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GEOLOGIC AND GEOTECHNICAL ENGINEERING STUDY

Proposed Monument at Powder Mountain Development

East of Intersection of Summit Pass Road and Heartwood Drive
Eden, Utah

CMT PROJECT NO. 20435

FOR:
Fawkes Consultants
2701 North Thanksgiving Way
Lehi, Utah

August 8, 2023

CMT TECHNICAL SERVICES

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Casey Walker
Fawkes Consultants
2701 North Thanksgiving Way
Lehi, Utah

Subject: Geologic and Geotechnical Engineering Study
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Mr. Walker:

Submitted herewith is the report of our geologic and geotechnical engineering study for the subject site. This report contains the results of our findings and an interpretation of the results with respect to the available project characteristics. The report also contains recommendations to aid in the design and construction of the earth related phases of this project.

On July 3 through July 10, 2023, CMT Technical Services (CMT) personnel were onsite and supervised drilling of two boreholes to depths of about 6.0 to 14.0 feet below the existing ground surface, and the excavation of 19 test pits to depths of from about 4.0 to 8.5 feet below the existing ground surface. Soil samples were obtained during the field operation and subsequently transported to our laboratory for further testing and observation. Conventional spread and/or continuous footings may be utilized to support the proposed structures, provided the recommendations in this report are followed. A detailed discussion of design and construction criteria is presented in this report.

We appreciate the opportunity to work with you at this stage of the project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With offices in Utah, Arizona, Idaho, Colorado, and Texas, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at 801 590-0394.

Sincerely,
CMT Technical Services

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APPENDIX

1.0 INTRODUCTION

1.1 General

This report presents results of a geologic and geotechnical engineering study conducted by CMT Technical Services (CMT) for the proposed Monument at Powder Mountain Development in Eden, Utah. The site is in the Wasatch Range slightly south of the Cache County-Weber County line in the SW1/4 Section 5, Township 7 North, Range 2 East (Salt Lake Base Line and Meridian). The property is identified as Weber County Assessor parcel numbers 23-012-0189 and 23-129-0016. Elevation of the site ranges between about 8,734 and 8,871 feet above mean sea level. The site location is shown on ***Figure 1, Vicinity Map***. Regional geology of the site and surrounding area is provided on ***Figure 2, Geologic Map***. A high-resolution, pre-development air photo of the site and surrounding area is shown on ***Figure 3, 2012 Air Photo***. Locations of the test pits and boreholes conducted for our subsurface explorations are shown on ***Figure 4, Site Evaluation.*** Slope-terrain information is provided on ***Figure 5, LIDAR Analysis***. Site-specific surficial geology is shown on ***Figure 6, Site-Specific Geology***. The project boundary shown on ***Figures 3 through 6*** should be considered approximate.

1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Michael Brenny (authorized representative of Fawkes Consultants) and Andrew Harris of CMT, as outlined in our proposal dated May 30, 2023.

Our objectives and scope of work included:

1. Performing a site-specific geologic study, in accordance with Section 108-22 Natural Hazard Areas guidelines and standards of the Weber County Code of Ordinances (October 28, 2019), to assess whether all or parts of the site are exposed to natural hazards including, but not limited to: Surface-Fault Rupture, Landslides, Tectonic Subsidence, Rock Falls, Debris Flows, Liquefaction and Flooding.

2. Defining and evaluating site conditions, including: (a) a field program consisting of surficial observation and excavation, logging, and sampling of two boreholes and 19 test pits at the site and in surrounding areas to evaluate subsurface conditions; (b) a laboratory soils testing program; and (c) an office program consisting of data compilation and correlation, applicable engineering and geological analyses, and preparation of this report summarizing our findings.

Engineering geologic analyses and report sections have been conducted and prepared in accordance with Bowman and Lund (2020) and current generally accepted professional engineering geologic principles and practice in Utah.

1.3 Description of Proposed Construction

We understand the site will be developed to include residential condominiums, a clubhouse or commercial building, a well/pumphouse, a vehicle bridge, a ski tunnel, and a snow maintenance infrastructure, although the configuration of the development may vary. Structures are expected to be of wood-framed construction and founded on spread footings possibly with basements. Maximum continuous wall and column loads are anticipated to be 4,000 pounds per lineal foot and 100,000 pounds, respectively. Pavements at the site will consist of asphalt-paved public and private roadways and parking lots.

1.4 Executive Summary

Structures can be supported upon conventional spread and continuous wall foundations established on suitable natural sand/gravel soils or on structural fill extending to suitable natural soils. The most significant geotechnical/geological aspects of the site are:

1. The Project is at Powder Mountain Ski Area on the south flank of the range top marking the boundary between Cache and Weber Counties. Cobabe Canyon is to the north of the Project and Lefty's Canyon is to the south. Utah Geological Survey (UGS) mapping indicates the site is in an area mainly underlain by Tertiary Wasatch Formation, which is comprised of red to brownish-red sandstone, siltstone, mudstone and conglomerate. The head of a Pleistocene landslide is also mapped extending slightly into the southern part of the property. Summit Pass Road bounds the Project on the south.

2. Slopes at the site dip southeastward to southwestward at gradients of from 10 to 50 percent but are mainly moderate (between 15 to 30 percent). Overall slope across the middle of the site is 19.5 percent (or 5.1:1 horizontal:vertical). Steep slopes (> 30 percent) are found in the south part of the site associated with the road cut along the north frontage of Summit Pass Road, whereas gentle slopes (< 15 percent) are found in the northeast and northwest parts of the site.

3. The test pits and bore holes conducted for our field investigation at the site and in the surrounding area predominately exposed weathered bedrock soils comprised of Clayey SAND (SC) and Clayey GRAVEL (GC), with some sandy to gravelly Lean CLAY (CL) with cobbles and boulders. In bore hole B-1 layers of high plasticity SILT (MH) were encountered. Subsurface exploration depths were limited due to refusal conditions in the bore holes. Moist soils and seepage were observed in test pits TP-4, TP-5, TP-11 and TP-13 in the northeast part of the site. The groundwater appeared to be residual moisture from recent snowmelt infiltration. No groundwater was observed in the remaining test pits or boreholes to their explored depths.

4. A global slope stability analysis was performed on a cross section of the site selected by the project geologist. Results of the analysis indicate the cross section analyzed, in its current configuration, exhibits factors of safety more than typically acceptable levels. Proposed grading should be reviewed by CMT to assess possible effects on slope stability.

5. Some of the subsurface soils encountered exhibited high plasticity and are unsuitable for support of footings and floor slabs. Conventional foundations, supported on suitable, undisturbed natural sand/gravel soils or structural fill, may be utilized to support the proposed structures.

A geotechnical engineer/geologist from CMT must be allowed to observe footing excavations to assess if all topsoil, undocumented fill materials (if encountered), high plastic soils, or other unsuitable soils, have been completely removed from beneath proposed structures, and suitable natural soils encountered prior to the placement of structural fills, floor slabs, footings, foundations, or concrete flatwork.

In the following sections, detailed discussions pertaining to proposed construction, field exploration, the geologic setting and mapped hazards, geoseismic setting of the site, earthwork, foundations, lateral pressure and resistance, floor slabs, and subdrains are provided.

2.0 FIELD EXPLORATION

Subsurface soil conditions at the Project were explored by drilling two bore holes and excavating 19 test pits at the locations shown on ***Figure 4***. The bore holes were drilled with a truck mounted hydraulic drill rig using hollow-stem augers to depths of 6.5 to 14 feet below the existing ground surface where auger refusal occurred on bedrock. The test pits were excavated using a track-mounted excavator to depths of about 4 to 8.5 feet below the ground surface (bgs) for geologic/geotechnical logging and sampling. During the drilling and excavation operations, a continuous log of the subsurface conditions encountered was maintained.

Samples of the subsurface soils encountered in the bore holes were collected at varying depths through the hollow stem drill augers. A relatively undisturbed sample was obtained by hydraulically pushing a 3-inch diameter (Shelby) tube into the undisturbed soils below the drill augers. Disturbed samples were collected utilizing a standard split spoon sampler. This standard split spoon sampler was driven 18 inches into the soils below the drill augers using a 140-pound hammer free-falling a distance of 30 inches. The number of hammer blows needed for each 6-inch interval was recorded. The sum of the hammer blows for the final 12 inches of penetration is known as a standard penetration test and this 'blow count' was recorded on the bore hole logs. Where more than 50 blows occurred before the 6-inch interval was achieved, the sampling was terminated and the number of blows and inches penetrated by the sampler were recorded. The blow count provides a reasonable approximation of the relative density of granular soils, but only a limited indication of the relative consistency of fine-grained soils because the consistency of these soils is significantly influenced by the moisture content.

In the test pits undisturbed tube and block samples, and disturbed bulk samples of representative soils encountered were obtained. The samples were sealed in plastic bags and containers prior to transport to the laboratory.

The samples collected from the bore holes and the soils exposed in the test pits were classified in the field based upon visual and textural examination, logged, and described in general accordance with ASTM D-2488. These classifications were supplemented by subsequent inspection and testing of select samples in our laboratory. The subsurface conditions encountered in the field exploration are discussed below in **Section 3.2**. Geologic logs of test pits TP-1 through TP-5 at a scale of 1 inch equals five feet (1:60) are provided on ***Figures 7A through 7E, Geologic Test Pit Logs***. Logs of the boreholes are provided on ***Figures 9 and 10, Bore Hole Logs***. Geotechnical logs (measured sections) of the test pits are provided on ***Figures 11 through 29, Geotechnical Test Pit Logs***. Sampling information, location, trend, and other pertinent data and observations are provided on the logs. A

Key to Symbols defining the terms and symbols used on the geotechnical test pit and bore hole logs is provided on ***Figure 30, Key to Symbols***.

When backfilling the test pit excavations, only minimal effort was made to compact the backfill and no compaction testing was performed. Thus, the backfill must be considered as non-engineered and settlement of the backfill in the test pits over time must be anticipated.

3.0 SITE CONDITIONS

3.1 Surface Conditions

The site conditions and geology were interpreted through an integrated compilation of data, including a review of literature and mapping from previous studies conducted in the area (Coogan and King, 2016); photogeologic analyses of pre- and post-development aerial imagery from 2012 and 2018, as shown on ***Figures 3 and 4***; GIS analyses of elevation and geoprocessed LIDAR terrain data from 2016, as shown on ***Figure 5***; field reconnaissance of the general site area; and interpretation of the test pits and boreholes conducted at the site and in the surrounding area as part of our field program. Site-specific geology of the Project at a scale of 1 inch equals 100 feet (1:1,200) is shown on ***Figure 6***. Unit labels on ***Figure 6*** correspond to those of Coogan and King (2016).

The site is vacant land and the surface vegetated with grasses, weeds, and shrubs. The site grades slope downward to the south with an overall relief from the unpaved road on the north to the paved road on the south approaching 150 feet. Based upon aerial photos readily available online dating back to 1993 the site appears to have remained relatively unchanged since that time.

3.2 Subsurface Soils

A total of 2 bore holes were drilled and 19 test pits were excavated at the site and surrounding areas to evaluate subsurface soil conditions, at the approximate locations shown on ***Figure 4***. Stratigraphic interpretations and detailed unit descriptions are shown on the logs (***Figures 7A-E and 9 through 29***). A summary is provided in the table below. Test pit locations were measured using a hand-held GPS unit or mobile device and by trend and distance methods from known points. Geologic logging followed methodology in McCalpin (1996). Refusal conditions were encountered in most of the test pits at depths of 4.0 to 8.0 feet below the existing ground surface, and at 14.0 feet and 6.5 feet in bore holes B-1 and B-2, respectively.

Exposure	Subsurface Soils
Bore Hole 1	Sandy to gravelly high plasticity SILT (MH); weathered bedrock.
Bore Hole 2	Silty-Clayey GRAVEL (GC-GM) with sand; weathered bedrock.
Test Pit 1	Cobbly and bouldery Clayey SAND (SC) with gravel.
Test Pit 2	Cobbly and bouldery Clayey SAND (SC) with gravel.
Test Pit 3	Cobbly and bouldery Clayey SAND (SC) with gravel.
Test Pit 4	Cobbly and bouldery Clayey SAND (SC) with gravel. Seepage

Test Pit 5	Cobbly and bouldery Clayey SAND (SC) with gravel; saturated pockets.
Test Pit 6	Cobbly and bouldery Clayey SAND (SC) with gravel.
Test Pit 7	Cobbly and bouldery Clayey GRAVEL (GC) with sand.
Test Pit 8	Cobbly and bouldery Clayey SAND (SC) with gravel.
Test Pit 9	Cobbly and bouldery Clayey GRAVEL (GC) with sand.
Test Pit 10	Bouldery Sandy CLAY (CL) overlying CLAY (CL) with sand.
Test Pit 11	Bouldery Sandy CLAY (CL) overlying Clayey GRAVEL (GC) with sand; seepage.
Test Pit 12	Cobbly and bouldery Clayey GRAVEL (GC) with sand.
Test Pit 13	Cobbly and bouldery Sandy CLAY (CL) with gravel overlying and Clayey GRAVEL (GC) with sand and Sandy CLAY (CL); seepage.
Test Pit 14	Cobbly and bouldery CLAY (CL) with gravel overlying Clayey SAND (SC) with gravel.
Test Pit 15	Cobbly and bouldery Clayey GRAVEL (GC) with sand.
Test Pit 16	Cobbly and bouldery Clayey SAND (SC) with gravel.
Test Pit 17	Cobbly and bouldery Clayey SAND (SC) with gravel.
Test Pit 18	Bouldery Sandy CLAY (CL) with gravel overlying Silty GRAVEL (GM) with sand.
Test Pit 19	Cobbly and bouldery Clayey SAND (SC) with gravel.

3.3 Geologic Cross Section

Figure 8, Cross Section A-A', shows one geologic cross section across the steepest slopes in the south part of the site, as located on ***Figures 5 and 6***. The cross section is at a scale of 1 inch equals 25 feet with no vertical exaggeration. The geology is based on subsurface data from test pits TP-1 and TP-2 (***Figures 7A-B***), and the regional and site-specific geologic mapping on ***Figures 2 and 6***. The topographic profile is based on geoprocessed LIDAR data from 2016. The LIDAR data provide a snapshot of topographic conditions at the time of acquisition; past, present and future surficial topography may vary. Units and contacts should be considered approximate and inferred, and variations should be expected at depth and laterally.

3.4 Groundwater

Moist soils and seepage were observed in test pits TP-4, TP-5, TP-11 and TP-13 in the northeast part of the site. The seepage appeared to be residual moisture from recent snowmelt infiltration. No seepage or groundwater was observed in the remaining test pits or boreholes to their explored depths. No site-specific groundwater information was available for the Project, but the Utah Division of Water Rights Well Drillers' database indicates two water wells owned by Summit Mountain Holding Group (SMHG) are to the southeast and west, as located on ***Figure 2***. The SMHG well southeast of the Project was drilled in May 2013 to a depth of 2,800 feet. Static groundwater in this well was reportedly at a depth of 1,147 feet bgs. The SMHG well west of the Project was drilled in December 2017 to a depth of 2,500 feet. Static groundwater in this well was reportedly at a depth of 1,225.49 feet bgs.

Based on the above, we anticipate static groundwater depths at the site generally exceed 1,000 feet. However, groundwater depths may vary seasonally from snowmelt runoff and infiltration, annually from climatic fluctuations, and locally with topography and subsurface conditions. Seasonal saturation of near-surface unconsolidated deposits and weathered bedrock during spring snowmelt infiltration would be typical for the area. Following spring snowmelt, the groundwater depths likely increase significantly and rapidly, depending on the hydraulic conductivity of the underlying and downslope surficial deposits and bedrock. Maintaining proper surface drainage will help minimize unanticipated groundwater conditions.

3.5 Site Subsurface Variations

Based on the results of the subsurface explorations and our experience, variations in the continuity and nature of subsurface conditions should be anticipated. Due to the heterogeneous characteristics of natural soils, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory locations. When backfilling the test pit excavations, only minimal effort was made to compact the backfill and no compaction testing was performed. Thus, the backfill must be considered as non-engineered and settlement of the backfill in the test pits over time must be anticipated.

4.0 LABORATORY TESTING

4.1 General

Selected samples of the subsurface soils were subjected to various laboratory tests to assess pertinent engineering properties, as follows:

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Dry Density, ASTM D-2937, Dry unit weight representing field conditions
3. Atterberg Limits, ASTM D-4318, Plasticity and workability
4. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
5. One Dimension Consolidation, ASTM D-2435, Consolidation properties
6. Direct Shear Test, ASTM D-3080, Shear strength parameters

To provide data for an analysis of potential settlement from structural loading, a one-dimensional consolidation test was performed on a representative sample of the subsurface soil collected in bore hole B-1. Based upon data obtained from the consolidation test, the elastic silt soils at this site are moderately over-consolidated and moderately compressible under additional loading (see the **Lab Summary Table** below). Detailed results of the consolidation test are maintained within our files and can be transmitted to you, if so desired.

Laboratory test results are presented on the bore hole and test pit logs (***Figures 9 through 29***) and in the **Lab Summary Table** on the following page:

LAB SUMMARY TABLE

BORE HOLE	DEPTH (feet)	SOIL CLASS	SAMPLE TYPE	MOISTURE CONTENT(%)	DRY DENSITY (pcf)	GRADATION			ATTERBERG LIMITS		
						GRAV.	SAND	FINES	LL	PL	PI
B-1	5	MH	Shelby Tube	40	76	0	34	66	95	45	50
B-1	7.5	MH	SPT	39		2	14	84	90	50	40
B-2	2.5	GC-GM	SPT	6		36	33	31			
B-2	5	GC-GM	SPT	9					21	17	4
TP-1	6.5	SC	Bag	8		26	39	35			
TP-2	4.5	SC	Bag	9		27	39	34			
TP-4	2	SC	Bag	14		27	41	32			
TP-5	4	SC	Bag	9		43	26	31			
TP-5	6	SC	Bag	10		32	35	33			
TP-6	5	SC	Bag	8		22	43	35			
TP-7	4	GC	Bag	6		40	24	36			
TP-8	4	SC	Bag	9		32	36	32			
TP-8	7	SC	Bag	10		28	35	37			
TP-9	4	GC	Bag	10		37	32	31			
TP-10	7.5	CL	Block	36		1	17	82			
TP-11	4	CL	Bag	16		1	31	68			
TP-11	6	GC	Bag	19		37	26	37			
TP-12	3	GC	Bag	8		35	32	33			
TP-13	5	GC	Bag	8		47	31	22			
TP-13	8	CL	Bag	12		22	25	53			
TP-14	5	SC	Bag	8		33	35	32			
TP-15	5	GC	Bag	6		42	31	27			
TP-16	2	SC	Bag	8		20	34	46			
TP-17	1	SC	Bag	9		29	31	40			
TP-18	5	GM	Bag			55	24	21		NP	NP
TP-19	5.5	SC	Bag	9		34	36	30			

4.2 Direct Shear Testing

To determine the shear strength of the natural soils encountered at the site, laboratory direct shear testing was performed on representative samples obtained during the field explorations. Due to the granular nature of the soils, the samples were screened through a No. 4 sieve and the portion passing that sieve was used for the direct shear test, thus the direct shear test results will likely be lower (more conservative) in strength than the field sample. During the direct shear test, the sample was evenly consolidated within the test ring, loaded, and saturated immediately after the load was applied. The sample was then sheared at a slower rate to simulate saturated-drained condition, while recording the shearing load and the horizontal and vertical deformations. This process was repeated twice while increasing the normal load imposed on the sample. Detailed results of the tests are maintained within our files and can be transmitted to you, if so desired.

The results of the direct shear tests are presented in the following table:

DIRECT SHEAR RESULTS

Sample Location	Sample Depth (feet)	Unified Soils Classification	Sample Type	Natural Moisture Percent	Apparent Cohesion (psf)	Measured Internal Friction Angle (degrees)
TP-8	7	SC	Remolded	10	308	35.4
TP-12	3	GC	Remolded	8	207	34.1
TP-14	5	SC	Remolded	8	192	31.5
TP-18	5	GM	Remolded	11	59	34.8
B-1	5	MH	Shelby Tube	40	590	29.1

5.0 ENGINEERING GEOLOGY

5.1 Seismotectonic Setting

The site is located in the Wasatch Range slightly south of the divide between the Wellsville Creek and Wolf Creek drainage basins. Cobabe Canyon (a subsidiary drainage basin of Wellsville Creek) is to the north of the Project and Lefty's Canyon (a subsidiary drainage basin of Wolf Creek) is to the south. Wellsville Creek generally flows northward into Cache Valley, whereas Wolf Creek generally flows southward into Ogden Valley. Cache Valley is a major sediment-filled, north-south-trending intermontane valley flanked by the Bear River Range to the east and the Wellsville Mountains to the west. Ogden Valley is a roughly 40-square mile back valley within the Wasatch Range described by Gilbert (1928) as a structural trough similar to Cache and Morgan Valleys to the north and south, respectively. Both valleys are in a transition zone between the Basin and Range and Middle Rocky Mountains provinces (Stokes, 1977, 1986). The Basin and Range is characterized by a series of generally north-trending elongate mountain ranges, separated by predominately alluvial and lacustrine sediment-filled valleys and typically bounded on one or both sides by major normal faults (Stewart, 1978). The boundary between the Basin and Range and Middle Rocky Mountains provinces is the prominent, west-facing escarpment along the Wasatch fault zone at the base of the Wasatch Range. Late Cenozoic normal faulting, a characteristic of the Basin and Range, began between about 17 and 10 million years ago in the Nevada (Stewart, 1980) and Utah (Anderson, 1989) portions of the province. The faulting is a result of a roughly east-west directed, regional extensional stress regime that has continued to the present (Zoback and Zoback, 1989; Zoback, 1989).

