Intermountain GeoEnvironmental Services, Inc.
2702 S 1030 W, Suite 10, South Salt Lake City, Utah, 84119
Phone (801) 270-9400 | Fax (801) 270-9401
www.igesinc.com

Geotechnical and Geologic Hazard Study

Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

IGES Project No. 01628-046

February 11, 2025

Prepared for:
Summit Mountain Holding Group

R01628-046

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Prepared by:

9325094-2250
02-11-2025
PETER ELI
DOUMIT
ELECTRONIC
SEAL

Peter E. Doumit, P.G., C.P.G.
Senior Geologist

No. 6370734
DAVID A.
GLASS
02-11-25
ELECTRONIC
SEAL

David Glass

David A. Glass, P.E.
Associate

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APPENDICES

1.0 EXECUTIVE SUMMARY

This report presents the results of a geotechnical and geologic hazard study performed for the proposed Shelter Hill-Townhomes, part of the greater Powder Mountain Resort located in Weber County, Utah. Based on the literature reviewed and the surficial and subsurface conditions encountered on the property, **it is our opinion that the property is suitable for the proposed development from a geologic hazard and geotechnical perspective provided that the recommendations presented in this report are incorporated into the design and construction of the project**. A brief summary of our most pertinent findings, conclusions, and recommendations are presented in the following paragraphs:

- **The Shelter Hill-Townhomes project area appears to have a semi-localized shallow groundwater hazard that is capable of adversely impacting the southwestern portion of the development, and possibly beyond that area during spring runoff. Outside of the shallow groundwater hazard, no other geologic hazards have been identified that are currently considered capable of adversely impacting the proposed development.**

- Five test pits were excavated at representative locations across the subject property to evaluate the subsurface materials and to assess the geologic conditions. These excavations were intended to supplement the subsurface data collected from test pits excavated within and near the proposed building envelope from the previous Shelter Hill geotechnical and geologic hazard investigation (IGES, 2024). The test pits were excavated to depths of between 7½ and 11½ feet below existing grade, and were between 40 and 44 feet long.

- In general, the subject property is mantled by one to three feet of topsoil or undivided topsoil/colluvium cover forming on weathered Wasatch Formation bedrock, which extended to the maximum depth of the exploration in all of the excavations. The Wasatch Formation in this area consists of loosely to weakly consolidated conglomerate bedrock that generally weathers and disaggregates into a pale yellowish orange to moderate reddish brown, clayey GRAVEL with sand (GC) grading to clayey SAND with gravel (SC) and sandy lean to fat CLAY with gravel (CL-CH), commonly with cobbles and boulders up to two feet in diameter. The clay-rich portions of the unit were commonly encountered in the test pits excavated in the southwestern part of the property, and rare in the other parts of the property.

- Earthquake ground shaking may potentially affect all parts of the project area, and is likely to be very strong to severe in the event of an earthquake along the Weber Segment of the Wasatch Fault Zone.

- Shallow groundwater was not encountered in any of the five test pits excavated for this study. However, shallow groundwater was encountered in four of the IGES (2024) test pits excavated on or immediately adjacent to the subject property, with groundwater seepage encountered as shallow as 4½ feet below the existing ground surface. This groundwater occurrence appears to be restricted to the southwestern portion of the project area. The shallow groundwater hazard risk is considered to be *high* in the vicinity of these test pits (delineated as the *shallow groundwater area* on Figure A-6), and *low* to *moderate* for the rest of the property.

- Slope stability modeling indicates that the existing natural slopes associated with the subject property are stable under static and seismic conditions, and no evidence of landslide deposits was observed on the property in the aerial imagery review, site reconnaissance, or in the subsurface as a part of this investigation. Given this data, the subject property is not anticipated to be adversely impacted by landslide hazards. However, given the presence of shallow groundwater conditions and the proximity to steep slopes, the landslide/mass-movement hazard risk is considered to be *low* to *moderate* for those townhomes located along the northern and eastern margins of the property, and *low* for the rest of the property.

- The geologic hazard risk associated with rockfall, surface-fault-rupture, liquefaction, debris-flow, and flooding hazards is considered to be low for the property.

Given the conclusions listed above, IGES makes the following recommendations:

- The townhomes are presumed to be on-grade structures (no basement); accordingly, seasonal shallow/perched groundwater may cause some difficulty during construction, but is not otherwise expected to impact the proposed improvements. If structures with a basement are planned, IGES should be contacted to provide guidance regarding foundation drainage.

- Once a final grading plan is established, IGES should complete a grading plan review; this review will likely include supplemental slope stability analysis that focuses on those townhomes that are closest to the prominent northern and eastern slopes. Such slope stability modeling may require additional subsurface investigation and/or laboratory testing to provide site-specific geologic conditions for a particular townhome.

- An engineering geologist should observe and document the foundation excavations for the proposed townhomes to assess whether the excavation has been taken to an appropriate depth and into suitable subsurface materials, to assess the subgrade preparation, and to further evaluate for evidence of adverse geologic conditions.

- Shallow spread or continuous wall footings constructed *entirely* on competent bedrock (Wasatch Formation), or *entirely* on a minimum of 2 feet of granular structural fill *overlying bedrock*, may be proportioned utilizing a maximum net allowable bearing pressure of **3,500 pounds per square foot (psf)** for dead load plus live load conditions. The net allowable bearing value presented above is for dead load plus live load conditions. The allowable bearing capacity may be increased by one-third for short-term loading (wind and seismic). The minimum recommended footing width is 20 inches for continuous wall footings and 30 inches for isolated spread footings.

- Boulders up to 2 feet in diameter were observed on the surface and within the test pits; as such, excavation of the basement level may generate an abundance of over-size material that may require special handling, processing, or disposal.

NOTICE: The executive summary is not intended to replace the information presented in the report, of which the executive summary is an essential part. The executive summary should not be used separately from the report and is only provided as an overview, to summarize the primary conclusions and recommendations. The executive summary may omit a number of details, any one of which could be crucial to the proper interpretation and application of the report and implementation of the recommendations.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical and geologic hazard study performed for the proposed Shelter Hill-Townhomes, part of the Shelter Hill Development area within the greater Powder Mountain Resort located in Weber County, Utah. The purpose of our investigation was to assess the nature and engineering properties of the subsurface soils at the project site and to provide recommendations for the design and construction of foundations, grading, and drainage. In addition, geologic hazards have been assessed for the property. The scope of work completed for this study included literature review, site reconnaissance, subsurface exploration, laboratory testing, engineering analyses, and preparation of this report.

Our services were performed in accordance with our proposal dated June 7, 2024, and your signed authorization. The recommendations presented in this report are subject to the limitations presented in the "Limitations" section of this report (Section 8.1).

2.2 PROJECT DESCRIPTION

The project site is located south of the eastern extension of Summit Pass Road, and just east of Shelby John Way within the Shelter Hill Development area of the Powder Mountain Resort (see Figure A-1, *Site Vicinity Map*, in Appendix A). As such, the property was evaluated in part by the geotechnical and geologic hazard study performed for the Shelter Hill Development (IGES, 2024). The subject property is located in an area that is largely densely vegetated; an existing two-track road passes eastward through the northern portion of the project site (see Figure A-2, *Aerial Image*). The site is located atop a northwest-southeast trending topographic ridge, whereby a northeast-trending ridge finger projects from the main ridge top; gentle slopes are present across the majority of the project, though the project area abuts steep slopes descending to the north and east (see Figure A-3, *Slope Map*).

Our understanding of the project is based largely on a preliminary architectural drawing set prepared by Hart Howerton for the Shelter Hill-Townhomes Concept, dated September 20, 2024 (see Figure A-4, *Site Plan*). It is our understanding that proposed improvements include 18 townhomes, a neighborhood amenity shack, as well as an upper terminal to the Hill Track ski lift. Access to the site is to be via a roadway that is to extend to the southeast from Shelby John Way and reconnect with Shelby John Way in the southern end of the project area. The project is in the early stages of development, and detailed grading plans have yet to be completed.

Construction plans were not available for our review; however, based on our experience with similar projects in the Powder Mountain resort area, we anticipate the townhomes and amenity shack to be on-grade structures (no basement). The upper ski lift terminal will presumably be supported on a large spread footing; the townhomes will likely be supported on conventional shallow spread footings and will have slab-on-grade flooring.

2.3 PREVIOUS WORK

The subject property was previously evaluated in part by IGES as part of a geotechnical and geologic hazard study for the Shelter Hill Development (IGES, 2024). Test pits SH-TP-14 through SH-TP-22 were excavated within or near the margins of the project area (see Figure A-2). A discussion of the findings from the IGES (2024) is provided in Section 4.2.2 of this report, and test pit logs and laboratory test data from the IGES (2024) study have been incorporated into this study.

3.0 METHODS OF STUDY

3.1 LITERATURE REVIEW

3.1.1 Geotechnical

IGES completed a geotechnical investigation for the Powder Mountain Resort expansion in 2012 (2012a, 2012b). Our previous work included twenty-two test pits and one soil boring excavated at various locations across the 200-acre development; as a part of this current study, the logs from relevant nearby test pits and other data from our reports were reviewed. In addition, Western Geologic (2012) completed a geologic hazard study for the greater 200-acre Powder Mountain expansion project – this report was reviewed to assess the potential impact of geologic hazards within the project area.

As noted above, IGES has performed several geotechnical and geologic hazard investigations across this portion of the greater Powder Mountain expansion project area. The subject project site is contained at least in part within one of these project areas, the Shelter Hill Development (across the project area and extending to the north and south; IGES, 2024). The IGES (2024) report provides the nearest subsurface data to the project site. The pertinent test pit logs, conclusions, and recommendations from these studies were reviewed and have been included, where applicable.

3.1.2 Geological

Several pertinent publications were reviewed as part of this assessment. This includes, but is not limited to, the following documents:

- Anderson, et al. (2023) provides 1:24,000 scale geologic mapping of the Brown’s Hole 7.5-Minute Quadrangle (see Figure A-5, *Regional Geology Map*).
- Coogan and King (2016) provides additional recent geologic mapping of the project area at a more regional (1:62,500) scale.
- Western Geologic (2012) conducted a reconnaissance-level geologic hazard study for the greater 200-acre Powder Mountain expansion project, though the study area boundary was located to the north and west of the subject property. The Western Geologic (2012) study modified some of the potential landslide hazard boundaries that had previously been mapped at a regional scale (1:100,000) by Coogan and King (2001) and Elliott and Harty (2010).
- The corresponding United States Geological Survey (USGS) topographic map for the Brown’s Hole 7.5-Minute Quadrangle (2023; see Figure A-1) provides physiographic and hydrologic data for the project area.

