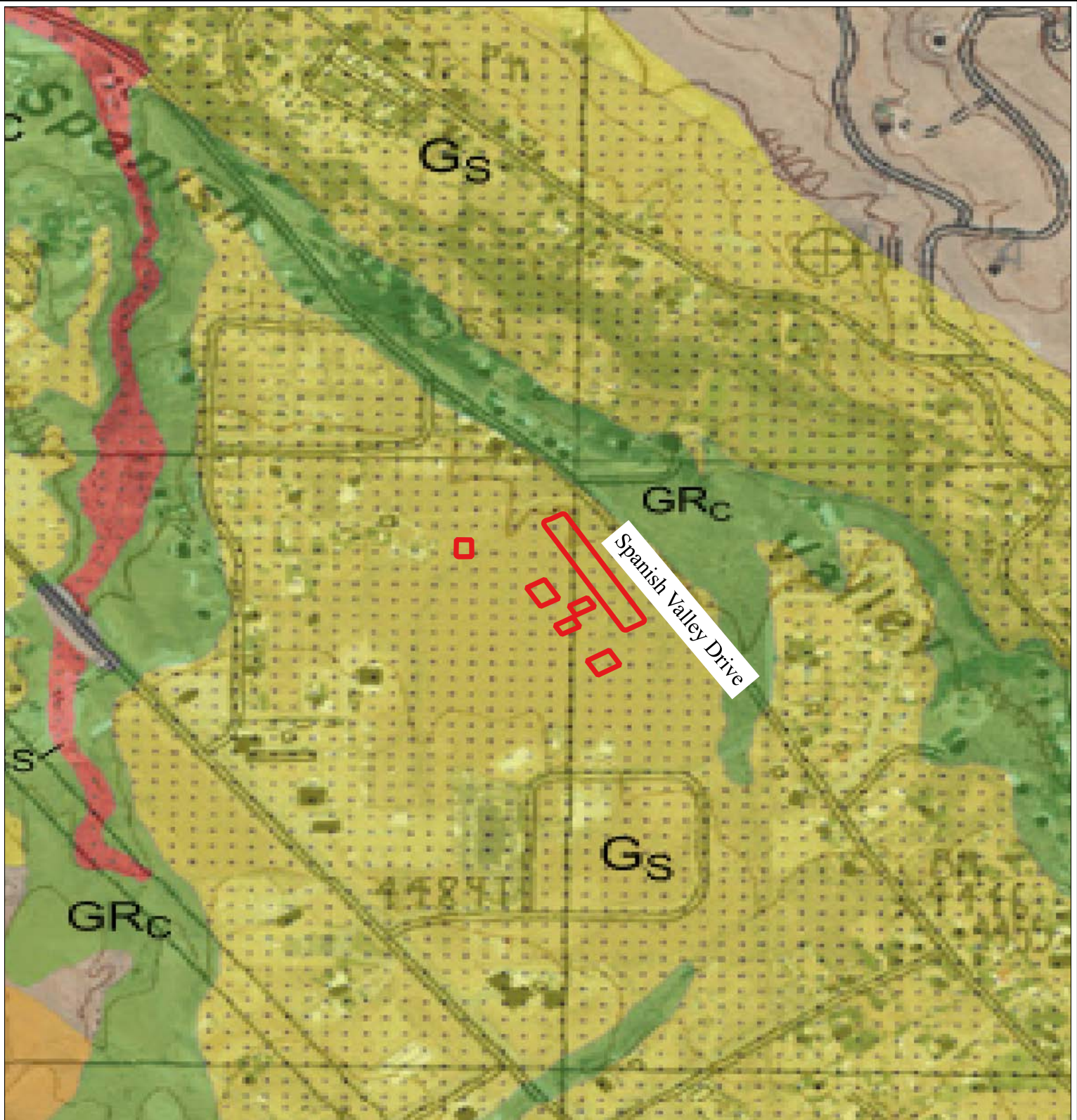
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TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

**EXPANSIVE SOIL
SUSCEPTIBILITY MAP**

Project No: 2021-003

August 2023

FIG. 13



LEGEND

Site Boundary

Select Abbreviated Descriptions

Gs: Gypsiferous Soil – Gypsum-bearing soils as mapped by the Natural Resources Conservation Service (NRCS). The gypsum in these soils is largely pedogenic (formed by dissolution and re-precipitation at depth during the soil formation process) and its presence may not be apparent at the ground surface.



0 400 800 ft



Source: Plate 9 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



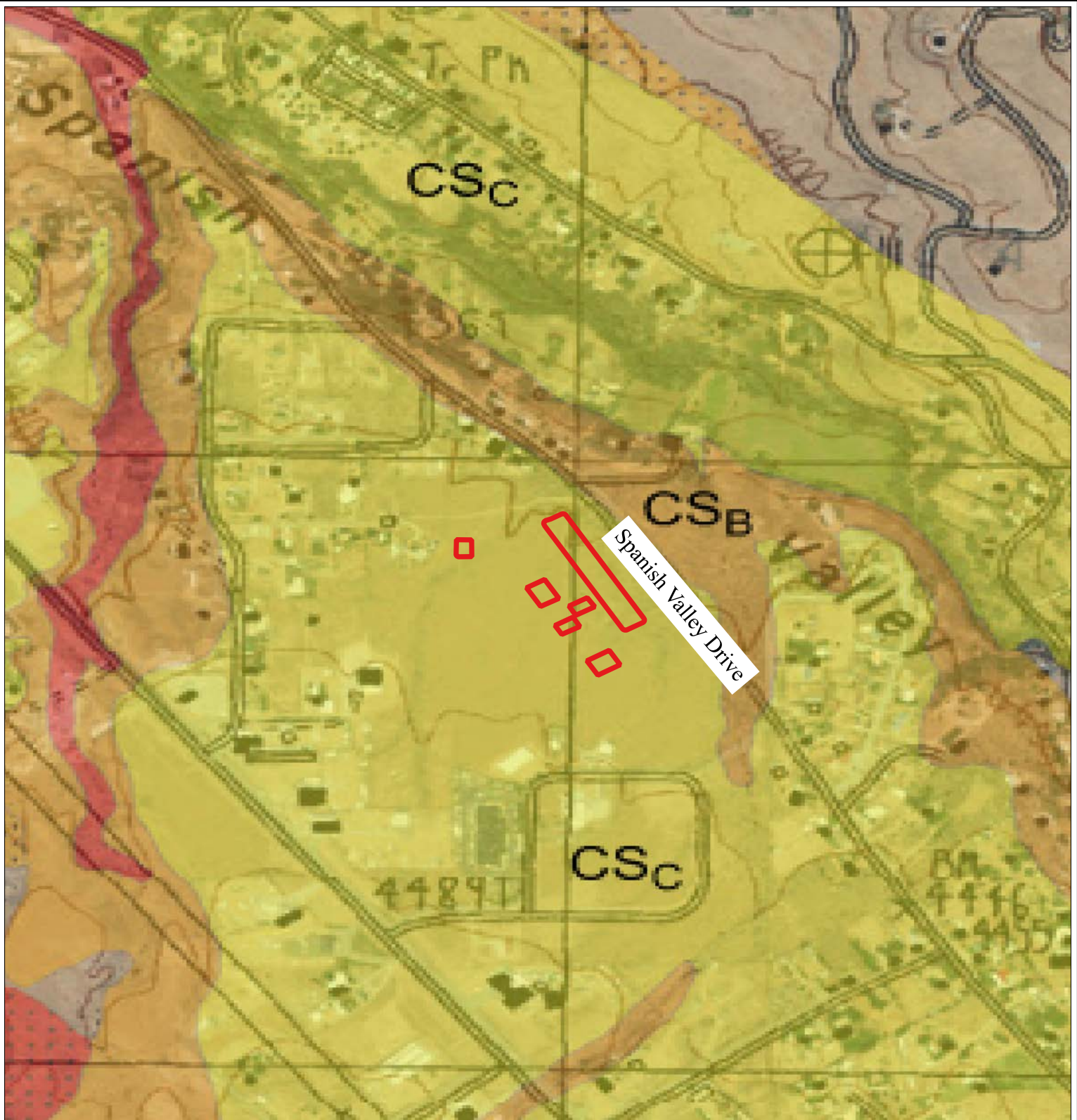
ARROYO CROSSING
TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

**SOLUBLE SOIL AND ROCK
SUSCEPTIBILITY MAP**

Project No: 2021-003

August 2023

FIG. 14



LEGEND

Site Boundary

Select Abbreviated Descriptions

Csc: Corrosive Soil C – Buried or embedded corrosive soil or rock. Areas where talus, colluvium, alluvium, or pediment mantle deposits make up a thin layer above units with high sulfate mineral content and/or the potential for low pH.



0 400 800 ft



Source: Plate 10 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



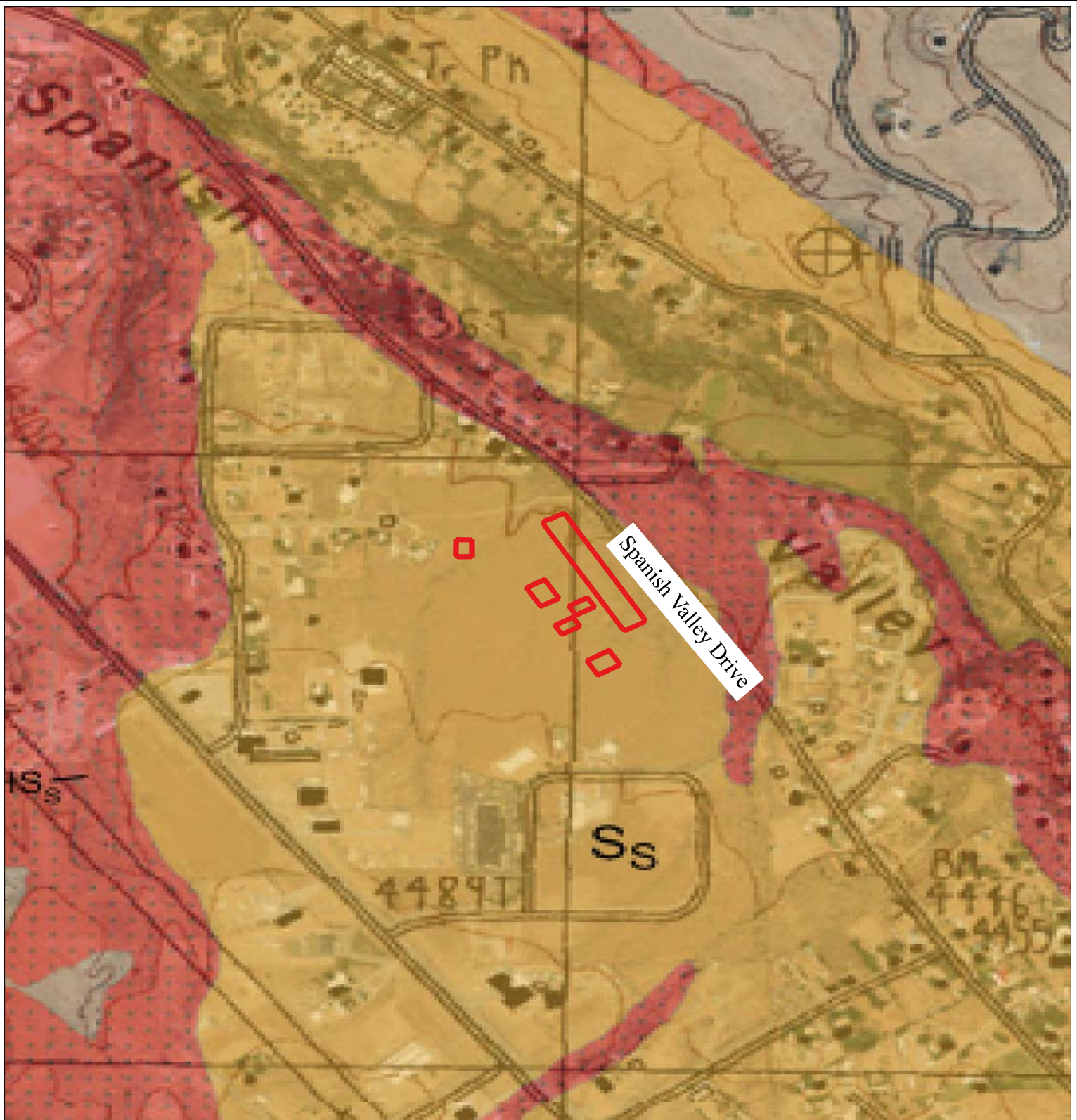
ARROYO CROSSING
TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

**CORROSIVE SOIL AND ROCK
SUSCEPTIBILITY MAP**

Project No: 2021-003

August 2023

FIG. 15



LEGEND

 Site Boundary

Select Abbreviated Descriptions

Ss: Susceptible Soil – Typically, fine-grained, loose to poorly consolidated sand or silt, and landslide deposits consisting of similar materials. For piping to develop, a free face and percolating water are also necessary.



Source: Plate 11 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



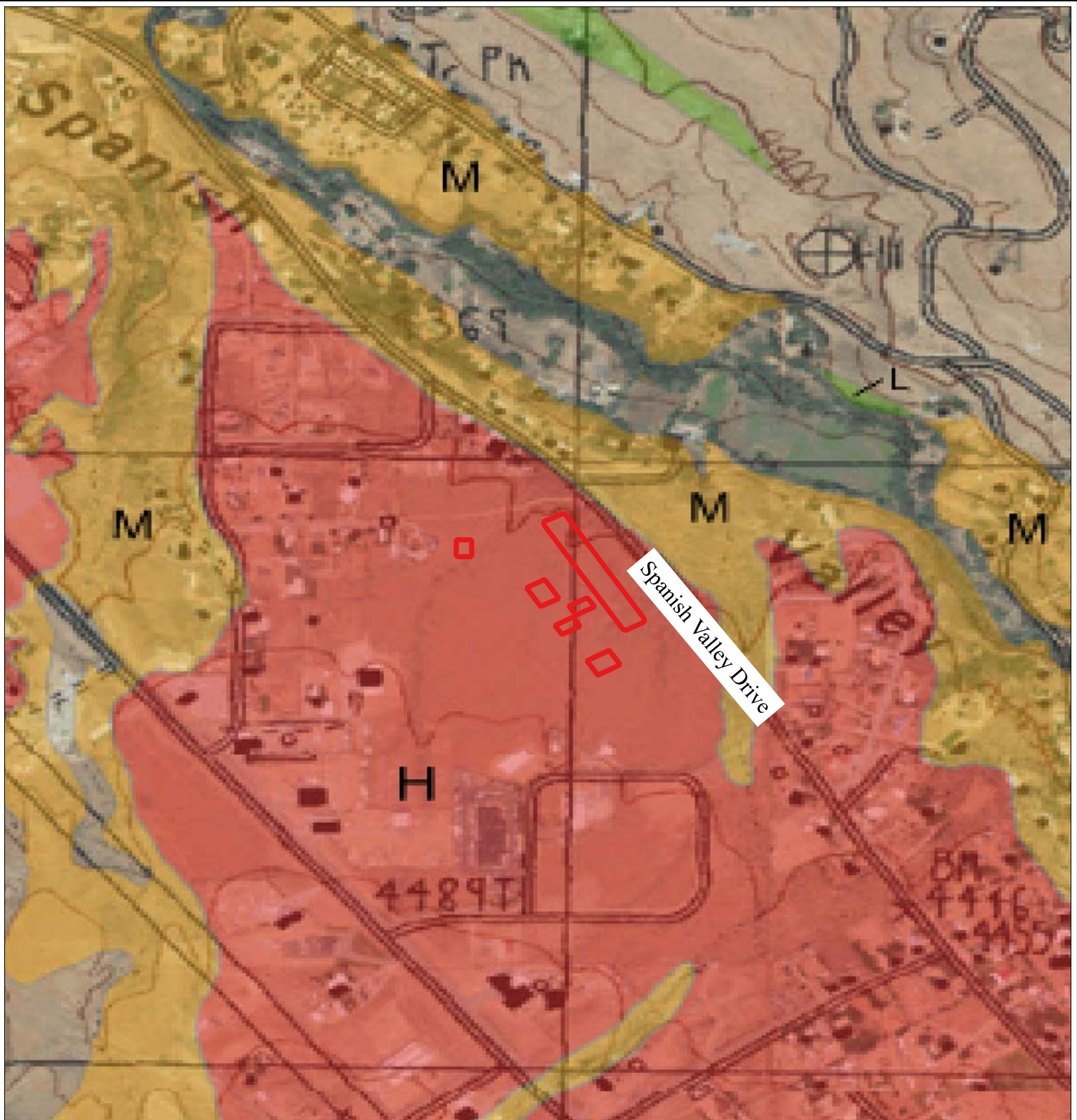
ARROYO CROSSING
TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

**PIPING AND EROSION
SUSCEPTIBILITY MAP**

Project No: 2021-003

August 2023

FIG. 16



LEGEND

 Site Boundary

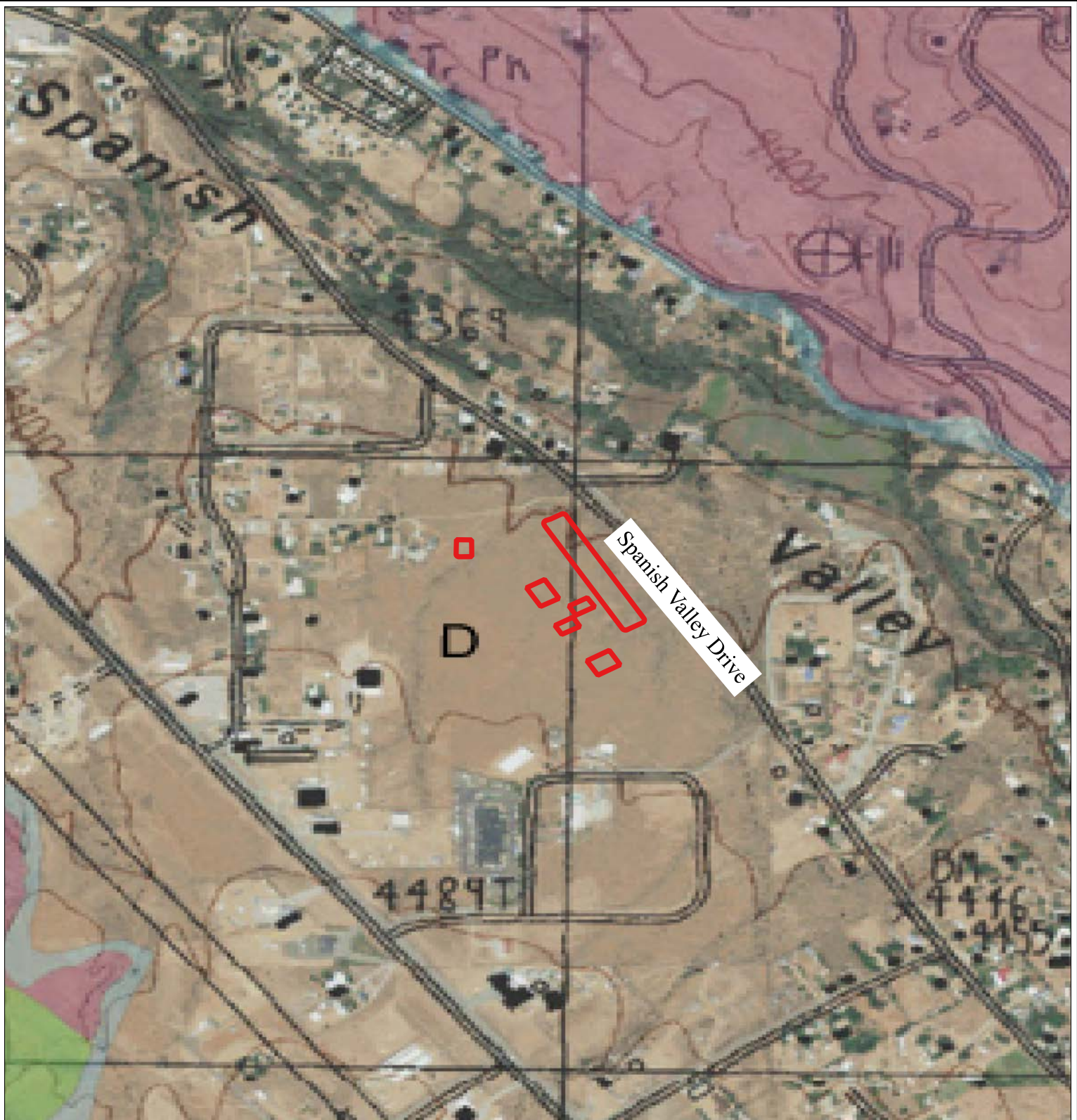
Select Abbreviated Descriptions

H: High – Modern sand-dune or sheet-sand deposits, either active or stabilized by natural vegetation with >50 percent sandy soil deposits. These active wind-blown deposits or reactivated formerly stabilized deposits are highly susceptible to wind erosion and transport. The moving sand may form deposits that can surround structures and bury agricultural fields and transportation corridors.



Source: Plate 12 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000

	ARROYO CROSSING TRACT E & RESIDENTIAL LOTS GRAND COUNTY, UTAH	WIND-BLOWN-SAND SUSCEPTIBILITY MAP	Project No: 2021-003	
			August 2023	FIG. 17



LEGEND

Site Boundary

Select Abbreviated Descriptions

D: Deep – Area where bedrock is likely greater than 10 feet (3 m) beneath the surface.



0 400 800 ft



Source: Plate 13 of 13 from Utah Geological Survey Special Study 162, Geologic Hazards of the Moab Quadrangle, Original Scale: 1:24,000



ARROYO CROSSING
TRACT E & RESIDENTIAL
LOTS
GRAND COUNTY, UTAH

SHALLOW BEDROCK SUSCEPTIBILITY MAP

Project No: 2021-003

August 2023

FIG. 18

APPENDIX A – TEST PIT LOGS

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Key to Log of Boring Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

- 1** Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Material Type: Type of material encountered.
6 Graphic Log: Graphic depiction of the subsurface material encountered.
7 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
8 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
9 Percent Fines: The percent fines (soil passing the No. 200 Sieve) in the sample. WA indicates a Wash Sieve, SA indicates a Sieve Analysis.
10 LL, %: Liquid Limit, expressed as a water content.
11 PI, %: Plasticity Index, expressed as a water content.
12 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
 COMP: Compaction test
 CONS: One-dimensional consolidation test
 LL: Liquid Limit, percent
 PI: Plasticity Index, percent
 SA: Sieve analysis (percent passing No. 200 Sieve)
 UC: Unconfined compressive strength test, Qu, in ksf
 WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

	Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)		Clayey SAND (SC)
	Poorly graded GRAVEL (GP)		Silty SAND (SM)
	SILT, SILT w/SAND, SANDY SILT (ML)		Well graded SAND with Silt (SW-SM)

OTHER GRAPHIC SYMBOLS

- ▽ Water level (at time of drilling, ATD)
 —▽ Water level (after waiting, AW)
 ↓ Minor change in material properties within a stratum
 - - Inferred/gradational contact between strata
 -?- Queried contact between strata

GENERAL NOTES

- 1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
 2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.
 3: psf = pounds per square foot, RQD = Rock Quality Designation, psi = pounds per square inch

Figure A-01

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-01
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 10 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4397
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Grab, Tube	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5427966, -109.5085672 (Tract E)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4397	0			Fill		SILTY SAND (SM) - light reddish brown, dry, with cobbles [FILL]					
		X	ST-01	SM		SILTY SAND WITH GRAVEL (SM) - reddish orange, moist	6.8	33.8			5.1% collapse at 1000 psf inundation load 4.6% collapse at 1500 psf inundation load
4392	5			SM		SILTY SAND (SM) - tan, light brown, moist, trace gravel and cobbles	6.8	26.5			harder at 6-feet
			GB-02								
						oxidation staining					
						increasing cobbles					
4387	10					total depth = 10-feet					

Figure A-02

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-02
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 10 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4401
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Grab	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5424898, -109.5084545 (Tract E)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4401	0			Fill		SILTY SAND (SM) - orangish brown, fine grained, moist, cemented nodules [FILL]					
				SW-SM		SAND WITH SILT AND GRAVEL (SW-SM) - orangish brown, moist					
			GB-01			heavily cemented 3-foot thick layer, reddish gray	6.9	10.9			
4396	5					encountered cobbles, angular					
			GB-02			oxidation staining					
4391	10					total depth = 10-feet					

Figure A-03

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-03
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 11 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4400
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Grab	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5422399, -109.5081001 (Tract E)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4400	0			SM		SILTY SAND (SM) - reddish brown, moist, dry in upper 6 inches, trace gravel, few cemented nodules					
						partially cemented 12-inch-thick seam					harder digging
4395	5		GB-01				6.4	34.5			
						encountered cobbles, purplish brown, subangular oxidation staining					harder digging
4390	10		GB-02	SM		SILTY SAND (SM) - tan, fine grained, moist, cemented nodules					
						total depth = 11-feet					

Figure A-04

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-04
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 11 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4403
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Bulk, Grab	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5418196, -109.5080280 (Tract E)	