The site is also in the central portion of the Intermountain Seismic Belt (ISB), a generally north-south trending zone of historical seismicity along the eastern margin of the Basin and Range province extending from northern Arizona to northwestern Montana (Sbar and others, 1972; Smith and Sbar, 1974). At least 16 earthquakes of magnitude 6.0 or greater have occurred within the ISB since 1850; the largest of these earthquakes was a M 7.5 event in 1959 near Hebgen Lake, Montana. None of these earthquakes occurred along the Wasatch fault or other known late Quaternary faults (Arabasz and others, 1992; Smith and Arabasz, 1991). The closest event was the 1934 Hansel Valley (M 6.6) event north of the Great Salt Lake. The March 18, 2020 M 5.7 earthquake[1] near Magna, Utah reportedly showed a style, location, and slip depth consistent with an earthquake on the Wasatch fault system. Despite being less than magnitude 6.0, this earthquake damaged multiple buildings and was felt from southern Idaho to south-central Utah[2]. The University of Utah Seismograph Stations[3] indicates the Magna earthquake was weakly felt in Ogden Valley, with a peak acceleration of about 0.005 g and an instrument intensity of II-III (on a Roman numeral scale of I-X).

5.2 Surficial Geology

The site is located in the Wasatch Range about 4.1 miles northeast of Ogden Valley near the divide between the Wellsville Creek and Wolf Creek drainage basins. This divide also marks the boundary between Cache and Weber Counties (on the north and south, respectively). The Wasatch Range is a major north-south trending mountain range that marks the eastern boundary of the Basin and Range physiographic province (Stokes; 1977, 1986); Ogden Valley is a sediment-filled intermontane valley within the Wasatch Range. Surficial geology of the site is mapped by Coogan and King (2016; **Figure 2**) as mainly Tertiary-age bedrock of the Wasatch Formation (unit Tw), with a small area of Pleistocene landslide deposits (unit Qmso) in the south part of the site. Detailed surficial geologic mapping at a scale of 1 inch equals 100 feet (1:1,200) is shown on **Figure 6** based on Coogan and King (2016), air photo evidence, and site-specific subsurface evidence.

Coogan and King (2016) describe surficial geologic units in the site area on **Figure 2** as follows:

> ***Qh, Qh?*** – *Human disturbances (Historical)*. Mapped disturbances obscure original deposits or rocks by cover or removal; only larger disturbances that pre-date the 1984 aerial photographs used to map the Ogden 30 x 60-minute quadrangle are shown; includes engineered fill, particularly along Interstate Highways 80 and 84, the Union Pacific Railroad, and larger dams, as well as aggregate operations, gravel pits, sewage-treatment facilities, cement plant quarries and operations, brick plant and clay pit, Defense Depot Ogden (Browning U.S. Army Reserve Center), gas and oil field operations (for example drill pads) including gas plants, and low dams along several creeks, including a breached dam on Yellow Creek.
>
> ***Qct*** – *Colluvium and talus, undivided (Holocene and Pleistocene)*. Unsorted clay- to boulder-sized angular debris (scree) at the base of and on steep, typically partly vegetated slopes; shown mostly on steep slopes of resistant bedrock units; 6 to 30 feet (2-9 m) thick.
>
> ***Qms, Qms?, Qmsy, Qmsy?, Qmso, Qmso?*** – *Landslide deposits (Holocene and upper and middle? Pleistocene).* Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with time and amount of water in material during emplacement; Qms may be in contact with Qms when landslides are different/distinct; thickness highly variable, up to about 20 to 30 feet (6-9 m) for small slides, and 80 to 100

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[1] https://earthquake.usgs.gov/earthquakes/eventpage/uu60363602/executive
[2] https://www.ksl.com/article/46731630/
[3] https://earthquakes.utah.gov/magna-quake/#

feet (25-30 m) thick for larger landslides. Qmsy and Qmso queried where relative age uncertain; Qms queried where classification uncertain. Numerous landslides are too small to show at map scale and more detailed maps shown in the index to geologic mapping should be examined.

Qms without a suffix is mapped where the age is uncertain (though likely Holocene and/or late Pleistocene), where portions of slide complexes have different ages but cannot be shown separately at map scale, or where boundaries between slides of different ages are not distinct. Estimated time of emplacement is indicated by relative-age letter suffixes with: Qmsy mapped where landslides deflect streams or failures are in Lake Bonneville deposits, and scarps are variably vegetated; Qmso typically mapped where deposits are "perched" above present drainages, rumpled morphology typical of mass movements has been diminished, and/or younger surficial deposits cover or cut Qmso. Lower perched Qmso deposits are at Qao heights above drainages (95 ka and older) and the higher perched deposits may correlate with high level alluvium (QTa_) (likely older than 780 ka) (see table 1). Suffixes y and o indicate probable Holocene and Pleistocene ages, respectively, with all Qmso likely emplaced before Lake Bonneville transgression. These older deposits are as unstable as other slides, and are easily reactivated with the addition of water, be it irrigation or septic tank drain fields.

Qmc *– Landslide and colluvial deposits, undivided (Holocene and Pleistocene).* Poorly sorted to unsorted clay- to boulder-sized material; mapped where landslide deposits are difficult to distinguish from colluvium (slope wash and soil creep) and where mapping separate, small, intermingled areas of landslide and colluvial deposits is not possible at map scale; locally includes talus and debris flow and flood deposits; typically mapped where landslides are thin ("shallow"); also mapped where the blocky or rumpled morphology that is characteristic of landslides has been diminished ("smoothed") by slope wash and soil creep; composition depends on local sources; 6 to 40 feet (2-12 m) thick. These deposits are as unstable as other landslide units (Qms, Qmsy, Qmso).

Tw *– Wasatch Formation (Eocene and upper Paleocene)*. Typically red to brownish-red sandstone, siltstone, mudstone, and conglomerate with minor gray limestone and marlstone locally (see Twl); lighter shades of red, yellow, tan, and light gray present locally and more common in uppermost part, complicating mapping of contacts with overlying similarly colored Norwood and Fowkes Formations; clasts typically rounded Neoproterozoic and Paleozoic sedimentary rocks, mainly Neoproterozoic and Cambrian quartzite; basal conglomerate more gray and less likely to be red, and containing more locally derived angular clasts of limestone, dolomite and sandstone, typically from Paleozoic strata, for example in northern Causey Dam quadrangle; sinkholes indicate karstification of limestone beds; thicknesses on Willard thrust sheet likely up to about 400 to 600 feet (120-180 m) in Sharp Mountain, Dairy Ridge, and Horse Ridge quadrangles (Coogan, 2006a-b), about 1300 feet (400 m) in Monte Cristo Peak quadrangle, about 1100 feet (335 m) in northeast Browns Hole quadrangle, about 2200 feet (670 m) in southwest Causey Dam quadrangle, about 2600 feet (800 m) at Herd Mountain in Bybee Knoll quadrangle, and about 1300 feet (400 m) in northwest Lost Creek Dam quadrangle, estimated by elevation differences between pre-Wasatch rocks exposed in drainages and the crests of gently dipping Wasatch Formation on adjacent ridges (King); thickness varies locally due to considerable relief on basal erosional surface, for example along Right Fork South Fork Ogden River, and along leading edge of Willard thrust; much thicker, about 5000 to 6000 feet (1500-1800 m), south of Willard thrust sheet near Morgan. Wasatch Formation is queried (Tw?) where poor exposures may actually be surficial deposits. The Wasatch Formation is prone to slope failures. Other information on the Wasatch

Formation is in Tw descriptions under the heading “Sub-Willard Thrust - Ogden Canyon Area” since Tw strata are extensive near Morgan Valley and cover the Willard thrust, Ogden Canyon, and Durst Mountain areas.

Along the South Fork Ogden River, Wasatch strata are mostly pebble, cobble, and boulder conglomerate with a matrix of smaller gravel, sand, and silt in the Browns Hole quadrangle, and coarse-grained sandstone to granule conglomerate as well as siltstone and mudstone to the east in the Causey Dam quadrangle; note thinning to east away from source area. The Wasatch weathers to boulder-covered dip(?) slopes north of the South Fork Ogden River, for example in Evergreen Park. Along the South Fork, the Wasatch Formation is separated from the underlying Hams Fork Member of the Evanston Formation by an angular unconformity of a few degrees, with the Hams Fork containing less siltstone and mudstone than the Wasatch and having a lighter color.

The Herd Mountain surface is developed on the Wasatch Formation at elevations of 7600 to 8600 feet (2300-2620 m) in the Bybee Knoll quadrangle and in remnants in the Huntsville, Browns Hole, and Sharp Mountain quadrangles. The origin of this boulder-strewn surface is debated (see Eardley, 1944; Hafen, 1961; Mullens, 1971). Eardley’s (1944) Herd Mountain surface is flat lying or gently east dipping, about the same as the underlying Wasatch Formation, and is strewn with quartzite boulders to pebbles that King thinks are residual and colluvial deposits of uncertain age that were derived from the Wasatch Formation. The other characteristic of this surface is the presence of pimple mounds and, given the elevations of greater than about 7500 feet (2300 m), possible periglacial patterned ground. Photogrammetric dips on the Wasatch Formation under the surface are nearly flat (<3°) and an apparent angular unconformity is present in the Wasatch since dips on older Wasatch strata are greater than 3 degrees. King mapped this unconformity as a marker bed, but Coogan does not agree that this is an unconformity.

Cbk, Cbk? – *Blacksmith Formation (Middle Cambrian)*. Typically, medium-gray, very thick to thick-bedded, dolomite and dolomitic limestone with tan-weathering, irregular silty partings to layers; weathers to lighter gray cliffs and ridges; 250 to 760 feet (75-230 m) thick in our map area. The Blacksmith Formation on the leading edge of the Willard thrust sheet thickens southward from 600 feet (180 m) along Sugar Pine Creek in the Dairy Ridge quadrangle, to about 760 feet (230 m) in the northwestern Horse Ridge quadrangle (Coogan, 2006a-b). To the south and west, the Blacksmith is about 500 feet (150 m) thick near Causey Dam (Mullens, 1969), with a 530-foot (161 m) thickness reported at the Baldy Ridge section (Rigo, 1968, aided by Mullens) in the Causey Dam or Horse Ridge quadrangle. Farther west, the Blacksmith is reportedly 409 feet (125 m) thick in the Sharp Mountain area (Hafen, 1961) and is about 250 feet (75 m) thick near the South Fork Wolf Creek in the Huntsville quadrangle (Coogan this report); still farther west, this unit is reportedly about 700 to 800 feet (210-245 m) thick near Mantua (Williams, 1948; Ezell, 1953; Sorensen and Crittenden, 1976a). So the thickness of the Blacksmith Formation is low in the Huntsville quadrangle and thickens to north, west, and east, and thickens southward on leading edge of thrust sheet.

The Blacksmith to the north of our map area is about 475 feet (144 m) thick in the Porcupine Reservoir quadrangle (Rigo, 1968; Hay, 1982), about 450 feet (137 m) thick near the Blacksmith Fork River (Maxey, 1958), and 410 feet (125 m) thick in Blacksmith Fork Canyon (Hay, 1982). The Blacksmith thickness in the Browns Hole area is uncertain due to poorly exposed Cambrian strata. Laraway’s (1958) Blacksmith contacts are not those of Crittenden (1972) or our mapping (see also Hodges member above); so his reported 730-foot (220 m) thickness is suspect. Laraway’s (1958) report of Bolaspidella and Ehmaniella trilobite fossils in his Blacksmith is also problematic because these fossils are characteristic of the Bloomington and Ute Formations, respectively (Maxey, 1958). Also, Laraway's description of covered intervals in typically cliff-forming Blacksmith imply a fault repetition of the Ute or his measuring at least 986 feet (300 m) of Ute (see Ute description for comparison) and less than 403 feet (123 m) of Blacksmith; further, Crittenden's (1972) large thicknesses (~1300 or less likely 1150 feet [~400 or <350 m]) and mixed carbonates above Ute shale on his lithologic column imply fault repetition(s). Our Blacksmith-Bloomington contact is above a non-resistant Ute interval that overlies a resistant cliffy interval in the Ute. This makes the Ute about 700 feet (215 m) thick on Crittenden's (1972) lithologic column, and the Blacksmith and lower Bloomington about 650 feet (200 m) thick on his column. Finally, Crittenden's (1972) lithologies are not like what Laraway (1958) reported in his measured section.

Cu, Cu? *– Ute Formation (Middle Cambrian)*. Interbedded gray thin- to thick-bedded limestone with tan-, yellowish-tan-, and reddish-tan-weathering, wavy, silty layers and partings, and olive-gray to tan-gray, thin-bedded shale and micaceous argillite; and minor, medium-bedded, gray to light-gray dolomite; sand content in limestone increases upward such that calcareous sandstone is present near top of formation; mostly slope and thin ledge former; base less resistant (more argillaceous) than underlying Langston Formation; Zacanthoides, Kootenia, Bathyuriscus, and Peronopsis sp. trilobite fossils reported by Rigo (1968, USGS No. 5960-CO) in Causey Dam quadrangle; estimate 450 to 1000 feet (140-300 m) thick and thinnest on leading edge of Willard thrust sheet.

The thickness range for the Ute Formation is based on multiple studies. It is reportedly 600 to 700 feet (180-210 m) thick west of Sharp Mountain (see Ezell, 1953; Crittenden, 1972; Deputy, 1984), and though a 840-foot (256 m) thickness was reported north of our map area in the Porcupine Reservoir area (Rigo, 1968), the Ute only looks about 600 feet (180 m) thick on the Porcupine Reservoir map of Berry (1989). The Ute is reportedly 1090 and 1380 feet (330 and 420 m) thick in the Sharp Mountain area (Hafen, 1961; Rigo, 1968, respectively), but these thicknesses are suspect since the Ute is thinner to the north, east, and west. We suspect that Hafen (1961) used dips that were too steep (~30 degrees vs ~16.5 degrees) so the real Ute thickness is about 620 feet (190 m) where he measured his section; we do not know what Rigo (1968) measured. North of our map area in the Hardware Ranch quadrangle, Deputy (1984) measured 681 feet (207.6 m) of Ute. To the east, the Ute is about 450 feet (137 m) thick in the Horse Ridge and Dairy Ridge quadrangles (Coogan, 2006a-b) and 515 feet (157 m) thick at the Baldy Ridge section (Rigo, 1968) in the Horse Ridge quadrangle. The thickest Ute may be near the South Fork Wolf Creek in the Huntsville quadrangle, where Coogan estimates a 1000-foot (300 m) thickness, 1150 feet (350 m) thick if steeper dip, while King estimates the Ute is about 1100 feet (335 m) thick, based on a higher Ute-Langston contact than Coogan picked. Rigo (1968) reported 1370 feet (418 m) of Ute near the South Fork Wolf Creek, but his contacts are not used on our map. To the south in the Browns Hole quadrangle, about 700 feet (210 m) of mixed shale and limestone was shown by Crittenden (1972) and his depiction is likely derived from the 659 feet (201 m) of Ute reported by Laraway (1958) along the South Fork Ogden River; this is about what Laraway (1958) mapped. But Crittenden (1972) did not map the Ute-Blacksmith contact; further, see problems above under Blacksmith Formation.

The Ute Formation as first mapped in the James Peak, Mantua, and Huntsville quadrangles was too thick because Coogan mapped the lower shale in the Langston Formation as the entire Langston, not realizing the base of the Ute is a shale above the upper carbonate (typically dolomite) of the Langston. He did this because the upper carbonate is not distinct in these quadrangles, like it is to the west in the Mount Pisgah quadrangle and to the east in the Sharp Mountain quadrangle. The same problem exists locally in the Sharp Mountain quadrangle. Though King revised the present map to place the upper Langston carbonate in the Langston, problems with this contact and Ute and Langston Formation thicknesses may persist.

Just north of our map area in the Wellsville Mountains, Maxey (1958) reported Ehmaniella(?) sp. and Glossopleura sp. trilobites in and at the base of the Ute Formation, respectively, making it Middle Cambrian. Deiss (1938) and Berry (1989) reported Ehmaniella sp. trilobites north of our map area near the Blacksmith Fork River.

Cl, Cl? – *Langston Formation (Middle Cambrian)*. Upper part is gray, sandy dolomite and limestone that weathers to ledges and cliffs; middle part is yellowish- to reddish-brown to gray weathering, greenish-gray, fossiliferous shale and lesser interbedded gray, laminated to very thin-bedded, silty limestone (Spence Shale Member); basal part is light-brown-weathering, ledge forming gray limestone and dolomite with local poorly indurated tan, dolomitic sandstone at bottom; basal part that is less resistant (Naomi Peak Member) is present at least in northwest part of our map area; conformably overlies Geertsen Canyon Quartzite; 200 to 400 feet (60-120 m) thick. Designated “Formation” rather than “Dolomite” due to the varied lithologies.

The thickness of the Langston Formation is based on several studies. North of the map area, 410 feet (125 m) of Langston was measured along the upper Blacksmith Fork River in the Hardware Ranch quadrangle by Buterbaugh (1982). The Langston is 270 feet (80 m) thick in the Sharp Mountain area (Hafen, 1961) and to the east it is about 200 to 250 feet (60 to 75 m) thick in the Horse and Dairy Ridge quadrangles (Coogan, 2006a-b); the 85-foot (26 m) thickness reported at the Baldy Ridge section (Rigo, 1968) in the Horse Ridge quadrangle is likely incorrect. The 170 feet (50 m) of dolomite reported near Browns Hole (Crittenden, 1972) is likely only the basal dolomite of the Langston Formation; Laraway (1958) probably measured 120 feet (37 m) of this basal dolomite and 298 feet (91 m) of Langston along the South Fork Ogden River in the Browns Hole quadrangle. Laraway’s (1958) reported 398-foot (121 m) Langston thickness is likely an error, since he measured and mapped about 300 feet (90 m) of Langston. Near the South Fork Wolf Creek in the Huntsville quadrangle, the Langston is about 300 feet (90 m) thick (Coogan’s measurements), but King used a higher contact on our map making the Langston about 390 feet (120 m) thick. Farther west the Langston is about 400 to 460 feet (120-140 m) thick (see Ezell, 1953; Maxey, 1958; Rigo, 1968; Buterbaugh, 1982).

Just north of the map area near the Blacksmith Fork River, the Langston trilobite fauna (Glossopleura zone) is Middle Cambrian in age (Maxey, 1958), and near Brigham City, the fauna (Glossopleura trilobite zone in Spence Shale, Albertella trilobite zone in Naomi Peak) is earliest Middle Cambrian in age (Maxey, 1958; Jensen and King, 1996, table 2).

Cgc, Cgc? – *Geertsen Canyon Quartzite (Middle and Lower Cambrian and possibly Neoproterozoic).* In the west mostly buff (off-white and tan) quartzite, with pebble conglomerate beds; pebbles are mostly rounded light colored quartzite; contains cross bedding, and pebble layers and lenses; colors vary from tan and light to medium gray, with pinkish, orangish, reddish, and purplish hues; outcrops darker than these fresh quartzite colors; cliff forming; some brown-weathering, interbedded micaceous argillite and quartzite common at top and mappable locally; pebble to cobble conglomerate lenses more abundant in middle part of quartzite, and basal, very coarse-grained arkose locally; near Huntsville, total thickness about 4200 feet

(1280 m), including upper argillite about 375 feet (114 m) thick and basal coarse-grained arkose (arkosic to feldspathic quartzite) about 300 to 400 feet (90-120 m) thick (Crittenden and others, 1971). Overall seems to be thinner near Browns Hole. Called Prospect Mountain Quartzite and Pioche Shale (argillite at top) by some previous workers.

Upper and lower parts of Crittenden and others (1971; Crittenden, 1972; Sorensen and Crittenden, 1979) are not mappable outside the Browns Hole and Huntsville quadrangles, likely because the marker cobble conglomerate and change in grain size and feldspar content reported by Crittenden and others (1971) is not at a consistent horizon; quartz-pebble conglomerate beds are present in most of the Geertsen Canyon Quartzite.