- Regional-scale geologic hazard maps pertaining to landslides (Elliott and Harty, 2010; Colton, 1991), faults (USGS and Utah Geological Survey (UGS), 2006), and liquefaction (Christenson and Shaw, 2008; Anderson et al., 1994) that cover the project area were also reviewed.
- The Quaternary Fault and Fold Database (USGS and UGS, 2006), was reviewed to identify the location of proximal faults that have had associated Quaternary-aged displacement.
- A site-specific geologic hazards assessment for the subject property was produced from the UGS Hazards Portal and reviewed (UGS, 2024a).

Stereo-paired aerial imagery for the project site taken from the UGS Aerial Imagery Collection (UGS, 2024b), recent and historic Google Earth imagery, and available lidar imagery was also reviewed to assist in the identification of potential adverse geologic conditions. The aerial photographs reviewed are documented in the *References* section of this report (Section 8.0).

3.2 SITE RECONNAISSANCE

A team of IGES engineering geologists conducted site reconnaissance and site-specific geologic mapping of the project area on October 11, 2024. The site reconnaissance was performed to evaluate the geologic conditions at the property, to field-verify features and/or potential geologic hazard areas identified in the literature and aerial imagery review, to map the local geology across the subject property, and to identify any existing geologic hazards associated with the property that need further evaluation with subsurface explorations. During our site reconnaissance the locations of the proposed test pits for the subsequent subsurface investigation were identified and staked. Figure A-6 is a *Geotechnical and Local Geology Map,* which illustrates the local geology based upon the results of the field mapping and subsurface explorations described in the following sections.

3.3 SUBSURFACE INVESTIGATION

Subsurface soils were investigated by IGES through the excavation of five test pits (TP-1 through TP-5) at representative locations across the project area on October 24 and 25, 2024. The approximate locations of the test pits are illustrated on Figures A-2, A-3, and A-6. The test pits were excavated to supplement the previous test pit data from the Shelter Hill (IGES, 2024) report (test pits SH-TP-14 through SH-TP-22).

The test pits were excavated with the aid of a John Deere 245P tracked excavator with a 3-foot bucket to depths between 7½ feet (TP-4) and 11½ feet (TP-1) below existing grade; the test pits were between 40 feet (TP-1, TP-3) and 44 feet (TP-2, TP-4, TP-5) long. The soil types were visually logged at the time of our fieldwork in general accordance with the *Unified Soil Classification System* (USCS). Soil classifications and descriptions are included on the test pit logs, Figures A-7 through A-11. The Shelter Hill SH-TP-14 through SH-TP-22 logs from the IGES (2024) study have also been included as Figures A-12 through A-20. A key to USCS symbols and terminology is included as Figure A-21, and a key to physical rock properties is included as Figure A-22. Select test pit photos are presented as Figure A-23. A complete photographic record is available upon request. Upon completion of the logging of the test pits, the excavations were backfilled without engineered compaction controls and re-graded as close to original grade as possible.

Soil sampling was completed to collect representative samples of the various soil and lithologic units observed across the property. Disturbed samples were placed in plastic bags or buckets, and all samples were transported to the IGES laboratory to evaluate the engineering properties of the various earth materials observed.

3.4 LABORATORY TESTING

Samples retrieved during the subsurface investigation were transported to the IGES laboratory for evaluation of engineering properties. Also, relevant laboratory tests completed for the greater Shelter Hill project were also reviewed (IGES, 2024). Specific laboratory tests included:

- Moisture Content (D2216)
- Atterberg Limits (ASTM D4318)
- Modified Proctor (ASTM D1557)
- Direct Shear (ASTM D3080)
- Grain-Size Distribution (ASTM D6913)
- Fines Content (ASTM D1140)
- California Bearing Ratio (CBR) (ASTM D1883)
- Corrosion Suite (pH, soluble sulfate, soluble chloride, resistivity)

Results of the laboratory testing are discussed in this report and presented in Appendix B. Some test results, including moisture content, gradation, and Atterberg Limits, have been incorporated into the test pit logs (Figures A-7 through A-20).

3.5 SLOPE STABILITY MODELING

Utilizing the subsurface and laboratory data gathered from this investigation, two representative geologic cross-sections (Sections A-A’ and B-B’) were developed to assess the stability of the prominent descending slopes beyond the northern and eastern reaches of the property. The locations of the cross-sections are shown in plan-view on

Figures A-3 and A-6 and the respective geologic cross-sections are presented on Figure D-1 in Appendix D. The results of the slope stability modeling are found in Appendix D and are discussed in detail in Section 5.0 of this report.

4.0 GEOLOGIC CONDITIONS

4.1 GENERAL GEOLOGIC SETTING

4.1.1 Regional Geology

The subject property is situated in the western portion of the northern Wasatch Mountains, approximately 4½ miles north of Ogden Valley. Ogden Valley separates the western part of the Wasatch Range from the Bear River Range to the east, a subgroup of mountains that are part of the parent Wasatch Range. The Wasatch Mountains contain a broad depositional history of thick Precambrian and Paleozoic sediments that have been subsequently modified by various tectonic episodes that have included thrusting, folding, intrusion, and volcanics, as well as scouring by glacial and fluvial processes (Stokes, 1987). The uplift of the Wasatch Mountains occurred relatively recently during the Late Tertiary Period (Miocene Epoch) between 12 and 17 million years ago (Milligan, 2000).

The Wasatch Mountains, as part of the Middle Rocky Mountains Province (Milligan, 2000), were uplifted as a fault block along the Wasatch Fault (Hintze, 1988). Ogden Valley itself is a fault-bounded trough that has been partially filled by Tertiary-aged sediments (Wasatch Formation) and volcaniclastic rocks (Norwood Formation), and was occupied by Lake Bonneville until the Bonneville Flood and subsequent lake-level drop to the Provo Shoreline around 18,000 years ago (Oviatt, 2015). The valley was later cut through by the Ogden River, which was subsequently dammed in 1937 as a part of the *Ogden River Project* to form Pineview Reservoir.

4.1.2 Seismotectonic Setting

The Wasatch Fault and its associated segments are part of an approximately 230-mile-long zone of active normal faulting referred to as the Wasatch Fault Zone (WFZ), which has well-documented evidence of late Pleistocene and Holocene (though not historic) movement (Lund, 1990; Hintze, 1988). The faults associated with the WFZ are all normal faults, exhibiting block movement down to the west of the fault and up to the east. The WFZ is contained within a greater area of active seismic activity known as the Intermountain Seismic Belt (ISB), which runs approximately north-south from northwestern Montana, along the Wasatch Front of Utah, through southern Nevada, and into northern Arizona. In terms of earthquake risk and potential associated damage, the ISB ranks only second in North America to the San Andreas Fault Zone in California (Stokes, 1987).

The WFZ consists of a series of ten segments of the Wasatch Fault that each display different characteristics and past movement, and are believed to have movement independent of one another (Wong et al., 2016). The subject property is located approximately 10.6 miles northeast of the Weber Segment of the Wasatch Fault, which is the closest documented Holocene-aged (active) fault to the property and trends north-south along the Wasatch Front (USGS and UGS, 2006).

4.2 SURFICIAL GEOLOGY FROM LITERATURE

4.2.1 Published Literature

Coogan and King (2016) map the property to be entirely underlain by Wasatch Formation bedrock, with nearby bedding attitudes indicating the bedrock to be striking north-northeast and dipping at between 3 and 5 degrees to the east-southeast. A lobe of undivided glacial deposits are mapped on the steep slopes just north of the project site, and undivided mass-movement and colluvial deposits are mapped on the steep slopes just east of the project site.

Most recently, Anderson, et al. (2023; see Figure A-5) map the property similarly to be entirely underlain by Wasatch Formation bedrock (map unit Tw). Consistent with Coogan and King (2016), a lobe of undivided mass-movement and colluvial deposits (map unit Qmc) is mapped on the steep slopes east of the project site. Near the base of the steep slopes to the north of the property, undivided alluvium and colluvium is mapped (map unit Qac). A large south-trending lobe of colluvial deposits (map unit Qc) is mapped approximately 175 feet southwest of the property. Notably, two large glacial cirques[1] (shown as hachured blue semi-circles) are shown to correspond to the steep slopes just north and east of the subject property boundary.

The Wasatch Formation (map unit Tw) is described as an Eocene to Paleocene-aged "Moderate reddish-orange to pale yellowish-orange, cobble to boulder conglomerate with varying amounts of mudstone and sandstone; forms cobble- and boulder-strewn slopes but does not crop out; unconsolidated to consolidated claystone, sandstone, limestone, and dolomite reported in lithologic logs from water wells… clasts are tan, gray, purple, and green quartzite and well-indurated sandstone…deposited over considerable paleotopography…0 to over 2000 feet (0-610+ m) thick" (Anderson et al., 2023).

The undivided mass-movement and colluvial deposits (map unit Qmc) are described as Holocene to Middle Pleistocene?-aged "Poorly sorted to unsorted, mostly clay, silt, sand, gravel, cobbles, and boulders; angular to rounded clasts; non-bedded; mapped on slopes where individual landslide, slumps, slopewash, and soil creep are difficult to distinguish from one another; often characterized by hummocky slopes composed of numerous

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[1] **Cirque**: A deep steep-walled half-bowl-like recess or hollow, variously described as horseshoe- or crescent-shaped or semicircular in plan, situated high on the side of a mountain and commonly at the head of a glacial valley, and produced by the erosive activity of a mountain glacier. It often contains a small round lake, and it may or may not be occupied by ice or snow (AGI, 2005).

slumps of various sizes and ages; includes soil creep, talus, slopewash, and debris-flow deposits but lacks clear landslide scarps and lateral margins to allow separate mapping; typically forms on slopes overlying clay-bearing, landslide-prone bedrock units; 0 to 40 feet (0-12 m) thick" (Anderson et al., 2023).