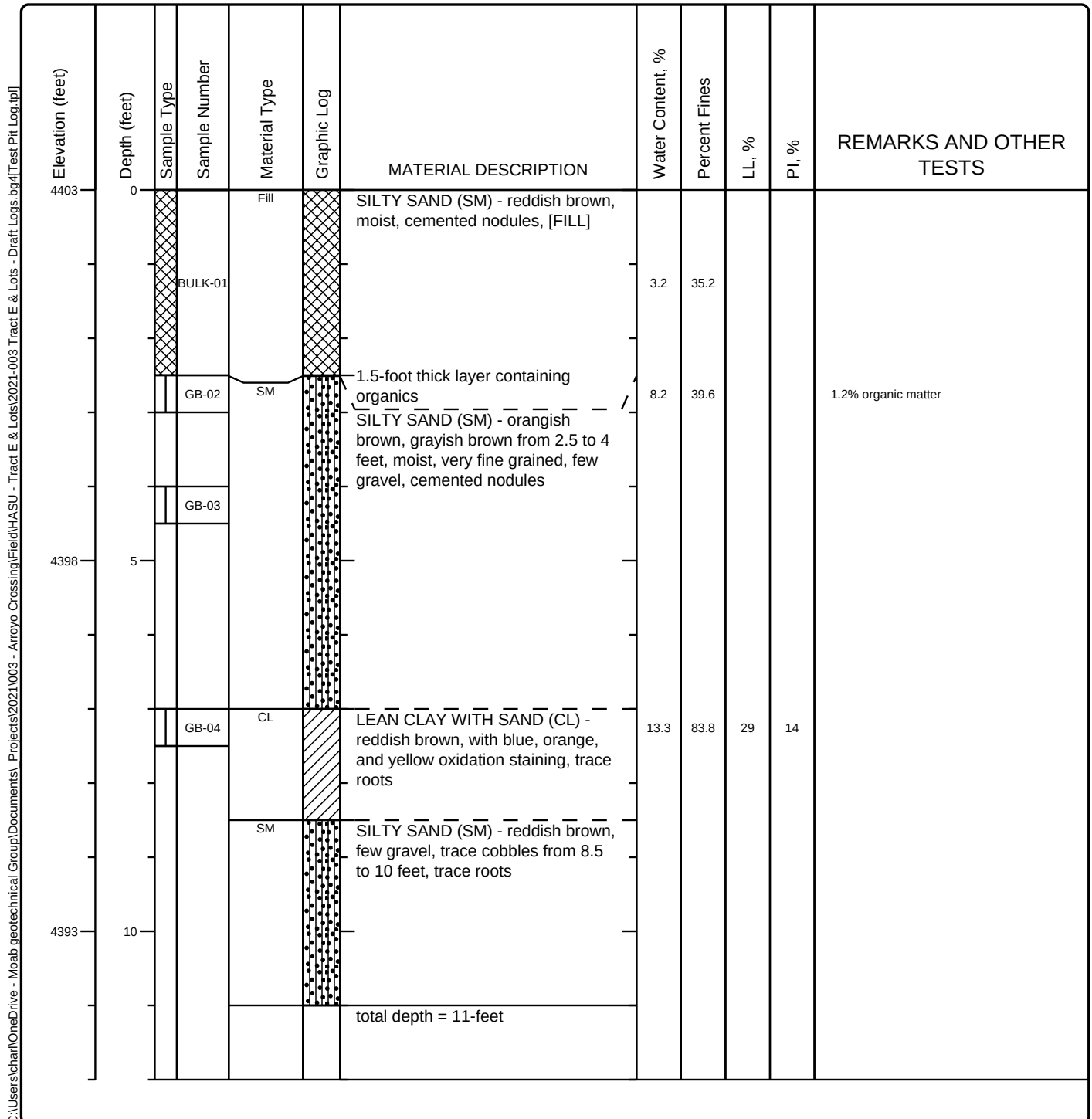


Figure A-05

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-05
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 10 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4403
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Bulk, Grab, Tube	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5416633, -109.5076693 (Tract E)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4403	0			SM		SILTY SAND (SM) - reddish brown, moist, dry in upper 12 inches, trace to few gravel and cobbles, subangular, partially cemented nodules	3.9	31.6			
			BULK-01								
			ST-02				3.6	36.4	17	1	2.7% collapse at 500 psf inundation load 6.2% collapse at 1500 psf inundation load
			GB-03								
4398	5										
			GB-04			increasing silt, no gravel and cobbles, becomes tan with oxidation staining	9.8	46.0			
						encountered large root					
				ML		SANDY SILT (ML) - reddish brown, with yellow, blue and red oxidation staining					
			GB-05			encountered root	11.7	53.1			
4393	10					total depth = 10-feet					

Figure A-06

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-06
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 10 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4407
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Grab	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5413680, -109.5076787 (Tract E)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4407	0			SM		SILTY SAND (SM) - reddish brown, moist, dry in upper 12 inches, few gravel, trace cobbles, subangular, partially cemented nodules					
			GB-01				8.8	33.8			
			GB-02			becomes slightly clayey, increasing cobbles					
4402	5					encountered roots					
						encountered gravel-size evaporite nodule					
4397	10					total depth = 10 feet					

Figure A-07

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-07
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 9.5 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4418
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Grab	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5407800, -109.5078950 (Lot 47)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4418	0			SM		SILTY SAND (SM) - reddish brown in upper 6 inches, yellowish brown, few gravel, angular, partially cemented nodules	7.1	45.9			
			GB-01			encountered cobbles					
				GP		GRAVEL WITH SAND (GP) - purplish tan, moist, some cobbles, rounded	2.9	5.0			
			GB-02								
4413	5					increasing cobbles, few boulders, subangular to rounded					
						becomes orangish tan					
						decreasing cobble content, no boulders					
4408	10					total depth = 9.5 feet					

Figure A-08

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-09
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 8 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4415
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Grab, Tube	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5417050, -109.5088290 (Lot 29)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4415	0			SM		SILTY SAND (SM) - orangish red, moist, dry in upper 18 inches					
			GB-01				5.2	29.7			
			ST-02				2.4	20.1			3.2% collapse at 1000 psf inundation load 2.4% collapse at 1500 psf inundation load
4410	5					becomes heavily cemented					harder digging
						total depth = 8-feet, practical refusal					
4405	10										

Figure A-10

Project: Tract E and Lots 20, 26, 29, 30, 37, 46 & 47 Project Location: Arroyo Crossing, Grand County, Utah Project Number: 2021-003	Log of Boring TP-10 Sheet 1 of 1
---	--

Date(s) Drilled	6/12/2023	Logged By	CAV	Checked By	TQH
Drilling Method	Compact (Mini) Excavator	Drill Bit Size/Type	24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole	6.5 feet bgs
Drill Rig Type	Deere 50G	Drilling Contractor	AW Construction	Approximate Surface Elevation	4414
Groundwater Level and Date Measured	Not Encountered	Sampling Method(s)	Grab, Tube	Hammer Data	
Borehole Backfill	Excavation Spoils	Location	38.5418489, -109.5089718 (Lot 30)		

[illegible]

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-11
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 9.5 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4410
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Grab, Tube	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5424594, -109.5100752 (Lot 37)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4410	0			SM		SILTY SAND (SM) - fine grained, reddish orange, moist, dry in upper 18 inches, partially cemented nodules, roots in upper 18 inches					
			GB-01								
			ST-02				2.4	29.1			1.1 % collapse at 1000 psf inundation load 3.7% collapse at 1500 psf inundation load
4405	5					increasing cementation, becomes orangish-brown	5.5	48.1			
			GB-03								
4400	10					total depth = 9.5-feet					

Figure A-12

Project: **Tract E and Lots 20, 26, 29, 30, 37, 46 & 47**
 Project Location: **Arroyo Crossing, Grand County, Utah**
 Project Number: **2021-003**

Log of Boring TP-12
Sheet 1 of 1

Date(s) Drilled 6/12/2023	Logged By CAV	Checked By TQH
Drilling Method Compact (Mini) Excavator	Drill Bit Size/Type 24-inch-wide Bucket with Tiger Teeth	Total Depth of Borehole 9.5 feet bgs
Drill Rig Type Deere 50G	Drilling Contractor AW Construction	Approximate Surface Elevation 4407
Groundwater Level and Date Measured Not Encountered	Sampling Method(s) Bulk, Grab	Hammer Data
Borehole Backfill Excavation Spoils	Location 38.5415750, -109.5083020 (Lot 20)	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Percent Fines	LL, %	PI, %	REMARKS AND OTHER TESTS
4407	0			SM		SILTY SAND (SM) - reddish brown, moist, very dry and loose in upper 6-inches, slightly clayey, trace to few gravel, partially cemented nodules	4.1	35.1			
			BULK-01								
						becomes reddish orange	4.9	26.3			easier digging
			GB-02								
4402	5					encountered cobbles, angular					harder digging
			GB-03								
						decreasing cobbles and less cementation					easier digging
4397	10					total depth = 9.5 feet					

Figure A-13

APPENDIX B – LABORATORY TEST RESULTS

Table of Contents

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Gradation.....	B-4
Modified Proctor.....	B-27
Collapse/Swell.....	B-29
Organic Content.....	B-38
Corrosion and Resistivity.....	B-39

Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/13/2023

By: BRR

Grooving tool type: Plastic

Liquid limit device: Mechanical

Rolling method: Hand

Boring No.: TP-04

Sample: GB-04

Depth: 7-7.5'

Description: Reddish brown lean clay

Preparation method: Wet

Liquid limit test method: Multipoint

Screened over No.40: Yes

Larger particles removed: Wet sieved

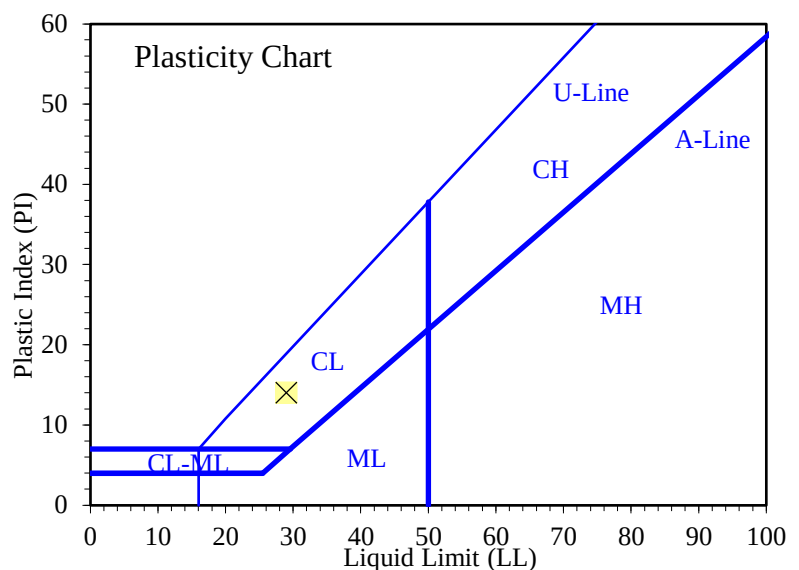
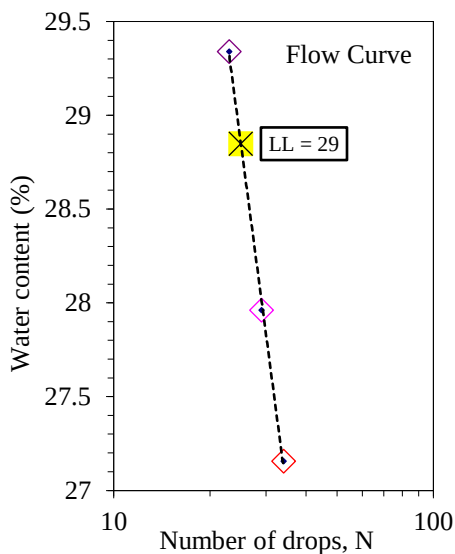
Plastic Limit

Determination No	1	2				
Wet Soil + Tare (g)	13.56	14.63				
Dry Soil + Tare (g)	12.69	13.63				
Water Loss (g)	0.87	1.00				
Tare (g)	7.04	7.02				
Dry Soil (g)	5.65	6.61				
Water Content, w (%)	15.40	15.13				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	29	23			
Wet Soil + Tare (g)	13.96	14.00	13.69			
Dry Soil + Tare (g)	12.48	12.56	12.27			
Water Loss (g)	1.48	1.44	1.42			
Tare (g)	7.03	7.41	7.43			
Dry Soil (g)	5.45	5.15	4.84			
Water Content, w (%)	27.16	27.96	29.34			
One-Point LL (%)		28	29			

Liquid Limit, LL (%)	29
Plastic Limit, PL (%)	15
Plasticity Index, PI (%)	14



Entered by: _____

Reviewed: _____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/14/2023

By: BRR

Grooving tool type: Plastic

Liquid limit device: Mechanical

Rolling method: Hand

Boring No.: TP-05

Sample: ST-02

Depth: 3-4'

Description: Reddish brown silt

Preparation method: Wet

Liquid limit test method: Multipoint

Screened over No.40: Yes

Larger particles removed: Wet sieved

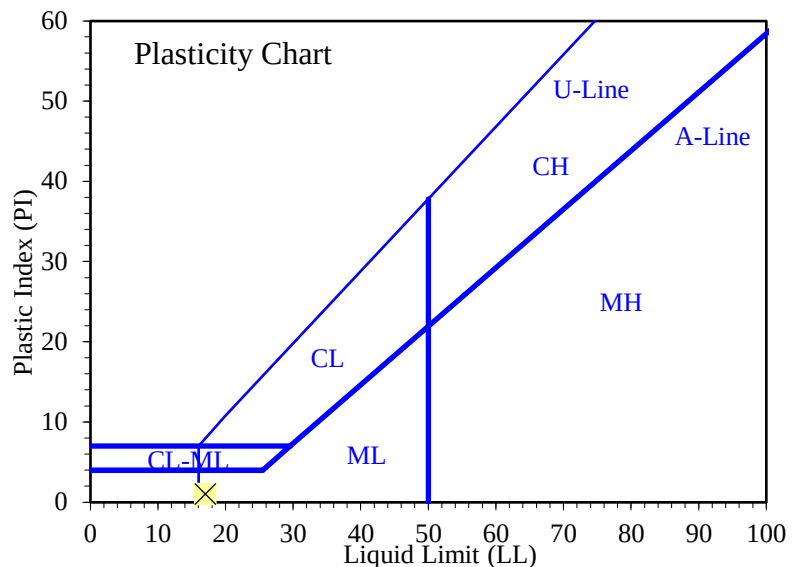
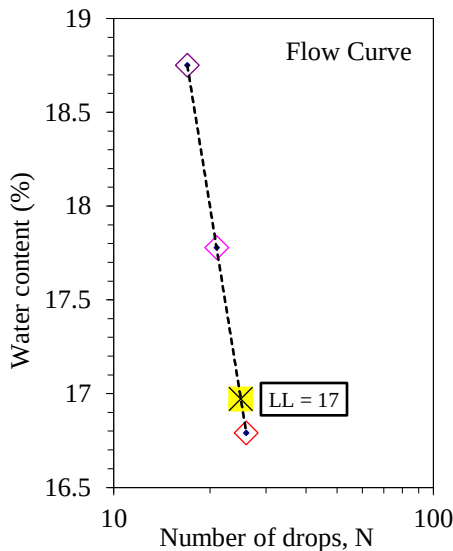
Plastic Limit

Determination No	1	2				
Wet Soil + Tare (g)	13.31	13.17				
Dry Soil + Tare (g)	12.46	12.34				
Water Loss (g)	0.85	0.83				
Tare (g)	7.05	7.10				
Dry Soil (g)	5.41	5.24				
Water Content, w (%)	15.71	15.84				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	26	21	17			
Wet Soil + Tare (g)	13.40	13.94	13.70			
Dry Soil + Tare (g)	12.49	12.90	12.71			
Water Loss (g)	0.91	1.04	0.99			
Tare (g)	7.07	7.05	7.43			
Dry Soil (g)	5.42	5.85	5.28			
Water Content, w (%)	16.79	17.78	18.75			
One-Point LL (%)	17	17				

Liquid Limit, LL (%)	17
Plastic Limit, PL (%)	16
Plasticity Index, PI (%)	1



Entered by: _____

Reviewed: _____

Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/14/2023

By: BRR

Grooving tool type: Plastic

Liquid limit device: Mechanical

Rolling method: Hand

Boring No.: TP-08

Sample: GB-02

Depth: 3-3.5'

Description: Reddish brown silt

Preparation method: Wet

Liquid limit test method: Multipoint

Screened over No.40: Yes

Larger particles removed: Wet sieved

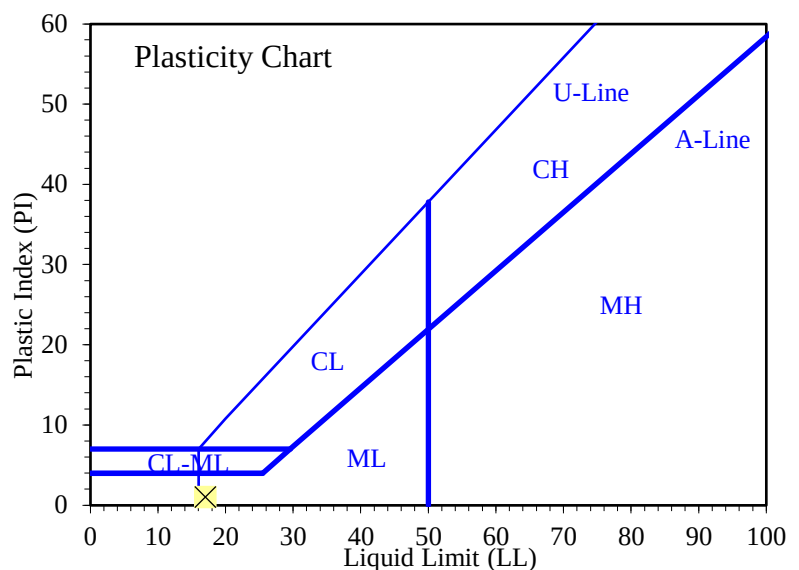
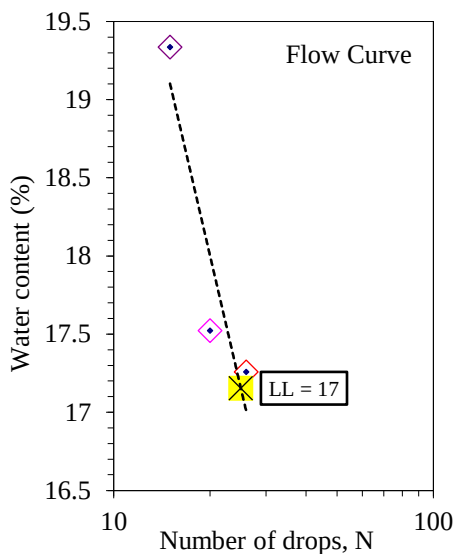
Plastic Limit

Determination No	1	2				
Wet Soil + Tare (g)	15.19	14.98				
Dry Soil + Tare (g)	14.08	13.93				
Water Loss (g)	1.11	1.05				
Tare (g)	7.06	7.09				
Dry Soil (g)	7.02	6.84				
Water Content, w (%)	15.81	15.35				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	26	20	15			
Wet Soil + Tare (g)	14.27	13.60	15.24			
Dry Soil + Tare (g)	13.20	12.61	13.96			
Water Loss (g)	1.07	0.99	1.28			
Tare (g)	7.00	6.96	7.34			
Dry Soil (g)	6.20	5.65	6.62			
Water Content, w (%)	17.26	17.52	19.34			
One-Point LL (%)	17	17				

Liquid Limit, LL (%)	17
Plastic Limit, PL (%)	16
Plasticity Index, PI (%)	1



Entered by: _____

Reviewed: _____

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/13/2023

By: BRR

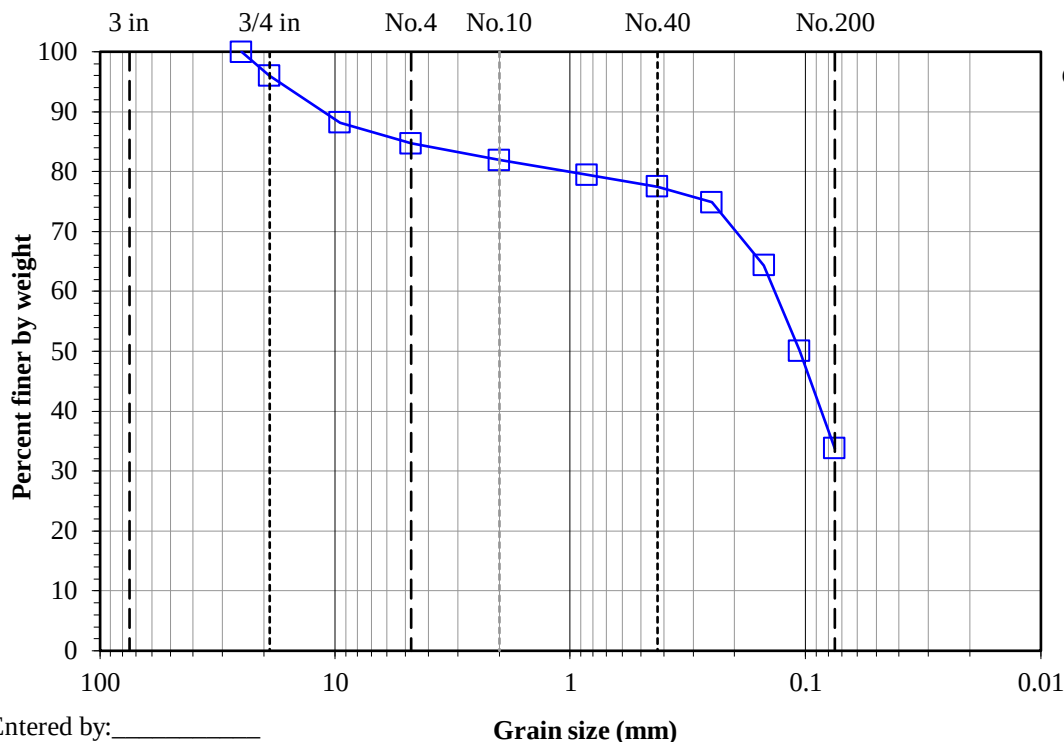
Boring No.: TP-01

Sample: ST-01

Depth: 3-4'

Description: Reddish brown silty sand with gravel

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 606.98 570.58 +3/8" Coarse fraction (g): 69.62 67.37 -3/8" Split fraction (g): 282.65 264.69 Split fraction: 0.882				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 198.43 422.66 Dry soil + tare (g): 196.01 404.70 Tare (g): 123.59 140.01 Water content (%): 3.3 6.8	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	100.0		
3/4"	22.76	19	96.0		
3/8"	67.37	9.5	88.2		
No.4	10.54	4.75	84.7		
No.10	18.87	2	81.9		
No.20	26.18	0.85	79.5		
No.40	32.12	0.425	77.5		
No.60	39.98	0.25	74.9		
No.100	71.52	0.15	64.4		
No.140	114.45	0.106	50.1		
No.200	163.29	0.075	33.8		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/7/2023

By: LM

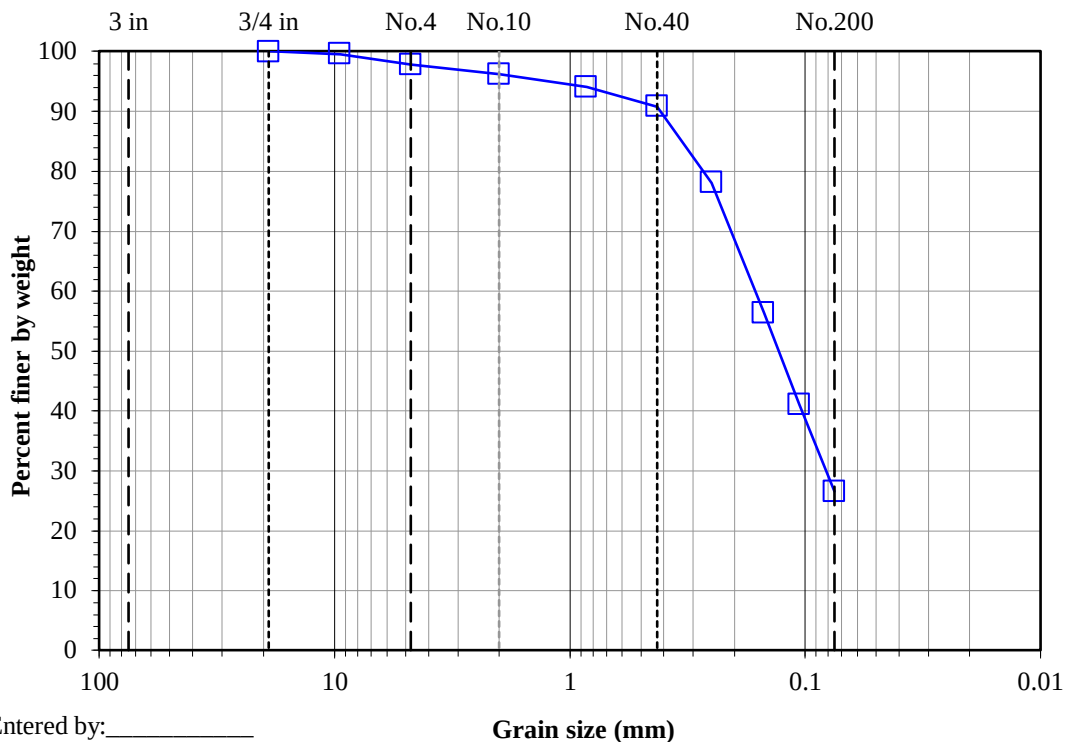
Boring No.: TP-01

Sample: GB-02

Depth: 6-7'

Description: Red silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 3276.86 3068.80 +3/8" Coarse fraction (g): 12.85 12.45 -3/8" Split fraction (g): 211.88 198.40 Split fraction: 0.996				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 38.12 340.54 Dry soil + tare (g): 37.72 327.06 Tare (g): 25.27 128.66 Water content (%): 3.2 6.8	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	100.0		
3/8"	12.45	9.5	99.6		
No.4	3.55	4.75	97.8		
No.10	6.70	2	96.2		
No.20	10.98	0.85	94.1		
No.40	17.47	0.425	90.8		
No.60	42.76	0.25	78.1		
No.100	86.05	0.15	56.4		
No.140	116.51	0.106	41.1		
No.200	145.52	0.075	26.5		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/11/2023

By: JJ

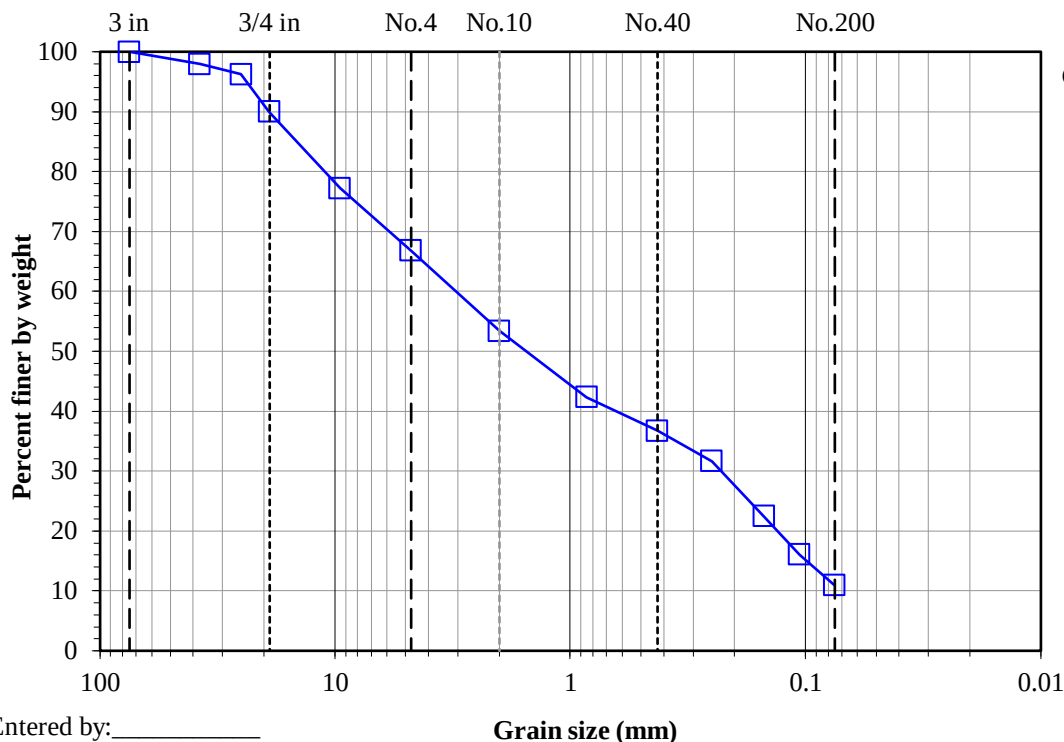
Boring No.: TP-02

Sample: GB-01

Depth: 3-3.5'

Description: Red sand with silt and gravel

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 3672.1 3445.9 +3/8" Coarse fraction (g): 827.16 785.68 -3/8" Split fraction (g): 275.08 257.22 Split fraction: 0.772				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 1137.26 428.29 Dry soil + tare (g): 1095.79 410.43 Tare (g): 310.33 153.21 Water content (%): 5.3 6.9	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	←Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	100.0		
1.5"	71.52	37.5	97.9		
1"	130.59	25	96.2		
3/4"	344.37	19	90.0		
3/8"	785.68	9.5	77.2		
No.4	34.71	4.75	66.8		
No.10	79.27	2	53.4		
No.20	116.22	0.85	42.3		
No.40	134.87	0.425	36.7		
No.60	151.77	0.25	31.6		
No.100	182.29	0.15	22.5		
No.140	203.80	0.106	16.0		
No.200	220.84	0.075	10.9		



Gravel (%): 33.2

Sand (%): 55.9

Fines (%): 10.9

Comments:

These results are in nonconformance with Method D6913 because the minimum dry mass was not met.