To the east on leading margin of Willard thrust sheet, the Geertsen Canyon is thinner, an estimated 3200 feet (975 m) total thickness (Coogan, 2006a-b), and may be divided into different members, though informal members to west and east are based on conglomerate lenses near member contact and feldspathic lower member (see Crittenden and others, 1971; Coogan, 2006a-b).

Lower part in west (Cgcl, Cgcl?) is typically conglomeratic and feldspathic quartzite (only up to 20% feldspar reported by Crittenden and Sorensen, 1985a, so not an arkosic), with 300- to 400-foot (90-120 m), basal, very coarse-grained, more feldspathic or arkosic quartzite; 1175 to 1700 feet (360-520 m) thick (Crittenden and others, 1971; Crittenden, 1972; Sorensen and Crittenden, 1979) and at least 200 to 400 feet (60-120 m) thinner near Browns Hole (compare Crittenden, 1972 to Sorensen and Crittenden, 1979). Unit queried where poor exposures may actually be surficial deposits.

Zm, Zm? – *Mutual Formation (Neoproterozoic).* Grayish-red to purplish-gray, medium to thick-bedded quartzite with pebble conglomerate lenses; also reddish-gray, pink, tan, and light-gray in color and typically weathering to darker shades than, but at least locally indistinguishable from, Geertsen Canyon Quartzite; commonly cross-bedded and locally feldspathic; contains argillite beds and, in the James Peak quadrangle, a locally mappable medial argillite unit; 435 to 1200 feet (130-370 m) thick in Browns Hole quadrangle (Crittenden, 1972) and thinnest near South Fork Ogden River (W. Adolph Yonkee, Weber State University, verbal communication, 2006); thicker to northwest, up to 2600 feet (800 m) thick in Huntsville quadrangle (Crittenden and others, 1971) and 2556 feet (780 m) thick in James Peak quadrangle (Blau, 1975); may be as little as 300 feet (90 m) thick south of the South Fork Ogden River (King this report); absent or thin on leading edge of Willard thrust sheet (see unit Zm?c); thins to south and east.

Zi, Zi? – *Inkom Formation (Neoproterozoic).* Overall gray to reddish-gray weathering, poorly resistant, psammite and argillite, with gray-weathering meta-tuff lenses in lower part; upper half dominantly dark green, very fine-grained meta-sandstone (psammite) with lower half olive gray to lighter green-gray, greenish gray-weathering, laminated, micaceous meta-siltstone (argillite); lower greenish-weathering part missing near South Fork Ogden River and the Inkom is less than 200 feet (60 m) thick; in Mantua quadrangle, Inkom typically 300 feet (90 m) thick, and is only less than 200 feet (60 m) thick where faulted (King this report); 360 to 450 feet (110-140 m) thick northeast of Huntsville (Crittenden and others, 1971), and absent on leading edge of Willard thrust sheet (Coogan, 2006a); location of “pinch-out” not exposed.

***Zcc, Zcc?** – Caddy Canyon Quartzite (Neoproterozoic).* Mostly vitreous, almost white, cliff-forming quartzite; colors vary and are tan, light-gray, pinkish-gray, greenish-gray, and purplish-gray, that are typically lighter shades than the Geertsen Canyon Quartzite; 1000 to 2500 feet (305-760 m) thick in west part of our map area, thickest near Geertsen Canyon in Huntsville quadrangle (Crittenden and others, 1971; Crittenden, 1972); 1500 feet (460 m) thick near South Fork Ogden River (Coogan and King, 2006); thinner, 725 to 1300 feet (220-400 m) thick, and less vitreous on leading edge of Willard thrust sheet. Lower contact with Kelley Canyon Formation is gradational with brownish-gray quartzite and argillite beds over a few tens to more than 200 feet (3-60 m) (see Crittenden and others, 1971). Where thick, this gradational-transitional zone is what is mapped as the Papoose Creek Formation. Near Geertsen Canyon, this transition zone is 600 feet (180 m) thick and was mapped with and included in the Caddy Canyon Quartzite by Crittenden and others (1971, figure 7), and in the Caddy Canyon and Kelley Canyon Formations by Crittenden (1972, see lithologic column).

***Zkc, Zkc?** – Kelley Canyon Formation (Neoproterozoic).* Dark-gray to black, gray to olive-gray-weathering argillite to phyllite, with rare metacarbonate (for example basal meta-dolomite); grades into overlying Caddy Canyon quartzite with increasing quartzite; gradational interval mapped as Papoose Creek Formation (Zpc); 1000 feet (300 m) thick in Mantua quadrangle (this report), where Papoose Creek Formation is mapped separately, and reportedly 2000 feet (600 m) thick near Huntsville (Crittenden and others, 1971, figure 7), but only shown as about 1600 feet (500 m) thick to Papoose Creek transition zone by Crittenden (1972). The Kelley Canyon Formation is prone to slope failures.

Citations, tables, and figures in the above descriptions are not provided herein but are in Coogan and King (2016). Descriptions of other units on Figure 2 not provided above are also in Coogan and King (2016).

5.3 Seismic Hazards

5.3.1 Strong Ground Motions

Strong ground motion is likely to present a significant risk during moderate to large earthquakes located within a 60-mile radius of the Project area (Boore and others, 1993). Seismic sources include mapped active faults, as well as a random or "floating" earthquake source on faults not evident at the surface. The Utah Geological Survey Quaternary Fault Database (Black and others, 2003; 2020 update) shows numerous class A faults within 60 miles of the Project that may pose potential seismic sources. Strong ground motions originating from the Wasatch fault or other near-by seismic sources are capable of impacting the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.3 (Arabasz and others, 1992).

5.3.2 Site Class

Utah has adopted the International Building Code (IBC) 2018 and recently adopted IBC 2021 (to go into effect on July 1, 2023), both of which determine the seismic hazard for a site based upon 2014 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2018 (and IBC 2021) Section 1613.2.2 refers to Chapter

20, Site Classification Procedure for Seismic Design, of ASCE[4] 7-16, which stipulates that the average values of shear wave velocity, blow count and/or shear strength within the upper 100 feet (30 meters) be utilized to determine seismic site class.

Considering our explorations only extended to a maximum depth of 14 feet, and that refusal of exploration equipment occurred at this and shallower depths, it is our opinion that the site best fits Site Class C – Very Dense Soil and Soft Rock Profile, which we recommend for seismic structural design.

5.3.3 Ground Motions

The 2014 USGS mapping utilized by the IBC provides values of peak ground, short period and long period spectral accelerations for the Site Class B/C boundary and the Risk-Targeted Maximum Considered Earthquake (MCE_R). This Site Class B/C boundary represents average bedrock values for the Western United States and must be corrected for local soil conditions. The table and response spectra on the following page summarize the peak ground, short period and long period accelerations for the MCE_R event, and incorporates appropriate soil correction factors for a Site Class C soil profile at site grid coordinates of 41.3692 degrees north latitude and -111.7536 degrees west longitude:

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[4] American Society of Civil Engineers

SPECTRAL ACCELERATION PERIOD, T	SITE CLASS B/C BOUNDARY [mapped values] (g)	SITE COEFFICIENT	SITE CLASS C [adjusted for site class effects] (g)	MULTI-PLIER	DESIGN VALUES (g)
Peak Ground Acceleration	PGA = **0.354**	F_{pga} = 1.200	PGA_M = 0.425	1.000	PGA_M = 0.425
0.2 Seconds (Long Period Acceleration)	S_S = **0.814**	F_a = 1.200	S_{MS} = 0.977	0.667	S_{DS} = 0.651
	(no exceptions needed)	F_a = (N/A)	S_{MS} = (N/A)	0.667	S_{DS} = (N/A)
1.0 Second (Long Period Acceleration)	S_1 = **0.281**	F_v = 1.500	S_{M1} = 0.422	0.667	S_{D1} = 0.281
	(no exceptions needed)	F_v = (N/A)	S_{M1} = (N/A)	0.667	S_{D1} = (N/A)

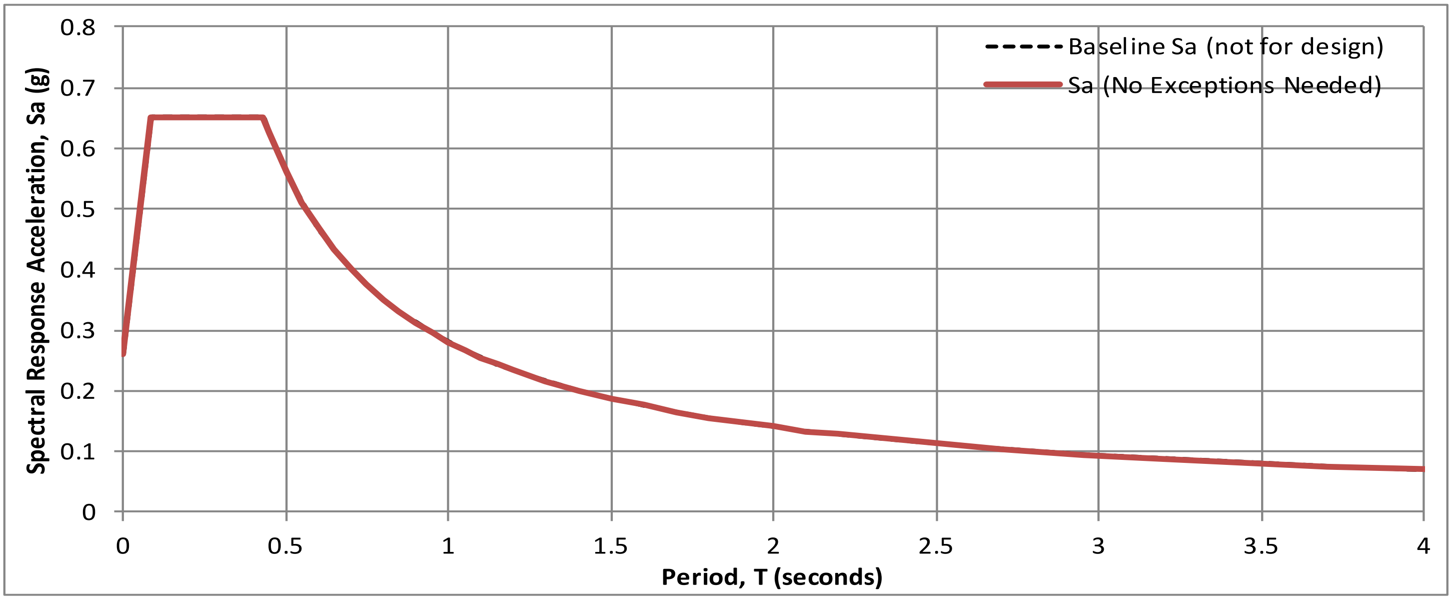
NOTES: 1. TL (seconds): **8**

*** Site Class C With Measurements**

2. Site Class: **C**

4. No Exceptions Needed

3. Have data to verify? **yes**



As indicated in the above table, S_1 is greater than 0.2 seconds and a site-specific ground motion hazard analysis (GMHA) is required for the site, unless the Exception 2 values shown are used for seismic design. If a site-specific GMHA is desired instead of using the higher exception values for design, please contact CMT for a proposal to perform the GMHA.

5.3.4 Surface Faulting

Movement along faults at depth generates earthquakes. During earthquakes larger than Richter magnitude 6.5, ruptures along normal faults in the intermountain region generally propagate to the surface (Smith and Arabasz, 1991) as one side of the fault is uplifted and the other side down dropped. The resulting fault scarp has a near-vertical slope. The surface rupture may be expressed as a large singular rupture or several smaller ruptures in a broad zone. Ground displacement from surface fault rupture can cause significant damage or even collapse to structures located on an active fault.

No evidence of active surface faulting is mapped or was evident at the site. The nearest active (Holocene-age) fault to the site is the Weber segment of the Wasatch fault zone about 9.8 miles to the southwest. Surface faulting is not therefore considered to pose a risk to the site.

5.3.5 Liquefaction

Liquefaction is a phenomenon whereby loose, saturated, granular soil units lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or free-face conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

Liquefaction potential has not been studied or mapped for the Project area, but subsurface data from the test pits suggest the risk from liquefaction is likely low. Weber County hazard mapping shows the site is in an area of very low liquefaction potential (Code 1).

5.3.6 Tectonic Subsidence

Tectonic subsidence is surface tilting subsidence that occurs along the boundaries of normal faults in response to surface-faulting earthquakes (Keaton, 1986). The site is not located on the downthrown side of and near any active earthquake faults, and tectonic subsidence is not therefore considered to pose a risk.

5.4 Landslide and Slump Deposits

Landslides, slumps, and other mass movements are gravity-induced downslope movements of rock or soil. Such failures may be both deep and shallow seated. Deep-seated failures include rotational and translational slides and associated earthflows where the failure plane is more than 10 feet deep (Varnes, 1978; Cruden and Varnes, 1996). Landslides can develop in moderate to steep slopes where a slope has been disturbed, the head of a slope loaded, or where increased groundwater pore pressures result in driving forces within the slope exceeding restraining forces.

The head of a Pleistocene landslide extends into the south part of the Project, but no other landslides are mapped at the site and no evidence for recent or ongoing landsliding or slope instability was observed during our reconnaissance. However, slopes in the south part of the site are steep and may be subject to shallow surficial failures. Slope stability is discussed in **Section 6.0**.

5.5 Other Geologic Hazards

Other potential geologic hazards at the Project are addressed in the following subsections.

5.5.1 Sloping Surfaces

Slopes at the site dip southeastward to southwestward at gradients of from 10 to 50 percent but are mainly moderate (between 15 to 30 percent). Overall slope across the middle of the site is 19.5 percent (or 5.1:1 horizontal:vertical). Steep slopes (> 30 percent) are found in the south part of the site associated with the road cut along the north frontage of Summit Pass Road, whereas gentle slopes (< 15 percent) are found in the northeast and northwest parts of the site. Slope stability is addressed in **Section 6.0**.

5.5.2 Alluvial Fan Flooding

Alluvial-fan flooding refers to a continuum of processes that includes debris slides, debris flows, debris floods, and flash flooding on alluvial fans (National Research Council, 1996). Debris flows and related sediment-enriched floods and flows are fast moving flow-type landslides comprised of a slurry of rock, mud, organic matter, and water that move down drainage-basin channels onto alluvial fans. Debris flow hazards are commonly associated with areas underlain by Holocene alluvial-fan deposits at the mouths of range-front drainages, such as those along the Wasatch Range. Evaluation of the need for mitigation of alluvial-fan flooding is a planning decision that weighs the existing and future hazard potential against what will be at risk and level of exposure. Both active and passive measures are typically employed to mitigate risk. Active measures (such as debris basins) are considered optimal to attenuate flows, but such strategies are typically deployed to protect subdivision-scale developments and are not always feasible. Passive measures (such as berms and routing channels) may be deployed for smaller-scale developments, but are not always effective and tend to increase risk to adjacent properties.

The property is not in a mapped alluvial fan; no evidence of debris-flow channels, levees, or other debris-flow features were observed at the site; and no inferred debris-flow deposits were exposed in the test pits. Given this, debris flows and floods are not considered to pose a risk to the site.

5.5.3 Stream Flooding Hazards

No active drainages were observed crossing the property and Federal Emergency Management Agency flood insurance rate mapping (Map Number 49057C0250F, effective 06/02/2015) does not show any flood hazard areas at the Project. Given the above, we rate the risk from stream flooding as low. Site hydrology and drainage should be addressed in the civil engineering design in accordance with all applicable local government development guidelines. Care should be taken that proper surface drainage is maintained.

5.5.4 Rockfall Hazards

The Project is not located on or adjacent to steep slopes with bedrock source areas where rockfalls may originate. Given this, rockfalls are not considered to pose a risk to the proposed development.

6.0 SLOPE STABILITY

6.1 Input Parameters

The properties of the natural soils encountered in the test pits and bore hole were estimated using laboratory testing, published correlations[5], and our experience with similar soils. Accordingly, we estimated the following parameters for use in the stability analyses:

Material	Internal Friction Angle (degrees)	Apparent Cohesion (psf)	Unit Weight (pcf)
Tertiary Wasatch Formation	32	100	125

The stability analyses provided are based on **Figure 6A, Cross Section A-A'** and represent the existing slope conditions and do not include any future grading. No grading plans were provided. CMT must review future grading plans.

The pseudostatic coefficient for the seismic analyses was obtained by utilizing the MCEr calculations and the modified peak ground acceleration (0.44g) queried for the site which resulted in a value of 0.207g.

6.2 Stability Analyses

We evaluated the global stability of the cross-section A-A' located as shown on **Figure 6**. The analysis was completed using the computer program *SLIDE* version 7.0. This program uses a limit equilibrium (Simplified Bishop) method for calculating factors of safety against sliding on an assumed failure surface and evaluates numerous potential failure surfaces, with the most critical failure surface identified as the one yielding the lowest factor of safety of those evaluated. Typically, the required minimum factors of safety are 1.5 for static conditions and 1.0 for seismic (pseudostatic) conditions.

A projected water (phreatic) surface was not incorporated in the model based on nearby water well data placing the groundwater at an elevation deeper than the cross section analyzed.

- Cross-section A-A' consists of a 350-foot long horizontal cross section with an overall elevation change of about 145 feet to the northeast. The geologic cross section (**Figure 8**) shows the entire profile to consist of Tertiary Wasatch Formation generally composed of Clayey Gravel to Clayey Sand. Based on the slope stability analysis, the current slope has factors of safety for both static and pseudo-static (earthquake) conditions greater than those typically considered acceptable (See **Figures 31 and 32 Stability Results**). The ten failure surfaces with the lowest factors of safety are shown on the stability analysis plots, with the lowest calculated factor of safety highlighted.

Slope movements or even failure can occur if the slope soils are undermined or become saturated. Any planned retaining walls must be properly engineered, including stability analyses. Proposed grading at the site must be reviewed/evaluated by CMT prior to initiation of any construction in order to assess if our findings and recommendations remain applicable and additional recommendations provided as needed.

7.0 SITE PREPARATION AND GRADING

7.1 General

Initial site preparation shall consist of the removal of surface vegetation, topsoil, any other deleterious materials, and loose/disturbed surface soils from beneath structures, pavements and exterior flatwork areas. We also recommend that high plasticity soils be removed from below structures, or over excavated a minimum of 3 feet below footings and 2 feet below floor slabs, whichever is less.

Following clearing and grubbing the subgrade should be observed by a CMT geotechnical engineer to assess that suitable natural soils have been exposed and/or properly prepared and that any deleterious materials, loose and/or disturbed soils have been removed, prior to placing site grading fills, footings, slabs, and pavements.

Fill placed over large areas to raise overall site grades can induce settlements in the underlying natural soils. If more than 3 feet of site grading fill is anticipated over the natural ground surface, we should be notified to assess potential settlements and provide additional recommendations as needed. These recommendations may include placement of the site grading fill far in advance to allow potential settlements to occur prior to construction or the monitoring of settlement following placement.

Fills placed on slopes must be benched into the hillside at a minimum 2 feet for every 4 feet of fill height.

7.2 Temporary Excavations

It is the contractor’s responsibility to provide safe working conditions and comply with the regulations in OSHA Standards-Excavations, 29 CFR Part 1926. The following guidelines are provided for planning purposes. Sloping and shoring requirements must be evaluated at the time of construction by the contractor’s competent person as defined by OSHA. The geotechnical engineer is NOT the contractor’s “competent person” in any circumstance, including but not limited to, by way of default or delegation. OSHA classifications for various material types and the steepest allowable slope configuration corresponding to those classifications are shown in the following table:

MATERIAL TYPE	OSHA CLASSIFICATION	STEEPEST ALLOWABLE SLOPE CONFIGURATION*
Native Clay/Silt	Type B	1:1
Native Sand/Gravel	Type C	1-1/2:1

* Units horizontal to units vertical. The values shown apply to excavation less than 20 feet in height. Conditions can change and evaluation is the contractor’s responsibility.

The preceding classifications and slope configurations assume that excavations are above the groundwater table, there is no standing water in the excavations, and there is no seepage from the slope into the excavations, unless otherwise specified. The preceding classifications and slope configurations assume that the material in the excavations is not fractured, adversely bedded, jointed, nor left open to desiccate, crack, or slough, and is protected from surface runoff. There are other considerations regarding allowable slope configurations that the contractor is responsible for, including proximity of equipment, stockpiles, and other surcharge loads to the excavation. The contractor's competent person is responsible for all decisions regarding slope configuration and safety conditions for excavations.