The undivided alluvial and colluvial deposits (map unit Qac) are described as Holocene to Late Pleistocene?-aged "Unsorted to variably sorted silt, sand, gravel, clay, cobbles, and boulders in variable proportions and roundness; includes stream and fan alluvium, colluvium, sheetwash deposits, and locally mass-movement deposits that are too small to map separately at map scale; typically mapped along drainages bounded by hillslopes where colluvium grades into alluvium without distinct break in slope and in smaller drainages lacking flat bottoms or too small to subdivide at map scale; 0 to 20 feet (0-6 m) thick" (Anderson et al., 2023).

The colluvial deposits (map unit Qc) are described as Holocene to Late Pleistocene?-aged "Poorly sorted silt, sand, gravel, clay, cobbles, and boulders; angular to subangular clasts; rounded clasts derived from Tertiary Wasatch Formation (Tw) are common; massive to poorly bedded; composition depends on local bedrock source; mapped on moderate to steep slopes; includes slopewash and soil creep deposits and may include local mass-movement and talus deposits; includes residual deposits developed on Wasatch Formation; 6 to 50 feet (2-15 m) thick" (Anderson et al., 2023).

4.2.2 Site-Specific Studies

For the IGES (2024) *Shelter Hill Development* study, test pits SH-TP-14 through SH-TP-22 were excavated across or adjacent to the project site (see Figure A-2). These test pits encountered up to three feet of a mixed topsoil/colluvial unit overlying weathered Wasatch Formation that extended to the maximum depth of exploration in the test pits (see the corresponding test pit logs, Figures A-12 through A-20). In these test pits, the weathered Wasatch Formation was generally observed to be comprised of a moderate reddish brown to moderate reddish orange clayey gravel with sand, clayey sand with gravel, and sandy lean clay with gravel. In the southern test pits (SH-TP-21 and SH-TP-22), the unit was observed to consist of two subunits: an upper sandy fat clay with gravel, and a lower clayey gravel with sand grading to clayey sand with gravel. Notably, groundwater was encountered in SH-TP-18 through SH-TP-21 at depths of between 4½ and 7 feet below existing grade. No other adverse geologic conditions encountered.

4.3 HYDROLOGY

The USGS 7.5-minute topographic map for the Brown's Hole Quadrangle (2023; see Figure A-1) indicates that the project area is situated on a topographic high, with steep slopes descending to the north and east. No active or intermittent drainages are shown to be passing through the property, and no drainages were observed on the property during the site reconnaissance.

The FEMA flood map that covers the project area was not printed due to the entire region covered in the map as being located in Zone X, corresponding to being located outside of the 500-year flood floodplain for any nearby drainage (FEMA, 2015).

Baseline groundwater depths for the project area are currently unknown, but are anticipated to fluctuate both seasonally and annually. No springs are mapped on the property, and hydrophilic vegetation indicative of shallow groundwater conditions was not observed on or near the subject property during site reconnaissance. Groundwater was not encountered in the five test pits excavated for this study, though shallow groundwater seepage was encountered in SH-TP-18 through SH-TP-22 between the depths of 4½ and 7 feet below existing grade in the IGES (2024) study. Notably, these test pits are located near the southwestern margin of the subject project area, and were included in an identified *shallow groundwater zone* that extended to the southeast from SH-TP-18 and SH-TP-19 (as shown on Figure A-6).

4.4 GEOLOGIC HAZARDS FROM LITERATURE

Based upon the available geologic literature, regional-scale geologic hazard maps that cover the subject property have been produced for landslide, fault, debris-flow, and liquefaction hazards. The following is a summary of the data presented in these regional geologic hazard maps as well as other source data.

4.4.1 Landslides

Two regional-scale landslide hazard maps have been produced that cover the project area. Colton (1991) maps a northeast-trending landslide lobe north and east of the project area and just downslope of the location of the glacial cirques. Elliott and Harty (2010) map the same landslide lobe as Colton (1991), but identify the deposits as “landslide undifferentiated from talus, colluvial, rock-fall, glacial, and soil-creep deposits.” Coogan and King (2016) map distinct lobes north and east of the property, with the northern lobe identified as undivided glacial deposits, and the eastern lobe identified as undivided landslide and colluvial deposits (Qmc). Anderson et al. (2023; see Figure A-5) show glacial cirques to the north and east of the subject property, and map undivided mass-movement and colluvial deposits downslope of the cirque to the east and undivided alluvial and colluvial deposits downslope of the cirque to the north.

Landslide deposits or evidence of shearing were not observed in any of Shelter Hill (IGES, 2024) test pits excavated on or near the property.

4.4.2 Faults

The Quaternary Fault and Fold Database of the United States (USGS and UGS, 2006) does not show any Quaternary-aged (~2.6 million years ago to the present) faults to be present on or projecting towards the subject property. The Weber County Natural Hazards Overlay Districts defines an *active fault* to be "a fault displaying evidence of greater than four inches of displacement along one or more of its traces during Holocene time (about 11,000 years ago to the present)" (Weber County, 2015). The closest active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 10.6 miles southwest of the western margin of the property (USGS and UGS, 2006).

4.4.3 Debris Flows

Elliott and Harty (2010) do not indicate any debris-flow paths on or near the property, and Anderson et al. (2023) do not map any young alluvial fan deposits on the property.

4.4.4 Liquefaction

Anderson, et al. (1994) and Christenson and Shaw (2008) both show the project area to be located in an area designated as having a *very low* potential for liquefaction.

4.5 REVIEW OF AERIAL IMAGERY

A series of aerial photographs that cover the project area were taken from the UGS Aerial Imagery Collection (UGS, 2024b) and analyzed stereoscopically for the presence of adverse geologic conditions across the property. This included a review of photos collected from the years 1946, 1952, and 1963. A table displaying the details of the aerial photographs reviewed can be found in the *References* section at the end of this report.

No geologic lineaments, fault scarps, landslide headscarps, or landslide deposits were observed in the aerial photography on the subject property. However, the bowl-shaped cirques mapped along the steep slopes north and east of the property were readily evident in the imagery.

Google Earth imagery of the property from between the years of 1993 and 2024 was also reviewed. No landslides or other geological hazard features were noted on the property in the imagery. In the 1993 imagery, the property was observed to be in its native state and largely covered in dense tree vegetation. The property appeared to remain largely unchanged between 1993 and 2014, when a southeast-trending bike trail was observed to have been cut in near the western margin of the property, and a two-track road had been cut in across the northern portion of the property, extending to the east from Shelby John Way and terminating near the eastern margin (see Figure A-2). The project area appears to have remained largely unchanged from 2014 to the present time, though a warming hut was observed to have been constructed immediately east of Shelby John Way near the southwestern margin of the property in the 2023 imagery.

Utah Geological Survey (UGS) 2015-2017 State of Utah lidar data that covers the project area was also reviewed. No evidence of landslides was observed within the property boundaries in the imagery. Irregular, hummocky topography was observed downslope of the cirque to the east of the property, though hummocky topography was not observed downslope of the cirque to the north of the property.

4.6 LOCAL GEOLOGY FROM SITE RECONNAISSANCE

A team of IGES geologists conducted reconnaissance of the site and the surrounding area on October 11, 2024, to supplement the site reconnaissance previously performed for the IGES (2024) study. At the time of the site reconnaissance, the property was observed to be generally gently sloping downhill to the east and northeast across the property. Dense vegetation in the form of aspen and pine trees and tall grasses were observed throughout the property. Surficial soils appeared to be weathered Wasatch Formation, consisting of a moderate reddish brown sandy lean CLAY with gravel (CL) and clayey SAND with gravel (SC). In some places, the surficial soils were largely clast-poor and heavily burrowed. In other places, common 1- to 2-inch diameter subrounded to subangular quartzite clasts[2] were observed scattered across the surface of the property.

No springs, seeps, or running water were observed on the property at the time of the site visit. No surface expression of landslides or other geologic hazards was observed on the property during the site reconnaissance.

4.7 LOCAL GEOLOGY FROM SUBSURFACE INVESTIGATION

On October 24 and 25, 2024, five test pits were excavated throughout the project area in the vicinity of the proposed townhomes (see Figure A-4). Detailed logs for the test pits from this study are presented as Figures A-7 through A-11, with the relevant test pit logs from the previous study (IGES, 2024) presented as Figures A-12 through A-20. Select test pit photos are presented in Figure A-23.

Subsurface earth materials were found to be consistent with the Coogan and King (2016) and Anderson et al. (2023) mapping and the IGES (2024) study, comprised largely of a thin

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[2] Clast: An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical or chemical disintegration or a larger rock mass. (AGI, 2005)

topsoil/colluvium cover overlying weathered Wasatch Formation conglomerate bedrock. The soil and moisture conditions encountered during our investigation are discussed in the following paragraphs.

4.7.1 Earth Materials

A/B Soil Horizon Topsoil and Colluvium (Qc): This topsoil unit was found to be present in all test pits, measured to range from 1 to 3 feet thick. Commonly, this unit was poorly developed and often difficult to distinguish from a thin colluvial cover upon which the topsoil had formed. In general, the unit was observed to be a grayish brown to brownish black to brownish gray, loose to medium dense, dry to slightly moist, clayey SAND with gravel (SC) grading to sandy lean CLAY with gravel (CL). Gravel and larger-sized subrounded to subangular quartzite clasts comprised between approximately 20% and 40% of the unit, and were up to 2 feet in diameter, though most commonly 1 to 4 inches in diameter. This unit contained an abundance of plant and tree roots, and commonly exhibited a stone line along the basal contact.

Wasatch Formation (Tw): This unit was encountered and extended to the maximum depth of exploration in all of the test pits, being at least 9½ feet thick. The unit generally consisted of highly weathered, loosely consolidated conglomerate, sandstone, and mudstone bedrock that had disaggregated in places to two interbedded subunits. In general, the unit consisted of a pale yellowish orange to moderate reddish brown to moderate reddish orange, loose to medium dense to dense, dry to slightly moist, massive to weakly bedded clayey GRAVEL with sand (GC) grading to clayey SAND with gravel (SC) and sandy lean to fat CLAY with gravel (CL-CH). Gravel and larger-sized subrounded to subangular quartzite clasts comprised up to 75% of the unit, with individual clasts up to two feet in diameter, though the mode clast size was commonly 1 to 4 inches in diameter in a wide range of clast sizes. The clay-rich portions of the unit were commonly encountered in the test pits excavated in the southwestern part of the property, and rare in the other parts of the property.