Entered by: _____

Reviewed: _____

Z:\PROJECTS\M03898_Moab_Geotechnical_Group\038_Arroyo_Crossing\GSDv2.xlsm]3

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/13/2023

By: JJ

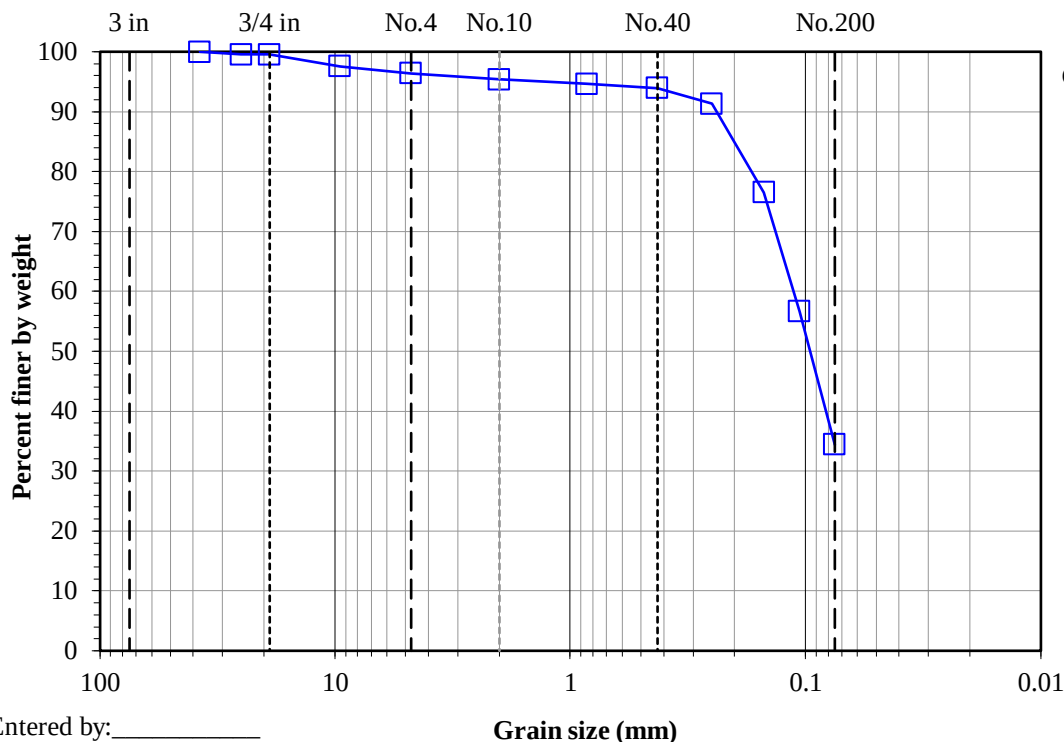
Boring No.: TP-03

Sample: GB-01

Depth: 5-5.5'

Description: Red silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4193.3 3944.0 +3/8" Coarse fraction (g): 100.59 96.06 -3/8" Split fraction (g): 217.91 204.88 Split fraction: 0.976				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 228.49 339.33 Dry soil + tare (g): 223.96 326.30 Tare (g): 127.96 121.42 Water content (%): 4.7 6.4	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	←Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	100.0		
1"	18.80	25	99.5		
3/4"	18.80	19	99.5		
3/8"	96.06	9.5	97.6		
No.4	2.44	4.75	96.4		
No.10	4.57	2	95.4		
No.20	6.11	0.85	94.7		
No.40	7.61	0.425	93.9		
No.60	13.11	0.25	91.3		
No.100	44.24	0.15	76.5		
No.140	85.94	0.106	56.6		
No.200	132.44	0.075	34.5		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/12/2023

By: JJ

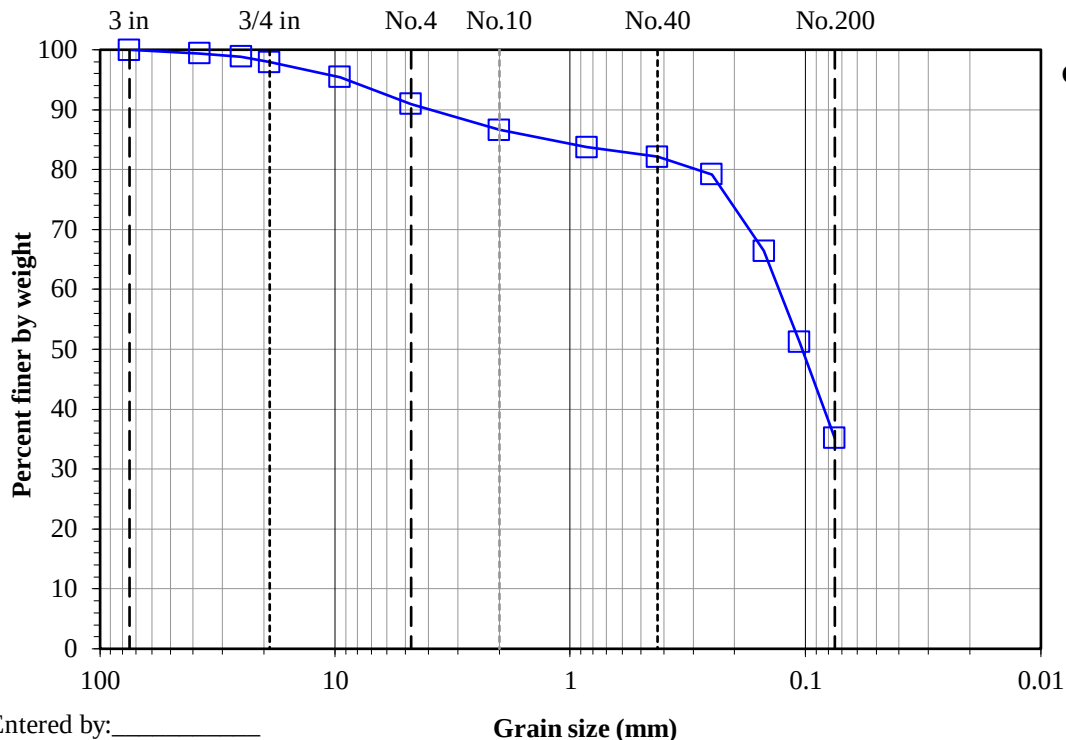
Boring No.: TP-04

Sample: BULK-01

Depth: 0-2.5'

Description: Brown silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 22217.7 21538.4 +3/8" Coarse fraction (g): 1000.02 986.88 -3/8" Split fraction (g): 267.23 258.84 Split fraction: 0.954				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 540.66 388.65 Dry soil + tare (g): 535.22 380.26 Tare (g): 126.69 121.42 Water content (%): 1.3 3.2	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	100.0		
1.5"	129.25	37.5	99.4		
1"	242.86	25	98.9		
3/4"	441.78	19	97.9		
3/8"	986.88	9.5	95.4		
No.4	12.19	4.75	90.9		
No.10	23.88	2	86.6		
No.20	31.65	0.85	83.8		
No.40	36.10	0.425	82.1		
No.60	44.00	0.25	79.2		
No.100	78.69	0.15	66.4		
No.140	120.01	0.106	51.2		
No.200	163.41	0.075	35.2		



Gravel (%): 9.1
Sand (%): 55.7
Fines (%): 35.2

Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/12/2023

By: JJ

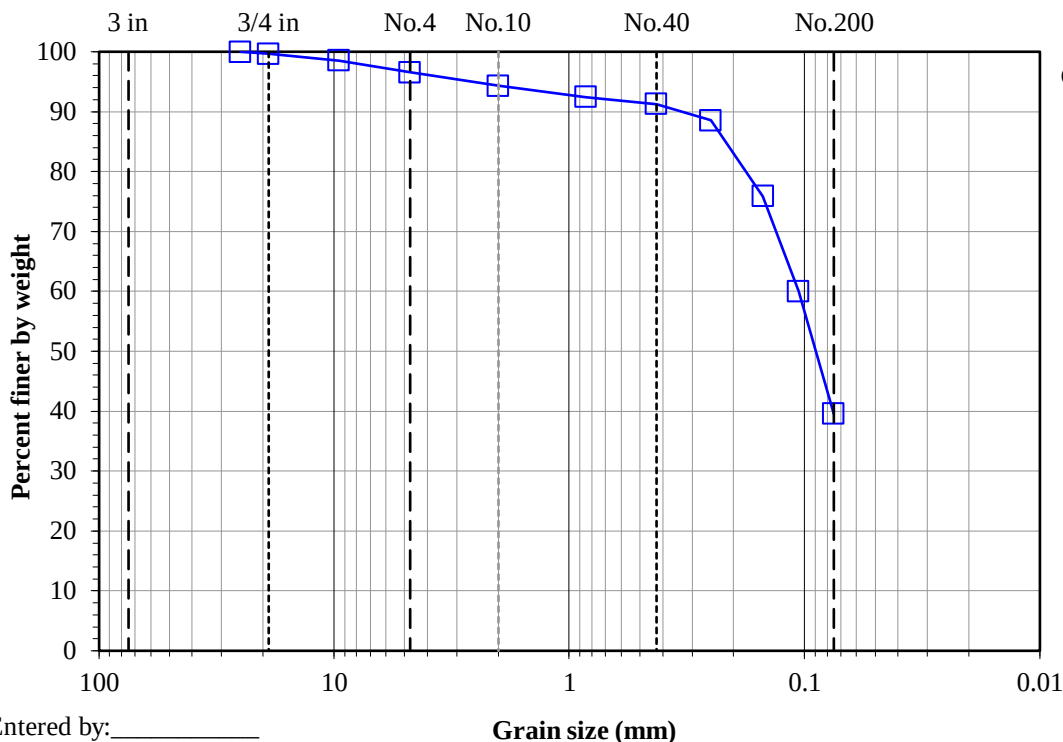
Boring No.: TP-04

Sample: GB-02

Depth: 3-3.5'

Description: Red silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4274.6 3951.5 +3/8" Coarse fraction (g): 59.93 57.54 -3/8" Split fraction (g): 242.18 223.75 Split fraction: 0.985				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 213.84 364.95 Dry soil + tare (g): 211.46 346.52 Tare (g): 154.04 122.77 Water content (%): 4.1 8.2	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	100.0		
3/4"	13.56	19	99.7		
3/8"	57.54	9.5	98.5		
No.4	4.55	4.75	96.5		
No.10	9.66	2	94.3		
No.20	13.82	0.85	92.5		
No.40	16.55	0.425	91.3		
No.60	22.71	0.25	88.5		
No.100	51.48	0.15	75.9		
No.140	87.47	0.106	60.0		
No.200	133.85	0.075	39.6		



Gravel (%): 3.5
Sand (%): 56.9
Fines (%): 39.6

Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/13/2023

By: JJ

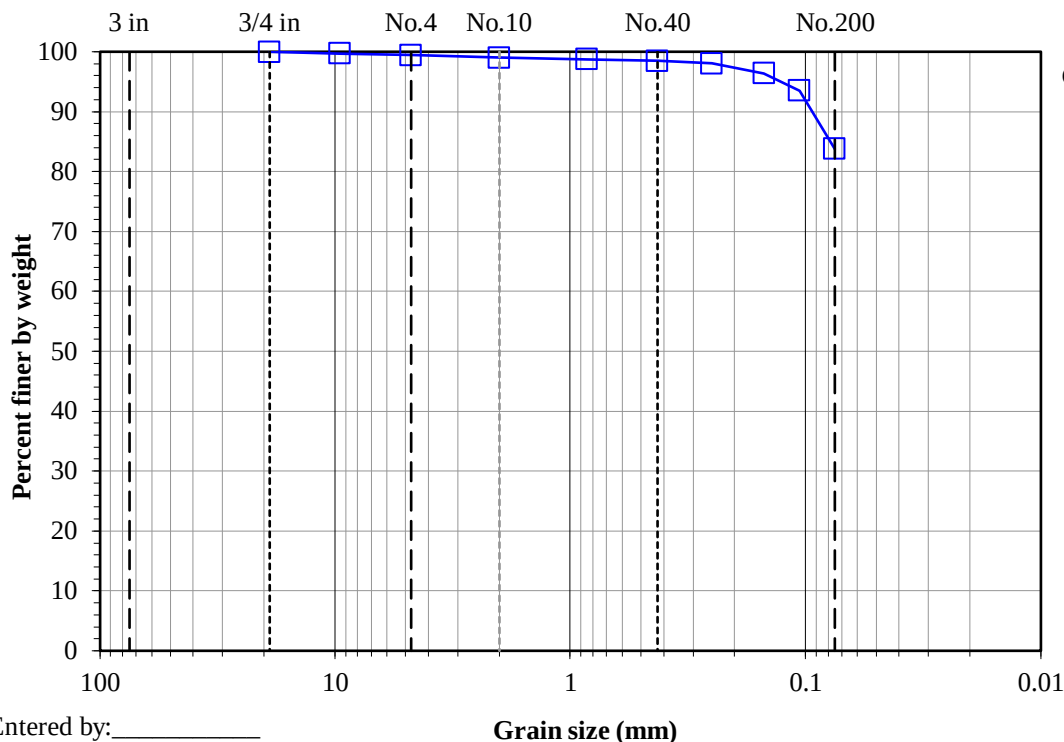
Boring No.: TP-04

Sample: GB-04

Depth: 7-7.5'

Description: Reddish brown lean clay with sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4154.4 3667.6 +3/8" Coarse fraction (g): 12.13 11.70 -3/8" Split fraction (g): 247.64 218.56 Split fraction: 0.997				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 138.51 372.65 Dry soil + tare (g): 138.07 343.57 Tare (g): 126.19 125.01 Water content (%): 3.7 13.3	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	←Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	100.0		
3/8"	11.70	9.5	99.7		
No.4	0.53	4.75	99.4		
No.10	1.43	2	99.0		
No.20	2.10	0.85	98.7		
No.40	2.60	0.425	98.5		
No.60	3.54	0.25	98.1		
No.100	7.26	0.15	96.4		
No.140	13.48	0.106	93.5		
No.200	34.88	0.075	83.8		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/10/2023

By: JJ

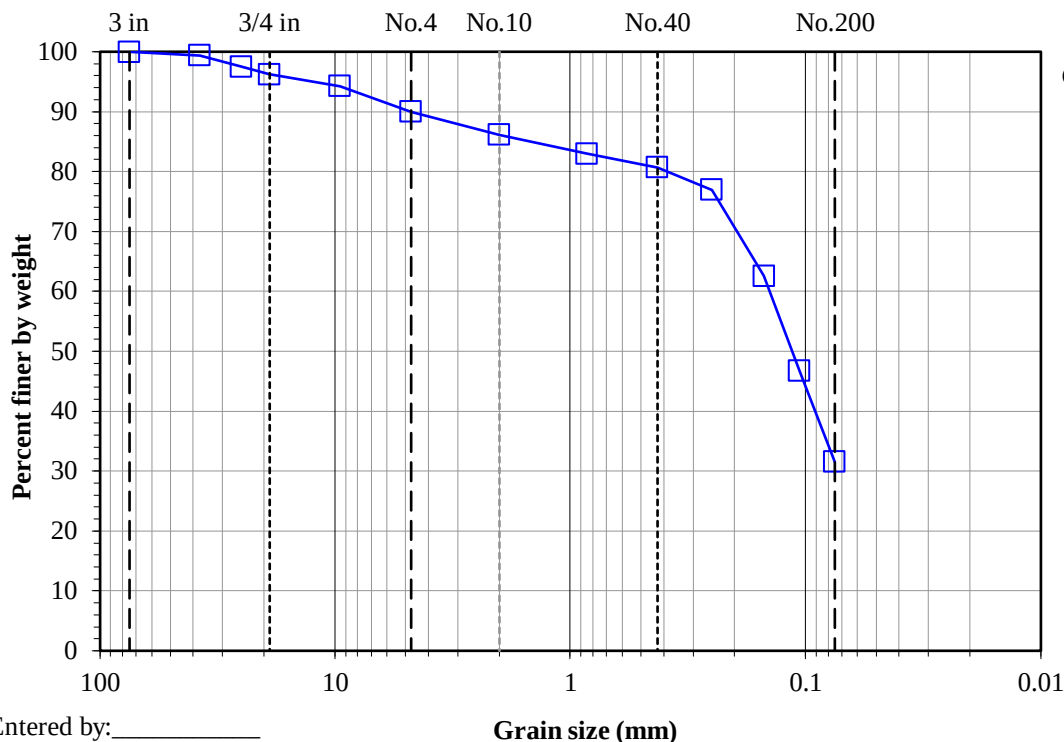
Boring No.: TP-05

Sample: BULK-01

Depth: 0-2'

Description: Reddish brown silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 29384.3 28334.8 +3/8" Coarse fraction (g): 1645.0 1628.0 -3/8" Split fraction (g): 215.19 207.18 Split fraction: 0.943				<u>Water content data</u> C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 626.51 426.90 Dry soil + tare (g): 622.35 418.89 Tare (g): 223.33 211.71 Water content (%): 1.0 3.9	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	100.0		
1.5"	180.0	37.5	99.4		
1"	711.3	25	97.5		
3/4"	1073.8	19	96.2		
3/8"	1628.0	9.5	94.3		
No.4	9.33	4.75	90.0		
No.10	17.89	2	86.1		
No.20	24.75	0.85	83.0		
No.40	29.79	0.425	80.7		
No.60	38.09	0.25	76.9		
No.100	69.60	0.15	62.6		
No.140	104.44	0.106	46.7		
No.200	137.78	0.075	31.6		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: RH

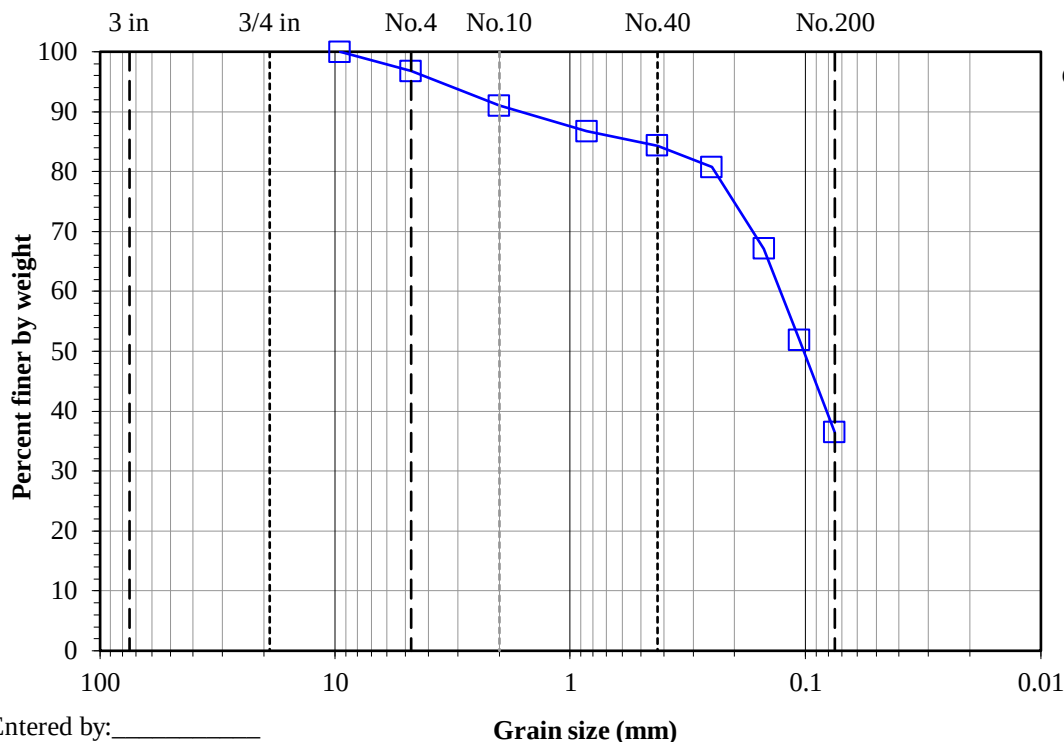
Boring No.: TP-05

Sample: ST-02

Depth: 3-4'

Description: Reddish brown silty sand

Split: No				Water content data	
Moist				Moist soil + tare (g):	- 387.03
Dry				Dry soil + tare (g):	- 379.73
Total sample wt. (g): 208.46				Tare (g):	- 178.57
-				Water content (%):	0.0 3.6
Split fraction: 1.000					
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	-		
3/8"	-	9.5	100.0		
No.4	6.49	4.75	96.8		
No.10	18.16	2	91.0		
No.20	26.69	0.85	86.7		
No.40	31.55	0.425	84.3		
No.60	38.69	0.25	80.8		
No.100	66.18	0.15	67.1		
No.140	96.85	0.106	51.9		
No.200	127.84	0.075	36.4		



Gravel (%): 3.2
Sand (%): 60.3
Fines (%): 36.4

Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/13/2023

By: LM

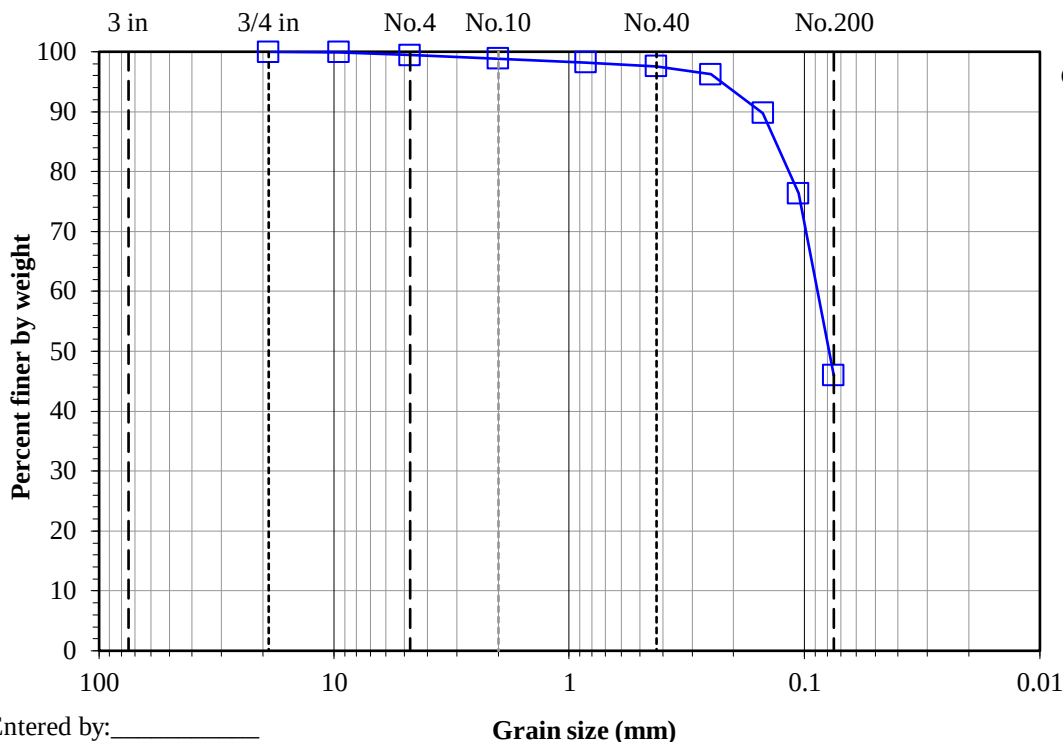
Boring No.: TP-05

Sample: GB-04

Depth: 6-6.5'