7.3 Fill Material

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and potentially as replacement fill below structures. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

Following are our recommendations for the various fill types we anticipate will be used at this site:

Fill Material Type	Description/Recommended Specification
Select Structural Fill	Placed below structures, flatwork and pavement. Imported structural fill should consist of well-graded sand/gravel mixture, with maximum particle size of 4 inches, a minimum 70% passing 3/4-inch sieve, a maximum 20% passing the No. 200 sieve, and a maximum Plasticity Index of 10.
Site Grading Fill	Placed over larger areas to raise the site grade. Sandy to gravelly soil, with a maximum particle size of 6 inches, a minimum 70% passing 3/4-inch sieve, and a maximum 40% passing No. 200 sieve.
Non-Structural Fill	Placed below non-structural areas, such as landscaping. On-site soils or imported soils, with a maximum particle size of 8 inches, including silt/clay soils not containing excessive amounts of degradable/organic material.
Stabilization Fill	Placed to stabilize soft areas prior to placing structural fill and/or site grading fill. Coarse angular gravels and cobbles 1 inch to 8 inches in size. May also use 1.5- to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i, or equivalent (see **Section 6.6**).

On-site sand and gravel soils may be suitable for use as structural fill, if found to meet or processed to meet the requirements given above and may also be used in site grading fill and non-structural fill situations.

On-site silt/clay soils are not suitable for use as structural fill or site grading fill but may be used as non-structural fill.

All fill material should be approved by a CMT geotechnical engineer prior to placement.

7.4 Fill Placement and Compaction

The various types of compaction equipment available have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about 4 inches and most "trench compactors" have a maximum, consistent compaction depth of about 6 inches. Large rollers, depending on soil and moisture conditions, can achieve compaction at 8 to 12 inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density as determined by ASTM D-1557 (or AASHTO[6] T-180) in accordance with the following recommendations:

LOCATION	TOTAL FILL THICKNESS (FEET)	MINIMUM PERCENTAGE OF MAXIMUM DRY DENSITY
Beneath an area extending at least 4 feet beyond the perimeter of structures, and below flatwork and pavement (applies to structural fill and site grading fill) extending at least 2 feet beyond the perimeter	0 to 5 5 to 8	95 98
Site grading fill outside area defined above	0 to 5 5 to 8	92 95
Utility trenches within structural areas	--	96
Base course and subbase	-	96
Non-structural fill	0 to 5 5 to 8	90 92

Structural fills greater than 8 feet thick are not anticipated at the site. For best compaction results, we recommend that the moisture content for structural fill/backfill be within 2% of optimum. Field density tests should be performed on each lift as necessary to verify that proper compaction is being achieved.

7.5 Utility Trenches

For the bedding zone around the utility, we recommend utilizing sand bedding fill material that meets current APWA[7] requirements.

All utility trench backfill material below structurally loaded facilities (foundations, floor slabs, flatwork, parking lots/drive areas, etc.) should be placed at the same density requirements established for structural fill in the previous section.

Most utility companies and local governments are requiring Type A-1a or A-1b (AASHTO Designation) soils (sand/gravel soils with limited fines) be used as backfill over utilities within public rights of way, and the backfill be compacted over the full depth above the bedding zone to at least 96% of the maximum dry density as determined by AASHTO T-180 (ASTM D-1557).

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[6] American Association of State Highway and Transportation Officials
[7] American Public Works Association

Where the utility does not underlie structurally loaded facilities and public rights of way, natural soils may be utilized as trench backfill above the bedding layer, provided they are properly moisture conditioned and compacted to the minimum requirements stated above in **Section 6.4**.

7.6 Stabilization

The natural silt/clay soils at this site will likely be susceptible to rutting and pumping. The likelihood of disturbance or rutting and/or pumping of the existing natural soils is a function of the soil moisture content, the load applied to the surface, as well as the frequency of the load. Consequently, rutting and pumping can be minimized by avoiding concentrated traffic, minimizing the load applied to the surface by using lighter equipment and/or partial loads, by working in drier times of the year, or by providing a working surface for the equipment. Rubber-tired equipment particularly, because of high pressures, promotes instability in moist/wet, soft soils.

If rutting or pumping occurs, traffic should be stopped, and the disturbed soils should be removed and replaced with stabilization material. Typically, a minimum of 18 inches of the disturbed soils must be removed to be effective. However, deeper removal is sometimes required.

To stabilize soft subgrade conditions (if encountered), a mixture of coarse, clean, angular gravels and cobbles and/or 1.5- to 2.0-inch clean gravel should be utilized, as indicated above in **Section 6.3**. This coarse material may be placed and worked into the soft soils until firm and non-yielding or the soft soils removed an additional, minimum of 18 inches, and backfilled with the clean stabilizing fill. A test area should be implemented to achieve a proper stabilization strategy. Often the amount of gravelly material can be reduced with the use of a geotextile fabric such as Mirafi RS280i or equivalent. Its use will also help avoid mixing of the subgrade soils with the gravelly material. After excavating the soft/disturbed soils, the fabric should be spread across the bottom of the excavation and up the sides a minimum of 18 inches. Otherwise, it should be placed in accordance with the manufacturer's recommendation, including proper overlaps. The gravel material can then be placed over the fabric in compacted lifts as described above.

8.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed based on the previously described Project characteristics, including the maximum loads discussed in **Section 1.3**, the subsurface conditions observed in the field and the laboratory test data, and standard geotechnical engineering practice.

8.1 Foundation Recommendations

Based on our geotechnical engineering analyses, proposed structures may be supported upon conventional spread and/or continuous wall foundations placed on suitable, undisturbed natural sand/gravel soils and/or on structural fill extending to suitable natural sand/gravel soils. Footings may then be designed using a net bearing pressure of 2,500 psf. The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade, thus the weight of the footing and backfill to lowest adjacent final grade need not be considered. The allowable bearing pressure may be increased by 1/3 for temporary loads such as wind and seismic forces.

We also recommend the following:

1. Exterior footings subject to frost should be placed at least 36 inches below final grade.
2. Interior footings not subject to frost should be placed at least 16 inches below grade.
3. Continuous footing widths should be maintained at a minimum of 18 inches.
4. Spot footings should be a minimum of 24 inches wide.

8.2 Installation

Under no circumstances shall the footings be established upon topsoil, loose or disturbed soils, rubbish, construction debris, other deleterious materials, high plastic soils, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill.

The base of footing excavations should be observed by a CMT geotechnical engineer to assess if suitable bearing soils have been exposed **prior to placement of select structural fill and/or foundations**.

All structural fill should meet the requirements for such, and should be placed and compacted in accordance with **Section 6** above. The width of structural replacement fill below footings should be equal to the width of the footing plus 1 foot for each foot of fill thickness. For instance, if the footing width is 2 feet and the structural fill depth beneath the footing is 2 feet, the fill replacement width should be 4 feet, centered beneath the footing.

8.3 Estimated Settlement

Foundations designed and constructed in accordance with our recommendations could experience some settlement, but we anticipate that total settlements of footings founded as recommended above will not exceed 1 inch, with differential settlements on the order of 0.5 inches over a distance of 25 feet. We expect approximately 50% of the total settlement to initially take place during construction.

8.4 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.40 for natural sand/gravel soils or structural fill, may be utilized for design. Passive resistance provided by properly placed and compacted natural sand/gravel soils or structural fill above the water table may be considered equivalent to a fluid with a density of 425 pcf. A combination of passive earth resistance and friction may be utilized if the passive component of the total is divided by 1.5.

9.0 LATERAL EARTH PRESSURES

Parameters, as presented within this section, are for backfills which will consist of drained natural sand/gravel soils or structural fill placed and compacted in accordance with the recommendations presented herein.

The lateral pressures imposed upon subgrade facilities will depend upon the relative rigidity and movement of the backfilled structure. Following are the recommended lateral pressure values, which also assume that the soil surface behind the wall is horizontal and that the backfill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

CONDITION	STATIC (psf/ft)*	SEISMIC (psf)*
Active Pressure (wall is allowed to yield, i.e. move away from the soil, with a minimum 0.001H movement/rotation at the top of the wall, where "H" is the total height of the wall)	35	19
At-Rest Pressure (wall is not allowed to yield)	55	N/A
Passive Pressure (wall moves into the soil)	425	145

*Equivalent Fluid Pressure (applied at 1/3 Height of Wall)
*Equivalent Fluid Pressure (added to static and applied at 1/3 Height of Wall)

10.0 FLOOR SLABS

Floor slabs may be established upon suitable, undisturbed, natural sand/gravel soils, or structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established directly on any topsoil, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. Floor slabs should not be established on high plasticity silt soils such as encountered in bore hole B-1.

In order to facilitate curing of the concrete, we recommend that floor slabs be directly underlain by at least 4 inches of "free-draining" fill, such as "pea" gravel or 3/4-inch to 1-inch minus, clean, gap-graded gravel. To help control normal shrinkage and stress cracking, the floor slabs may include the following features:

1. Adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints;
2. Frequent crack control joints; and
3. Non-rigid attachment of the slabs to foundation walls and bearing slabs.

11.0 DRAINAGE RECOMMENDATIONS

It is important to the long-term performance of foundations and floor slabs that water is not allowed to collect near the foundation walls and infiltrate into the underlying soils. We recommend the following:

1. All areas around structures should be sloped to provide drainage away from the foundations. Where possible we recommend a minimum slope of 6 inches in the first 10 feet away from the structure.

2. All roof drainage should be collected in rain gutters with downspouts designed to discharge at least 10 feet from the foundation walls or well beyond the backfill limits, whichever is greater.

3. Adequate compaction of the foundation backfill should be provided. We suggest a minimum of 90% of the maximum laboratory density as determined by ASTM D-1557. Water consolidation methods should not be used under any circumstances.

4. Sprinklers should be aimed away from the foundation walls. The sprinkling systems should be designed with proper drainage and be well-maintained. Over watering should be avoided.

5. Other precautions may become evident during construction.

12.0 PAVEMENTS

All pavement areas must be prepared as discussed above in **Section 6.1**. Under no circumstances shall pavements be established over topsoil, undocumented fills (if encountered), loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In pavement areas, subsequent to stripping and prior to the placement of pavement materials, the exposed subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or otherwise unsuitable soils are encountered, we recommend they be removed to a minimum of 18 inches below the subgrade level and replaced with structural fill.

We anticipate the natural sand/gravel soils will exhibit fair pavement support characteristics when saturated or nearly saturated. Based on our laboratory testing experience with similar soils, our pavement design utilized a California Bearing Ratio (CBR) of 5 for the natural sand/gravel soils.

	PAVEMENT SECTION THICKNESS (inches)			
	PARKING AREAS (1 ESAL per day)		DRIVE AREAS (3 ESAL'S per day)	
MATERIAL				
Asphalt	3	3	3.5	3.5
Untreated Base Course	10	6	10	6
Subbase	0	6	0	6
Total Thickness	13	15	13.5	15.5

Untreated base course (UTBC) should conform to city specifications, or to 1-inch-minus UDOT specifications for A–1-a/NP, and have a minimum CBR value of 70%. Material meeting our specification for structural fill can be used for subbase, as long as the fines content (percent passing No. 200 sieve) does not exceed 15%. Roadbase and subbase material should be compacted as recommended above in **Section 6.4**. Asphalt material generally should conform to APWA requirements, having a ½-inch maximum aggregate size, containing no more than 15% of recycled asphalt (RAP) and a PG58-28 binder.

13.0 QUALITY CONTROL

We recommend that CMT be retained to as part of a comprehensive quality control testing and observation program. With CMT onsite we can help facilitate implementation of our recommendations and address, in a timely manner, any subsurface conditions encountered which vary from those described in this report. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This program may include, but not necessarily be limited to, the following:

13.1 Field Observations

Observations should be completed during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement.

13.2 Fill Compaction

Compaction testing by CMT is required for all structural supporting fill materials. Maximum Dry Density (Modified Proctor, ASTM D-1557) tests should be requested by the contractor immediately after delivery of any fill materials. The maximum density information should then be used for field density tests on each lift as necessary to ensure that the required compaction is being achieved.

13.3 Excavations

All excavation procedures and processes should be observed by a geotechnical engineer from CMT or their representative. In addition, for the recommendations in this report to be valid, all backfill and structural fill placed in trenches and all pavements should be density tested by CMT. We recommend that freshly mixed concrete be tested by CMT in accordance with ASTM designations.

14.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. The exploration logs reflect the subsurface conditions only at the specific location at the particular time designated on the logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 870-6730. To schedule materials testing, please call (801) 381-5141.

15.0 REFERENCES

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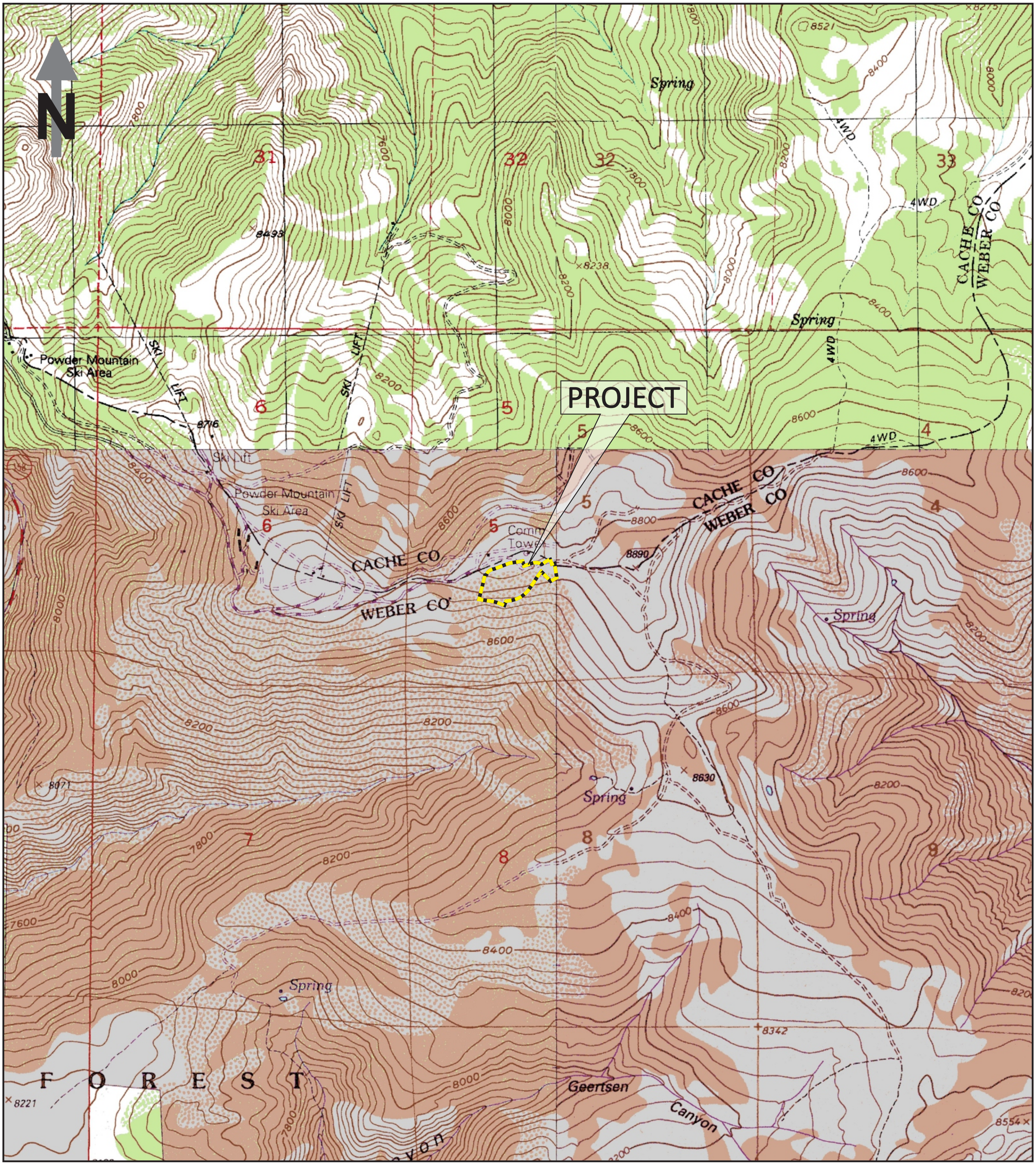
APPENDIX

SUPPORTING DOCUMENTATION



Base:
USGS 7.5-minute topographic quadrangles,
Utah; HUNTSVILLE and BROWNS HOLE, 1998;
and JAMES PEAK and SHARP MOUNTAIN, 1991.

0 2,000 ft 4,000 ft

1:24,000 (1 inch equals 2,000 feet)

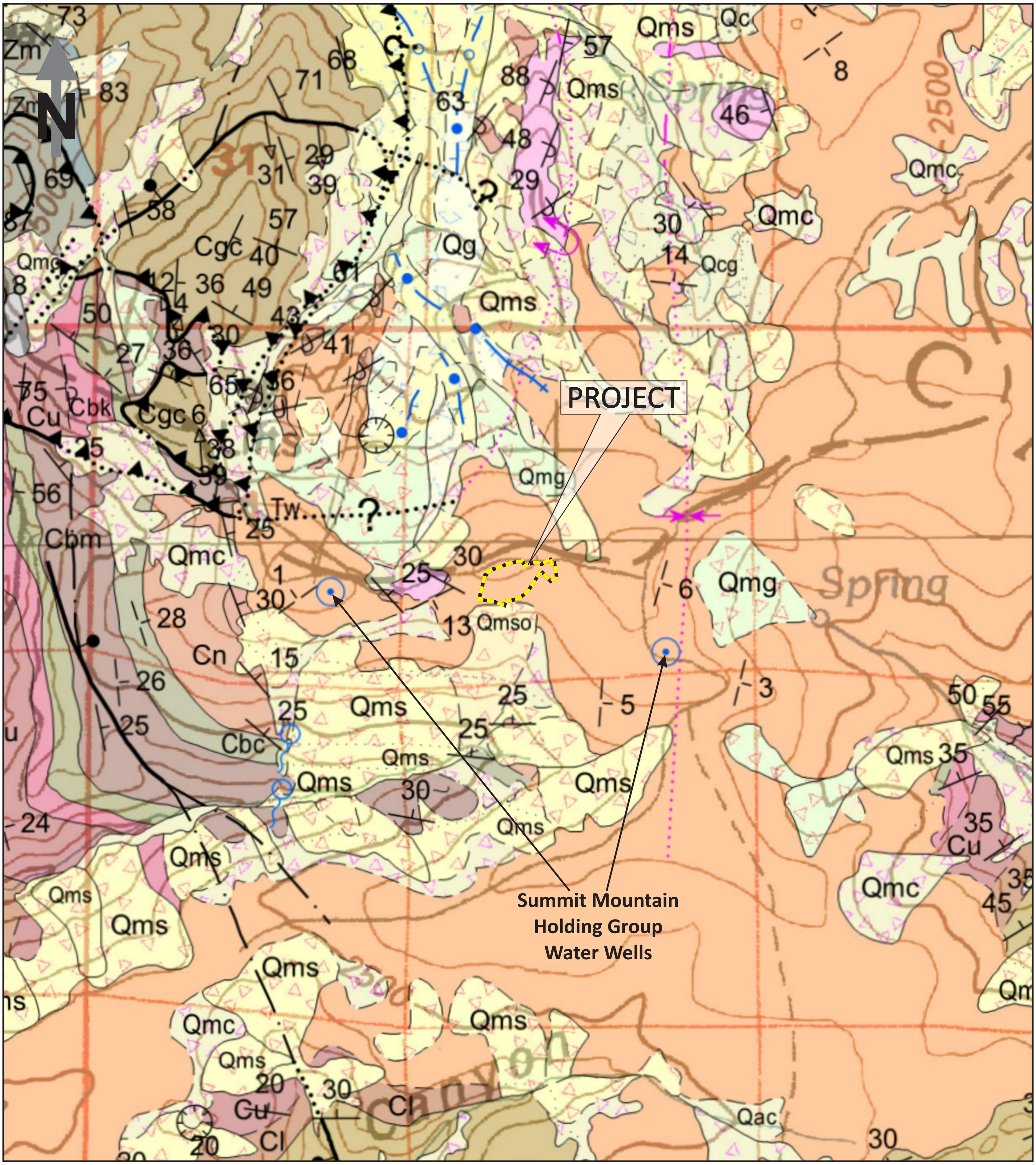
Proposed Monument at Powder Mountain Development
East of Intersection of Summit Pass Road
and Heartwood Drive, Eden, Utah

CMT TECHNICAL SERVICES

Vicinity Map

Date:	17-July-2023
Job #	20435

Figure
1



Base:
Interim Geologic Map of the Ogden 30' x 60'
Quadrangle (Coogan and King, 2016).