4.7.2 Groundwater

Groundwater was not encountered in any of the test pits excavated for this investigation, excavated to depths of up to 11½ feet below existing grade (and potholed to up to 13½ feet below existing grade). However, groundwater was encountered in the IGES (2024) test pits SH-TP-18 through SH-TP-21 excavated within or adjacent to the southwestern portion of the project area. In these test pits, the groundwater was encountered between the depths of 4½ and 7 feet below existing grade, and commonly resulted in the filling of the test pits.

4.7.3 Strength of Earth Materials

To assess the representative strength of near-surface earth materials, three direct shear tests (ASTM D3080) were performed on representative specimens of the prevailing Wasatch Formation conglomerate bedrock. All direct shear tests were performed under drained conditions; also, all tests were performed on specimens remolded to approximately 93% of the maximum dry density per ASTM D1557 (the specimens were too coarse to be sampled with a brass tube). The test results are summarized in Table 4.7.3; detailed test results are presented in Appendix B.

Table 4.7.3
Summary of Direct Shear Test Results (Tw)

Sample Location	Depth (ft)	USCS	γ_m/γ_{sat} (pcf)	Cohesion (psf)	Friction Angle (deg.)	Notes
TP-2	6.0	GC	124.9/ 134.1	33	47	G:54.0% S:28.7% F:17.3%
TP-3	7.5	GC	129.6/ 138.7	556	40	G:59.1% S:26.8% F:14.2%
TP-5	7.5	GC	127.0/ 135.6	309	43	G:45.1% S:31.2% F:23.7%

4.8 SEISMICITY

Following the criteria outlined in the 2021 International Building Code (IBC, 2021), which references ASCE-7-16, spectral response at the site was evaluated for the risk-targeted *Maximum Considered Earthquake* (MCE_R), which represents the spectral response accelerations in the direction of maximum horizontal response represented by a 5% damped acceleration response spectrum that equates to a 1% probability of building collapse within a 50-year period. The MCE_R spectral accelerations were determined based on the location of the site using the *ASCE-7 Hazard Tool*; this software incorporates seismic hazard maps depicting probabilistic ground motions and spectral response data developed for the United States by the U. S. Geological Survey. These maps have been incorporated into the *International Building Code* (IBC) (International Code Council, 2021).

To account for site effects, site coefficients that vary with the magnitude of spectral acceleration and *Site Class* are used. Site Class is a parameter that accounts for site amplification effects of soft soils and is based on the average shear wave velocity of the upper 100 feet (30 meters, Vs_{30}); site classifications are identified in Table 4.8a.

Table 4.8a
Site Class Categories

Site Class	Earth Materials	Shear Wave Velocity Range (Vs_{30}) m/s
A	Hard Rock	>1,500
B	Rock	760-1,500
C	Very Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Soil	<180
F	Special Soils Requiring Site-Specific Evaluation (e.g., liquefiable)	n/a

Based on our field exploration and understanding of the geology in this area, the site is underlain by weathered Wasatch Formation bedrock, and would likely classify as Site Class C or possibly B. However, lacking site-specific shear wave velocity measurements, IBC requires a conservative approach, thus Site Class C has been assumed (very dense soil or soft rock). Based on the Site Class C site coefficients, the short- and long-period *Design Spectral Response Accelerations* are presented in Table 4.8b. For geotechnical practice, the geo-mean peak ground acceleration (PGA_M)[3] is presented in Table 4.8c.

Table 4.8b
Spectral Accelerations for MCE_R, Risk-Targeted Values (Structural)

Mapped B/C Boundary S_a (g)		Site Coefficient (Site Class C)		Design Sa (g)	
Ss	S_1	F_a	F_v	S_{DS}	S_{D1}
0.792	0.273	1.2	1.5	0.633	0.273

1) T_L=8

Table 4.8c
Spectral Accelerations for MCE, Geo-Mean (2PE50) Values (Geotechnical)

Mapped B/C Boundary PGA (g)	Site Coefficient F_{PGA} (Site Class C)	PGA_M (g)
0.345	1.2	0.414

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[3] The PGA_M is based on a uniform hazard approach and represents the probabilistic PGA with a 2% probability of exceedance in a 50-year period (2PE50) (as opposed to the risk-targeted MCE_R, which is based on a uniform risk approach).

4.9 SLOPE STABILITY

The stability of the prevailing east-facing and north-facing slopes have been assessed in accordance with methodologies set forth in Blake et al. (2002) with respect to two representative geologic cross-sections – Sections A-A’ and B-B’, illustrated on Figure D-1 in Appendix D (the sections are identified in plan-view on Figures A-3 and A-6). The stability of the slopes were modeled using SLIDE, a computer application incorporating (among others) Spencer’s Method of analysis. Calculations for stability were developed by searching for the minimum factor of safety for a rotational-type failure occurring through the prevailing Wasatch Formation. Analysis was performed for both static and seismic (pseudo-static) cases.

Strength of earth materials were assessed based primarily on the results of laboratory testing, with due consideration given to our experience with critical geologic units in other parts of the greater Powder Mountain Resort. For shallow geologic units located well beyond the project site (that generally have little or no impact to slope stability), engineering characteristics were estimated based on our experience in other parts of the greater Powder Mountain project area. A summary of selected engineering parameters is presented in Table 4.9a.

Table 4.9a
Engineering Parameters for Geologic Units

Geologic Unit	Moist Unit Weight (γ_m) (pcf)	Effective Friction Angle (ϕ’) (deg.)	Cohesion (c’) (psf)
Wasatch Formation (Tw)	130	40	200
Undivided Mass-Movement/Colluvial (Qmc)	125	31	200
Glacial Deposits (Qgp)	125	34	100
Undivided Alluvium/Colluvium (Qac)	125	31	200

Groundwater, e.g., a potentiometric groundwater surface, was not encountered during our subsurface investigation, although localized perched groundwater conditions were identified in the area delineated on Figure A-6. However, this shallow/perched groundwater is thought to occur largely on the flatter parts of the project area (along the top of the ridge), and therefore is not expected to have a meaningful impact to the global stability. Accordingly, groundwater was not modeled in our limit-equilibrium analysis.

Pseudo-static (seismic screening) analysis of the existing slopes was performed in general conformance with Blake et al. (2002). The design seismic event was taken as the ground motion with a 2 percent probability of exceedance in 50 years (2PE50). Based on information provided by the ASCE-7-16 *Seismic Hazard Tool*, the geometric mean Peak Ground Acceleration (PGA_M) associated with a 2PE50 event is estimated to be 0.414g. Half of the PGA, (0.207g), was taken as the horizontal seismic coefficient (k_h) (Hynes and Franklin, 1984), and used in the pseudo-static seismic screen analysis.

Our analysis indicates that the static and seismic factors of safety meet or exceed the generally accepted minimum values of 1.5 and 1.0, respectively. Accordingly, the prominent descending slopes to the east and north of the project area are expected to remain stable from a global stability standpoint during the lifespan of the project. A summary of our slope stability analysis is presented in Table 4.9b; detailed analysis results are presented in Appendix D.

Table 4.9b
Summary of Slope Stability Analysis

Section	Factor of Safety	
	Static	Seismic
A-A’	2.54	1.58
B-B’	1.93	1.20

5.0 GEOLOGIC HAZARD ASSESSMENT

Geologic hazard assessments are necessary to determine the potential risk associated with particular geologic hazards that are capable of adversely affecting a proposed development area. As such, they are essential in evaluating the suitability of an area for development and provide critical data in both the planning and design stages of a proposed development. The geologic hazard assessment discussion below is based upon a qualitative assessment of the risk associated with a particular geologic hazard, based upon the data reviewed and collected as part of this investigation.

A "low" hazard rating is an indication that the hazard is either absent, is present in such a remote possibility so as to pose limited or little risk or is not anticipated to impact the project in an adverse way. Areas with a low-risk determination for a particular geologic hazard do not require additional site-specific studies or associated mitigation practices with regard to the geologic hazard in question.

A "moderate" hazard rating is an indication that the hazard has the capability of adversely affecting the project at least in part, and that the conditions necessary for the geologic hazard are present in a significant, though not abundant, manner. Areas with a moderate-risk determination for a particular geologic hazard may require additional site-specific studies, depending on location and construction specifics, as well as associated mitigation practices in the areas that have been identified as the most prone to susceptibility to the particular geologic hazard.

A "high" hazard rating is an indication that the hazard is very capable of adversely affecting or currently does adversely affect the project, that the geologic conditions pertaining to the particular hazard are present in abundance, and/or that there is geologic evidence of the hazard having occurred at the area in the historic or geologic past. Areas with a high-risk determination always require additional site-specific hazard investigations and associated mitigation practices where the location and construction specifics are directly impacted by the hazard. For areas with a high-risk geologic hazard, simple avoidance is often considered.

The following is a summary of the geologic hazard assessment for the project site.

5.1 LANDSLIDES/MASS-MOVEMENT

The project site does not have landslide deposits mapped on any part of the property (Elliott and Harty, 2010; Coogan and King 2016; Anderson et al., 2023). Evidence of landsliding was not observed on the property in the aerial imagery review, site reconnaissance, or in the subsurface as part of this investigation.

Slope stability modeling performed as part of this investigation demonstrates that natural slopes will be stable under static and seismic conditions (see Section 4.9). Given this data, the subject property is not anticipated to be adversely impacted by landslide hazards. However, given the presence of shallow groundwater conditions and the proximity to steep slopes, the landslide/mass-movement hazard risk is considered to be *low* to *moderate* for the townhomes to be located along the northern and eastern margins of the property, and *low* for the rest of the property.

5.2 ROCKFALL

The subject property is on a topographic high, and no bedrock outcrops are exposed upslope of the property. As such, the rockfall hazard risk associated with the property is considered to be *low*.

5.3 SURFACE-FAULT-RUPTURE AND EARTHQUAKE-RELATED HAZARDS

No faults are known to be present on or project across the property, and the closest active fault to the property is the Weber Segment of the Wasatch Fault Zone, located approximately 10.6 miles to the southwest of the property (USGS and UGS, 2006). Given this information, the risk associated with surface-fault-rupture on the property is considered *low*.

The entire property is subject to earthquake-related ground shaking from a large earthquake generated along the active Wasatch Fault. Given the distance from the Wasatch Fault, the hazard associated with ground shaking is considered to be very strong to severe (UGS, 2024a). Proper building design according to appropriate building code and design parameters can assist in mitigating the hazard associated with earthquake ground shaking.