Description: Reddish orange silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4054.16 3690.92 +3/8" Coarse fraction (g): 2.21 2.14 -3/8" Split fraction (g): 234.86 213.81 Split fraction: 0.999				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 24.59 362.21 Dry soil + tare (g): 24.52 341.16 Tare (g): 22.40 127.35 Water content (%): 3.3 9.8	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	100.0		
3/8"	2.14	9.5	99.9		
No.4	1.11	4.75	99.4		
No.10	2.31	2	98.9		
No.20	3.71	0.85	98.2		
No.40	5.06	0.425	97.6		
No.60	7.90	0.25	96.2		
No.100	21.74	0.15	89.8		
No.140	50.39	0.106	76.4		
No.200	115.49	0.075	46.0		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/13/2023

By: LM

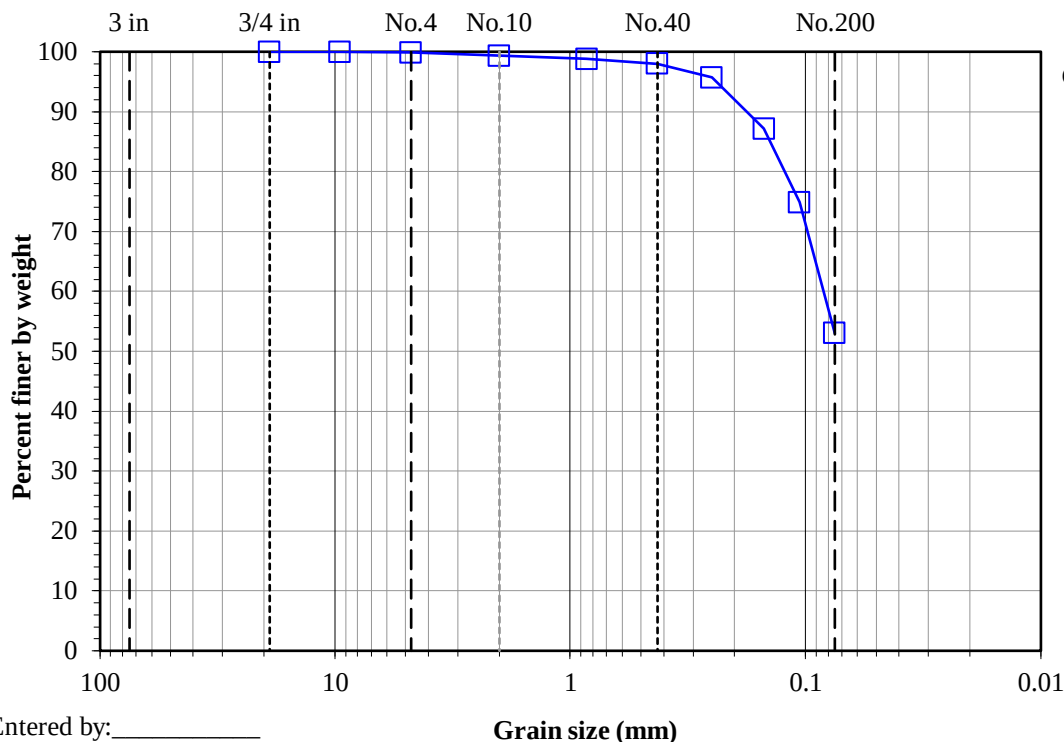
Boring No.: TP-05

Sample: GB-05

Depth: 9-10'

Description: Yellowish brown sandy clay

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4409.29 3948.31 +3/8" Coarse fraction (g): 1.79 1.72 -3/8" Split fraction (g): 219.27 196.34 Split fraction: 1.000				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 24.47 345.97 Dry soil + tare (g): 24.40 323.04 Tare (g): 22.69 126.70 Water content (%): 4.1 11.7		
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split		
6"	-	150	-			
4"	-	100	-			
3"	-	75	-			
1.5"	-	37.5	-			
1"	-	25	-			
3/4"	-	19	100.0			
3/8"	1.72	9.5	100.0			
No.4	0.22	4.75	99.8			
No.10	1.18	2	99.4			
No.20	2.23	0.85	98.8			
No.40	3.81	0.425	98.0			
No.60	8.31	0.25	95.7			
No.100	25.15	0.15	87.2			
No.140	49.24	0.106	74.9			
No.200	92.12	0.075	53.1			



Gravel (%): 0.2
Sand (%): 46.8
Fines (%): 53.1

Entered by: _____

Reviewed: _____

Z:\PROJECTS\M03898_Moab_Geotechnical_Group\038_Arroyo_Crossing\GSDv2.xlsm]11

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



© IGES 2004, 2023

Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/13/2023

By: LM

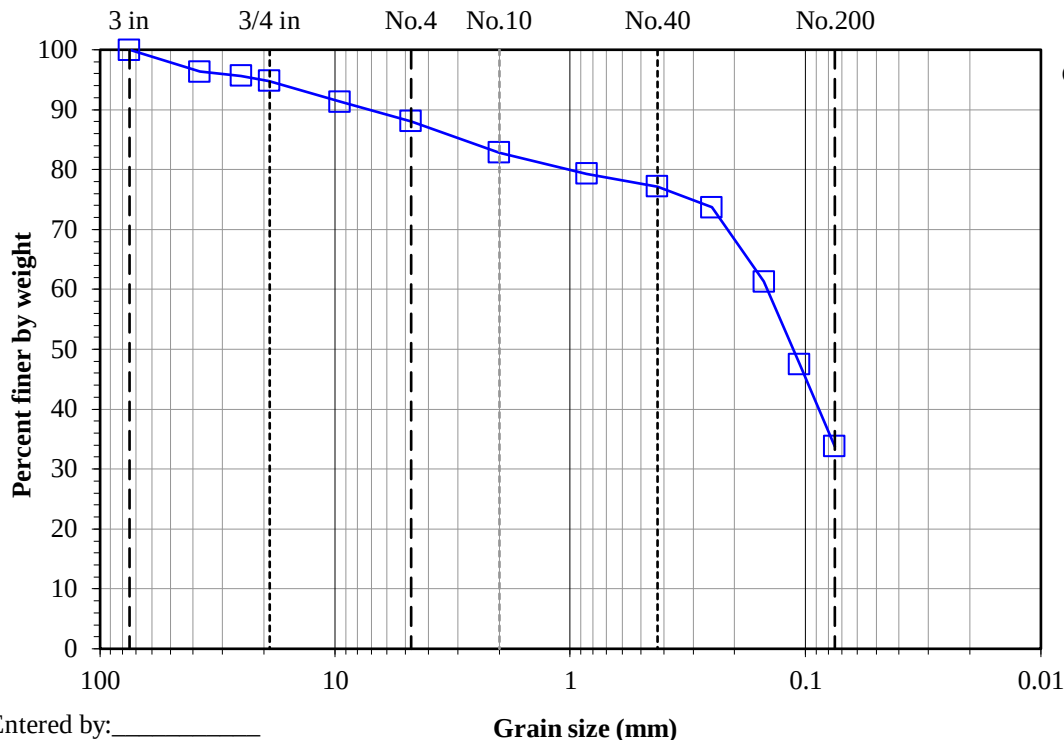
Boring No.: TP-06

Sample: GB-01

Depth: 1.5-2'

Description: Red clayey sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 5135.60 4742.05 +3/8" Coarse fraction (g): 422.28 411.07 -3/8" Split fraction (g): 208.83 191.89 Split fraction: 0.913				<u>Water content data</u> C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 570.41 335.47 Dry soil + tare (g): 558.65 318.53 Tare (g): 127.41 126.64 Water content (%): 2.7 8.8	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	100.0		
1.5"	172.79	37.5	96.4		
1"	205.23	25	95.7		
3/4"	246.22	19	94.8		
3/8"	411.07	9.5	91.3		
No.4	6.84	4.75	88.1		
No.10	17.90	2	82.8		
No.20	25.28	0.85	79.3		
No.40	29.81	0.425	77.1		
No.60	37.03	0.25	73.7		
No.100	63.13	0.15	61.3		
No.140	92.10	0.106	47.5		
No.200	120.87	0.075	33.8		



Gravel (%): 11.9
Sand (%): 54.3
Fines (%): 33.8

Comments:

These results are in nonconformance with Method D6913 because the minimum dry mass was not met.

Entered by: _____

Reviewed: _____

Grain size (mm)

Z:\PROJECTS\M03898_Moab_Geotechnical_Group\038_Arroyo_Crossing\GSDv2.xlsm\12

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

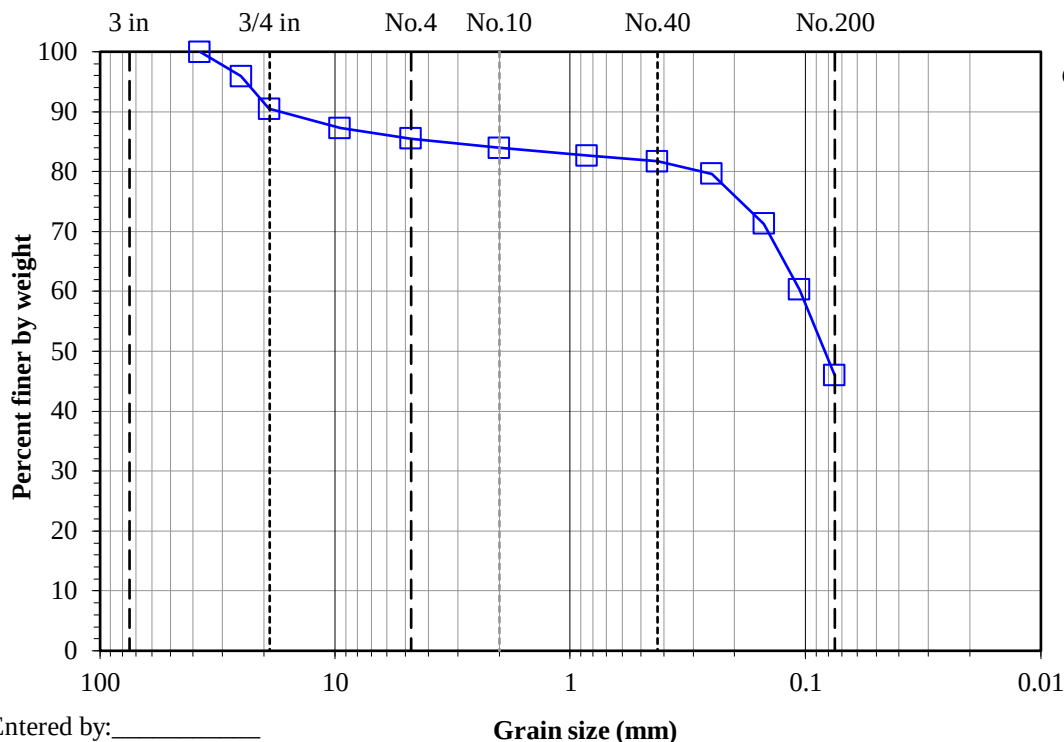
Boring No.: TP-07

Sample: GB-01

Depth: 1-1.5'

Description: Brown silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4040.11 3792.60 +3/8" Coarse fraction (g): 494.10 483.04 -3/8" Split fraction (g): 210.85 196.79 Split fraction: 0.873				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 679.70 404.42 Dry soil + tare (g): 668.19 390.36 Tare (g): 165.34 193.57 Water content (%): 2.3 7.1		
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split		
6"	-	150	-			
4"	-	100	-			
3"	-	75	-			
1.5"	-	37.5	100.0			
1"	155.97	25	95.9			
3/4"	361.84	19	90.5			
3/8"	483.04	9.5	87.3			
No.4	4.01	4.75	85.5			
No.10	7.42	2	84.0			
No.20	10.31	0.85	82.7			
No.40	12.59	0.425	81.7			
No.60	17.29	0.25	79.6			
No.100	35.99	0.15	71.3			
No.140	60.89	0.106	60.3			
No.200	93.18	0.075	45.9			



Gravel (%): 14.5

Sand (%): 39.5

Fines (%): 45.9

Comments:

These results are in nonconformance with Method D6913 because the minimum dry mass was not met.

Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



© IGES 2004, 2023

Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

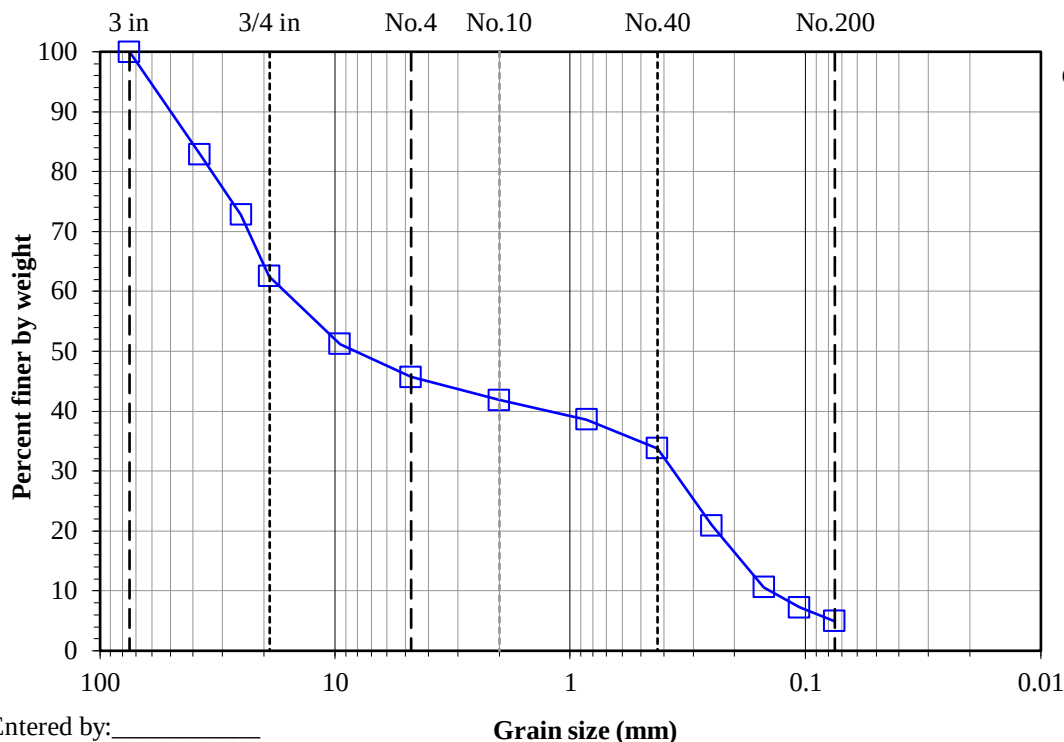
Boring No.: TP-07

Sample: GB-02

Depth: 3-3.5'

Description: Reddish brown gravel with silt and sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 6056.80 5886.30 +3/8" Coarse fraction (g): 2949.30 2871.24 -3/8" Split fraction (g): 223.88 217.22 Split fraction: 0.512				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 3275.24 348.18 Dry soil + tare (g): 3197.20 341.52 Tare (g): 326.60 124.30 Water content (%): 2.7 3.1	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	100.0		
1.5"	1008.05	37.5	82.9		
1"	1602.74	25	72.8		
3/4"	2204.47	19	62.5		
3/8"	2871.24	9.5	51.2		
No.4	23.40	4.75	45.7		
No.10	39.82	2	41.8		
No.20	53.59	0.85	38.6		
No.40	73.83	0.425	33.8		
No.60	128.61	0.25	20.9		
No.100	172.31	0.15	10.6		
No.140	186.49	0.106	7.2		
No.200	196.00	0.075	5.0		



Gravel (%): 54.3

Sand (%): 40.7

Fines (%): 5.0

Comments:

These results are in nonconformance with Method D6913 because the minimum dry mass was not met.

Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

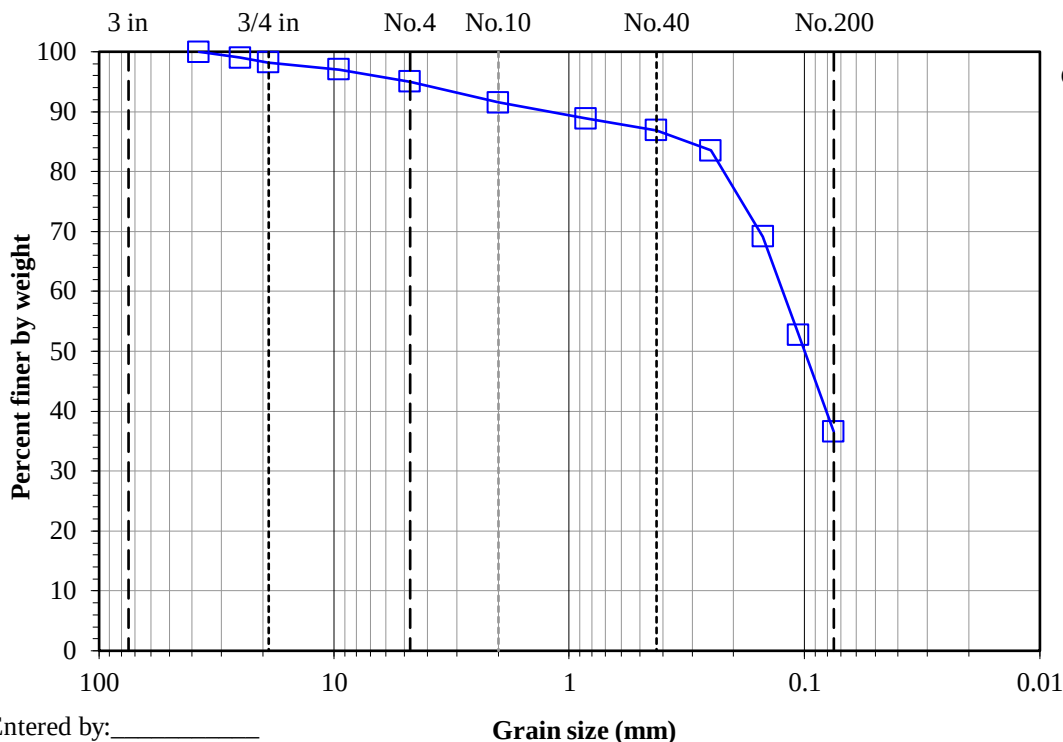
Boring No.: TP-08

Sample: GB-01

Depth: 1-1.5'

Description: Reddish brown clayey sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 3721.82 3496.25 +3/8" Coarse fraction (g): 107.47 104.14 -3/8" Split fraction (g): 233.05 218.72 Split fraction: 0.970				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 137.32 357.46 Dry soil + tare (g): 133.99 343.13 Tare (g): 29.82 124.41 Water content (%): 3.2 6.6	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	100.0		
1"	34.57	25	99.0		
3/4"	62.34	19	98.2		
3/8"	104.14	9.5	97.0		
No.4	4.59	4.75	95.0		
No.10	12.34	2	91.5		
No.20	18.45	0.85	88.8		
No.40	22.89	0.425	86.9		
No.60	30.42	0.25	83.5		
No.100	62.88	0.15	69.1		
No.140	99.79	0.106	52.8		
No.200	136.32	0.075	36.6		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/14/2023

By: JJ

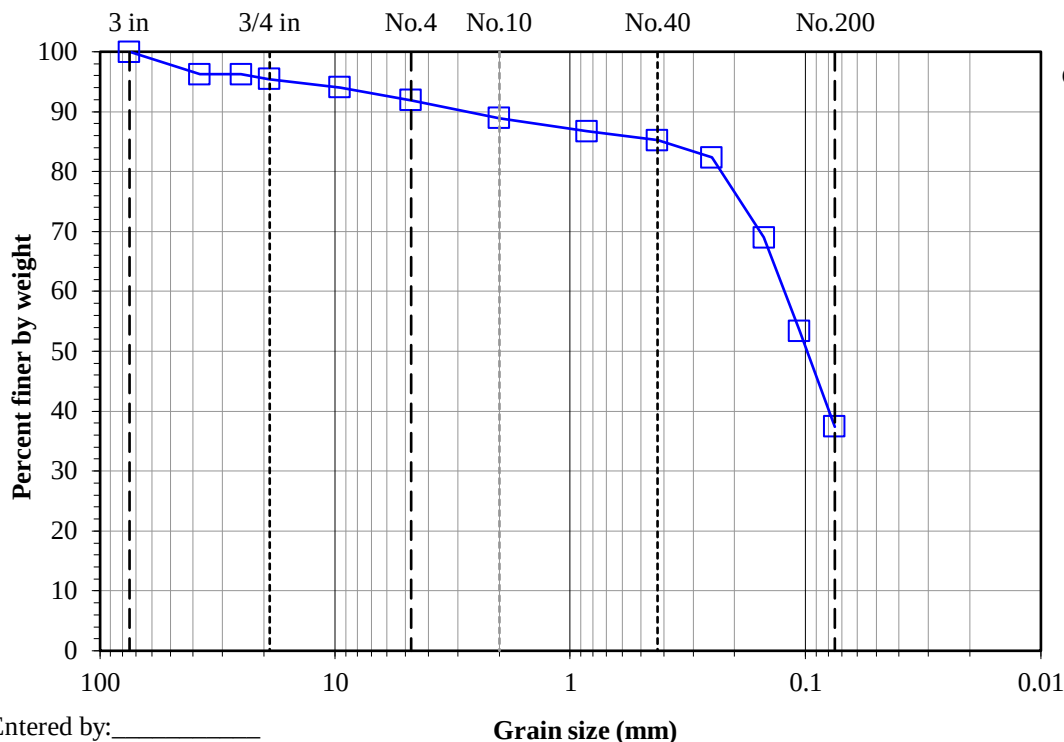
Boring No.: TP-08

Sample: GB-02

Depth: 3-3.5'

Description: Reddish brown silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4350.7 4041.59 +3/8" Coarse fraction (g): 245.62 239.92 -3/8" Split fraction (g): 230.94 213.87 Split fraction: 0.941				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 368.95 359.54 Dry soil + tare (g): 363.25 342.47 Tare (g): 123.34 128.60 Water content (%): 2.4 8.0		
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split		
6"	-	150	-			
4"	-	100	-			
3"	-	75	100.0			
1.5"	152.73	37.5	96.2			
1"	152.73	25	96.2			
3/4"	183.67	19	95.5			
3/8"	239.92	9.5	94.1			
No.4	4.89	4.75	91.9			
No.10	11.75	2	88.9			
No.20	16.73	0.85	86.7			
No.40	20.08	0.425	85.2			
No.60	26.70	0.25	82.3			
No.100	57.00	0.15	69.0			
No.140	92.42	0.106	53.4			
No.200	128.74	0.075	37.4			



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

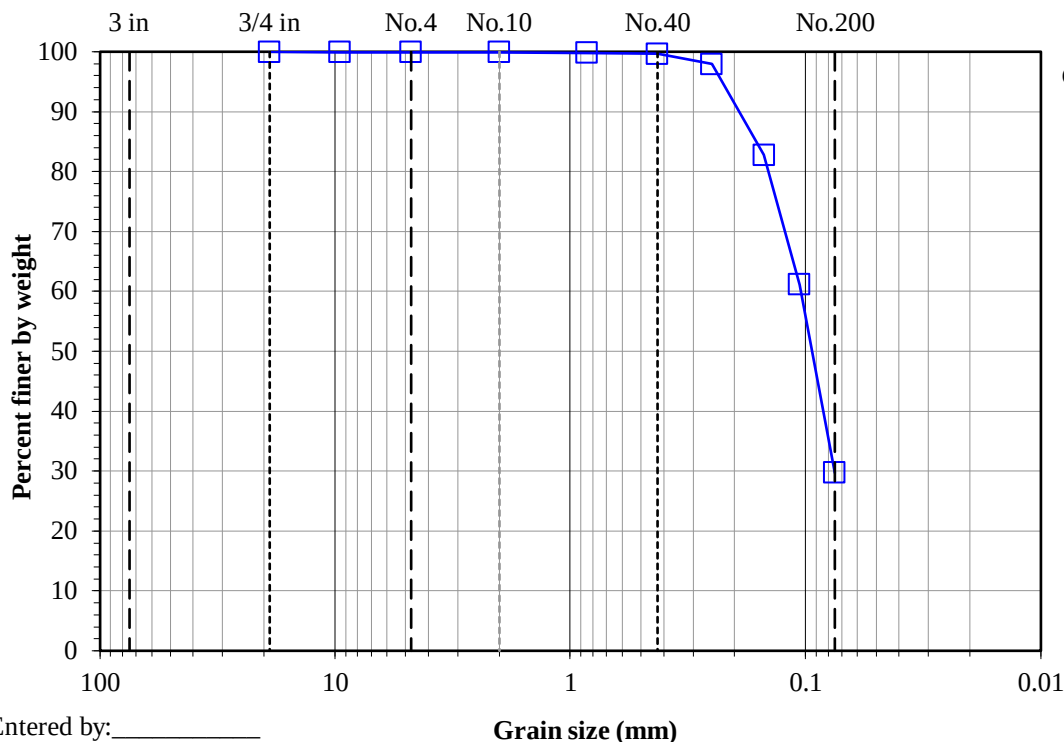
Boring No.: TP-09

Sample: GB-01

Depth: 1.5-2'