0 2,000 ft 4,000 ft
1:24,000 (1 inch equals 2,000 feet)

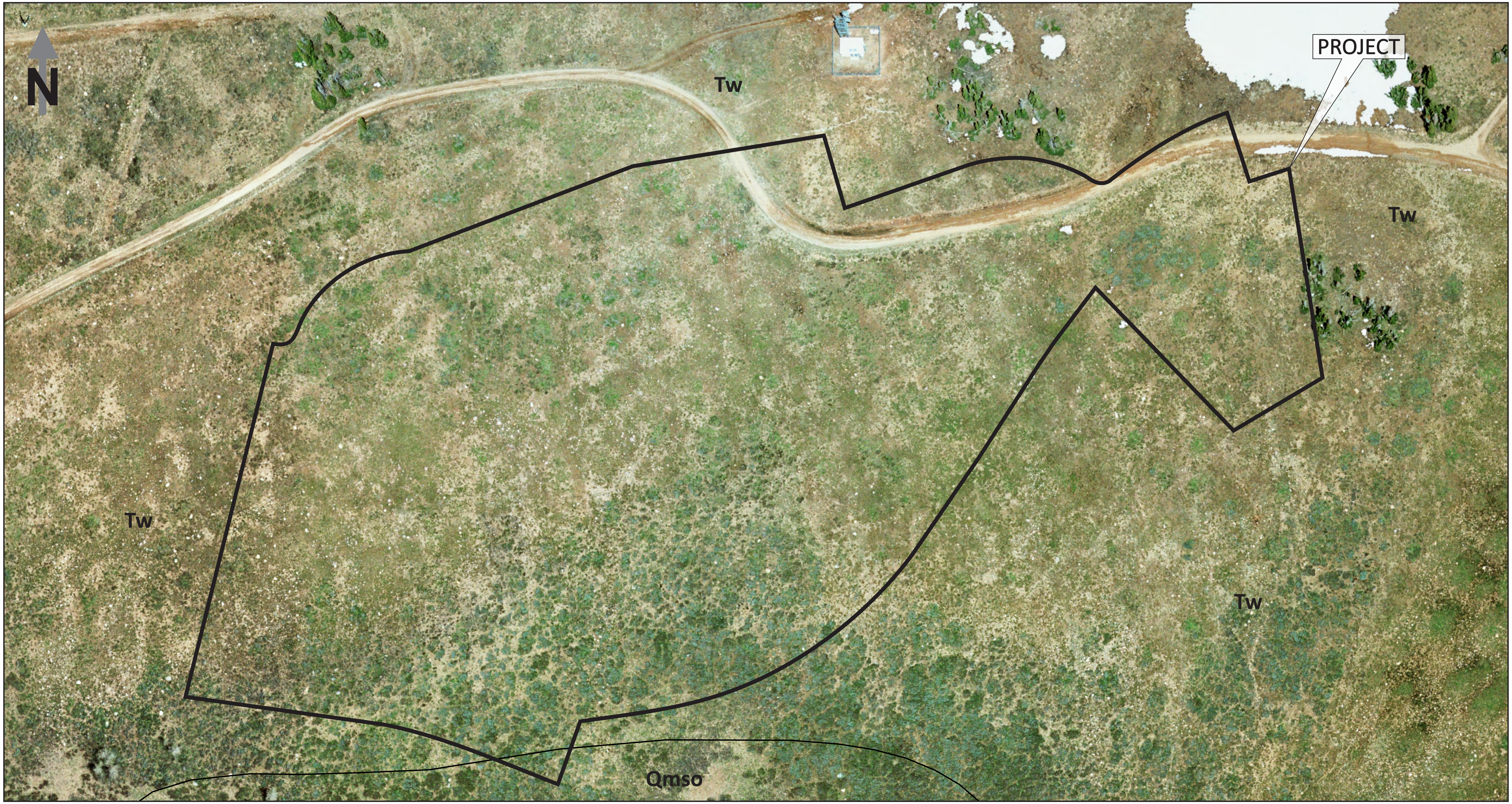
Proposed Monument at
Powder Mountain Development
East of Intersection of Summit Pass Road
and Heartwood Drive, Eden, Utah

CMT TECHNICAL SERVICES

Geologic
Map

Date: 17-July-2023
Job # 20435

Figure
2



Base:
Summit Engineering 2012 high-resolution SID, Powder Mountain Area 1. Surficial geology modified from Coogan and King (2016).

1:1,200 (1 inch equals 100 feet)

CMT TECHNICAL SERVICES

Proposed Monument at Powder Mountain Development
East of Intersection of Summit Pass Road and Heartwood Drive, Eden, Utah

2012
Air Photo

Date:	17-July-2023
CMT No.:	20435

Figure
3

Base:
2018 Google Earth image.

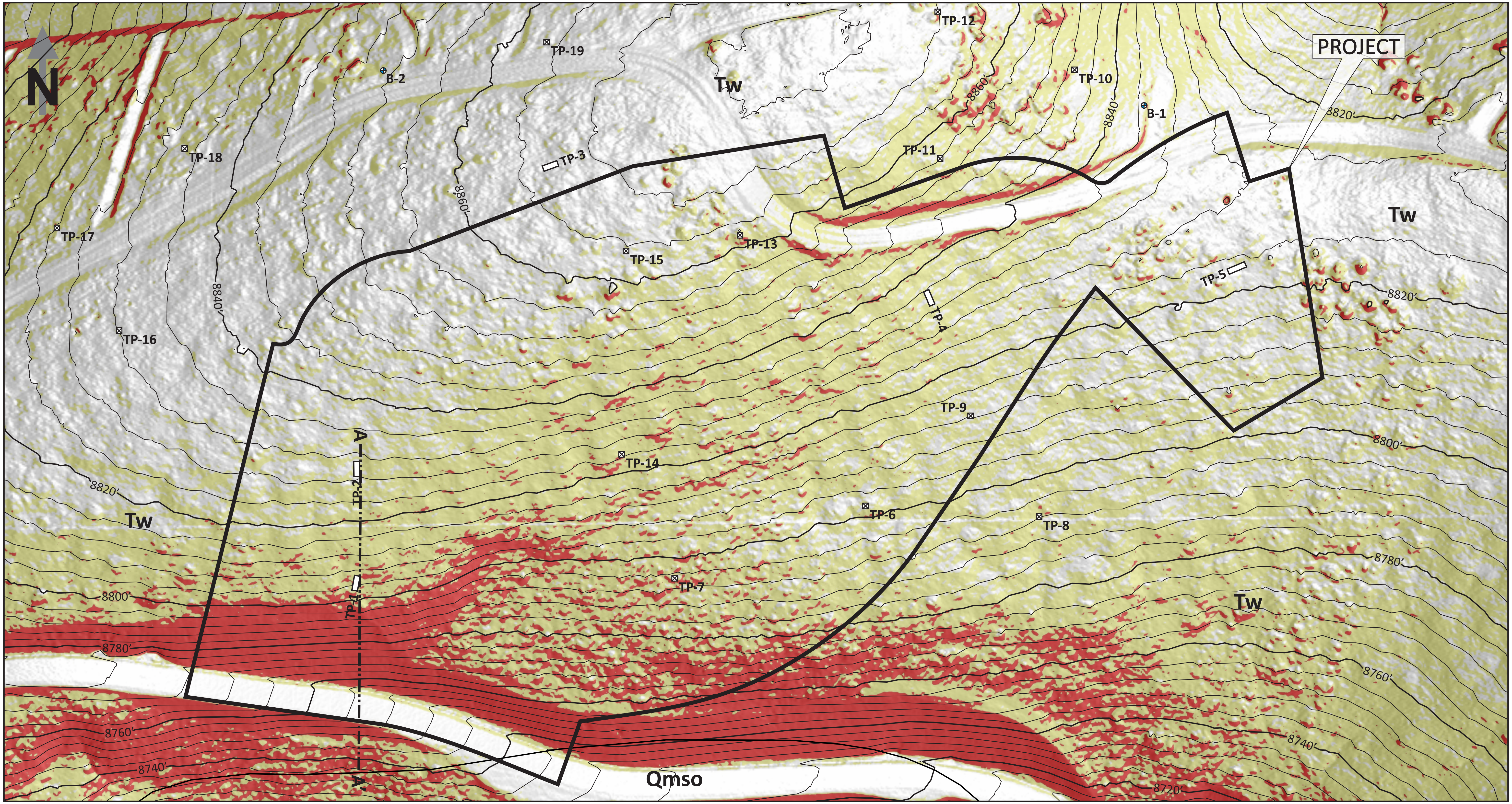
CMT TECHNICAL SERVICES

Proposed Monument at Powder Mountain Development
East of Intersection of Summit Pass Road and Heartwood Drive, Eden, Utah

Site Evaluation

Date:	17-July-2023
CMT No.:	20435

Figure
4



Base:
Utah Geospatial Resource Center 2016 LIDAR bare earth DEM, 50 centimeter resolution. Slopes <15% unshaded, 15-30% shaded in yellow, and >30% shaded in red. Contours generated by Global Mapper, 4 foot interval.

0 100 ft 200 ft

1:1,200 (1 inch equals 100 feet)

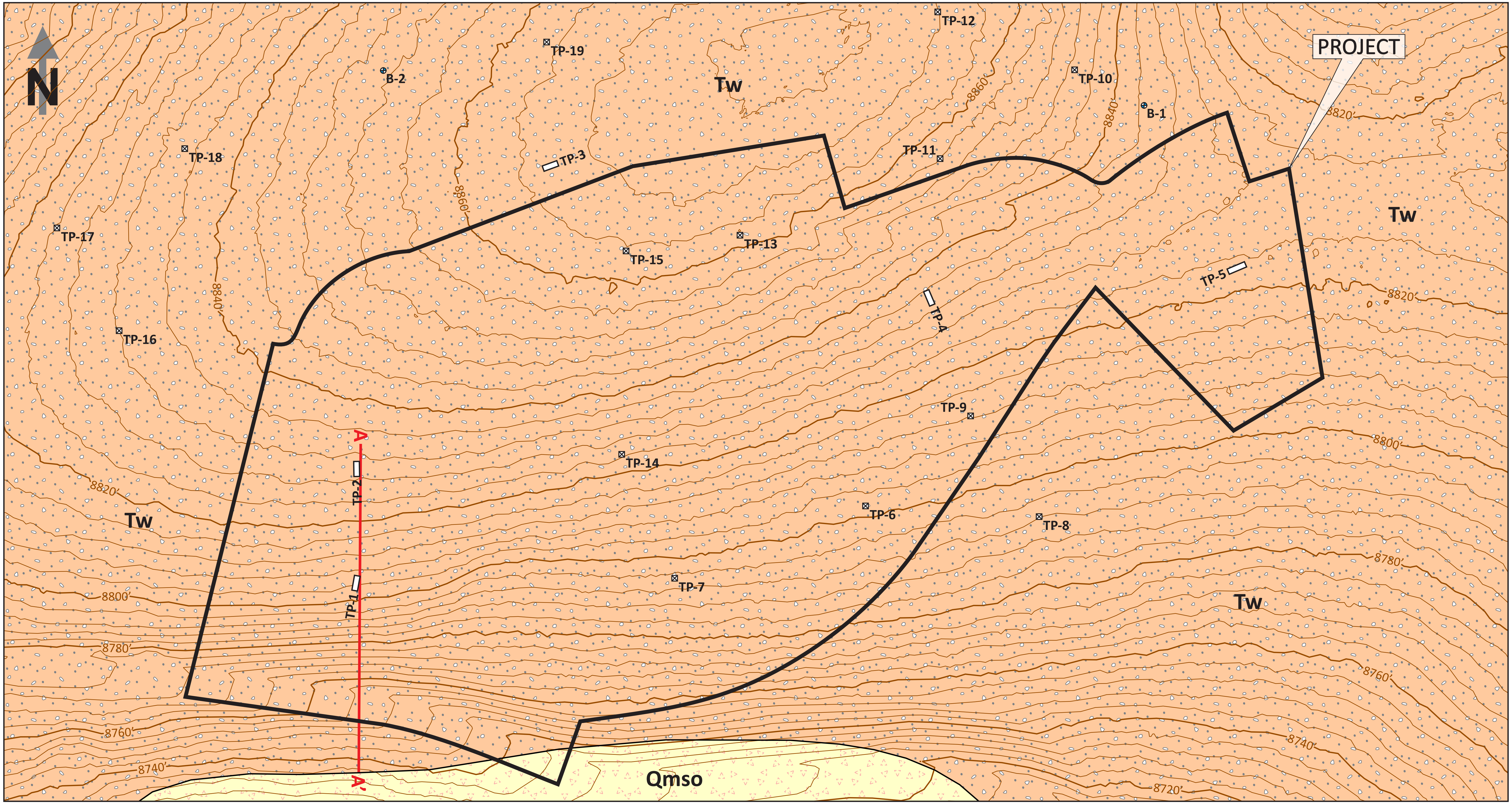
CMT TECHNICAL SERVICES

Proposed Monument at Powder Mountain Development
East of Intersection of Summit Pass Road and Heartwood Drive, Eden, Utah

LIDAR Analysis

Date:	17-July-2023
CMT No.:	20435

Figure 5



Base:
Surficial geology modified from Coogan and King (2016). Contours generated by Global Mapper from geoprocessed 2016 LIDAR data, 4 foot interval.

0 100 ft 200 ft

1:1,200 (1 inch equals 100 feet)

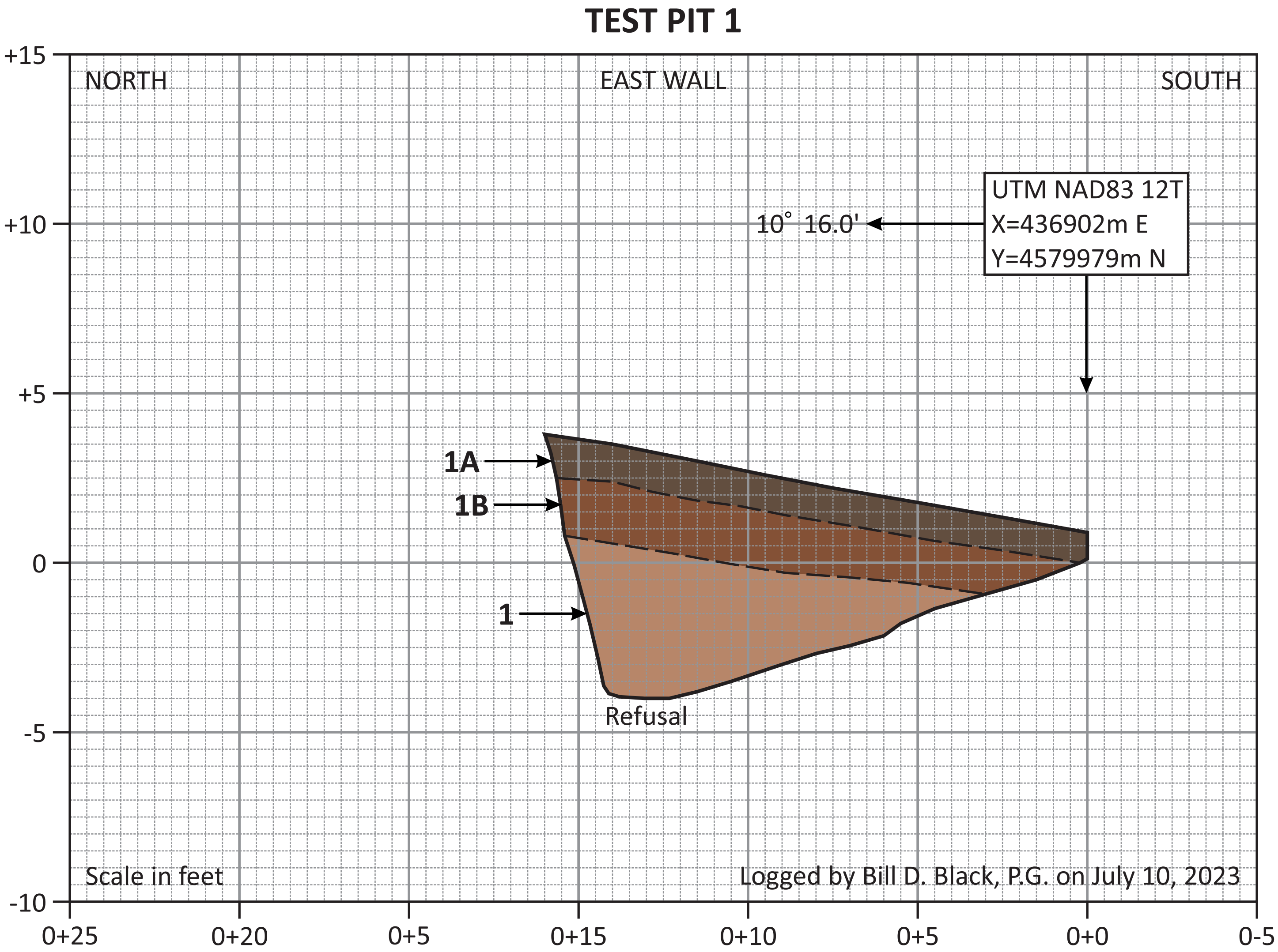
CMT TECHNICAL SERVICES

Proposed Monument at Powder Mountain Development
East of Intersection of Summit Pass Road and Heartwood Drive, Eden, Utah

Site-Specific Geology

Date: 17-July-2023
CMT No.: 20435

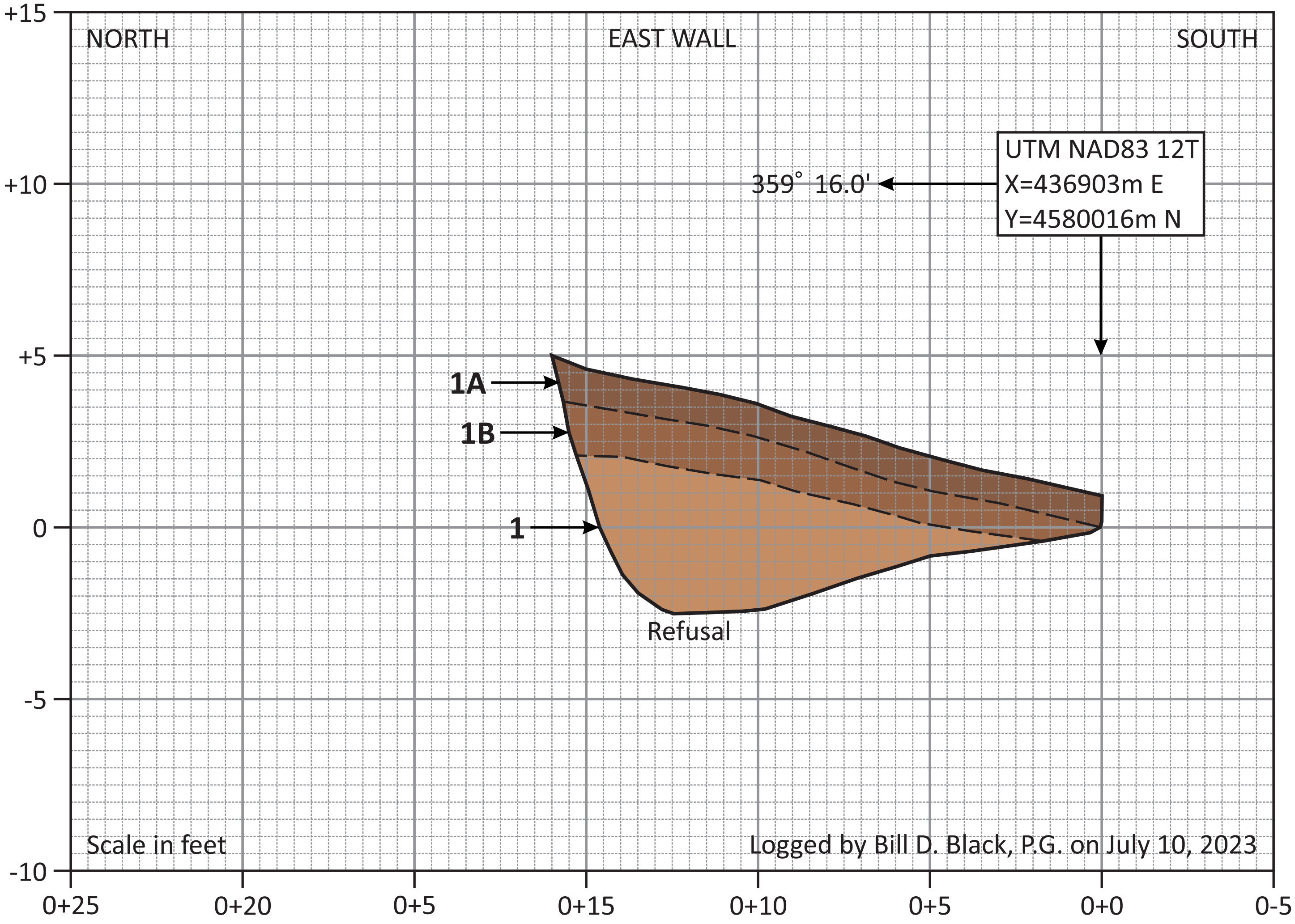
Figure
6



UNIT DESCRIPTIONS

Unit 1. *Tertiary Wasatch Formation* - weathered conglomerate comprised of reddish-brown to brown, medium dense, massive, clayey sand with gravel to gravelly clay with sand (SC/CL) and round to subangular cobbles and boulders with strong stage II carbonate; A and Bt soil horizons formed in unit (1A and 1B).