5.4 LIQUEFACTION

Soil liquefaction results from loss of strength due to the rapid buildup of pore water pressure during cyclic loading, such as imposed by earthquakes. Soil most susceptible to liquefaction are clean, loose, saturated, and uniformly graded sand below the water table, whereas earth materials consisting of cohesive clay, dense sand/gravel, and bedrock are generally considered not susceptible to liquefaction. Effects of liquefaction can include surficial sand boils, settlement, bearing capacity failures, and lateral spreading.

The site is underlain by Wasatch Formation conglomeratic bedrock, a weathered but still largely competent sedimentary rock unit that is anticipated to increase in competency with depth. Rock units such as these are not considered susceptible to liquefaction. Additionally, shallow groundwater was not encountered in the subsurface. As such, and consistent with the published literature, the potential for liquefaction occurring at the site is considered *low*.

5.5 DEBRIS-FLOWS AND FLOODING HAZARDS

Debris-flows typically deposit on existing alluvial fans located at the mouth of active canyons, while flooding typically occurs in drainage channels and lowland areas within a drainage basin. Anderson et al. (2023) does not map any young alluvial fans on the subject property, nor were young alluvial fan deposits observed during the site reconnaissance or subsurface investigation. Given this information, the debris-flow hazard risk is considered to be *low* for the property.

The property is located on a topographic high, and no drainages are present on or adjacent to the property. Given this data, the flood hazard risk is considered to be low.

5.6 SHALLOW GROUNDWATER

Groundwater was not encountered in any of the five test pits excavated across the property in this investigation, excavated across the eastern portion of the project area and in late October when the groundwater level was likely decreasing to its annual low level. However, groundwater was encountered in four of the other test pits excavated across or near the southwestern portion of the property in the IGES (2024) study, excavated in late June when the groundwater level was likely to be at or near its annual high level. The shallow groundwater hazard area in the southwestern portion of the property is identified on Figure A-6.

Given the existing data, it is expected that groundwater levels will fluctuate both seasonally and annually, and the risk associated with shallow groundwater hazards is considered to be *high* in the delineated *shallow groundwater area* on Figure A-6, and *low* to *moderate* for the rest of the property. Spring thaw and runoff are likely to significantly contribute to elevated groundwater conditions (including possibly localized perched conditions), and the identified shallow groundwater hazard area may expand to other parts of the project area during these times.

6.0 GEOLOGIC CONCLUSIONS AND RECOMMENDATIONS

6.1 GEOLOGIC HAZARD CONCLUSIONS

Based upon the data collected and reviewed as part of this investigation, IGES makes the following conclusions regarding the geologic hazards present across the property:

- **The Shelter Hill-Townhomes project area appears to have a semi-localized shallow groundwater hazard that is capable of adversely impacting the southwestern portion of the development, and possibly beyond that area during spring runoff. Outside of the shallow groundwater hazard, no other geologic hazards have been identified that are currently considered capable of adversely impacting the proposed development, and the property is considered suitable for the proposed development from a geologic hazard perspective.**

- Five test pits were excavated at representative locations across the subject property to evaluate the subsurface materials and to assess the geologic conditions. These excavations were intended to supplement the subsurface data collected from test pits excavated within and near the proposed building envelope from the previous Shelter Hill geotechnical and geologic hazard investigation (IGES, 2024). The test pits were excavated to depths of between 7½ and 11½ feet below existing grade, and were between 40 and 44 feet long.

- In general, the subject property is mantled by one to three feet of topsoil or undivided topsoil/colluvium cover forming on weathered Wasatch Formation bedrock, which extended to the maximum depth of the exploration in all of the excavations. The Wasatch Formation in this area consists of loosely to weakly consolidated conglomerate bedrock that generally weathers and disaggregates into a pale yellowish orange to moderate reddish brown, clayey GRAVEL with sand (GC) grading to clayey SAND with gravel (SC) and sandy lean to fat CLAY with gravel (CL-CH), commonly with cobbles and boulders up to two feet in diameter. The clay-rich portions of the unit were commonly encountered in the test pits excavated in the southwestern part of the property, and rare in the other parts of the property.

- Earthquake ground shaking may potentially affect all parts of the project area, and is likely to be very strong to severe in the event of an earthquake along the Weber Segment of the Wasatch Fault Zone.

- Shallow groundwater was not encountered in any of the five test pits excavated for this study. However, shallow groundwater was encountered in four of the IGES (2024) test pits excavated on or immediately adjacent to the subject property, with groundwater seepage encountered as shallow as 4½ feet below the existing ground surface. This groundwater occurrence appears to be restricted to the southwestern portion of the project area. The shallow groundwater hazard risk is considered to be high in the vicinity of these test pits (delineated as the *shallow groundwater area* on Figure A-6), and low to moderate for the rest of the property.

- Slope stability modeling indicates that the existing natural slopes associated with the subject property are stable under static and seismic conditions, and no evidence of landslide deposits was observed on the property in the aerial imagery review, site reconnaissance, or in the subsurface as a part of this investigation. Given this data, the subject property is not anticipated to be adversely impacted by landslide hazards. However, given the presence of shallow groundwater conditions and the proximity to steep slopes, the landslide/mass-movement hazard risk is considered to be *low* to *moderate* for those townhomes located along the northern and eastern margins of the property, and low for the rest of the property.

- The geologic hazard risk associated with rockfall, surface-fault-rupture, liquefaction, debris-flow, and flooding hazards is considered to be *low* for the property.

6.2 GEOLOGIC HAZARD RECOMMENDATIONS

Given the findings of this study, IGES recommends the following:

- The townhomes are presumed to be on-grade structures (no basement); accordingly, seasonal shallow/perched groundwater may cause some difficulty during construction, but is not otherwise expected to impact the proposed improvements. If structures with a basement are planned, IGES should be contacted to provide guidance regarding foundation drainage.

- Once a final grading plan is established, IGES should complete a grading plan review; this review will likely include supplemental slope stability analysis that focuses on those townhomes that are closest to the prominent northern and eastern slopes. Such slope stability modeling may require additional subsurface investigation and laboratory testing to provide site-specific geologic conditions for a particular townhome.

- An engineering geologist should observe and document the foundation excavations for the proposed Shelter Hill-Townhomes to assess whether the excavation has been taken to an appropriate depth and into suitable subsurface materials, to assess the subgrade preparation, and to further evaluate for evidence of adverse geologic conditions.

7.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

7.1 GENERAL CONCLUSIONS

Based on the results of the field observations and literature review, **the subsurface conditions are considered suitable for the proposed development provided that the recommendations presented in this report are incorporated into the design and construction of the project.**

Supporting data upon which the following conclusions and recommendations are based have been presented in the previous sections of this report. The recommendations presented herein are governed by the physical properties of the earth materials encountered in the subsurface explorations. If subsurface conditions other than those described herein are encountered in conjunction with construction, and/or if design and layout changes are initiated, IGES must be informed so that our recommendations can be reviewed and revised as necessary.

7.2 EARTHWORK

Prior to the placement of foundations and pavement, general site grading is recommended to provide proper support for foundations, exterior concrete flatwork, and concrete slabs-on-grade. Site grading is also recommended to provide proper drainage and moisture control on the subject property.

7.2.1 General Site Preparation and Grading

Below proposed structures, fills, retaining walls, and other man-made improvements, all vegetation, topsoil, debris, frozen soil, and undocumented fill (if any) should be removed. Any existing utilities should be re-routed or protected in place. All excavation bottoms should be observed by an IGES representative prior to placement of structural fill or construction of footings to evaluate whether soft, loose, or otherwise deleterious earth materials have been or need to be removed, and to assess whether the recommendations presented in this report have been implemented.

7.2.2 Excavations

Soft, loose, or otherwise unsuitable soils beneath structural elements, hardscape or pavements may need to be over-excavated and replaced with structural fill. Where over-excavation is required, the excavations should extend ½ foot laterally for every foot of depth of over-excavation. Excavations should extend laterally at least two feet beyond flatwork, pavements, and slabs-on-grade. Structural fill should consist of granular materials and should be placed and compacted in accordance with the recommendations presented in this report.

Prior to placing structural fill, loose soils should either be removed or compacted until relatively firm. Compaction of the exposed native subgrade should be completed with *compaction equipment* (e.g., vibratory drum roller, wheel-rolling with heavy rubber-tired equipment, etc.). Compacting by means of “track-walking” with tracked earth-moving equipment, or by ‘tamping’ with an excavator bucket is not considered acceptable as a means of soil compaction.

7.2.3 Temporary Excavation Stability

The contractor is responsible for site safety, including all temporary slopes and trenches excavated at the site and design of any required temporary shoring. The contractor is responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Soil types are expected to consist primarily of *Type C* soils (generally cohesionless sand and gravel) in the top 10 feet, although cohesive clay soils may be encountered locally. Close coordination between the competent person and IGES should be maintained to facilitate construction while providing safe excavations.

Based on Occupational Safety and Health (OSHA) guidelines for excavation safety, trenches with vertical walls up to 5 feet in depth may be occupied. Where very moist soil conditions or groundwater is encountered, or when the trench is deeper than 5 feet, we recommend a trench-shield or shoring be used to protect workers in the trench. Sloping of the sides at 1.5H:1V in *Type C* soils may be used as an alternative to shoring or shielding. Steeper excavations may be allowed locally where stiff/cohesive earth materials are exposed, subject to written approval of the “competent person” or IGES professional staff.

7.2.4 Structural Fill and Compaction

All fill placed for the support of structures, flatwork or pavements should consist of structural fill. Structural fill may consist of onsite soils or an approved imported material. Imported structural fill should consist of granular soils containing less than 35% fines and no rock larger than 4 inches in nominal size (6 inches in greatest dimension). Structural fill should also be free of vegetation and debris. Soils not meeting these criteria may be suitable for use as structural fill; however, such soils should be evaluated on a case-by-case basis and should be approved by IGES prior to use.

All structural fill should be placed in maximum 6-inch loose lifts if compacted by small hand-operated compaction equipment, maximum 8-inch loose lifts if compacted by light-duty rollers, and maximum 12-inch loose lifts if compacted by heavy duty compaction equipment that is capable of efficiently compacting the entire thickness of the lift. Thicker lifts may be allowed provided the Contractor can demonstrate that the full lift thickness can be compacted with the compaction equipment being used. We recommend that all structural fill be compacted on a horizontal plane (maximum slope 5H:1V), unless otherwise approved by IGES. Structural fill underlying footings and pavements should be compacted to at least 95 percent of the MDD as determined by ASTM D-1557. **The moisture content should be at, or slightly above, the OMC for all structural fill**. Placing structural fill dry of optimum is discouraged. Any imported fill materials should be approved prior to importing. Also, prior to placing any fill, the excavations should be observed by IGES to assess whether unsuitable earth materials have been removed. In addition, proper grading should precede placement of structural fill, as described in the General Site Preparation and Grading subsection of this report.