Description: Red silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 3609.00 3429.13 +3/8" Coarse fraction (g): 2.89 2.74 -3/8" Split fraction (g): 226.74 215.44 Split fraction: 0.999				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 25.21 355.54 Dry soil + tare (g): 25.06 344.24 Tare (g): 22.32 128.80 Water content (%): 5.5 5.2	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	100.0		
3/8"	2.74	9.5	99.9		
No.4	-	4.75	99.9		
No.10	0.02	2	99.9		
No.20	0.19	0.85	99.8		
No.40	0.59	0.425	99.6		
No.60	4.21	0.25	98.0		
No.100	36.98	0.15	82.8		
No.140	83.59	0.106	61.2		
No.200	151.35	0.075	29.7		



Gravel (%): 0.1
Sand (%): 70.2
Fines (%): 29.7

Entered by: _____

Reviewed: _____

Grain size (mm)

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: RH

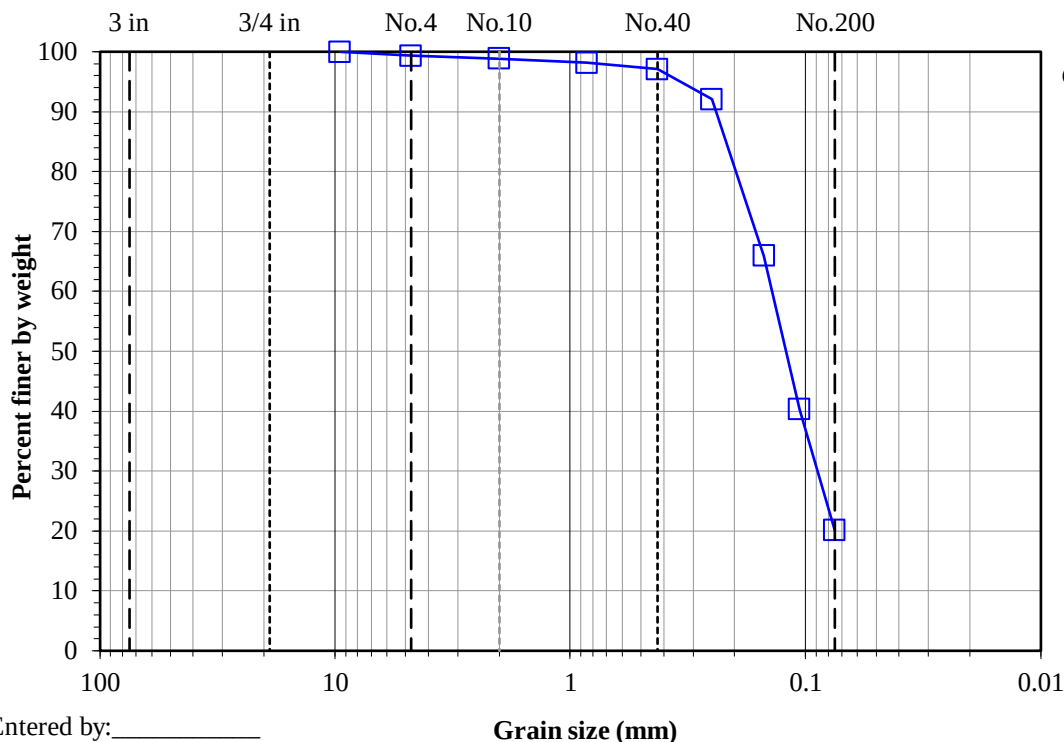
Boring No.: TP-09

Sample: ST-02

Depth: 3.5-4.5'

Description: Reddish brown silty sand

Split: No				Water content data	
Moist				Moist soil + tare (g):	- 326.90
Dry				Dry soil + tare (g):	- 322.29
Total sample wt. (g): 198.54				Tare (g):	- 128.36
-				Water content (%):	0.0 2.4
Split fraction: 1.000					
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	-		
3/8"	-	9.5	100.0		
No.4	1.34	4.75	99.3		
No.10	2.20	2	98.9		
No.20	3.56	0.85	98.2		
No.40	5.61	0.425	97.1		
No.60	15.36	0.25	92.1		
No.100	66.05	0.15	65.9		
No.140	115.80	0.106	40.3		
No.200	154.95	0.075	20.1		



Gravel (%): 0.7
Sand (%): 79.2
Fines (%): 20.1

Entered by: _____

Reviewed: _____

Z:\PROJECTS\M03898_Moab_Geotechnical_Group\038_Arroyo_Crossing[GSDv2.xlsm]18

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

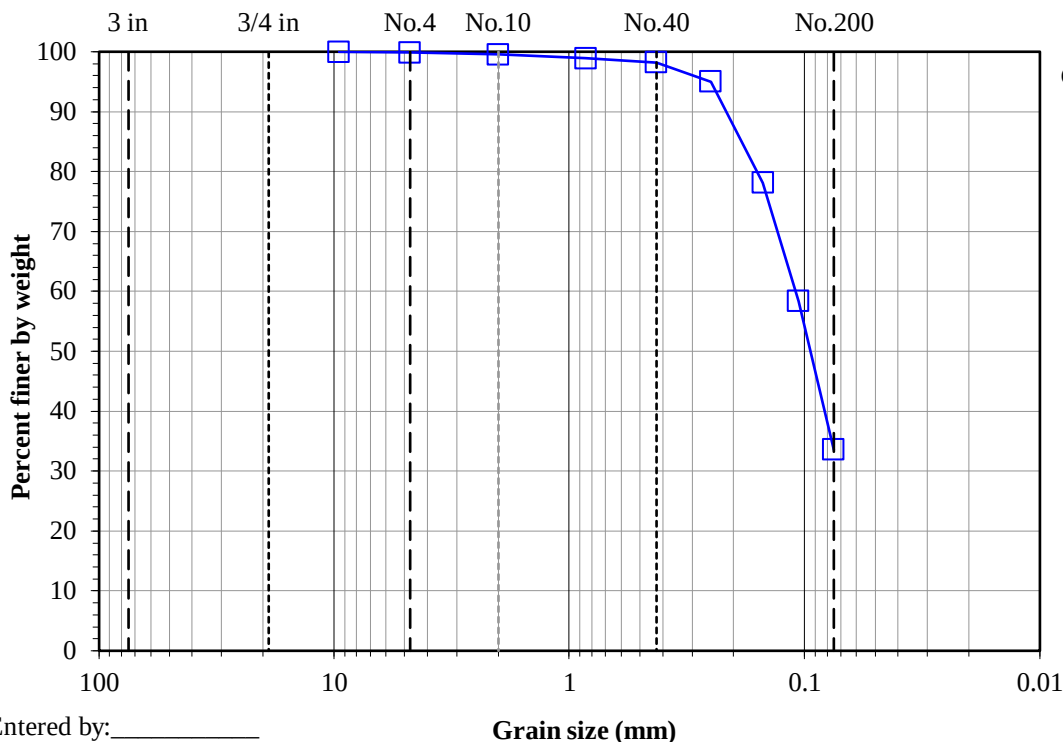
Boring No.: TP-10

Sample: ST-01

Depth: 2-2.5'

Description: Red clayey sand

Split: No				Water content data	
Moist				Moist soil + tare (g):	- 345.31
Dry				Dry soil + tare (g):	- 336.99
Total sample wt. (g): 217.67				Tare (g):	- 127.64
-				Water content (%):	0.0 4.0
Split fraction: 1.000					
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	-		
3/8"	-	9.5	100.0		
No.4	0.29	4.75	99.9		
No.10	1.00	2	99.5		
No.20	2.24	0.85	98.9		
No.40	3.79	0.425	98.2		
No.60	10.48	0.25	95.0		
No.100	45.74	0.15	78.2		
No.140	87.12	0.106	58.4		
No.200	139.09	0.075	33.6		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

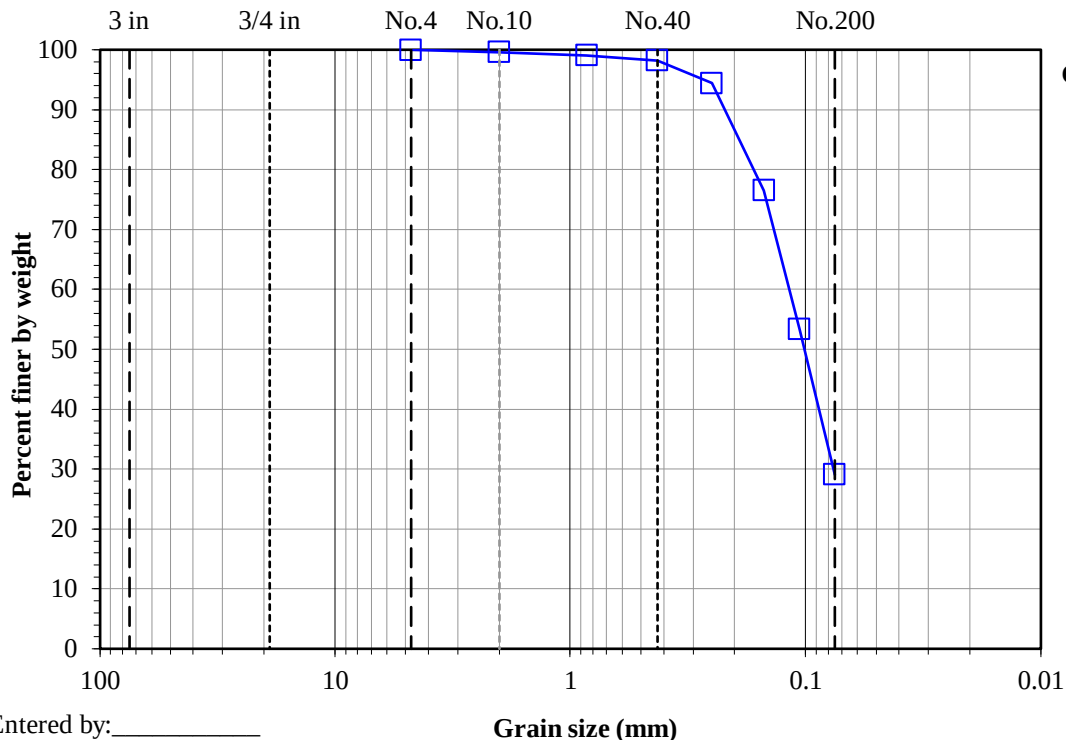
Boring No.: TP-11

Sample: ST-02

Depth: 3.5-4.5'

Description: Reddish brown silty sand

Split: No				<u>Water content data</u>	
Moist				Moist soil + tare (g):	- 334.84
Dry				Dry soil + tare (g):	- 330.01
Total sample wt. (g): 206.94				Tare (g):	- 127.90
-				Water content (%):	0.0 2.4
Split fraction: 1.000					
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	-		
3/8"	-	9.5	-		
No.4	-	4.75	100.0		
No.10	0.81	2	99.6		
No.20	1.94	0.85	99.0		
No.40	3.63	0.425	98.2		
No.60	11.32	0.25	94.4		
No.100	47.48	0.15	76.5		
No.140	94.27	0.106	53.4		
No.200	143.33	0.075	29.1		



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

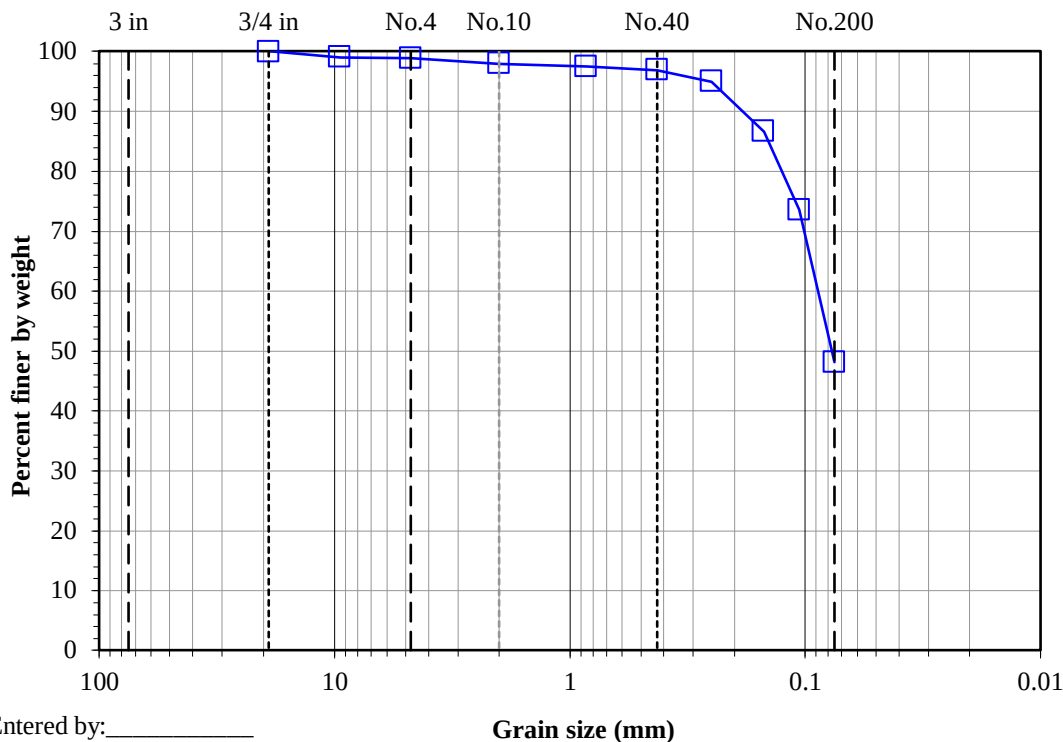
Boring No.: TP-11

Sample: GB-03

Depth: 6-7'

Description: Red silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4294.26 4069.48 +3/8" Coarse fraction (g): 40.55 38.60 -3/8" Split fraction (g): 213.04 201.88 Split fraction: 0.991				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 70.55 364.75 Dry soil + tare (g): 68.60 353.59 Tare (g): 30.01 151.71 Water content (%): 5.1 5.5	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	100.0		
3/8"	38.60	9.5	99.1		
No.4	0.33	4.75	98.9		
No.10	2.19	2	98.0		
No.20	3.20	0.85	97.5		
No.40	4.34	0.425	96.9		
No.60	8.24	0.25	95.0		
No.100	25.23	0.15	86.7		
No.140	51.86	0.106	73.6		
No.200	103.82	0.075	48.1		



Entered by: _____

Reviewed: _____

Z:\PROJECTS\M03898_Moab_Geotechnical_Group\038_Arroyo_Crossing\GSDv2.xlsm]21

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



© IGES 2004, 2023

Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: RH

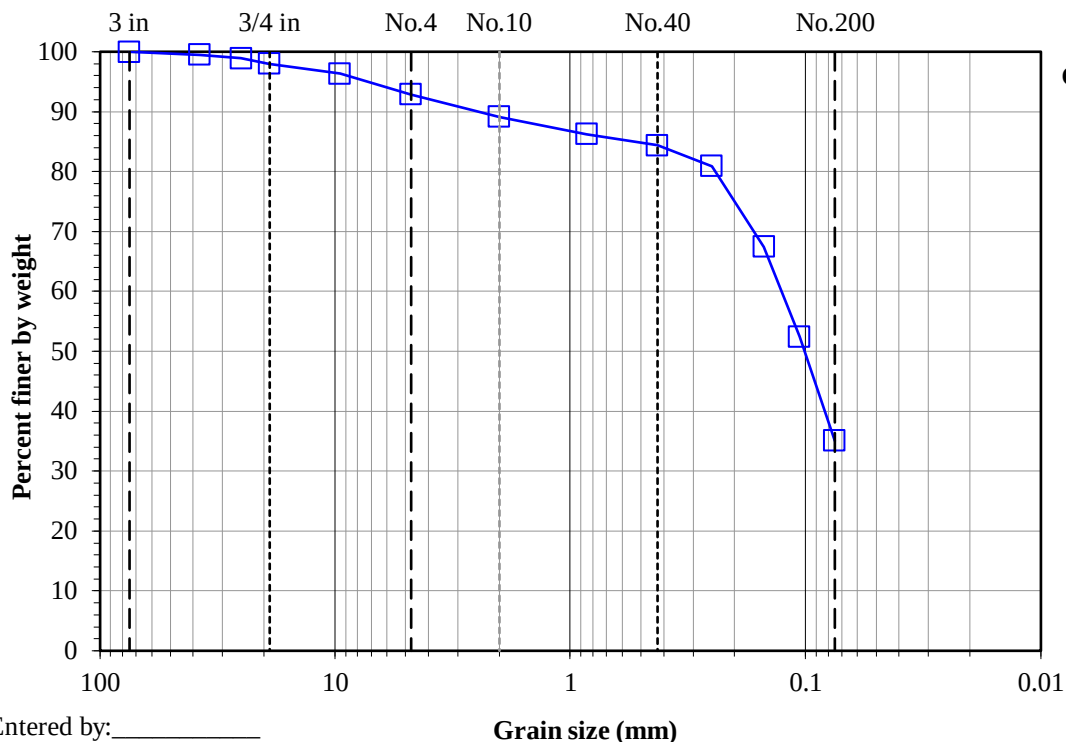
Boring No.: TP-12

Sample: BULK-01

Depth: 0.5-1.5'

Description: Reddish brown silty, clayey sand

Split: Yes		Water content data C.F.(+3/8") S.F.(-3/8")	
Split sieve: 3/8"		Moist soil + tare (g): 625.17	335.61
Moist	Dry	Dry soil + tare (g): 616.68	327.41
Total sample wt. (g): 26686.8	25649.75	Tare (g): 219.36	128.16
+3/8" Coarse fraction (g): 958.28	938.23	Water content (%): 2.1	4.1
-3/8" Split fraction (g): 207.45	199.25		
Split fraction: 0.963			
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
6"	-	150	-
4"	-	100	-
3"	-	75	100.0
1.5"	132.48	37.5	99.5
1"	277.57	25	98.9
3/4"	509.43	19	98.0
3/8"	938.23	9.5	96.3
No.4	7.21	4.75	92.9
No.10	14.92	2	89.1
No.20	20.90	0.85	86.2
No.40	24.77	0.425	84.4
No.60	31.96	0.25	80.9
No.100	59.72	0.15	67.5
No.140	90.80	0.106	52.4
No.200	126.69	0.075	35.1



Entered by: _____

Reviewed: _____

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)



© IGES 2004, 2023

Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/17/2023

By: LM

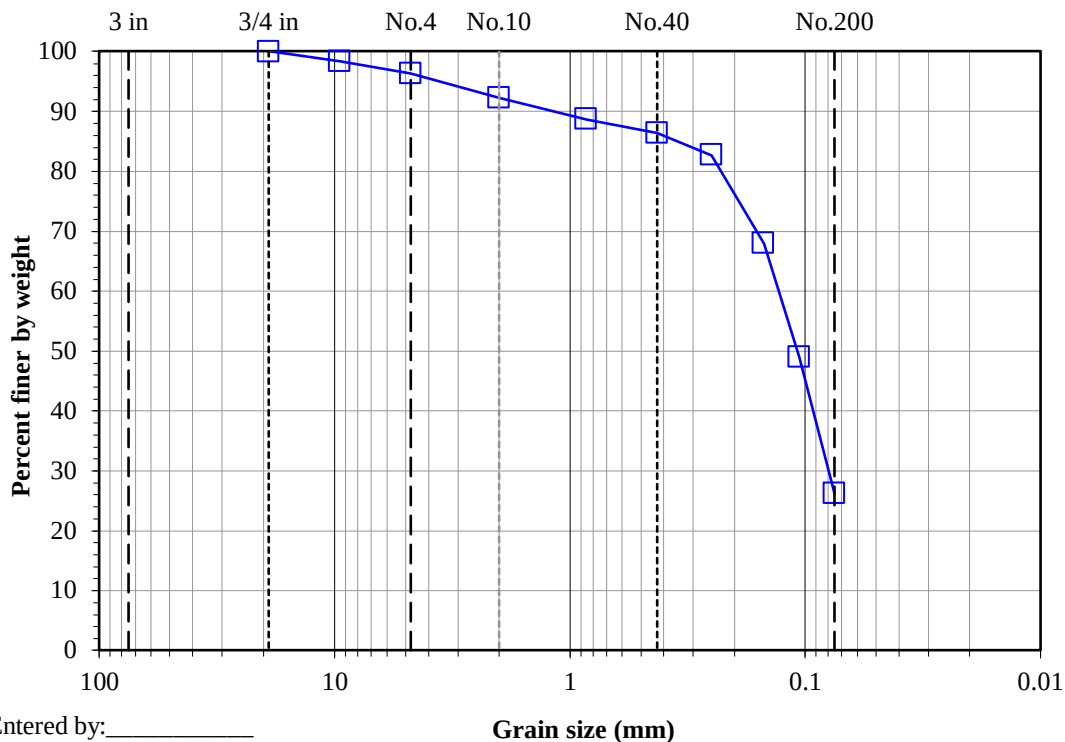
Boring No.: TP-12

Sample: GB-02

Depth: 3-3.5'

Description: Red silty sand

Split: Yes Split sieve: 3/8" Moist Dry Total sample wt. (g): 4477.26 4267.70 +3/8" Coarse fraction (g): 71.96 69.83 -3/8" Split fraction (g): 215.99 205.82 Split fraction: 0.984				Water content data C.F.(+3/8") S.F.(-3/8") Moist soil + tare (g): 191.05 339.53 Dry soil + tare (g): 188.76 329.36 Tare (g): 113.54 123.54 Water content (%): 3.0 4.9	
Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	← Split	
6"	-	150	-		
4"	-	100	-		
3"	-	75	-		
1.5"	-	37.5	-		
1"	-	25	-		
3/4"	-	19	100.0		
3/8"	69.83	9.5	98.4		
No.4	4.30	4.75	96.3		
No.10	12.80	2	92.2		
No.20	20.20	0.85	88.7		
No.40	25.04	0.425	86.4		
No.60	32.74	0.25	82.7		
No.100	63.64	0.15	67.9		
No.140	103.30	0.106	49.0		
No.200	150.87	0.075	26.3		



Gravel (%): 3.7
Sand (%): 70.0
Fines (%): 26.3

Entered by: _____

Reviewed: _____

Grain size (mm)

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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)



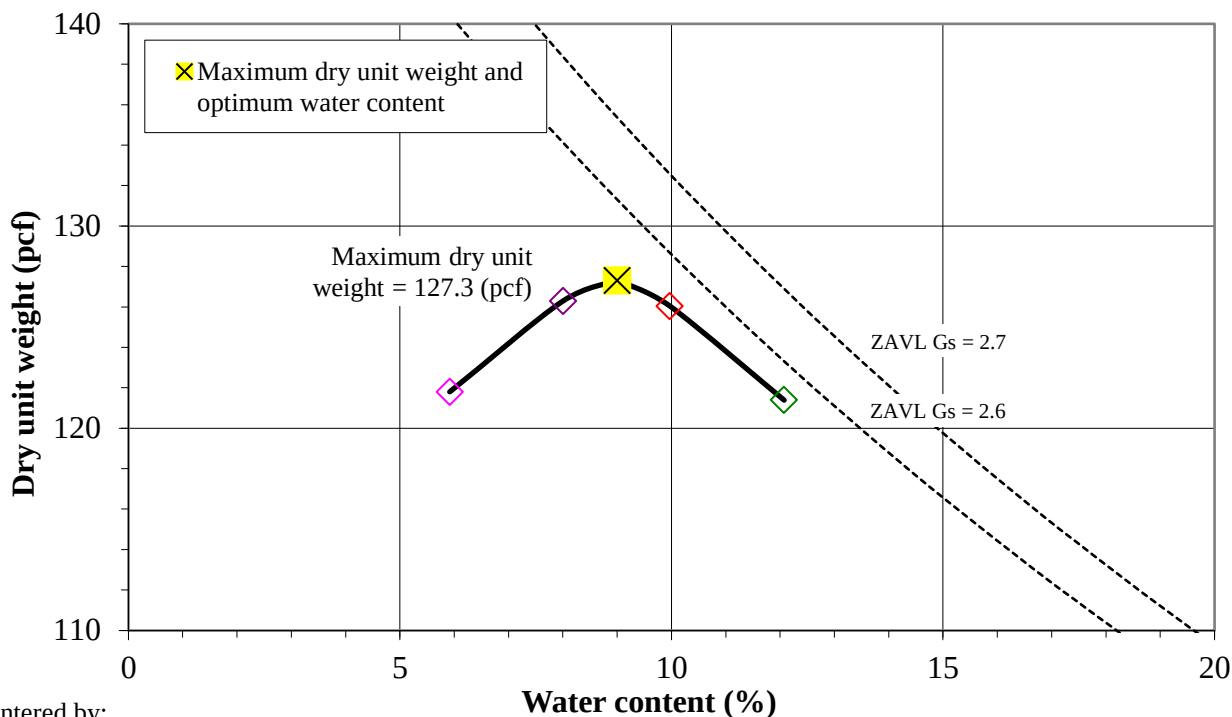
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Project: Moab Geotechnical Group LLC**No:** M03898-038 (2021-003)**Location:** Arroyo Crossing**Date:** 7/17/2023**By:** RH**Method:** ASTM D1557 B**Mold Id.** INC 1**Mold volume (ft³):** 0.0333**Boring No.:** TP-05**Sample:** BULK-01**Depth:** 0-2'**Sample Description:** Reddish brown silty sand**Engineering Classification:** Not requested**As-received water content (%):** Not requested**Preparation method:** Moist**Rammer:** Mechanical-circular face**Rock Correction:** Yes * See results below**Percent fraction retained, P_c (%)** 5.7**Percent fraction passing, P_f (%)** 94.3**Optimum water content (%):** 9.0**Maximum dry unit weight (pcf):** 127.3