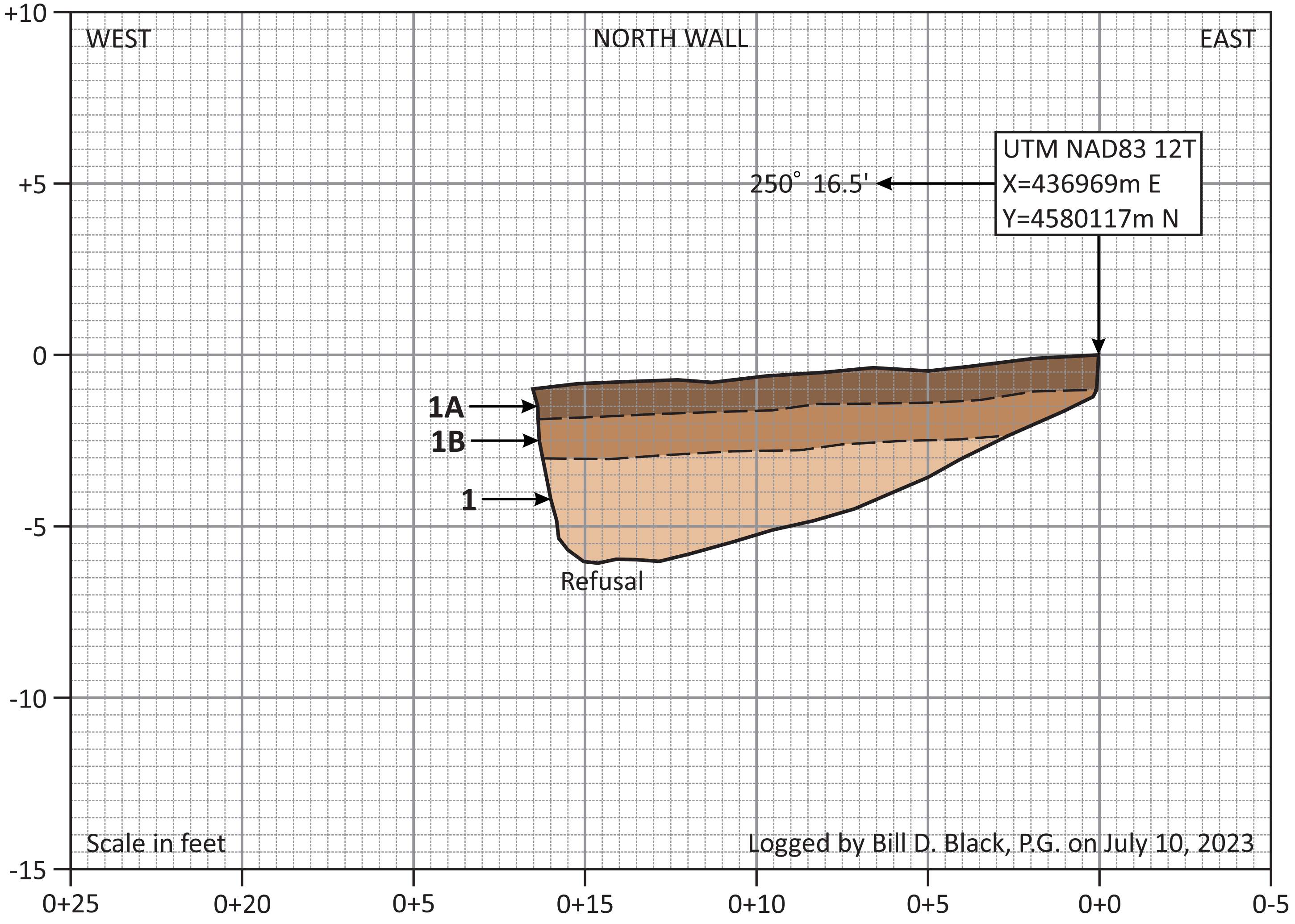
TEST PIT 2



UNIT DESCRIPTIONS

Unit 1. *Tertiary Wasatch Formation* - weathered conglomerate comprised of reddish-brown, brown and grayish-brown; medium dense to dense; massive to poorly bedded; clayey sand with gravel to gravelly clay with sand (SC/CL) and round to subangular cobbles and boulders with strong stage II carbonate; A and Bt soil horizons formed in unit (1A and 1B).

TEST PIT 3

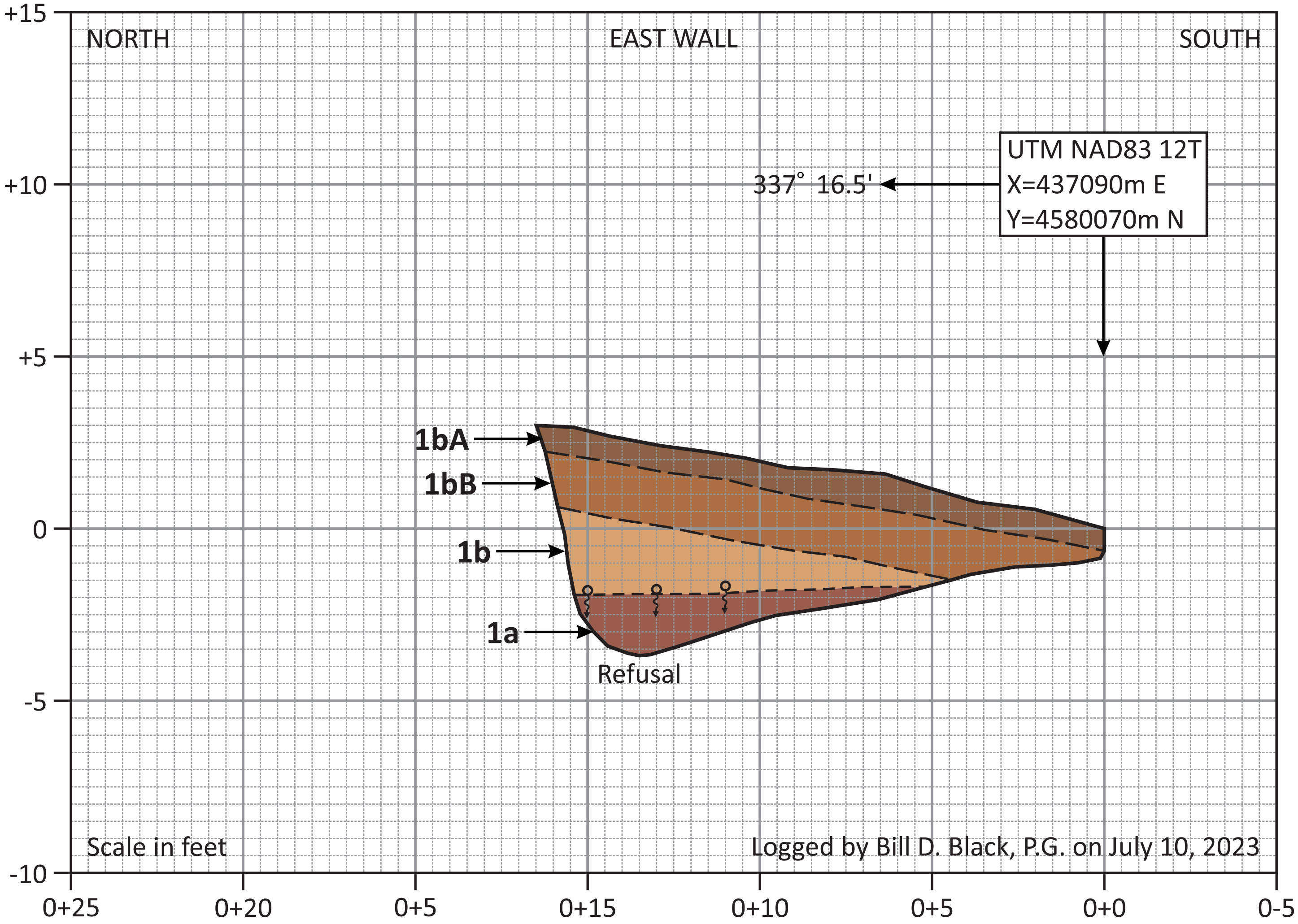


UNIT DESCRIPTIONS

Unit 1. *Tertiary Wasatch Formation* - weathered conglomerate comprised of reddish-brown, brown and grayish-brown; medium dense to dense; massive to poorly bedded; clayey sand with gravel (SC) and round to subangular cobbles with strong stage II carbonate; A and Bk/Bt soil horizons formed in unit (1A and 1B).

Proposed Monument at **Powder Mountain Development** East of Intersection of Summit Pass Road and Heartwood Drive, Eden, Utah	CMT TECHNICAL SERVICES **Geologic Log** **Test Pit 3**	Date: 17-July-2023 Job # 20435	Figure 7C

TEST PIT 4



UNIT DESCRIPTIONS

Unit 1. *Tertiary Wasatch Formation* - weathered conglomerate comprised of a lower (1a) brownish-red, dense, massive, sandy clay with gravel (CL); and an upper (1b) orange-brown, brown and grayish-brown; massive; medium dense; clayey sand with gravel (SC) and round to subangular cobbles and boulders with strong stage II carbonate; A and Bt soil horizons formed in unit 1b (1bA and 1bB); roughly 1-foot thick saturated zone at base of unit 1b seeping into test pit, likely perched groundwater from snowmelt infiltration.

Proposed Monument at
Powder Mountain Development
East of Intersection of Summit Pass Road
and Heartwood Drive, Eden, Utah

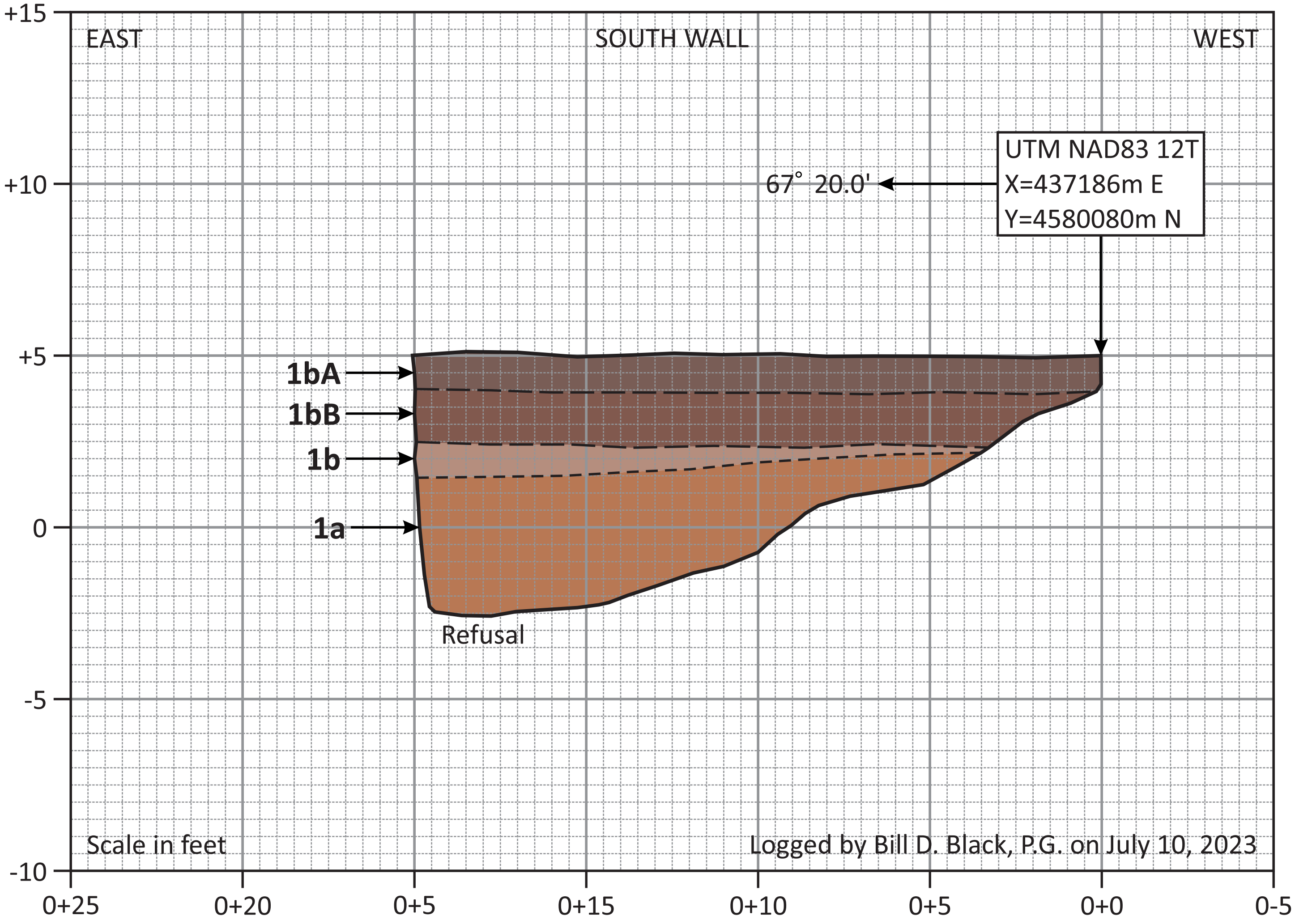
CMT TECHNICAL SERVICES

Geologic Log
Test Pit 4

Date:	17-July-2023
Job #	20435

Figure
7D

TEST PIT 5



UNIT DESCRIPTIONS

Unit 1. *Tertiary Wasatch Formation* - weathered conglomerate comprised of a lower (1a) reddish-brown, dense, massive, clayey sand to clayey gravel (SC/GC) with round to subangular cobbles, slightly moist with remnant saturated pockets; and an upper (1b) reddish-brown, brown and grayish-brown; massive; medium dense; clayey gravel with sand (GC) and round to subround cobbles and boulders with strong stage II carbonate; A and Bt/Bk soil horizons formed in unit 1b (1bA and 1bB).

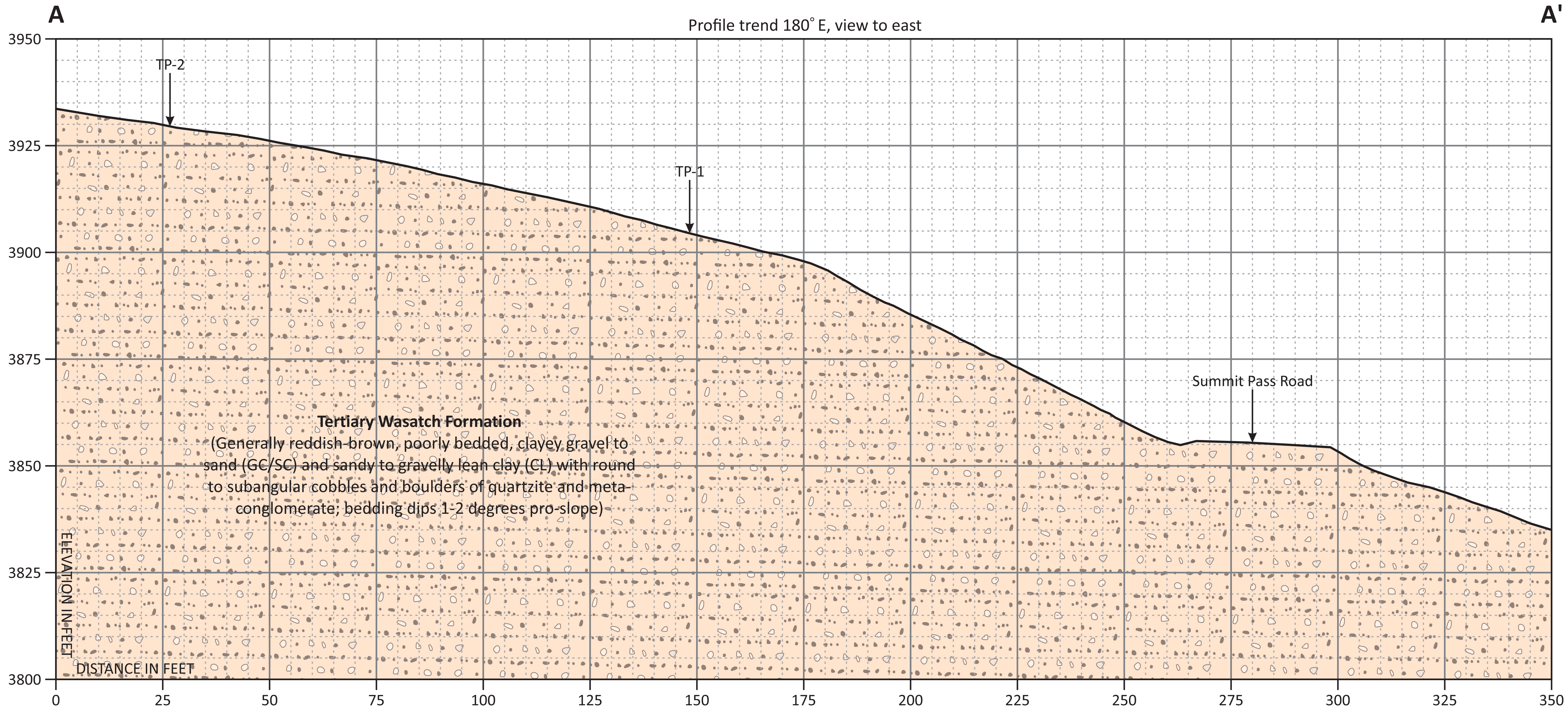
Proposed Monument at
Powder Mountain Development
East of Intersection of Summit Pass Road
and Heartwood Drive, Eden, Utah

CMT TECHNICAL SERVICES

Geologic Log
Test Pit 5

Date:	17-July-2023
Job #	20435

Figure
7E



Scale 1 inch equals 25 feet (1:300) with no vertical exaggeration. Profile based on geoprocessed LIDAR data from 2016. Contacts and units are inferred and approximate.

CMT TECHNICAL SERVICES

Proposed Monument at Powder Mountain Development
East of Intersection of Summit Pass Road and Heartwood Drive, Eden, Utah

Cross Section A-A'

Date: 17-July-2023
CMT No.: 20435

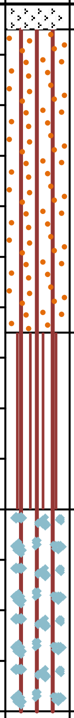
Figure
8

Monument at Powder Mountain Development Bore Hole Log B-1

Near Intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 14'
Water Depth: (see Remarks)

Date: 7/3/23
Job #: 20433



Depth (ft)	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	Topsoil												
	Brown Coarse Sandy SILT (MH), moist												
	soft	◤	1	0 1 2	3								
4													
		‖	2			40	76	0	34	66	95	45	50
	Weathered Bedrock: Reddish Brown SILT (MH) with sand, moist												
8	stiff	◤	3	4 5 9	14	39		2	14	84	90	50	40
	Weathered Bedrock: Brown Gravelly SILT (MH), some sand, moist very stiff	◤	4	6 12 14	26								
12													
	grades with boulders hard	◤	5	50/1"									
	REFUSAL AT 14.0'												
16													
20													
24													
28													

Remarks: Groundwater not encountered during drilling.