Specifications from governing authorities such as Weber County and/or special service districts having their own precedence for backfill and compaction should be followed where more stringent.

7.2.5 Utility Trench Backfill

Utility trenches should be backfilled with structural fill in accordance with Section 7.2.4 of this report. Utility trenches can be backfilled with the onsite soils free of debris, organic and oversized material. Prior to backfilling the trench, pipes should be bedded in and shaded with a uniform granular material that has a Sand Equivalent (SE) of 30 or greater. Pipe bedding may be water-densified in-place (jetting). Alternatively, pipe bedding and shading may consist of clean ¾-inch gravel, which can generally be effectively densified with vibratory methods. However, in all cases the pipe bedding and shading should meet the design criteria of the pipe manufacturer.

Native earth materials can be used as backfill over the pipe bedding zone. All utility trenches backfilled below pavement sections, curb and gutter, and hardscape, should be backfilled with structural fill compacted to at least 95 percent of the MDD as determined by ASTM D-1557. All other trenches should be backfilled and compacted to approximately 90 percent of the MDD (ASTM D-1557). Specifications from governing authorities having their own precedence for backfill and compaction should be followed where they are more stringent.

7.3 FOUNDATIONS

Based on our field observations and considering the presence of relatively competent native earth materials, we recommend that the footings for the townhomes, amenity shack, and upper ski lift terminal be founded either *entirely* on competent Wasatch Formation bedrock (Tw) or *entirely* on structural fill, extending to the Wasatch Formation. Bedrock/fill transition zones are not allowed – transition zones will likely result in excess differential settlement. Where soft, loose, or otherwise deleterious earth materials are exposed on the foundation subgrade, IGES recommends that these soils be removed and replaced with structural fill, such that the zone of structural fill below the townhome has a relatively uniform thickness. We recommend that IGES assess the exposed foundation subgrade prior to the placement of steel or concrete, or structural fill, to identify the competent native earth materials as well as any unsuitable soils or transition zones. Additional over-excavation may be required based on the actual subsurface conditions observed (we anticipate that competent Wasatch Formation will be encountered approximately two feet below existing grade, however this depth may be greater locally).

Shallow spread or continuous wall footings constructed *entirely* on competent, uniform bedrock (Wasatch Formation), or *entirely* on a minimum of 2 feet of granular structural fill *overlying bedrock*, may be proportioned utilizing a maximum net allowable bearing pressure of **3,500 pounds per square foot (psf)** for dead load plus live load conditions. The net allowable bearing value presented above is for dead load plus live load conditions. The allowable bearing capacity may be increased by one-third for short-term loading (wind and seismic). The minimum recommended footing width is 20 inches for continuous wall footings and 30 inches for isolated spread footings.

All conventional foundations exposed to the full effects of frost should be established at a minimum depth of 42 inches below the lowest adjacent final grade. Interior footings, not subjected to the full effects of frost (i.e., *a continuously heated structure*), may be established at higher elevations, however, a minimum depth of embedment of 12 inches is recommended for confinement purposes.

The allowable bearing stress presented above may be utilized for the design of the upper ski terminal; if greater allowable bearing stress is desirable, IGES should review the final terminal foundation plans to assess whether additional allowable bearing stress is feasible. Any updates to the allowable bearing stress presented herein would be dependent on (a) the size of the footing, (b) the depth of the footing, and (c) the allowable total settlement.

7.4 SETTLEMENT

Static settlements of properly designed and constructed conventional foundations, founded as described in Section 7.3, are anticipated to be on the order of 1 inch or less. Differential settlement is expected to be half of the total settlement over a distance of 30 feet.

7.5 EARTH PRESSURES AND LATERAL RESISTANCE

Lateral forces imposed upon conventional foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footing and the supporting soils. In determining the frictional resistance against concrete, a coefficient of friction of 0.47 for undisturbed earth materials or structural fill may be used.

Ultimate lateral earth pressures from natural soils and *granular* backfill acting against retaining walls and buried structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in Table 7.5. The coefficients and densities presented in Table 7.5 assume no buildup of hydrostatic pressures. The force of the water should be added to the presented values if hydrostatic pressures are anticipated. Also, the values in Table 7.5 assume a relatively level backfill; if a sloped backfill is planned, IGES should be contacted to provide updated values.

Table 7.5
Recommended Lateral Earth Pressure Coefficients

Condition	**Level Backfill**	
	Lateral Pressure Coefficient	**Equivalent Fluid Density (pcf)**
Active (Ka)	0.31	40
At-rest (Ko)	0.47	60
Passive (Kp)	3.30	410

Clayey soils drain poorly and may swell upon wetting, thereby greatly increasing lateral pressures acting on earth retaining structures. Therefore, clayey soils should not be used as retaining wall backfill. Backfill should consist of either native granular soil or sandy imported material.

Walls and structures allowed to rotate slightly should use the active condition. If the element is constrained against rotation (i.e., a basement wall or other subterranean structure), the at-rest condition should be used. However, according to the IBC, foundation walls for buried or partially buried structures are allowed to be designed for active pressures if no more than 8 feet of the wall extends below grade and are laterally supported by flexible diaphragms.

The values listed in 7.5 should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used. Additionally, if passive resistance is calculated in conjunction with frictional resistance, the passive resistance should be reduced by ½.

7.6 RETAINING WALL DESIGN

The subsurface data provided in this report may be used for retaining wall design. Retaining wall design should be completed under a separate design package that contains construction drawings and specifications for each specific wall. The design package should include elevation (profile) drawings, stationing, section drawings and construction specifications for the particular wall type and planned accessories such as fencing. Drawings should be completed so that an accurate construction layout can be provided.

7.7 CONCRETE SLAB-ON-GRADE CONSTRUCTION

To minimize settlement and cracking of slabs, and to aid in drainage beneath the concrete floor slabs, all concrete slabs should be founded on a minimum 4-inch layer of densified gravel overlying properly prepared subgrade. The gravel should consist of free-draining gravel or road base with a ¾-inch maximum particle size and no more than 5 percent passing the No. 200 mesh sieve.

All concrete slabs should be designed to minimize cracking as a result of shrinkage. Consideration should be given to reinforcing the slab with a welded wire fabric, re-bar, or fiber mesh. Slab reinforcement should be designed by the structural engineer; however, as a minimum, slab reinforcement should consist of 4''×4'' W2.9×W2.9 welded wire mesh within the middle third of the slab. We recommend that concrete be tested to assess whether the slump and/or air content is in compliance with the plans and specifications. We recommend that concrete be placed in general accordance with the requirements of the American Concrete Institute (ACI). A Modulus of Subgrade Reaction of **270 psi/inch** may be used for design (Wasatch Formation or granular structural fill).

7.8 MOISTURE PROTECTION AND SURFACE DRAINAGE

As part of good construction practices, moisture should not be allowed to infiltrate into the subgrade in the vicinity of the foundations. Excessive moisture can increase the risk of wetting-induced settlement of both structural fill and native subgrade. As such, design strategies to minimize ponding and infiltration near the structure should be implemented as follows:

1. Rain gutters should be installed and maintained to collect and discharge all roof runoff a minimum of 10 feet from foundation elements or as far away as is practically

possible. However, it is noted that some architectural elements preclude the practical incorporation of rain gutters; in such cases, efforts should be made to provide aggressive, positive drainage away from foundation elements (this may include a concrete swale or a similar water conveyance system).

2. The ground surface within 10 feet of the foundations should be sloped to drain away from the structures with a minimum fall of 6 inches (5%); 2% is acceptable if the area is hardscaped with a relatively impermeable surface such as asphalt or concrete pavement.

7.9 SOIL CORROSION POTENTIAL

To assess the potential corrosive effects of site soils on concrete, a representative soil sample was tested for soluble sulfate content. The test indicated that the sample tested has a soluble sulfate content of less than 50 ppm. Based on this result, the soils are classified as having a 'low' potential for deterioration of concrete due to the presence of soluble sulfate. Accordingly, conventional Type IL Portland cement may be used for all concrete in contact with site soils.

To evaluate the corrosion potential of ferrous metal in contact with onsite native soil, a representative soil sample was tested in our soils laboratory for soil resistivity (AASHTO T288), soluble chloride content, and pH. The test indicated that the onsite soil tested has a minimum soil resistivity of 12,864 OHM-cm, a soluble chloride content of less than 50 ppm, and a pH of 4.9. Based on this result, the prevailing earth materials are considered somewhat acidic and may be *moderately corrosive* to ferrous metal in direct contact with site soils.

7.10 PAVEMENT

7.10.1 Pavement Design

CBR testing for the greater Shelter Hill development (IGES, 2024) indicates the most clay-rich specimen tested had a CBR of 16.7 (0.1" deflection), although the other two CBR tests indicated fairly high CBR values. Accordingly, based on our observations, for pavement design we have modeled a CBR of 16. Anticipated traffic volumes were not available at the time this report was prepared; however, based on our understanding of the project development we assume traffic on the roadways would consist primarily of passenger cars with occasional heavy vehicles associated with construction, municipal waste collection, public transportation, fire trucks, and similar. The following pavement designs have been developed for a 20-year design life assuming a 0 percent annual growth rate, and our assumed equivalent single axle load (ESAL) of 200,000 ESALs for interior roadways. Based on the information obtained and the assumptions listed above, recommended pavement section alternatives are presented in Table 7.10.

Table 7.10
Pavement Design CBR 16 – SC and GC

Material Type	Option 1	Option 2
Asphalt Concrete Pavement (inches)	3.5	3.5
Untreated Road Base (inches)	6	9
Subbase	6	None

The pavement section thicknesses presented in Table 7.10 assume that there is no mixing over time between the road base and the clayey subgrade. In order to minimize mixing or fines migration, and thereby prolong the life of the pavement section, we recommend that the owner place a 4-oz. non-woven filter fabric between the native soils and the aggregate section, such as the **Mirafi 140N** or an IGES-approved equivalent.