Point Number	+4%	+6%	+8%	2%				
Wt. Sample + Mold (g)	6278.8	6312.1	6273.5	6167.2				
Wt. of Mold (g)	4218.3	4218.3	4218.3	4218.3				
Wet Unit Wt., γ_m (pcf)	136.4	138.6	136.0	129.0				
Wet Soil + Tare (g)	596.13	607.61	583.24	584.21				
Dry Soil + Tare (g)	561.36	564.05	533.70	558.26				
Tare (g)	126.87	126.97	123.25	119.61				
Water Content, w (%)	8.0	10.0	12.1	5.9				
Dry Unit Wt., γ_d (pcf)	126.3	126.0	121.4	121.8				

***Correction of Unit Weight and Water Content for Soils Containing Oversize Particles**

(ASTM D4718)

Oversized fraction, +3/8-in. (%): 5.7**Water content, +3/8-in. (%):** 3.9**Sieve for oversized fraction:** 3/8-in.**Bulk specific gravity, G_s:** 2.65 Assumed**Corrected water content (%):** 8.7**Corrected dry unit weight (pcf):** 129.0

Entered by: _____

Reviewed: _____

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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/14/2023

By: JJ

Method: ASTM D1557 B

Mold Id. INC 2

Mold volume (ft³): 0.0333

Boring No.: TP-12

Sample: Bulk-01

Depth: 0.5-1.5'

Sample Description: Reddish brown silty, clayey sand

Engineering Classification: Not requested

As-received water content (%): Not requested

Preparation method: Moist

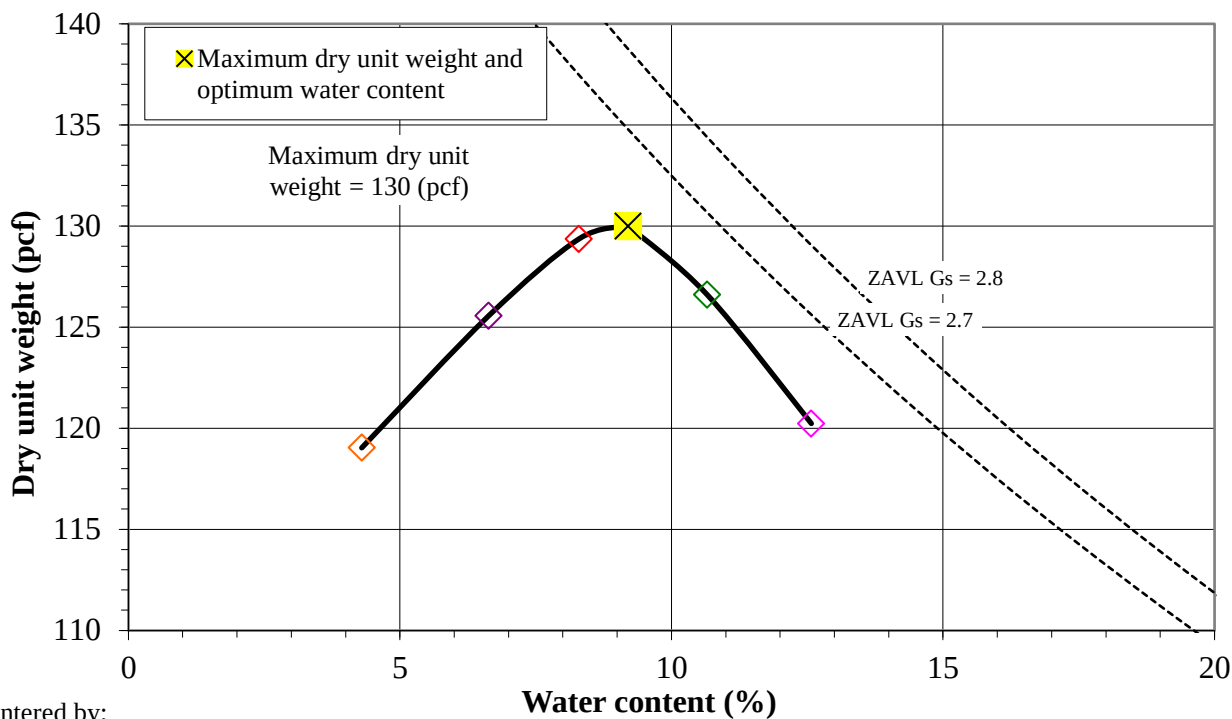
Rammer: Mechanical-circular face

Rock Correction: No

Optimum water content (%): 9.2

Maximum dry unit weight (pcf): 130

Point Number	+2%	+4%	+6%	+8%	As is			
Wt. Sample + Mold (g)	6227.7	6321.3	6321.3	6249.6	6080.7			
Wt. of Mold (g)	4207.2	4207.2	4207.2	4207.2	4207.2			
Wet Unit Wt., γ_m (pcf)	133.9	140.1	140.1	135.3	124.2			
Wet Soil + Tare (g)	721.03	712.99	583.21	725.93	469.97			
Dry Soil + Tare (g)	687.25	675.62	538.94	658.76	455.84			
Tare (g)	177.99	225.07	123.46	124.47	126.81			
Water Content, w (%)	6.6	8.3	10.7	12.6	4.3			
Dry Unit Wt., γ_d (pcf)	125.6	129.4	126.6	120.2	119.0			



Entered by: _____

Reviewed: _____

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Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-01**

Sample: **ST-01**

Depth: **3-4'**

Sample Description: **Reddish brown silty sand with gravel**

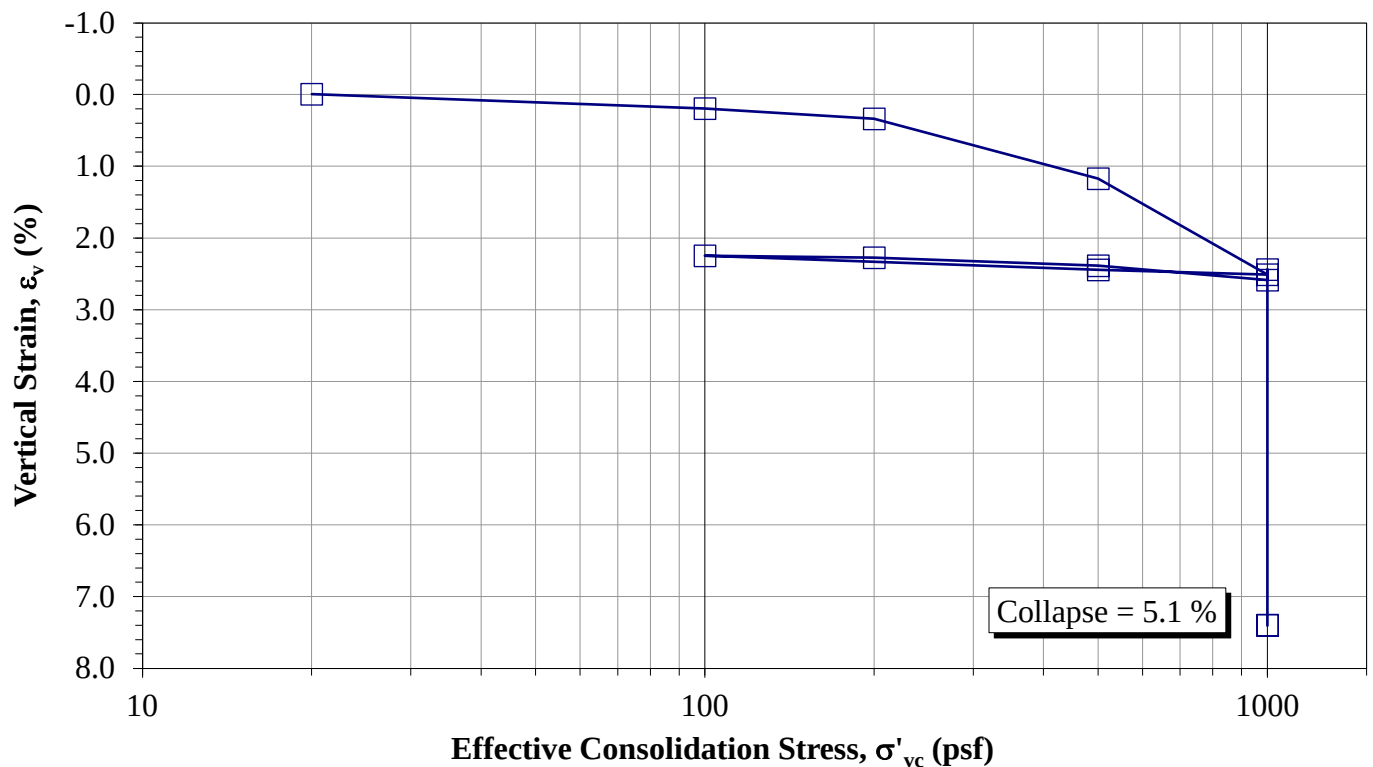
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **2**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **5.1**
Collapse stress (psf): **1000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.914	0.846
Sample diameter, D (in.)	2.412	2.412
Mass rings + wet soil (g)	151.37	169.43
Mass rings/tare (g)	44.84	44.84
Moist unit wt., γ_m (pcf)	97.17	122.73
Wet soil + tare (g)	404.89	246.31
Dry soil + tare (g)	388.12	222.76
Tare (g)	127.15	126.52
Water content, w (%)	6.4	24.5
Dry unit wt., γ_d (pcf)	91.3	98.6
Saturation	20.5	93.1

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9140	0.846
20	-0.00005	-0.01	0.9141	0.846
100	0.00180	0.20	0.9122	0.842
200	0.00310	0.34	0.9109	0.840
500	0.01070	1.17	0.9033	0.824
1000	0.02295	2.51	0.8911	0.800
500	0.02235	2.45	0.8917	0.801
100	0.02055	2.25	0.8935	0.804
200	0.02080	2.28	0.8932	0.804
500	0.02180	2.39	0.8922	0.802
1000	0.02365	2.59	0.8904	0.798
1000	0.02230	2.44	0.8917	0.801
1000	0.06760	7.40	0.8464	0.709
1000	0.06765	7.40	0.8464	0.709



Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



© IGES 2014, 2023

Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-01**

Sample: **ST-01**

Depth: **3-4'**

Sample Description: **Reddish brown silty sand with gravel**

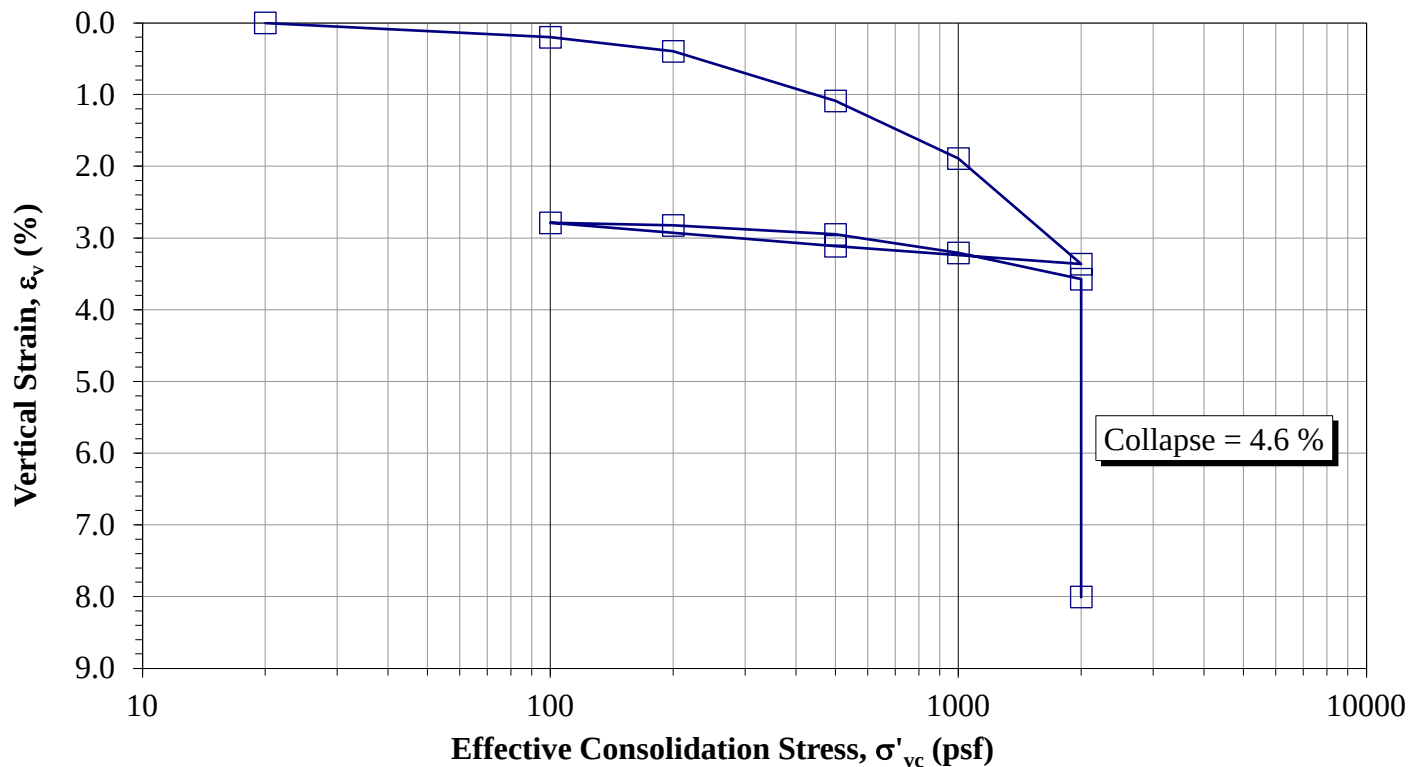
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **5**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **4.6**
Collapse stress (psf): **2000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.917	0.844
Sample diameter, D (in.)	2.414	2.414
Mass rings + wet soil (g)	148.84	168.58
Mass rings/tare (g)	45.94	45.94
Moist unit wt., γ_m (pcf)	93.40	121.01
Wet soil + tare (g)	404.89	238.94
Dry soil + tare (g)	388.12	214.16
Tare (g)	127.15	121.86
Water content, w (%)	6.4	26.8
Dry unit wt., γ_d (pcf)	87.8	95.4
Saturation	18.8	94.5

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9170	0.921
20	0.00000	0.00	0.9170	0.921
100	0.00185	0.20	0.9152	0.917
200	0.00365	0.40	0.9134	0.913
500	0.00996	1.09	0.9070	0.900
1000	0.01735	1.89	0.8997	0.884
2000	0.03085	3.36	0.8862	0.856
500	0.02855	3.11	0.8885	0.861
100	0.02555	2.79	0.8915	0.867
200	0.02590	2.82	0.8911	0.866
500	0.02705	2.95	0.8900	0.864
1000	0.02940	3.21	0.8876	0.859
2000	0.03275	3.57	0.8843	0.852
2000	0.07340	8.00	0.8436	0.767



Comments: **3/4" gravel - scalped**

Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-05**

Sample: **ST-02**

Depth: **3-4'**

Sample Description: **Reddish brown silty sand**

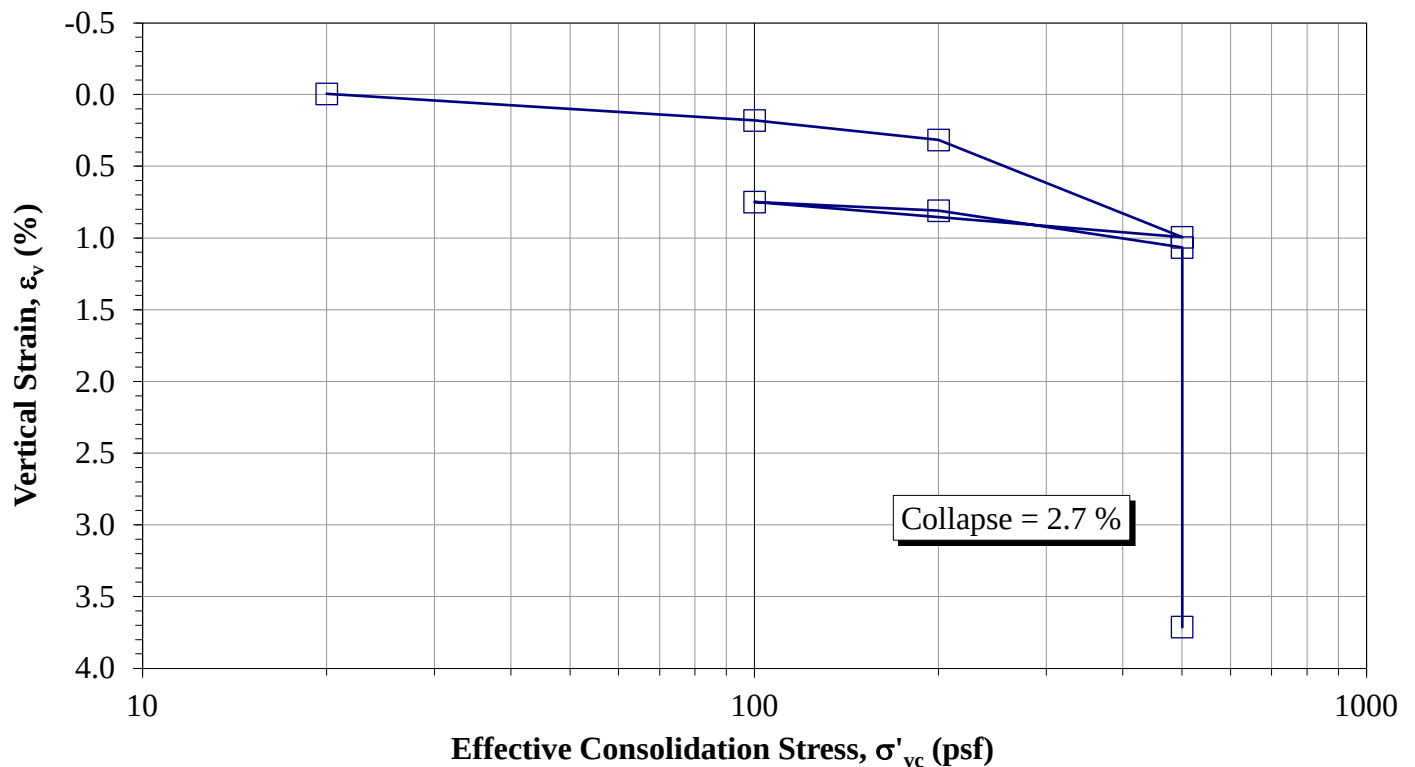
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from shelly tube**

Consolidometer No.: **3**
Specific gravity, G_s **2.70** *Assumed*
Collapse (%) **2.7**
Collapse stress (psf) **500**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.920	0.886
Sample diameter, D (in.)	2.414	2.414
Mass rings + wet soil (g)	164.63	177.75
Mass rings/tare (g)	45.42	45.42
Moist unit wt., γ_m (pcf)	107.85	124.33
Wet soil + tare (g)	301.10	259.41
Dry soil + tare (g)	292.32	240.33
Tare (g)	127.33	127.49
Water content, w (%)	5.3	16.9
Dry unit wt., γ_d (pcf)	102.4	106.4
Saturation	22.2	78.1

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9200	0.646
20	-0.00005	-0.01	0.9201	0.646
100	0.00165	0.18	0.9184	0.643
200	0.00290	0.32	0.9171	0.641
500	0.00915	0.99	0.9109	0.630
100	0.00690	0.75	0.9131	0.634
200	0.00745	0.81	0.9126	0.633
500	0.00980	1.07	0.9102	0.628
500	0.03415	3.71	0.8859	0.585



Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-05**

Sample: **ST-02**

Depth: **3-4'**

Sample Description: **Reddish brown silty sand**

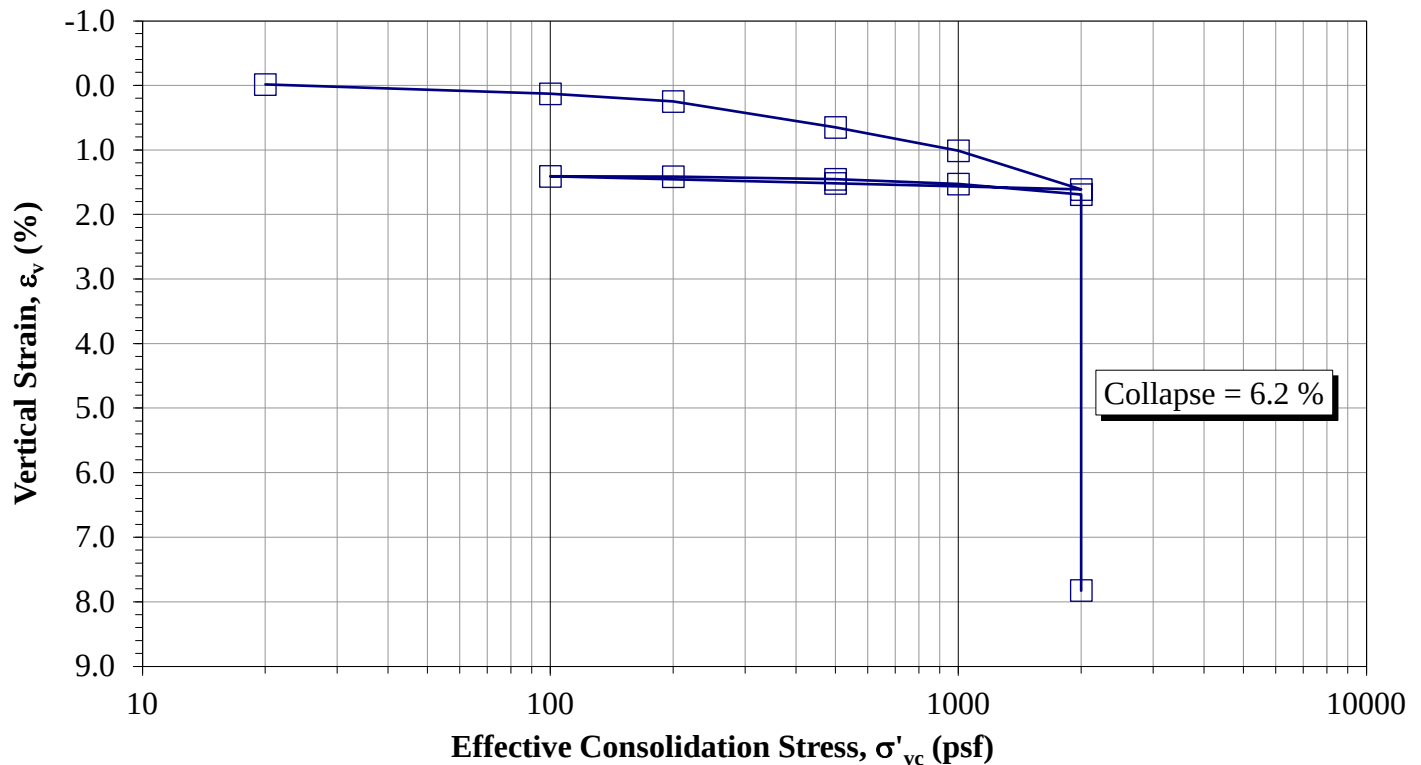
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **6**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **6.2**
Collapse stress (psf): **2000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.922	0.850
Sample diameter, D (in.)	2.417	2.417
Mass rings + wet soil (g)	164.59	183.45
Mass rings/tare (g)	45.54	45.54
Moist unit wt., γ_m (pcf)	107.21	134.73
Wet soil + tare (g)	301.10	355.27
Dry soil + tare (g)	292.32	337.29
Tare (g)	127.33	255.58
Water content, w (%)	5.3	22.0
Dry unit wt., γ_d (pcf)	101.8	110.4
Saturation	21.9	100.0

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9220	0.656
20	-0.00015	-0.02	0.9222	0.656
100	0.00120	0.13	0.9208	0.654
200	0.00230	0.25	0.9197	0.652
500	0.00600	0.65	0.9160	0.645
1000	0.00935	1.01	0.9127	0.639
2000	0.01485	1.61	0.9072	0.629
500	0.01400	1.52	0.9080	0.631
100	0.01300	1.41	0.9090	0.633
200	0.01305	1.42	0.9090	0.632
500	0.01340	1.45	0.9086	0.632
1000	0.01410	1.53	0.9079	0.631
2000	0.01560	1.69	0.9064	0.628
2000	0.07215	7.83	0.8499	0.526



Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-09**

Sample: **ST-02**

Depth: **3.5-4.5'**

Sample Description: **Reddish brown silty sand**

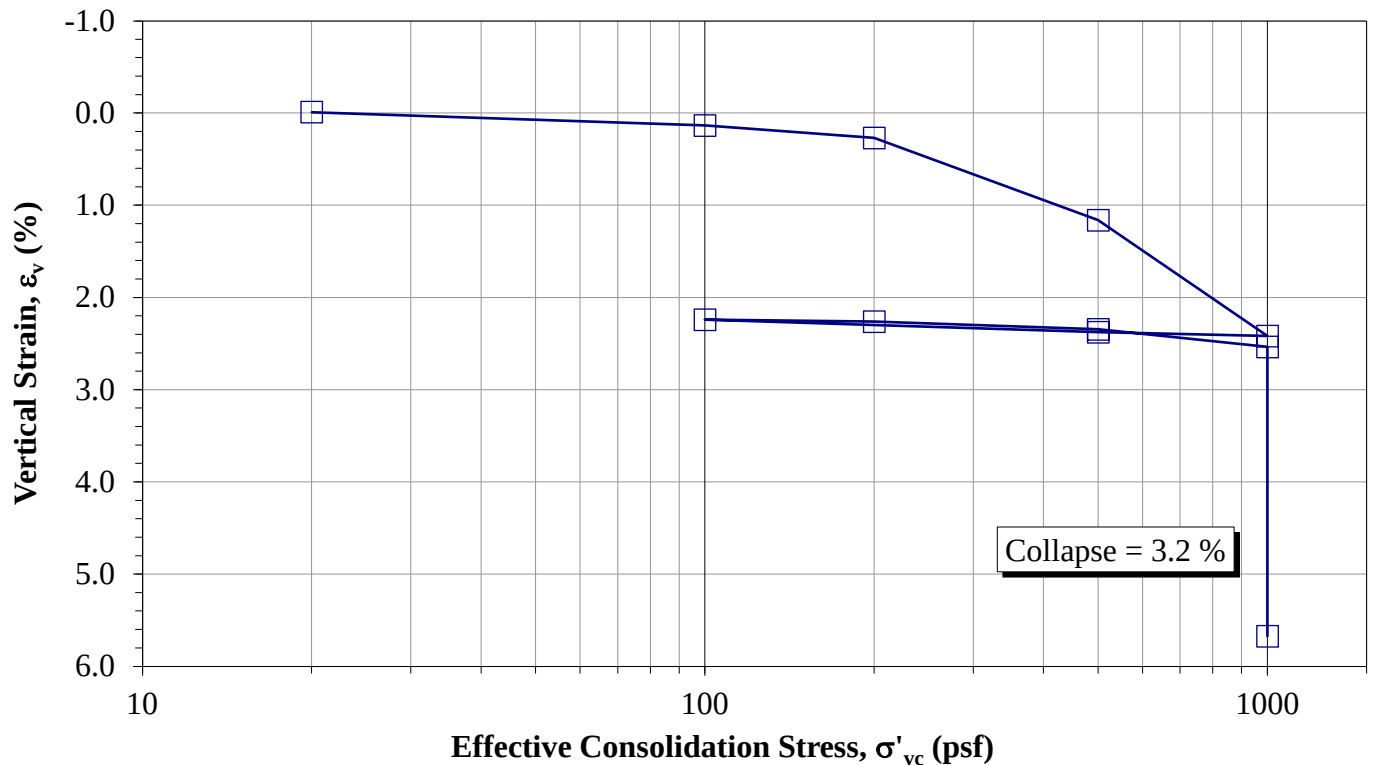
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **2**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **3.2**
Collapse stress (psf): **1000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.960	0.906
Sample diameter, D (in.)	2.413	2.413
Mass rings + wet soil (g)	151.41	167.65
Mass rings/tare (g)	44.05	44.05
Moist unit wt., γ_m (pcf)	93.16	113.70
Wet soil + tare (g)	277.40	244.35
Dry soil + tare (g)	269.83	223.32
Tare (g)	124.09	123.68
Water content, w (%)	5.2	21.1
Dry unit wt., γ_d (pcf)	88.6	93.9
Saturation	15.5	71.7

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9600	0.903
20	-0.00010	-0.01	0.9601	0.903
100	0.00130	0.14	0.9587	0.901
200	0.00260	0.27	0.9574	0.898
500	0.01115	1.16	0.9489	0.881
1000	0.02320	2.42	0.9368	0.857
500	0.02280	2.38	0.9372	0.858
100	0.02150	2.24	0.9385	0.861
200	0.02170	2.26	0.9383	0.860
500	0.02250	2.34	0.9375	0.859
1000	0.02435	2.54	0.9357	0.855
1000	0.05445	5.67	0.9056	0.795



Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-09**

Sample: **ST-02**

Depth: **3.5-4.5'**

Sample Description: **Reddish brown silty sand**

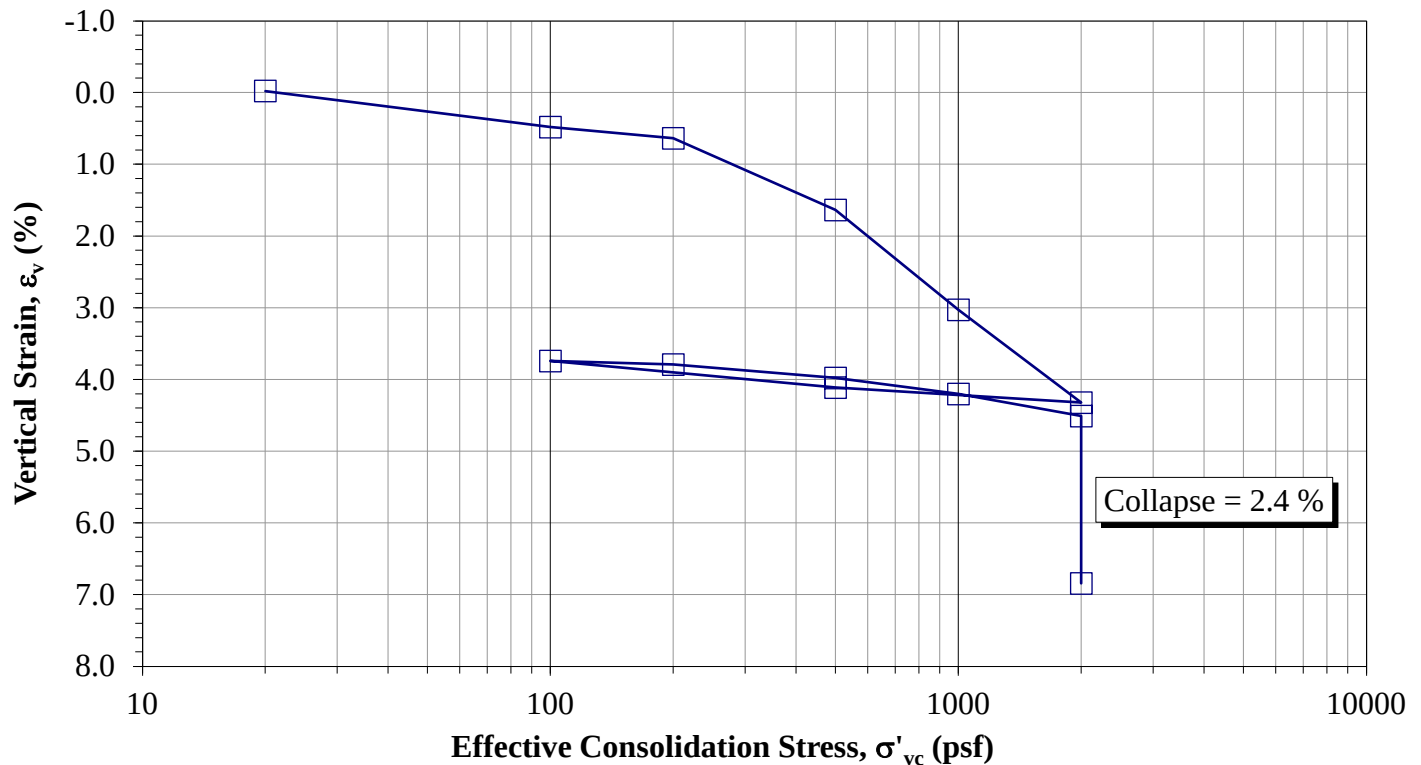
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **7**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **2.4**
Collapse stress (psf): **2000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.917	0.854
Sample diameter, D (in.)	2.413	2.413
Mass rings + wet soil (g)	160.26	174.68
Mass rings/tare (g)	45.50	45.50
Moist unit wt., γ_m (pcf)	104.25	125.98
Wet soil + tare (g)	277.40	247.62
Dry soil + tare (g)	269.83	227.92
Tare (g)	124.09	120.94
Water content, w (%)	5.2	18.4
Dry unit wt., γ_d (pcf)	99.1	106.4
Saturation	20.0	85.1

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9170	0.701
20	-0.00020	-0.02	0.9172	0.701
100	0.00440	0.48	0.9126	0.693
200	0.00585	0.64	0.9112	0.690
500	0.01500	1.64	0.9020	0.673
1000	0.02775	3.03	0.8893	0.649
2000	0.03965	4.32	0.8774	0.627
500	0.03770	4.11	0.8793	0.631
100	0.03430	3.74	0.8827	0.637
200	0.03475	3.79	0.8823	0.636
500	0.03650	3.98	0.8805	0.633
1000	0.03855	4.20	0.8785	0.629
2000	0.04135	4.51	0.8757	0.624
2000	0.06275	6.84	0.8543	0.584



Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-10**

Sample: **ST-01**

Depth: **2-2.5'**

Sample Description: **Red brown clayey sand**

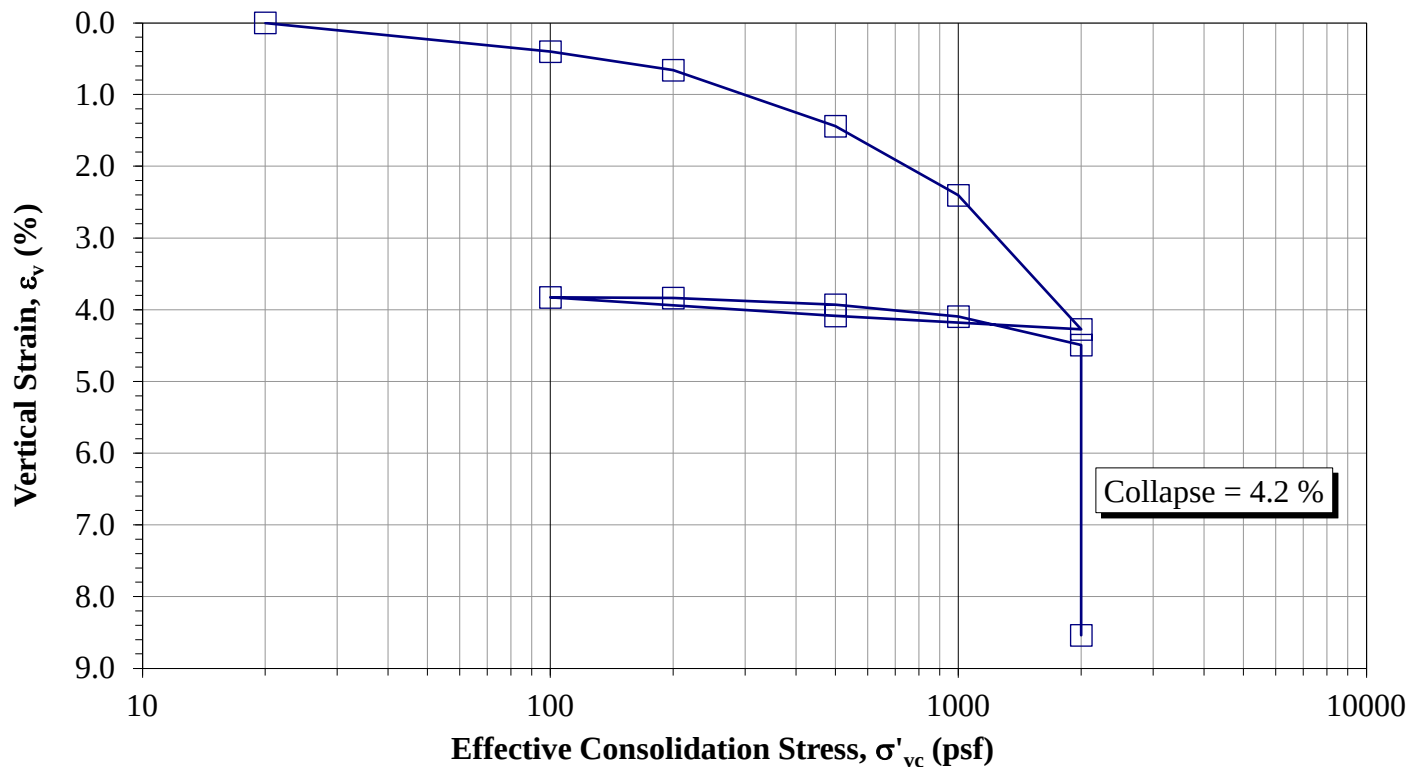
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **8**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **4.2**
Collapse stress (psf): **2000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.924	0.845
Sample diameter, D (in.)	2.414	2.414
Mass rings + wet soil (g)	157.93	171.55
Mass rings/tare (g)	45.09	45.09
Moist unit wt., γ_m (pcf)	101.65	124.55
Wet soil + tare (g)	332.58	351.00
Dry soil + tare (g)	321.21	331.49
Tare (g)	124.27	226.24
Water content, w (%)	5.8	18.5
Dry unit wt., γ_d (pcf)	96.1	105.1
Saturation	20.7	82.8

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9240	0.754
20	0.00000	0.00	0.9240	0.754
100	0.00370	0.40	0.9203	0.747
200	0.00610	0.66	0.9179	0.742
500	0.01330	1.44	0.9107	0.729
1000	0.02220	2.40	0.9018	0.712
2000	0.03950	4.27	0.8845	0.679
500	0.03775	4.09	0.8863	0.682
100	0.03535	3.83	0.8887	0.687
200	0.03545	3.84	0.8886	0.687
500	0.03630	3.93	0.8877	0.685
1000	0.03785	4.10	0.8862	0.682
2000	0.04150	4.49	0.8825	0.675
2000	0.07890	8.54	0.8451	0.604



Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/18/2023**

By: **BRR**

Boring No.: **TP-11**

Sample: **ST-02**

Depth: **3.5-4.5'**

Sample Description: **Reddish brown silty sand**

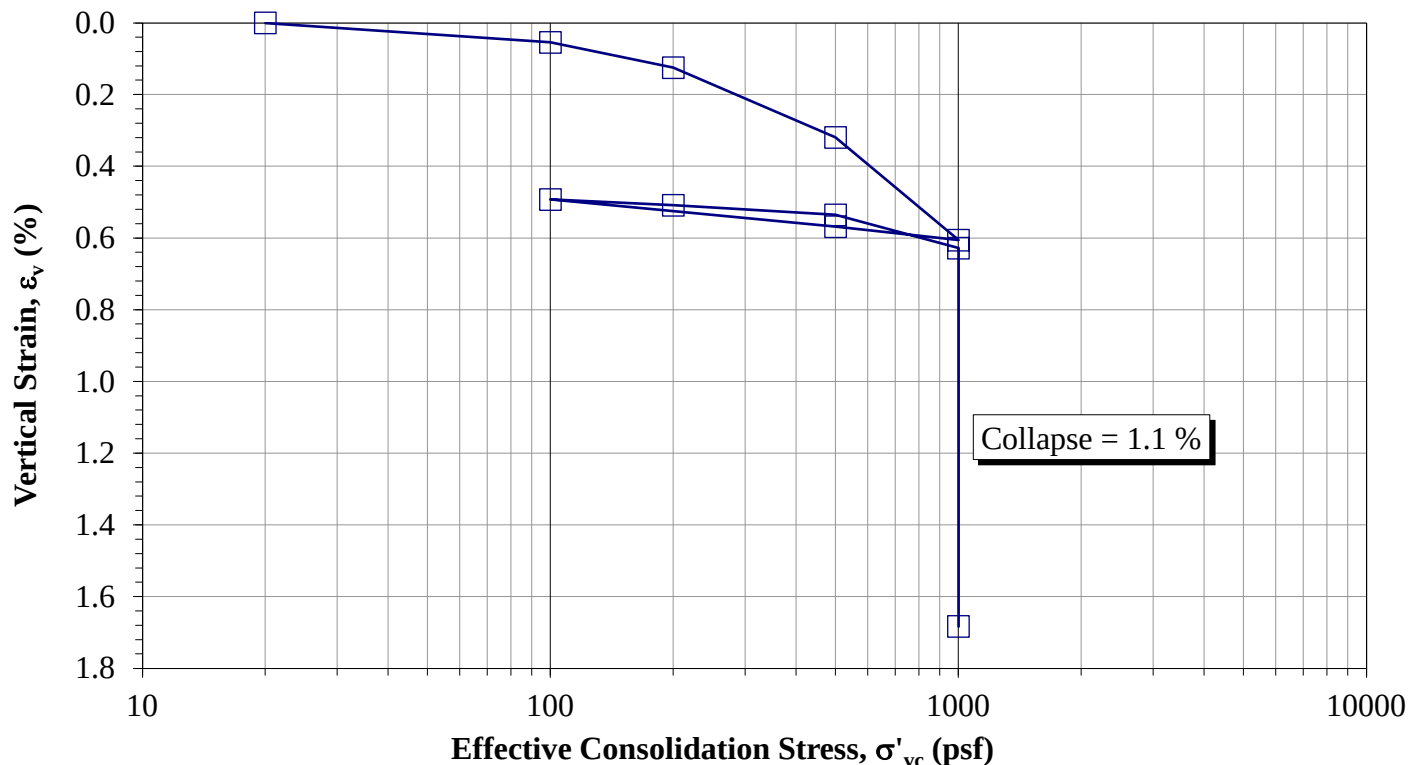
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **2**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **1.1**
Collapse stress (psf): **1000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.924	0.908
Sample diameter, D (in.)	2.410	2.410
Mass rings + wet soil (g)	157.07	179.90
Mass rings/tare (g)	44.75	44.75
Moist unit wt., γ_m (pcf)	101.52	124.24
Wet soil + tare (g)	323.42	260.27
Dry soil + tare (g)	316.52	234.16
Tare (g)	126.82	128.47
Water content, w (%)	3.6	24.7
Dry unit wt., γ_d (pcf)	98.0	99.6
Saturation	13.6	96.4

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9240	0.721
20	0.00000	0.00	0.9240	0.721
100	0.00050	0.05	0.9235	0.720
200	0.00115	0.12	0.9229	0.719
500	0.00295	0.32	0.9211	0.715
1000	0.00560	0.61	0.9184	0.710
500	0.00525	0.57	0.9188	0.711
100	0.00455	0.49	0.9195	0.712
200	0.00470	0.51	0.9193	0.712
500	0.00495	0.54	0.9191	0.712
1000	0.00580	0.63	0.9182	0.710
1000	0.01555	1.68	0.9085	0.692



Entered: _____

Reviewed: _____

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)



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Project: **Moab Geotechnical Group**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **BRR**

Boring No.: **TP-11**

Sample: **ST-02**

Depth: **3.5-4.5'**

Sample Description: **Reddish brown silty sand**

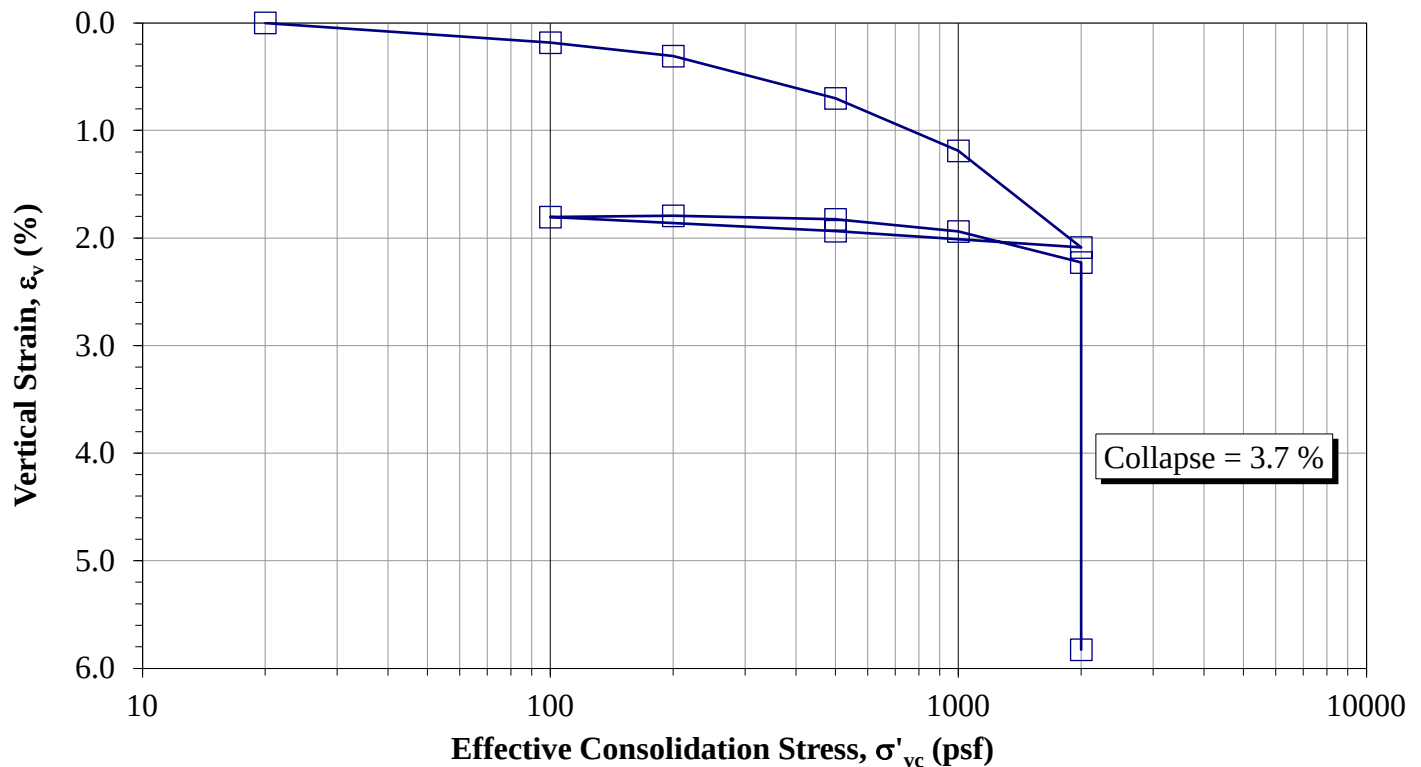
Engineering Classification: **Not requested**

Sample type: **Undisturbed-trimmed from Shelby tube**

Consolidometer No.: **9**
Specific gravity, G_s : **2.70** Assumed
Collapse (%): **3.7**
Collapse stress (psf): **2000**
Water type used for inundation **Tap**

	Initial (o)	Final (f)
Sample height, H (in.)	0.920	0.866
Sample diameter, D (in.)	2.412	2.412
Mass rings + wet soil (g)	153.16	172.95
Mass rings/tare (g)	45.89	45.89
Moist unit wt., γ_m (pcf)	97.21	122.27
Wet soil + tare (g)	323.42	247.05
Dry soil + tare (g)	316.22	223.62
Tare (g)	126.82	121.52
Water content, w (%)	3.8	22.9
Dry unit wt., γ_d (pcf)	93.7	99.4
Saturation	12.8	89.2

Stress (psf)	Dial (in.)	1-D ϵ_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9200	0.800
20	0.00000	0.00	0.9200	0.800
100	0.00170	0.18	0.9183	0.796
200	0.00285	0.31	0.9172	0.794
500	0.00645	0.70	0.9136	0.787
1000	0.01095	1.19	0.9091	0.778
2000	0.01920	2.09	0.9008	0.762
500	0.01780	1.93	0.9022	0.765
100	0.01660	1.80	0.9034	0.767
200	0.01650	1.79	0.9035	0.768
500	0.01680	1.83	0.9032	0.767
1000	0.01785	1.94	0.9022	0.765
2000	0.02050	2.23	0.8995	0.760
2000	0.05360	5.83	0.8664	0.695



Entered: _____

Reviewed: _____

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
(ASTM D2974)



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Project: Moab Geotechnical Group LLC

No: M03898-038 (2021-003)

Location: Arroyo Crossing

Date: 7/12/2023

By: JJ

Sample Info.	Boring No.	TP-04	TP-08						
	Sample:	GB-02	GB-02						
	Depth:	3-3.5'	3-3.5						
	Test Method:	C	C						
	Furnace temp. (°C)	440	440						
Moisture	Wet soil + tare (g)	348.09	358.73						
	Dry soil + tare (g)	331.59	341.38						
	Tare (g)	121.55	123.36						
Ash / Organic Info	Mass of crucible and oven-dried sample (g)	595.72	598.10						
	Mass of crucible and ash (g)	593.29	596.32						
	Mass of crucible (g)	385.66	380.05						
Moisture Content, w (%) ^a		7.9	8.0						
Ash Content (%)		98.8	99.2						
Organic Matter (%)		1.2	0.8						
^a Moisture contents are by proportion of oven-dried mass (geotechnical convention).									