Coordinates: 41.3702693°, -111.7514196°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push
Logged By: Steve Laird
Page: 1 of 1

Figure: 9

Monument at Powder Mountain Development

Bore Hole Log

B-2

Near Intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 6.5'
Water Depth: (see Remarks)

Date: 7/3/23
Job #: 20433

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Topsoil												
	▨	Weathered Bedrock: Reddish Silty Clayey GRAVEL with sand (GC-GM), slightly moist												
	▨	dense	◣	6	7 14 21	35	6		36	33	31			
4	▨	grades with more silt/clay												
	▨	very dense	◣	7	18 50 50/3"		9					21	17	4
		REFUSAL AT 6.5' Attempted to drill deeper at 2 other nearby locations, but refusal was encountered at about 6' at each location.												
8														
12														
16														
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 41.370371°, -111.754368°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
10

Monument at Powder Mountain Development

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Test Pit Log

TP-1

Total Depth: 7'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		Topsoil										
1		Brown Clayey SAND (SC) with gravel, some cobbles and boulders, moist medium dense (estimated)										
2			◢	1								
3												
4		grades reddish brown										
5												
6			◢	2	8		26	39	35			
7		REFUSAL AT 7'										
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
11

Monument at Powder Mountain Development

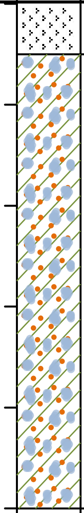
Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Test Pit Log

TP-2

Total Depth: 5'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435



Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
						Gravel %	Sand %	Fines %	LL	PL	PI
0	Topsoil										
1	Reddish Brown Clayey SAND (SC) with gravel, some cobbles and boulders, moist medium dense (estimated)										
2		◣	3								
3											
4											
		◣	4	9		27	39	34			
5	REFUSAL AT 5'										
6											
7											
8											
9											
10											
11											
12											
13											
14											

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Monument at Powder Mountain Development

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Test Pit Log

TP-3

Total Depth: 4'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	Topsoil										
1	▨	Reddish Brown Clayey SAND (SC) with gravel, some cobbles and boulders moist medium dense (estimated)										
2	▨		◣	5								
3	▨											
4		REFUSAL AT 4'										
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
13

Monument at Powder Mountain Development

Test Pit Log

TP-4

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 6'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	░	Topsoil										
1	▨	Brown Clayey SAND (SC) with gravel, some cobbles and boulders, moist medium dense (estimated)										
2	▨		◢	6	14		27	41	32			
3	▨											
4	▨	grades reddish in color, some seepage										
5	▨		◢	7								
6		REFUSAL AT 6'										
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °

Surface Elev. (approx): Not Given

Equipment: Mini Excavator

Excavated By: Blaine Hone

Logged By: Steve Laird

CMT TECHNICAL SERVICES

Monument at Powder Mountain Development

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Test Pit Log

TP-5

Total Depth: 7'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		Topsoil										
1		Brown Clayey SAND (SC) with grave, some cobbles and boulders, moist medium dense (estimated)										
2			◣	8								
3												
4		grades reddish brown, more gravel, some saturated pockets	◣	9	9		43	26	31			
5												
6		grades reddish	◣	10	10		32	35	33			
7		REFUSAL AT 7'										
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
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Monument at Powder Mountain Development

Test Pit Log

TP-6

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 7'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Topsoil										
		Brown Clayey SAND (SC) with gravel, some cobbles and boulders, moist medium dense (estimated)										
1												
			◣	11								
2												
3												
4												
5		grades reddish brown	◣	12	8		22	43	35			
6												
7		REFUSAL AT 7'										
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Page: 1 of 1

Figure: 16

Monument at Powder Mountain Development

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Test Pit Log

TP-7

Total Depth: 8.5'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	Topsoil										
	▨	Reddish Brown Clayey GRAVEL (GC) with sand, some cobbles and boulders, slightly moist medium dense (estimated)										
1	▨		◢	13								
2	▨											
3	▨	grades brown in color										
4	▨		◢	14	6		40	24	36			
5	▨											
6	▨											
7	▨	moist										
8	▨		◢	15								
		END AT 8.5'										
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure: 17

Monument at Powder Mountain Development

Test Pit Log

TP-8

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 8'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	 Sand %	 Fines %	Atterberg LL	 PL	 PI
0	⁘	Topsoil										
	▨	Brown Clayey SAND (SC) with gravel, some cobbles and boulders, moist medium dense (estimated)										
1	▨		▮	16								
2	▨											
3	▨											
4	▨	grades reddish brown	◣	17	9		32	36	32			
5	▨											
6	▨											
7	▨	grades reddish	◣	18	10		28	35	37			
8		REFUSAL AT 8'										
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °

Surface Elev. (approx): Not Given

Equipment: Mini Excavator

Excavated By: Blaine Hone

Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure: 18

Monument at Powder Mountain Development

Test Pit Log

TP-9

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 5'
Water Depth: (see Remarks)

Date: 7/7/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		Topsoil										
1		Reddish Brown Clayey GRAVEL (GC) with sand, some cobbles and boulders, moist medium dense (estimated)										
2			◢	19								
3												
4		grades red	◢	20	10		37	32	31			
5		REFUSAL AT 5'										
6												
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Page: 1 of 1

Figure:
19

Monument at Powder Mountain Development

Test Pit Log

TP-10

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 8'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

							Gradation			Atterberg		
Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0		Topsoil										
0.5		Reddish Brown Sandy CLAY (CL), trace gravel, boulders, slightly moist stiff (estimated)										
2				21								
3		Light Brown CLAY (CL) with sand, trace gravel, moist medium stiff (estimated)										
4				22								
7.5		grades with large boulders		23	36		1	17	82			
8		REFUSAL AT 8'										
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
20

Monument at Powder Mountain Development

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Test Pit Log

TP-11

Total Depth: 8.5'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		Topsoil										
1		Brown Sandy CLAY (CL), trace gravel, boulders, moist stiff (estimated)										
2		grades reddish brown	◢	24								
3												
4			◢	25	16		1	31	68			
5												
6		Reddish Clayey GRAVEL (GC) with sand cobbles and boulders, some water seepage, very moist medium dense (estimated)	◢	26	19		37	26	37			
7												
8			◢	27								
9		REFUSAL AT 8.5'										
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
21

Monument at Powder Mountain Development

Test Pit Log

TP-12

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 6'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	▨	Topsoil										
	▨	Reddish Clayey GRAVEL (GC) with sand, cobbles and boulders, moist medium dense (estimated)										
1	▨											
	▨		◢	28								
2	▨											
	▨	grades reddish brown										
3	▨		◢	29	8		35	32	33			
4	▨											
5	▨											
6		REFUSAL AT 6.0'										
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Page: 1 of 1

Figure:
22

Monument at Powder Mountain Development

Test Pit Log

TP-13

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 8.5'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	⁘	Topsoil										
1	▨	Brown Sandy CLAY (CL), some gravel, cobbles and boulders, slightly moist medium stiff (estimated)										
2	▨		◣	30								
3	▨											
4	▨	Reddish Clayey GRAVEL (GC) with sand, cobbles and boulders, moist medium dense (estimated)										
5	▨		◣	31	8		47	31	22			
6	▨											
7	▨	Reddish Brown Sandy CLAY with gravel (CL), cobbles and boulders some seepage very moist, medium stiff (estimated)										
8	▨		◣	32	12		22	25	53			
9		END AT 8.5'										
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.
Slotted PVC pipe installed to depth of 8.5 feet to facilitate water level measurements.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure: 23

Monument at Powder Mountain Development

Test Pit Log **TP-14**

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 6'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	Topsoil										
	▨	Brown CLAY (CL) with gravel, cobbles, boulders, some roots, slightly moist medium stiff (estimated)										
1	▨		◣	33								
2	▨											
3	▨											
4	▨	Brown Clayey SAND (SC) with gravel, cobbles and boulders, moist medium dense (estimated)										
5	▨		◣	34	8		33	35	32			
6		REFUSAL AT 6.0'										
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Monument at Powder Mountain Development

Test Pit Log

TP-15

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 6'

Water Depth: (see Remarks)

Date: 7/10/23

Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	░	Topsoil										
1	▨	Reddish Brown Clayey GRAVEL (GC) with sand, cobbles and boulders, moist medium dense (estimated)										
2	▨		◢	35								
3	▨											
4	▨											
5	▨	grades reddish	◢	36	6		42	31	27			
6		REFUSAL AT 6.0'										
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °

Surface Elev. (approx): Not Given

Equipment: Mini Excavator

Excavated By: Blaine Hone

Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure: 25

Monument at Powder Mountain Development

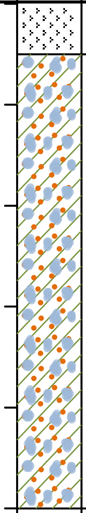
Test Pit Log

TP-16

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 5'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		Topsoil										
		Brown Clayey SAND (SC) with gravel, cobbles and boulders, moist medium dense (estimated)										
1												
2			◣	37	8		20	34	46			
3		grades reddish										
4			◣	38								
5		REFUSAL AT 5.0'										
6												
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
26

Monument at Powder Mountain Development

Test Pit Log TP-17

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 7'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	⁙	Topsoil										
	▨	Brown Clayey SAND (SC) with gravel, cobbles and boulders, some roots, moist medium dense (estimated)										
1	▨		◣	39	9		29	31	40			
2	▨											
3	▨											
4	▨	grades reddish	◣	40								
5	▨											
6	▨											
7		REFUSAL AT 7.0'										
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure: 27

Monument at Powder Mountain Development

Test Pit Log

TP-18

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 5.5'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	Topsoil										
1 2 3 4	▨	Reddish Brown Sandy CLAY (CL), some gravel and boulders, moist medium stiff (estimated)	◢	41								
5	▨	Reddish Silty GRAVEL (GM) with sand, some boulders, slightly moist medium dense (estimated)	◢	42			55	24	21		NP	NP
6 7 8 9 10 11 12 13 14		REFUSAL AT 5.5'										

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure:
28

Monument at Powder Mountain Development

Test Pit Log

TP-19

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Total Depth: 6'
Water Depth: (see Remarks)

Date: 7/10/23
Job #: 20435

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	░	Topsoil										
	▨	Brown Clayey SAND (SC) with gravel, cobbles and boulders, moist medium dense (estimated)										
1	▨											
	▨		◢	43								
2	▨											
3	▨											
4	▨											
5	▨											
	▨		◢	44	9		34	36	30			
6		REFUSAL AT 6.0'										
7												
8												
9												
10												
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Mini Excavator
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Monument at Powder Mountain Development

Key to Symbols

Near the intersection of Summit Pass and Heartwood Drive, Eden, Utah

Date: 7/7/23
Job #: 20435

① Depth (ft)	② GRAPHIC LOG	③ Soil Description	④ Sample Type	⑤ Sample #	⑥ Moisture (%)	⑦ Dry Density(pcf)	Gradation ⑧ Gravel %	Sand %	Fines %	Atterberg ⑨ LL	PL	PI

COLUMN DESCRIPTIONS

① **Depth (ft.):** Depth (feet) below the ground surface (including groundwater depth - see below right).

② **Graphic Log:** Graphic depicting type of soil encountered (see ② below).

③ **Soil Description:** Description of soils, including Unified Soil Classification Symbol (see below).

④ **Sample Type:** Type of soil sample collected; sampler symbols are explained below-right.

⑤ **Sample #:** Consecutive numbering of soil samples collected during field exploration.

⑥ **Moisture (%):** Water content of soil sample measured in laboratory (percentage of dry weight).

⑦ **Dry Density (pcf):** The dry density of a soil measured in laboratory (pounds per cubic foot).

⑧ **Gradation:** Percentages of Gravel, Sand and Fines (Silt/Clay), obtained from lab test results of soil passing the No. 4 and No. 200 sieves.

⑨ **Atterberg:** Individual descriptions of Atterberg Tests are as follows:

LL = Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.

PL = Plastic Limit (%): Water content at which a soil changes from liquid to plastic behavior.

PI = Plasticity Index (%): Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

STRATIFICATION	
Description	**Thickness**
Seam	Up to ½ inch
Lense	Up to 12 inches
Layer	Greater than 12 in.
Occasional	1 or less per foot
Frequent	More than 1 per foot

MODIFIERS
Trace
<5%
Some
5-12%
With
> 12%

MOISTURE CONTENT
Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp / moist to the touch, but no visible water.
Wet: Visible water, usually soil below groundwater.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	②	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	**GRAVELS** The coarse fraction retained on No. 4 sieve.	**CLEAN GRAVELS** (< 5% fines)	GW	▨	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	▨	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (≥ 12% fines)	GM	▨	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	▨	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS The coarse fraction passing through No. 4 sieve.	**CLEAN SANDS** (< 5% fines)	SW	▨	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	▨	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (≥ 12% fines)	SM	▨	Silty Sands, Sand-Silt Mixtures
			SC	▨	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	**SILTS AND CLAYS** Liquid Limit less than 50%		ML	▨	Inorganic Silts and Sandy Silts with No Plasticity or Clayey Silts with Slight Plasticity
			CL	▨	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL	▨	Organic Silts and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50%		MH	▨	Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils
			CH	▨	Inorganic Clays of High Plasticity, Fat Clays
			OH	▨	Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT	▨	Peat, Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

SAMPLER SYMBOLS

◨	Block Sample
◪	Bulk/Bag Sample
⧗	Modified California Sampler 3.5" OD, 2.42" ID
⧗	D&M Sampler
◫	Rock Core
◪	Standard Penetration Split Spoon Sampler
▥	Thin Wall (Shelby Tube)

WATER SYMBOL

▽	Encountered Water Level
▼	Measured Water Level

(see Remarks on Logs)

1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

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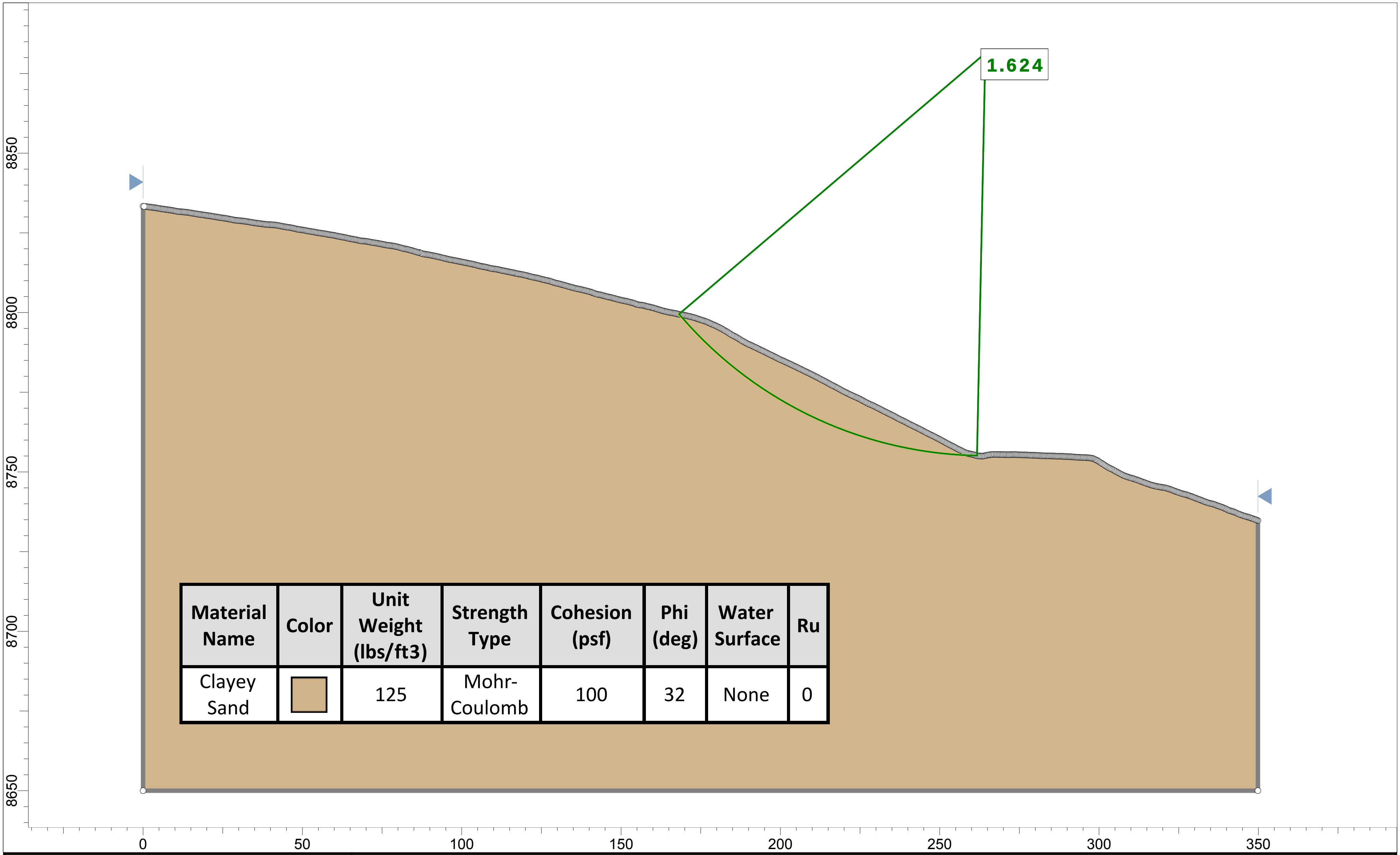

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand	🟫	125	Mohr-Coulomb	100	32	None	0

CMT
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SLIDEINTERPRET 9.020

Project	Monument at Powder Mountain
Analysis Description	Slope Stability Cross Section A-A

Drawn By	J. Egbert	*Company*	CMT Technical Services
Date	9/20/2018, 6:05:57 PM	*File Name*	Slope Stability.slmd

Figure:
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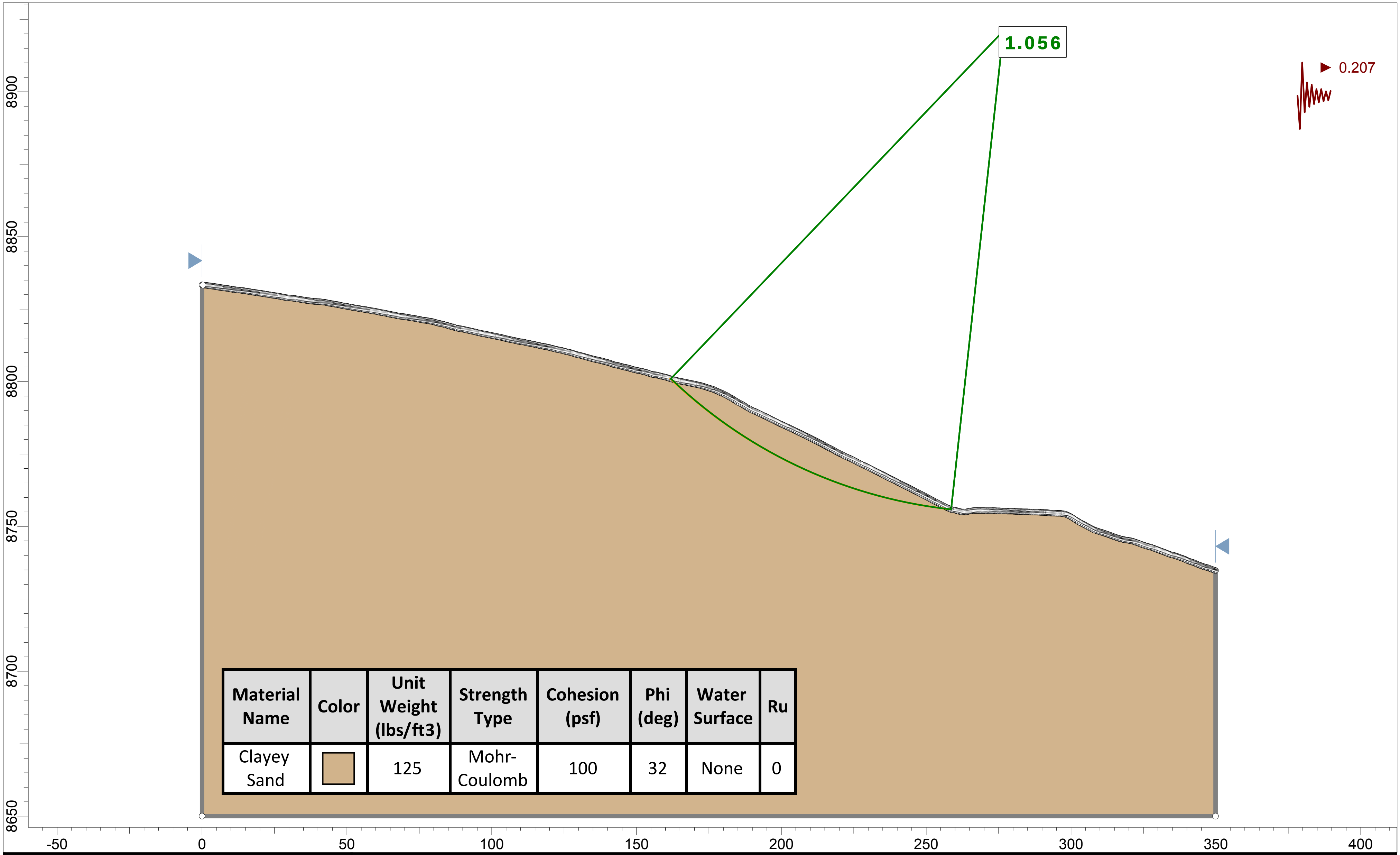

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand	🟫	125	Mohr-Coulomb	100	32	None	0

CMT TECHNICAL SERVICES

SLIDEINTERPRET 9.020

Project	Monument at Powder Mountain		
Analysis Description	Slope Stability Cross Section A-A		
Drawn By	J. Egbert	*Company*	CMT Technical Services
Date	9/20/2018, 6:05:57 PM	*File Name*	Slope Stability.slmd

Figure:
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Project Summary

File Name:	Slope Stability.slmd
Slide Modeler Version:	9.02
Project Title:	Monument at Powder Mountain
Analysis:	Slope Stability Cross Section A-A
Author:	J. Egbert
Company:	CMT Technical Services
Date Created:	9/20/2018, 6:05:57 PM

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Group 1 ◆	Master Scenario	Bishop Simplified: 1.624420	00h:00m:01.821s
	Scenario 2	Bishop Simplified: 1.056090	00h:00m:07.475s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	10
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Group 1 - Master Scenario