During construction, a significant amount of heavy construction traffic occurs. Some distress may manifest on pavement sections during this initial construction time period. Maintenance may need to be performed after completion of construction. A somewhat improved pavement section may be desirable if significant construction traffic is anticipated, e.g. if future development south of the Shelter Hill development is planned (e.g. the Owner could add 1 inch of asphalt and four inches of UTBC to help mitigate distress from significant construction traffic – this is a somewhat qualitative assessment, thus the Owner may wish to consult a *transportation engineer* with expertise in pavement design for a more precise assessment). It should also be noted that a minimum of 4 inches of asphalt will generally be more resistant to damage from snowplows.

As a minimum, the upper 4 inches of the native subgrade beneath all pavement sections should be reworked in-place and compacted to at least 93% of the MDD with the moisture content at or slightly above the OMC as determined by ASTM D-1557 (highly organic earth materials that appear to be topsoil should not be left in-place or be allowed to be mixed-in with the reworked soil). Asphalt has been assumed to be a high stability plant mix and untreated base course material (UTBC) composed of crushed stone with a minimum CBR of 70. UTBC should be compacted to a minimum density of 95 percent as determined by ASTM D-1557 (Modified Proctor). Asphalt should be compacted to a minimum of 96 percent of the Marshall maximum density. Asphalt and aggregate base material should conform to local requirements. Subbase should be a coarse, granular pit-run material with a minimum CBR of 30.

Where Portland Cement Concrete (PCC) pavements are planned, such as near trash enclosures or other areas expected to support heavy truck traffic, the pavement is recommended to be a minimum of 5 inches in thickness. Concrete pavement should be underlain by a minimum 6 inches of aggregate base course.

If conditions vary significantly from our stated assumptions, IGES should be contacted so we can modify our pavement design parameters accordingly.

7.10.2 Pavement Construction

The preceding pavement design options meet AASHTO design guidelines; however, where particularly soft, pumping subgrade is encountered, difficulty may be encountered during construction, particularly with respect to stabilization of the pavement subgrade (such conditions may be encountered locally). If soft, pumping soils or mobility problems arise during construction, one of the following options may be implemented:

A. Where particularly soft subgrade is encountered, over-excavate a minimum of 12 inches and then place Mirafi RS380i subgrade reinforcement (or an engineer-approved equivalent) on the exposed subgrade, and then place 12 inches of subbase over the reinforcement fabric. *The subbase should be compacted in two lifts*; some pumping/deflection may be noticed during compaction of the first lift, however upon placement of the final lift the 12 inches of subbase over RS380i is expected to stabilize the subgrade. If this option is selected, a separation fabric is not required, as the RS380i also performs that function.

B. Stabilization of soft or pumping subgrade can also be accomplished by using a clean, coarse angular material worked into the soft subgrade. We recommend the material be greater than 3 inches in nominal diameter, but less than 6 inches. Alternately, a locally available pit-run gravel may be suitable but should contain a high percentage of particles larger than 3 inches diameter and have less than 5 percent fines (material passing the No. 200 Sieve). A pit-run gravel may not be as effective as a coarse, angular material in stabilizing the soft soils and will likely require more material be placed. The stabilization material should be worked (pushed) into the soft subgrade soils until a relatively firm and unyielding surface is established. Once a relatively firm and unyielding surface is achieved, the area may be brought to final design grade using structural fill. Other earth materials not meeting aforementioned criteria may also be suitable; however, such material should be evaluated on a case-by-case basis and should be approved by IGES prior to use.

C. Where soft soils are encountered, the Contractor should consider compaction using static methods (e.g., wheel-rolling with heavy earth-moving equipment such as a loader or scraper). Compaction over soft soils using vibratory methods often proves to be marginally effective.

7.10.3 Frost Heave

The pavement designs presented in Table 7.10 do not take into account the deleterious effects of frost heave (positive volumetric strain of frozen soils). Some of the prevailing near-surface soils generally contain a significant clay fraction; such soils often have a high moisture content and can be particularly susceptible to frost heave. Because the soils may be particularly susceptible to frost heave, the Owner may wish to consider placing a relatively frost-free material below the pavement section, e.g. a coarse subbase material with less than 20 percent fines content. Within the Powder Mountain area, the frost depth is generally taken as 42 inches for design; however, the actual frost depth could be less, or more, depending on location and whether snow removal is maintained throughout the winter since snow often acts to insulate the ground from very cold air. In roadways, frost depth can exceed this value, particularly in shady areas that receive little sun, since snow insulation is negligible due to snow removal.

The thickness of frost-free material added to the pavement section will be dependent upon the degree of risk of frost heave that is acceptable to the Owner – as a minimum, a distance of 24 inches from finish grade to the frost-susceptible soils would be prudent (total pavement section thickness of 24 inches, which would include asphalt, UTBC, and subbase combined). The Owner may wish to consider additional thickness of frost-free material (generally considered subbase) to further reduce the risk of reduced pavement life arising from frost heave.

7.11 CONSTRUCTION CONSIDERATIONS

7.11.1 Oversize Material

Boulders up to 2 feet in diameter were observed on the surface and within the test pits; as such, excavation of the basement level may generate an abundance of over-size material that may require special handling, processing, or disposal.

7.11.2 Topsoil

Topsoil ranging in thickness from 1 to 2 feet was observed in the test pits; thicker sequences of topsoil may be present locally. Care should be exercised in keeping the topsoil segregated from earth materials that would otherwise be re-purposed as structural fill. Topsoil may not be incorporated into earth materials intended for use as structural fill or retaining wall backfill.

8.0 CLOSURE

8.1 LIMITATIONS

The concept of risk is a significant consideration of geotechnical analyses. The analytical means and methods used in performing geotechnical analyses and development of resulting recommendations do not constitute an exact science. Analytical tools used by geotechnical engineers are based on limited data, empirical correlations, engineering judgment and experience. As such the solutions and resulting recommendations presented in this report cannot be considered risk-free and constitute IGES's best professional opinions and recommendations based on the available data and other design information available at the time they were developed. IGES has developed the preceding analyses, recommendations and designs, at a minimum, in accordance with generally accepted professional geotechnical engineering practices and care being exercised in the project area at the time our services were performed. No warrantees, guarantees or other representations are made.

The information presented in this report is based on limited field testing and understanding of the project. The subsurface data used in the preparation of this report were obtained largely from the explorations made for the Shelter Hill-Townhomes project and data collected from nearby adjacent properties. It is very likely that variations in the soil, rock, and groundwater conditions exist between and beyond the point explored. The nature and extent of the variations may not be evident until construction occurs and additional explorations are completed. If any conditions are encountered at this site that are different from those described in this report, IGES must be immediately notified so that we may make any necessary revisions to recommendations presented in this report. In addition, if the scope of the proposed construction or grading changes from those described in this report, our firm must also be notified.

This report was prepared for our client's exclusive use on the project identified in the foregoing. Use of the data, recommendations or design information contained herein for any other project or development of the site not as specifically described in this report is at the user's sole risk and without the approval of IGES, Inc. It is the client's responsibility to see that all parties to the project including the designer, contractor, subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

8.2 ADDITIONAL SERVICES

We recommend that IGES be retained to review the final design plans, grading plans and specifications to determine if our engineering recommendations have been properly incorporated in the project development documents. We also recommend that IGES be retained to evaluate construction performance and other geotechnical aspects of the project as construction initiates and progresses through its completion.

Once a final grading plan is established, IGES should complete a grading plan review; this review will likely include supplemental slope stability analysis that focuses on those townhomes that are closest to the prominent northern and eastern slopes. Such slope stability modeling may require additional subsurface investigation and/or laboratory testing to provide site-specific geologic conditions for a particular townhome.

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AERIAL PHOTOGRAPHS

Data Set	Date	Flight	Photographs	Scale
1947 AAJ	August 10, 1946	AAJ_1B	88, 89, 90	1:20,000
1953 AAI	September 14, 1952	AAI_4K	34, 35, 36	1:20,000
1963 ELK	June 25, 1963	ELK_3	57, 58, 59	1:15,840

* https://geodata.geology.utah.gov/imagery/

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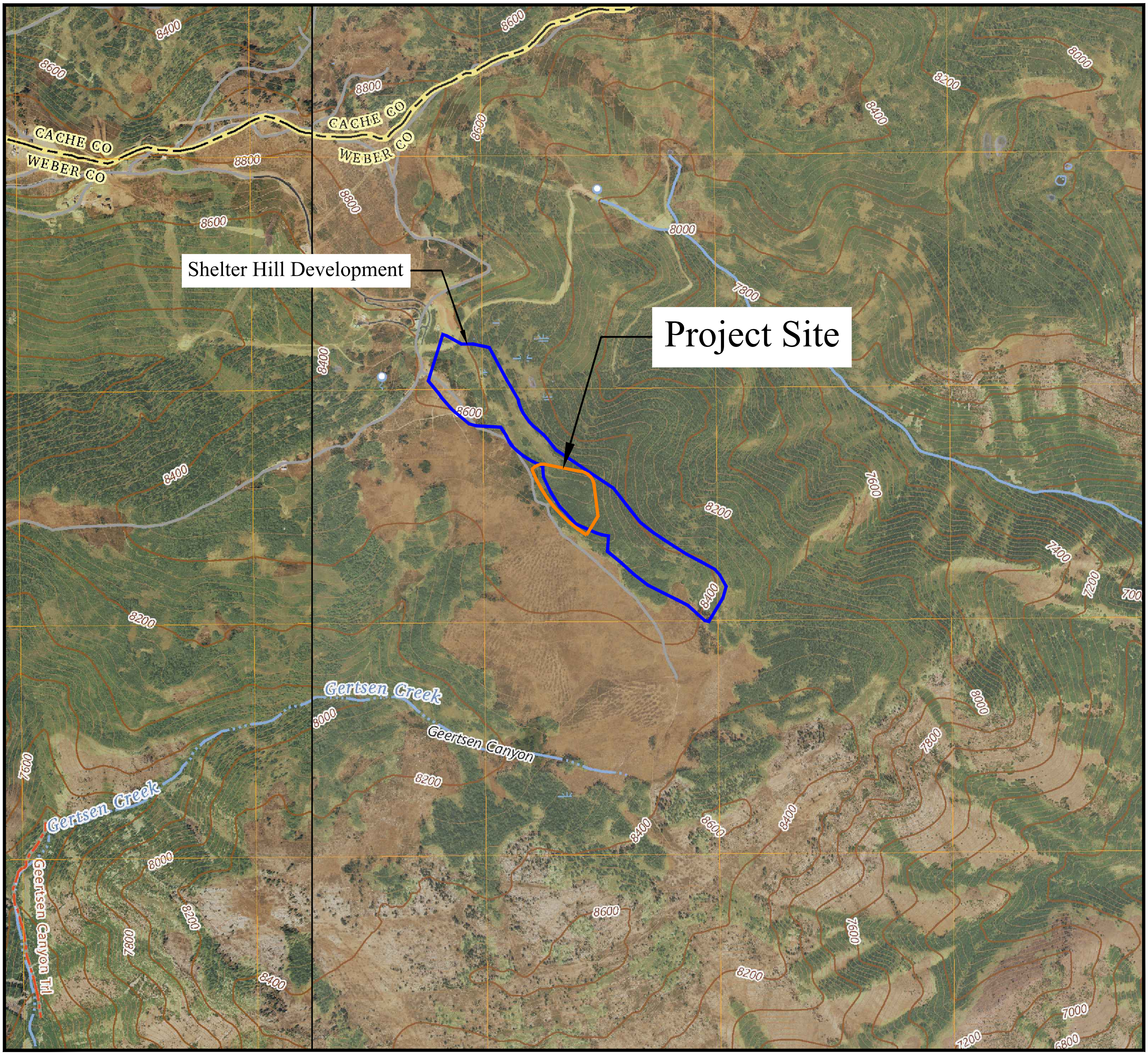
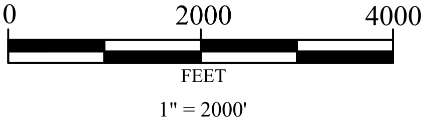
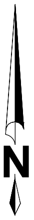
APPENDIX A