Entered by: _____

Reviewed: _____

**Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and
Ions in Water by Chemically Suppressed Ion Chromatography** (AASHTO T 288, T 289, ASTM D4327, and C1580)

Project: **Moab Geotechnical Group LLC**

No: **M03898-038 (2021-003)**

Location: **Arroyo Crossing**

Date: **7/17/2023**

By: **LM/CJ**

Sample info.	Boring No.	TP-05							
	Sample	GB-03							
	Depth	4-4.5'							
Water content data	Wet soil + tare (g)	46.59							
	Dry soil + tare (g)	44.27							
	Tare (g)	23.35							
	Water content (%)	11.1							
Chem. data	pH	8.7							
	Soluble chloride (ppm)	194.5							
	Soluble sulfate (ppm)	470							
Resistivity data	Pin method	2							
	Soil box	Miller Large							
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As is	4030	0.57	2297				
		+3	2571	0.57	1465				
		+6	2028	0.57	1156				
		+9	1675	0.57	955				
		+12	1613	0.57	919				
		+15	1565	0.57	892				
		+18	1586	0.57	904				
	Minimum resistivity (Ω-cm)	892							

Entered by: _____

Reviewed: _____

APPENDIX C – HISTORICAL GEOTECHNICAL REPORT DATA

Table of Contents

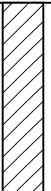
Select Bore Logs from Trautner Geotech LLC, April 26, 2019, Feasibility Level Geotechnical Engineering Study / Design Level Pavement Recommendations – Arroyo Crossing Project	C-1
Select Lab Data from Trautner Geotech LLC, April 26, 2019, Feasibility Level Geotechnical Engineering Study / Design Level Pavement Recommendations – Arroyo Crossing Project	C-3

Field Engineer : J. Butler
Hole Diameter : Four inch solid
Drilling Method : Continuous Flight Auger
Sampling Method : Mod. California Sampler
Date Drilled : 3/28/2019
Total Depth (approx.) : 25 feet
Location : See Figure 3.3 & 3.4

LOG OF BORING TB-7

Arroyo Crossing Project
Moab, Utah
Ms. Audrey Graham, Chair
Moab Area Community Land Trust

Project Number: 55599GE

Depth in feet	Sample Type	Water Level	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS				
	 Mod. California Sampler  Bag Sample  Standard Split Spoon  Water Level During Drilling  Water Level After Drilling <th>DESCRIPTION</th>	DESCRIPTION										
0	SAND, silty, medium dense, moist, red		SM					*notable gypsum cemented soils 6 feet to 21 feet				
1												
2												
3												
4	SAND, GRAVEL, silty, cobbles, dense, moist, tan		SM-GM			2/6 3/6						
5												
6	SAND, silty, few gravels, dense, moist to slightly moist, tan		SM									
7												
8	SAND, silty, white chemical deposits, very dense, slightly moist, light tan											
9			SM			10/6 48/6						
10												
11												
12												
13												
14												
15						20/6 50/5						
16												
17			GM/GP									
18												
19												
20												
21	GRAVEL, COBBLES, sandy, slightly silty, dense to very dense, moist, brown		GM/GP									
22												
23												
24												
25	Auger refusal at 25 feet on dense cobbles											
26												
27												

Field Engineer : J. Butler
 Hole Diameter : Four inch solid
 Drilling Method : Continuous Flight Auger
 Sampling Method : Mod. California Sampler
 Date Drilled : 3/28/2019
 Total Depth (approx.) : 9 feet
 Location : See Figure 3.3 & 3.4

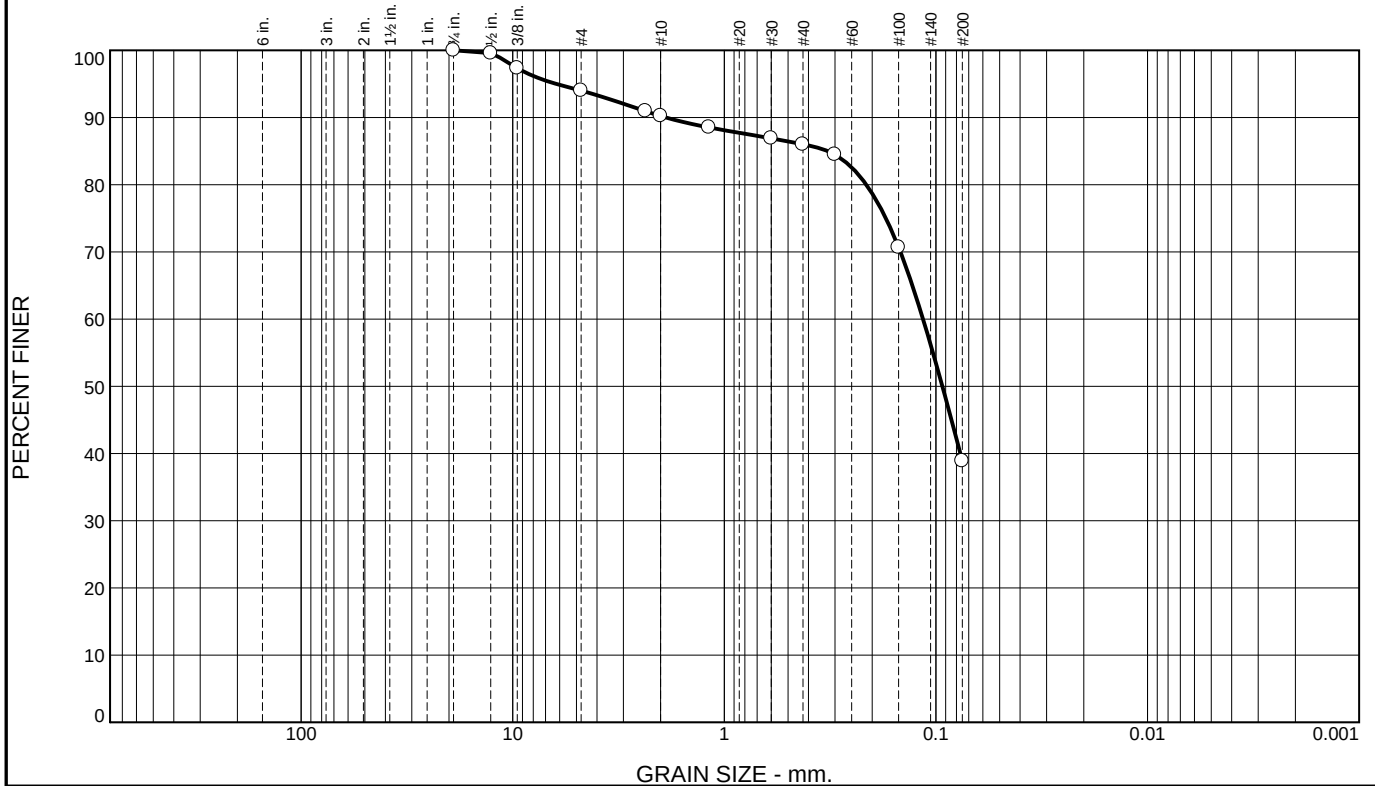
LOG OF BORING TB-9

Arroyo Crossing Project
 Moab, Utah
 Ms. Audrey Graham, Chair
 Moab Area Community Land Trust

Project Number: 55599GE

Depth in feet	Sample Type	Water Level	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
	Mod. California Sampler Bag Sample Standard Split Spoon	Water Level During Drilling Water Level After Drilling						
DESCRIPTION								
0	SAND, silty, medium dense to dense, moist to very moist, red		SM			4/6 25/6 rock		
1								
2								
3			SM					
4	SAND, silty, gravels, dense, moist, red							
5								
6	SAND, silty, few gravels, dense, moist to slightly moist, orange		SM			17/6 27/6		
7								
8								
9	Bottom of test boring at 9 feet							
10								

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.0	3.8	4.2	47.1	38.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.50	99.6		
.375	97.3		
#4	94.0		
#8	91.0		
#10	90.2		
#16	88.5		
#30	86.9		
#40	86.0		
#50	84.5		
#100	70.7		
#200	38.9		

* (no specification provided)

Soil Description
SM Silty Sand

Atterberg Limits
 PL= 0 LL= 0 PI= 0

Coefficients
 D₉₀= 1.8935 D₈₅= 0.3249 D₆₀= 0.1150
 D₅₀= 0.0933 D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= SM AASHTO= A-4(0)

Remarks

Location: Bulk TB-1,2,4,7,9 and 14
 Sample Number: C10219-B Depth: 0'-4'

Date: 4/2/19

TRAUTNER GEOTECH LLC

Client: Moab Area Community Land Trust, Audrey Graham, Chair
 Project: Arroyo Crossing, Moab, UT

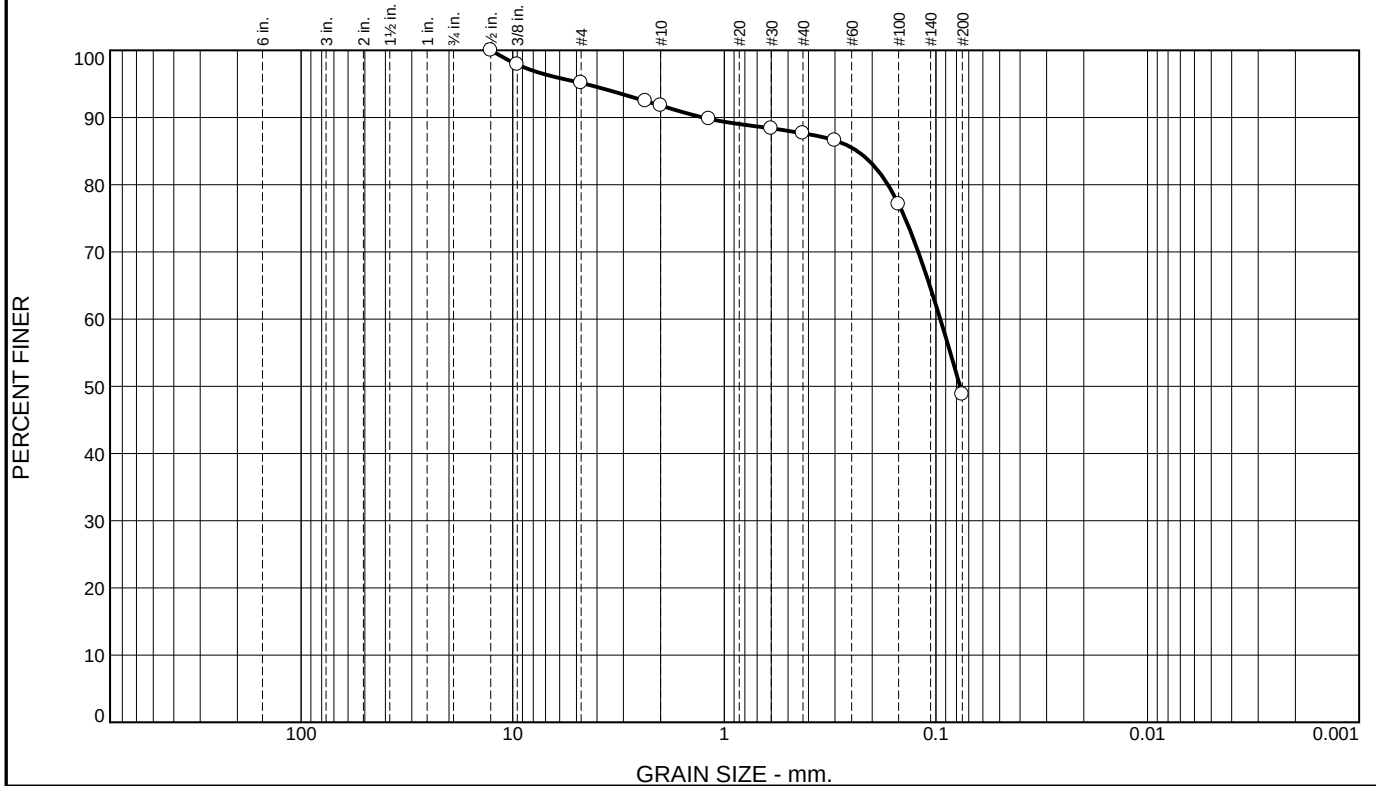
Project No: 55599GE

Figure 4.2

Tested By: R. Barrett

Checked By: J. Butler P.E.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.9	3.3	4.2	38.8	48.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.50	100.0		
.375	97.9		
#4	95.1		
#8	92.4		
#10	91.8		
#16	89.8		
#30	88.4		
#40	87.6		
#50	86.6		
#100	77.1		
#200	48.8		

* (no specification provided)

<u>Soil Description</u>		
SM Silty Sand		
<u>Atterberg Limits</u>		
PL= 16	LL= 17	PI= 1
<u>Coefficients</u>		
D ₉₀ = 1.2625	D ₈₅ = 0.2353	D ₆₀ = 0.0954
D ₅₀ = 0.0769	D ₃₀ =	D ₁₅ =
D ₁₀ =	C _u =	C _c =
<u>Classification</u>		
USCS= SM	AASHTO= A-4(0)	
<u>Remarks</u>		

Location: TB-7
Sample Number: C10219-LL

Depth: 4'-8'

Date: 4/2/19

TRAUTNER GEOTECH LLC

Client: Moab Area Community Land Trust, Audrey Graham, Chair
Project: Arroyo Crossing, Moab, UT

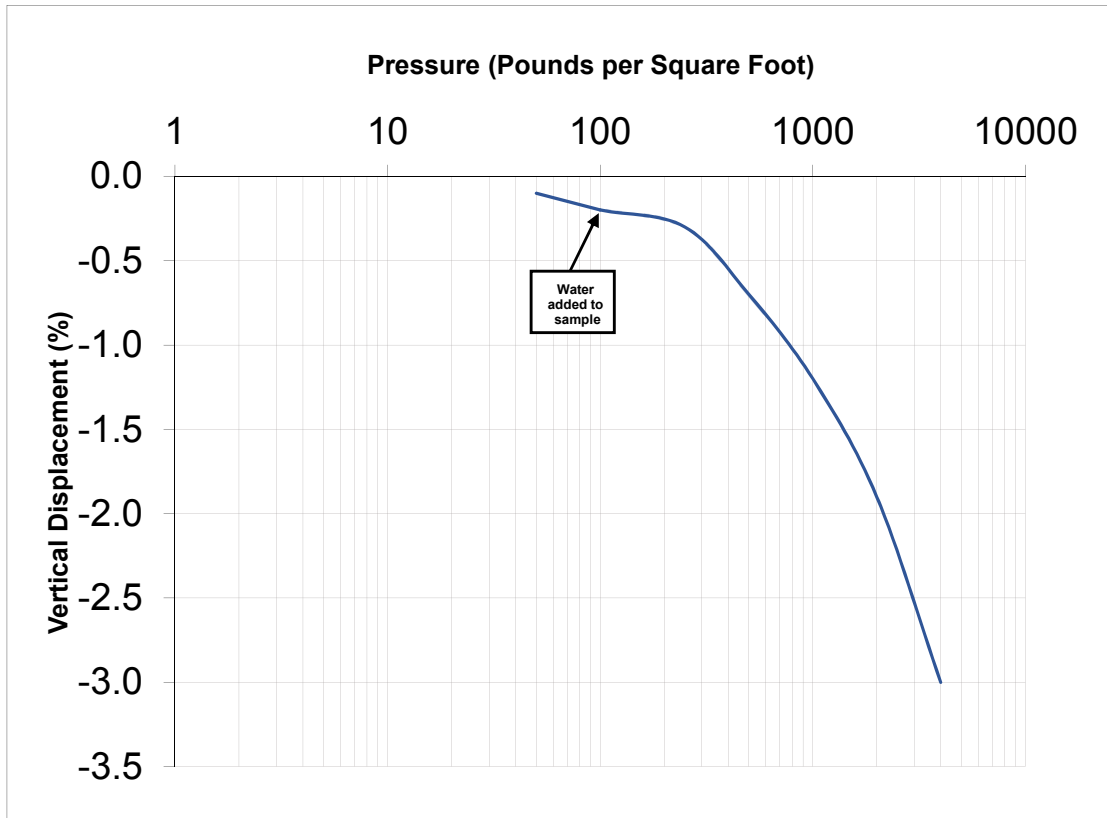
Project No: 55599GE

Figure 4.6

Tested By: R. Barrett

Checked By: J. Butler P.E.

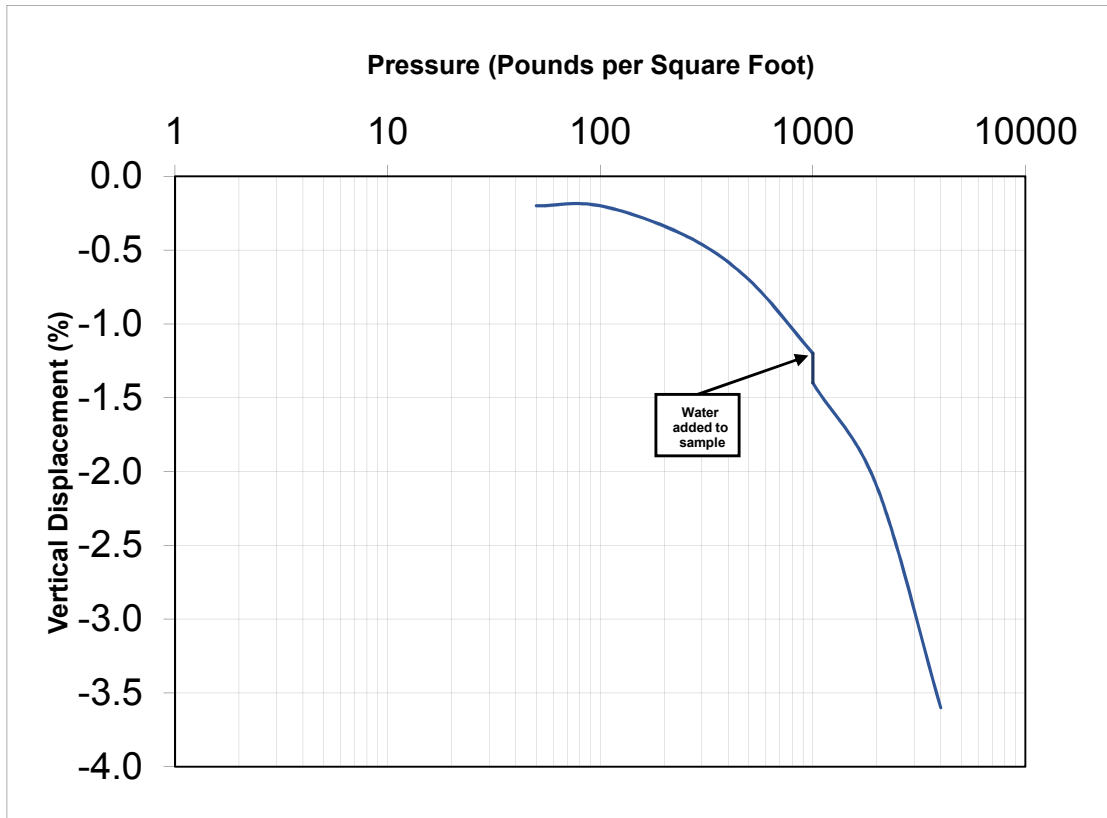
SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TB-7@3'	
Visual Soil Description:	SM Silty Sand	
Swell Potential (%)	Consolidated	
Constant Volume Swell Pressure (lb/ft²):	N/A	
	Initial	Final
Moisture Content (%):	7.6	17.0
Dry Density (lb/ft³):	110.3	112.7
Height (in.):	1.000	0.970
Diameter (in.):	1.94	1.94

Project Number:	55599GE
Sample ID:	C10219-KK
Figure:	4.15

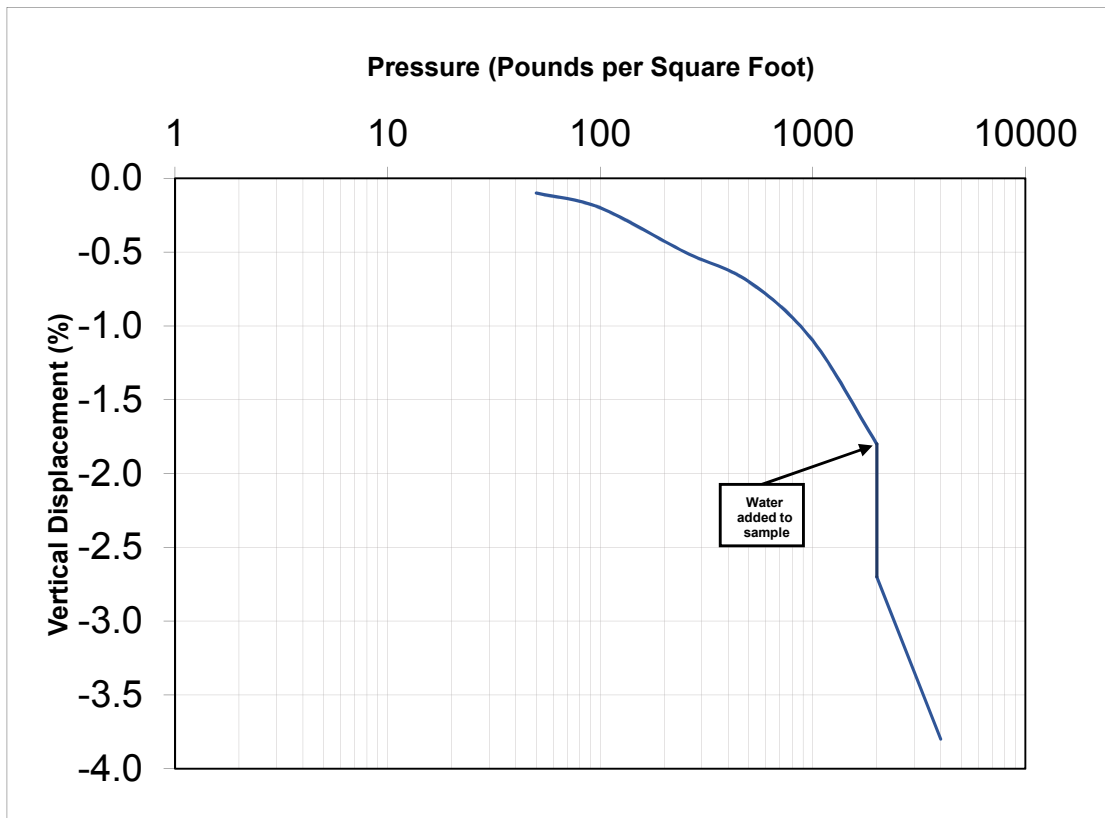
SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TB-7@8'	
Visual Soil Description:	SM Silty Sand	
Swell Potential (%)	Consolidated	
Constant Volume Swell Pressure (lb/ft ²):	N/A	
	Initial	Final
Moisture Content (%):	5.0	13.2
Dry Density (lb/ft ³):	122.0	125.2
Height (in.):	1.000	0.964
Diameter (in.):	1.94	1.94

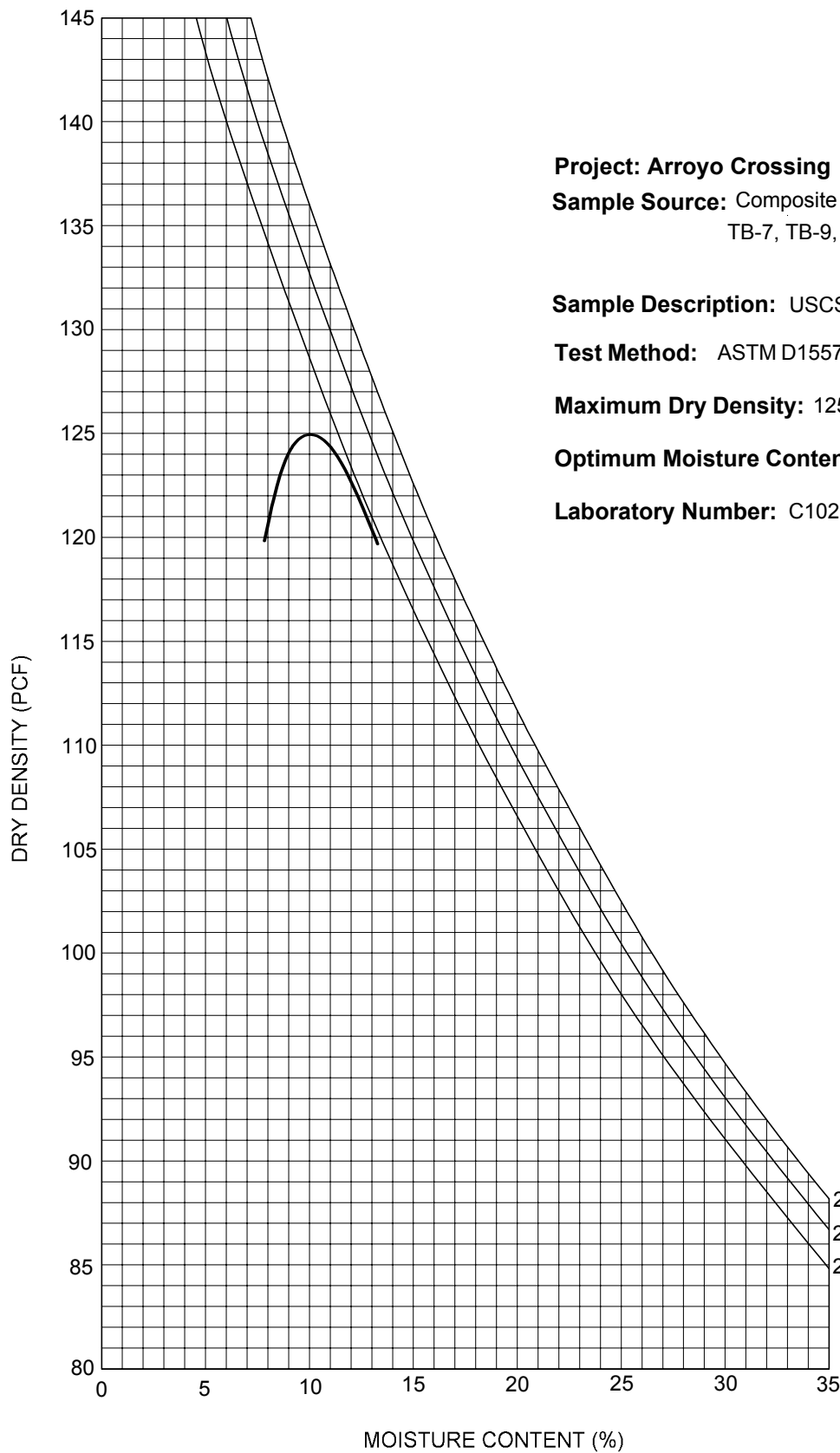
Project Number:	55599GE
Sample ID:	C10219-MM
Figure:	4.16

SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TB-7@13'	
Visual Soil Description:	SM Silty Sand	
Swell Potential (%)	Consolidated	
Constant Volume Swell Pressure (lb/ft²):	N/A	
	Initial	Final
Moisture Content (%):	3.9	14.5
Dry Density (lb/ft³):	120.8	124.0
Height (in.):	1.000	0.962
Diameter (in.):	1.94	1.94

Project Number:	55599GE
Sample ID:	C10219-OO
Figure:	4.17



Project: Arroyo Crossing

Sample Source: Composite Bulk from TB-1, TB-2, TB-4, TB-7, TB-9, TB-14

Sample Description: USCS "SM" silty sand

Test Method: ASTM D1557 Method A

Maximum Dry Density: 125.0 pcf

Optimum Moisture Content: 10.0%

Laboratory Number: C10219B

2.8
2.7
2.6
Zero Air Voids for
Specific Gravity