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Group 1 - Scenario 2

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.207

Materials

Silty Sand	
Color	🟫
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	100
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material	Group 1	Scenario 2
Silty Sand 🟫	✓	✓

Global Minimums

Group 1 - Master Scenario

Method: bishop simplified

FS	1.624420
Center:	264.321, 8881.371
Radius:	126.294
Left Slip Surface Endpoint:	168.180, 8799.474
Right Slip Surface Endpoint:	261.711, 8755.104
Resisting Moment:	8.84135e+06 lb-ft
Driving Moment:	5.44278e+06 lb-ft
Total Slice Area:	819.333 ft2
Surface Horizontal Width:	93.5301 ft
Surface Average Height:	8.76009 ft

Group 1 - Scenario 2

Method: bishop simplified

FS	1.056090
Center:	276.658, 8921.001
Radius:	166.144
Left Slip Surface Endpoint:	161.818, 8800.937
Right Slip Surface Endpoint:	258.593, 8755.842
Resisting Moment:	1.03161e+07 lb-ft
Driving Moment:	9.76827e+06 lb-ft
Total Slice Area:	784.148 ft2
Surface Horizontal Width:	96.7754 ft
Surface Average Height:	8.10276 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Group 1 - Master Scenario

Method: bishop simplified

Number of Valid Surfaces:	3434
Number of Invalid Surfaces:	0

◆ Group 1 - Scenario 2

Method: bishop simplified

Number of Valid Surfaces:	3000
Number of Invalid Surfaces:	0

Slice Data

◆ Group 1 - Master Scenario

Global Minimum Query (bishop simplified) - Safety Factor: 1.62442

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.8706	209.271	-48.9278	Silty Sand	100	32	72.5908	117.918	28.6746	0	28.6746	111.969	111.969
2	1.8706	611.473	-47.6521	Silty Sand	100	32	131.76	214.033	182.491	0	182.491	327.05	327.05
3	1.8706	968.081	-46.4068	Silty Sand	100	32	185.695	301.646	322.701	0	322.701	517.746	517.746
4	1.8706	1278.2	-45.1893	Silty Sand	100	32	233.931	380.002	448.095	0	448.095	683.577	683.577
5	1.8706	1560.94	-43.9974	Silty Sand	100	32	279.029	453.261	565.336	0	565.336	834.767	834.767
6	1.8706	1788.76	-42.8289	Silty Sand	100	32	316.631	514.341	663.085	0	663.085	956.586	956.586
7	1.8706	1988.65	-41.6822	Silty Sand	100	32	350.569	569.471	751.311	0	751.311	1063.46	1063.46
8	1.8706	2138.53	-40.5556	Silty Sand	100	32	377.276	612.855	820.74	0	820.74	1143.6	1143.6
9	1.8706	2239.72	-39.4476	Silty Sand	100	32	396.718	644.436	871.28	0	871.28	1197.7	1197.7
10	1.8706	2345.58	-38.357	Silty Sand	100	32	417.085	677.521	924.227	0	924.227	1254.29	1254.29
11	1.8706	2427.01	-37.2825	Silty Sand	100	32	433.767	704.619	967.591	0	967.591	1297.82	1297.82
12	1.8706	2511.77	-36.2233	Silty Sand	100	32	451.114	732.798	1012.69	0	1012.69	1343.14	1343.14
13	1.8706	2625.33	-35.1781	Silty Sand	100	32	473.262	768.777	1070.27	0	1070.27	1403.85	1403.85
14	1.8706	2716.1	-34.1463	Silty Sand	100	32	491.91	799.068	1118.74	0	1118.74	1452.37	1452.37
15	1.8706	2796.54	-33.1269	Silty Sand	100	32	509.016	826.855	1163.21	0	1163.21	1495.37	1495.37
16	1.8706	2860.37	-32.1192	Silty Sand	100	32	523.496	850.378	1200.86	0	1200.86	1529.49	1529.49
17	1.8706	2910.08	-31.1225	Silty Sand	100	32	535.711	870.219	1232.61	0	1232.61	1556.06	1556.06
18	1.8706	2966.37	-30.1362	Silty Sand	100	32	549.088	891.95	1267.38	0	1267.38	1586.14	1586.14
19	1.8706	3013.65	-29.1597	Silty Sand	100	32	561.016	911.325	1298.39	0	1298.39	1611.42	1611.42
20	1.8706	3044.39	-28.1923	Silty Sand	100	32	570.179	926.21	1322.21	0	1322.21	1627.84	1627.84
21	1.8706	3061.45	-27.2337	Silty Sand	100	32	577.012	937.31	1339.97	0	1339.97	1636.95	1636.95
22	1.8706	3070.95	-26.2832	Silty Sand	100	32	582.533	946.278	1354.33	0	1354.33	1642.02	1642.02
23	1.8706	3066.09	-25.3405	Silty Sand	100	32	585.532	951.15	1362.12	0	1362.12	1639.41	1639.41
24	1.8706	3044.36	-24.405	Silty Sand	100	32	585.526	951.14	1362.11	0	1362.11	1627.78	1627.78
25	1.8706	3012.12	-23.4764	Silty Sand	100	32	583.585	947.987	1357.06	0	1357.06	1610.53	1610.53
26	1.8706	2958.39	-22.5543	Silty Sand	100	32	577.731	938.477	1341.84	0	1341.84	1581.79	1581.79
27	1.8706	2911.22	-21.6384	Silty Sand	100	32	572.901	930.632	1329.29	0	1329.29	1556.56	1556.56
28	1.8706	2841.83	-20.7282	Silty Sand	100	32	563.954	916.098	1306.03	0	1306.03	1519.45	1519.45
29	1.8706	2785.81	-19.8235	Silty Sand	100	32	557.252	905.212	1288.61	0	1288.61	1489.49	1489.49
30	1.8706	2735.48	-18.9238	Silty Sand	100	32	551.445	895.778	1273.51	0	1273.51	1462.57	1462.57
31	1.8706	2670.9	-18.029	Silty Sand	100	32	542.911	881.915	1251.33	0	1251.33	1428.03	1428.03
32	1.8706	2580.73	-17.1388	Silty Sand	100	32	529.52	860.163	1216.51	0	1216.51	1379.81	1379.81
33	1.8706	2508.19	-16.2527	Silty Sand	100	32	519.191	843.384	1189.66	0	1189.66	1341.02	1341.02
34	1.8706	2415.17	-15.3707	Silty Sand	100	32	504.889	820.151	1152.48	0	1152.48	1291.27	1291.27
35	1.8706	2308.5	-14.4924	Silty Sand	100	32	487.833	792.446	1108.14	0	1108.14	1234.24	1234.24
36	1.8706	2202.34	-13.6175	Silty Sand	100	32	470.644	764.524	1063.46	0	1063.46	1177.47	1177.47
37	1.8706	2077.18	-12.7459	Silty Sand	100	32	449.635	730.396	1008.84	0	1008.84	1110.55	1110.55
38	1.8706	1952.73	-11.8772	Silty Sand	100	32	428.494	696.055	953.887	0	953.887	1044.01	1044.01
39	1.8706	1817.16	-11.0113	Silty Sand	100	32	404.965	657.834	892.722	0	892.722	971.523	971.523
40	1.8706	1680.06	-10.148	Silty Sand	100	32	380.856	618.67	830.045	0	830.045	898.214	898.214
41	1.8706	1538.05	-9.28696	Silty Sand	100	32	355.509	577.496	764.152	0	764.152	822.286	822.286
42	1.8706	1379.46	-8.42805	Silty Sand	100	32	326.638	530.597	689.097	0	689.097	737.494	737.494
43	1.8706	1219.74	-7.57104	Silty Sand	100	32	297.211	482.795	612.6	0	612.6	652.104	652.104
44	1.8706	1052.92	-6.71573	Silty Sand	100	32	266.048	432.173	531.588	0	531.588	562.915	562.915
45	1.8706	867.287	-5.86193	Silty Sand	100	32	230.805	374.925	439.971	0	439.971	463.668	463.668
46	1.8706	678.354	-5.00942	Silty Sand	100	32	194.507	315.961	345.61	0	345.61	362.659	362.659
47	1.8706	485.824	-4.15803	Silty Sand	100	32	157.078	255.161	248.309	0	248.309	259.728	259.728
48	1.8706	295.731	-3.30756	Silty Sand	100	32	119.716	194.47	151.183	0	151.183	158.102	158.102
49	1.8706	141.808	-2.45782	Silty Sand	100	32	89.2499	144.979	71.9822	0	71.9822	75.8131	75.8131
50	1.8706	55.9435	-1.60862	Silty Sand	100	32	72.2847	117.421	27.879	0	27.879	29.909	29.909

Group 1 - Scenario 2

Global Minimum Query (bishop simplified) - Safety Factor: 1.05609

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.93551	152.361	-43.2678	Silty Sand	100	32	90.7359	95.8253	-6.68094	0	-6.68094	78.7279	78.7279
2	1.93551	471.644	-42.3578	Silty Sand	100	32	155.168	163.872	102.216	0	102.216	243.695	243.695
3	1.93551	801.839	-41.4608	Silty Sand	100	32	223.163	235.68	217.133	0	217.133	414.299	414.299
4	1.93551	1109.38	-40.5761	Silty Sand	100	32	287.939	304.09	326.612	0	326.612	573.198	573.198
5	1.93551	1412.41	-39.7029	Silty Sand	100	32	353.04	372.842	436.64	0	436.64	729.769	729.769
6	1.93551	1681.17	-38.8406	Silty Sand	100	32	412.242	435.365	536.696	0	536.696	868.629	868.629
7	1.93551	1907.14	-37.9887	Silty Sand	100	32	463.531	489.53	623.377	0	623.377	985.38	985.38
8	1.93551	2111.1	-37.1466	Silty Sand	100	32	511.015	539.678	703.631	0	703.631	1090.76	1090.76
9	1.93551	2265.13	-36.3137	Silty Sand	100	32	548.603	579.374	767.158	0	767.158	1170.35	1170.35
10	1.93551	2394.41	-35.4896	Silty Sand	100	32	581.402	614.013	822.593	0	822.593	1237.14	1237.14
11	1.93551	2477.14	-34.6739	Silty Sand	100	32	604.536	638.444	861.691	0	861.691	1279.88	1279.88
12	1.93551	2512.46	-33.8662	Silty Sand	100	32	617.551	652.189	883.685	0	883.685	1298.13	1298.13
13	1.93551	2557.37	-33.066	Silty Sand	100	32	632.755	668.246	909.382	0	909.382	1321.34	1321.34
14	1.93551	2580.73	-32.2731	Silty Sand	100	32	643.277	679.358	927.164	0	927.164	1333.4	1333.4
15	1.93551	2617.54	-31.487	Silty Sand	100	32	656.85	693.693	950.108	0	950.108	1352.42	1352.42
16	1.93551	2684.8	-30.7075	Silty Sand	100	32	677.402	715.397	984.839	0	984.839	1387.17	1387.17
17	1.93551	2732.58	-29.9342	Silty Sand	100	32	693.712	732.622	1012.41	0	1012.41	1411.86	1411.86
18	1.93551	2770.36	-29.1669	Silty Sand	100	32	707.855	747.559	1036.31	0	1036.31	1431.38	1431.38
19	1.93551	2796.53	-28.4053	Silty Sand	100	32	719.405	759.756	1055.83	0	1055.83	1444.9	1444.9
20	1.93551	2811.9	-27.6491	Silty Sand	100	32	728.496	769.357	1071.19	0	1071.19	1452.84	1452.84
21	1.93551	2840.52	-26.8981	Silty Sand	100	32	740.725	782.272	1091.86	0	1091.86	1467.62	1467.62
22	1.93551	2855.52	-26.1521	Silty Sand	100	32	749.802	791.858	1107.21	0	1107.21	1475.37	1475.37
23	1.93551	2856.18	-25.4108	Silty Sand	100	32	755.485	797.86	1116.81	0	1116.81	1475.72	1475.72
24	1.93551	2847.72	-24.674	Silty Sand	100	32	758.956	801.526	1122.68	0	1122.68	1471.34	1471.34
25	1.93551	2832.65	-23.9416	Silty Sand	100	32	760.781	803.453	1125.76	0	1125.76	1463.55	1463.55
26	1.93551	2799.88	-23.2133	Silty Sand	100	32	758.225	800.754	1121.44	0	1121.44	1446.62	1446.62
27	1.93551	2756.19	-22.489	Silty Sand	100	32	752.86	795.088	1112.37	0	1112.37	1424.05	1424.05
28	1.93551	2696	-21.7684	Silty Sand	100	32	743.258	784.947	1096.14	0	1096.14	1392.95	1392.95
29	1.93551	2633.32	-21.0514	Silty Sand	100	32	732.821	773.925	1078.51	0	1078.51	1360.56	1360.56
30	1.93551	2557.26	-20.3379	Silty Sand	100	32	718.81	759.128	1054.83	0	1054.83	1321.26	1321.26
31	1.93551	2487.16	-19.6276	Silty Sand	100	32	706.043	745.645	1033.25	0	1033.25	1285.04	1285.04
32	1.93551	2426.78	-18.9205	Silty Sand	100	32	695.509	734.52	1015.45	0	1015.45	1253.85	1253.85
33	1.93551	2365.43	-18.2164	Silty Sand	100	32	684.521	722.916	996.875	0	996.875	1222.15	1222.15
34	1.93551	2272.96	-17.5151	Silty Sand	100	32	665.312	702.629	964.41	0	964.41	1174.37	1174.37
35	1.93551	2193.24	-16.8165	Silty Sand	100	32	649.097	685.505	937.005	0	937.005	1133.18	1133.18
36	1.93551	2104.07	-16.1204	Silty Sand	100	32	630.15	665.495	904.982	0	904.982	1087.11	1087.11
37	1.93551	1996.86	-15.4268	Silty Sand	100	32	606.167	640.167	864.448	0	864.448	1031.72	1031.72
38	1.93551	1891.42	-14.7355	Silty Sand	100	32	582.288	614.949	824.092	0	824.092	977.238	977.238
39	1.93551	1770.02	-14.0464	Silty Sand	100	32	553.81	584.873	775.956	0	775.956	914.513	914.513
40	1.93551	1646.99	-13.3593	Silty Sand	100	32	524.483	553.901	726.392	0	726.392	850.948	850.948
41	1.93551	1516	-12.6743	Silty Sand	100	32	492.59	520.219	672.491	0	672.491	783.269	783.269
42	1.93551	1384.25	-11.991	Silty Sand	100	32	460.044	485.848	617.487	0	617.487	715.197	715.197
43	1.93551	1247.83	-11.3095	Silty Sand	100	32	425.772	449.654	559.561	0	559.561	644.711	644.711
44	1.93551	1096.11	-10.6296	Silty Sand	100	32	386.819	408.516	493.729	0	493.729	566.327	566.327
45	1.93551	944.631	-9.95116	Silty Sand	100	32	347.401	366.887	427.109	0	427.109	488.06	488.06
46	1.93551	785.726	-9.27416	Silty Sand	100	32	305.382	322.511	356.092	0	356.092	405.959	405.959
47	1.93551	606.756	-8.59848	Silty Sand	100	32	257.167	271.592	274.605	0	274.605	313.491	313.491
48	1.93551	430.585	-7.92399	Silty Sand	100	32	209.1	220.828	193.365	0	193.365	222.47	222.47
49	1.93551	249.944	-7.25061	Silty Sand	100	32	159.12	168.045	108.894	0	108.894	129.138	129.138
50	1.93551	78.4469	-6.57823	Silty Sand	100	32	111.091	117.322	27.7209	0	27.7209	40.5318	40.5318

Interslice Data

Group 1 - Master Scenario

Global Minimum Query (bishop simplified) - Safety Factor: 1.62442

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	168.18	8799.47	0	0	0
2	170.051	8797.33	-74.086	0	0
3	171.922	8795.27	54.2542	0	0
4	173.792	8793.31	341.33	0	0
5	175.663	8791.43	748.005	0	0
6	177.534	8789.62	1247.79	0	0
7	179.404	8787.89	1805.93	0	0
8	181.275	8786.22	2402.29	0	0
9	183.145	8784.62	3011.19	0	0
10	185.016	8783.08	3610.95	0	0
11	186.887	8781.6	4199.8	0	0
12	188.757	8780.18	4767.29	0	0
13	190.628	8778.81	5312.02	0	0
14	192.498	8777.49	5838.89	0	0
15	194.369	8776.22	6339.12	0	0
16	196.24	8775	6807.95	0	0
17	198.11	8773.82	7239.97	0	0
18	199.981	8772.7	7631.15	0	0
19	201.851	8771.61	7981.49	0	0
20	203.722	8770.57	8288.4	0	0
21	205.593	8769.56	8548.8	0	0
22	207.463	8768.6	8760.74	0	0
23	209.334	8767.68	8923.45	0	0
24	211.204	8766.79	9036.04	0	0
25	213.075	8765.94	9098.08	0	0
26	214.946	8765.13	9110.21	0	0
27	216.816	8764.35	9073.22	0	0
28	218.687	8763.61	8989.21	0	0
29	220.557	8762.9	8860.01	0	0
30	222.428	8762.23	8687.74	0	0
31	224.299	8761.59	8474.11	0	0
32	226.169	8760.98	8221.55	0	0
33	228.04	8760.4	7933.92	0	0
34	229.91	8759.86	7612.58	0	0
35	231.781	8759.34	7261.84	0	0
36	233.652	8758.86	6886.14	0	0
37	235.522	8758.4	6488.66	0	0
38	237.393	8757.98	6075.41	0	0
39	239.263	8757.59	5650.06	0	0
40	241.134	8757.22	5218.33	0	0
41	243.005	8756.89	4784.63	0	0
42	244.875	8756.58	4354.12	0	0
43	246.746	8756.31	3934.8	0	0
44	248.616	8756.06	3531.78	0	0
45	250.487	8755.84	3151.77	0	0
46	252.358	8755.65	2805.01	0	0
47	254.228	8755.48	2498.25	0	0
48	256.099	8755.35	2238.52	0	0
49	257.969	8755.24	2031.18	0	0
50	259.84	8755.16	1870.2	0	0
51	261.711	8755.1	0	0	0

Group 1 - Scenario 2

Global Minimum Query (bishop simplified) - Safety Factor: 1.05609

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	161.818	8800.94	0	0	0
2	163.753	8799.11	-156.234	0	0
3	165.689	8797.35	-178.515	0	0
4	167.624	8795.64	-73.1161	0	0
5	169.56	8793.98	140.645	0	0
6	171.495	8792.38	451.478	0	0
7	173.431	8790.82	838.082	0	0
8	175.366	8789.31	1278.07	0	0
9	177.302	8787.84	1757.83	0	0
10	179.237	8786.42	2256.27	0	0
11	181.173	8785.04	2761.95	0	0
12	183.108	8783.7	3258.48	0	0
13	185.044	8782.4	3731.28	0	0
14	186.979	8781.14	4182.01	0	0
15	188.915	8779.92	4604.56	0	0
16	190.85	8778.73	5001.52	0	0
17	192.786	8777.58	5378.43	0	0
18	194.721	8776.47	5729.87	0	0
19	196.657	8775.39	6052.9	0	0
20	198.592	8774.34	6344.71	0	0
21	200.528	8773.33	6603.08	0	0
22	202.463	8772.34	6829.6	0	0
23	204.399	8771.39	7021.86	0	0
24	206.334	8770.47	7177.9	0	0
25	208.27	8769.58	7296.82	0	0
26	210.205	8768.73	7378.29	0	0
27	212.141	8767.9	7421.38	0	0
28	214.076	8767.09	7426.22	0	0
29	216.012	8766.32	7393.08	0	0
30	217.947	8765.58	7323.4	0	0
31	219.883	8764.86	7218.4	0	0
32	221.818	8764.17	7080.04	0	0
33	223.754	8763.51	6910.06	0	0
34	225.689	8762.87	6709.93	0	0
35	227.625	8762.26	6481.94	0	0
36	229.56	8761.67	6227.86	0	0
37	231.496	8761.11	5950.13	0	0
38	233.431	8760.58	5652.07	0	0
39	235.367	8760.07	5336.19	0	0
40	237.303	8759.59	5006.55	0	0
41	239.238	8759.13	4666.34	0	0
42	241.174	8758.69	4319.55	0	0
43	243.109	8758.28	3969.61	0	0
44	245.045	8757.89	3620.51	0	0
45	246.98	8757.53	3278.15	0	0
46	248.916	8757.19	2946.4	0	0
47	250.851	8756.87	2630.58	0	0
48	252.787	8756.58	2338.85	0	0
49	254.722	8756.31	2075.4	0	0
50	256.658	8756.07	1846.01	0	0
51	258.593	8755.84	0	0	0

Discharge Sections

Entity Information

Group 1

Shared Entities