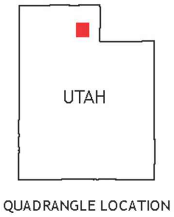


Base Map:

-USGS *Browns Hole and Huntsville*
7.5-Minute Topographic Quadrangles
(2023).







IGES

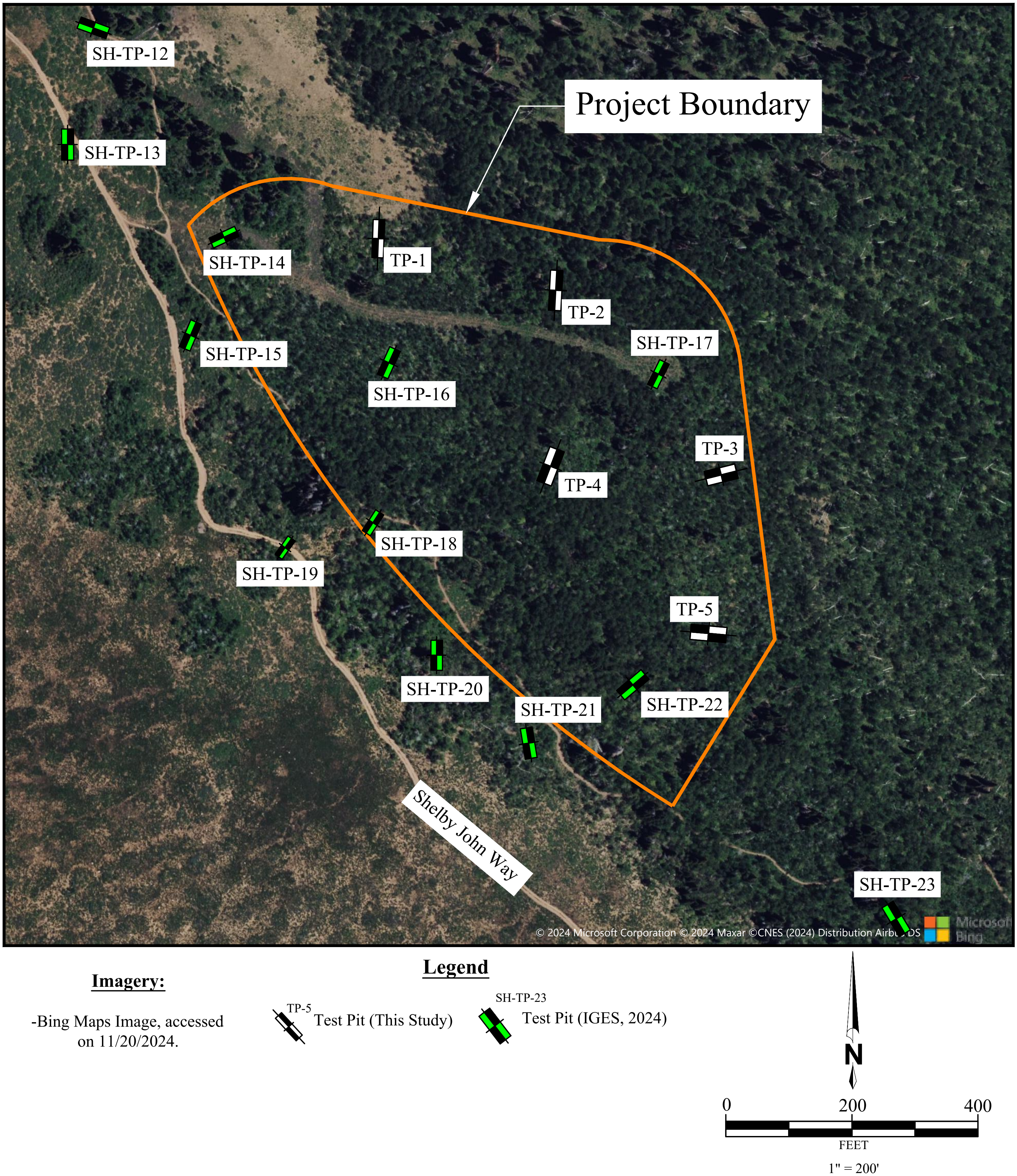
Project No: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Site Vicinity Map

Figure

A-1



Imagery:

-Bing Maps Image, accessed
on 11/20/2024.

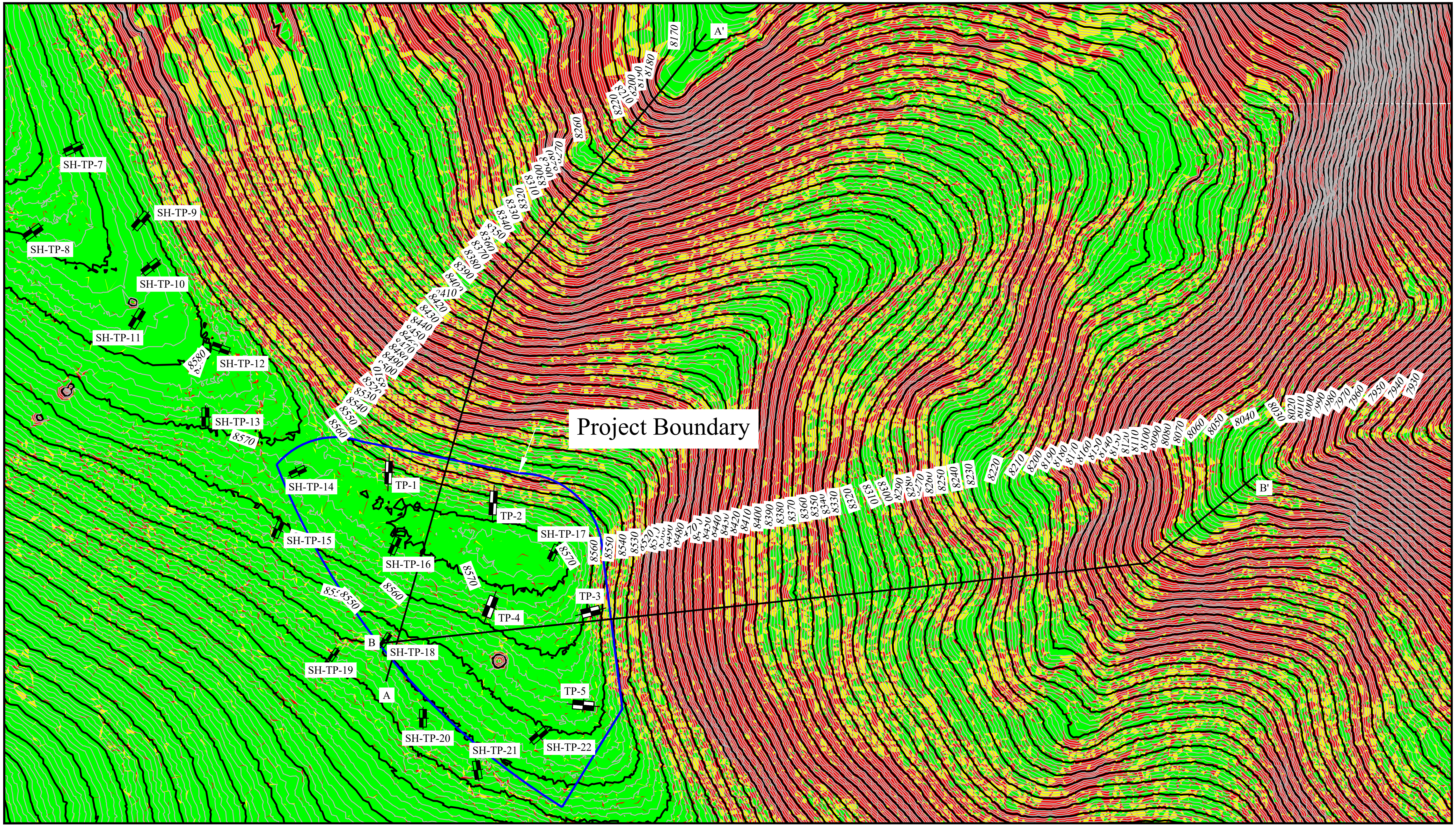
Project No: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Aerial Image

Figure

A-2



Topo Data:

-State of Utah and Partners, 2019, Regional Utah high-resolution lidar data 2015 - 2017: Collected by Quantum Spatial, Inc., Digital Mapping, Inc., and Aero-Graphics, Inc. and distributed by OpenTopography, https://doi.org/10.5069/G9RV0KSQ. Accessed: 01-08-2025.

Legend

TP-5 Test Pit (This Study)

SH-TP-23 Test Pit (IGES, 2024)

B B' Cross Section

Slope Grade

🟩 0-25%
🟨 25-30%
🟥 >30%

N

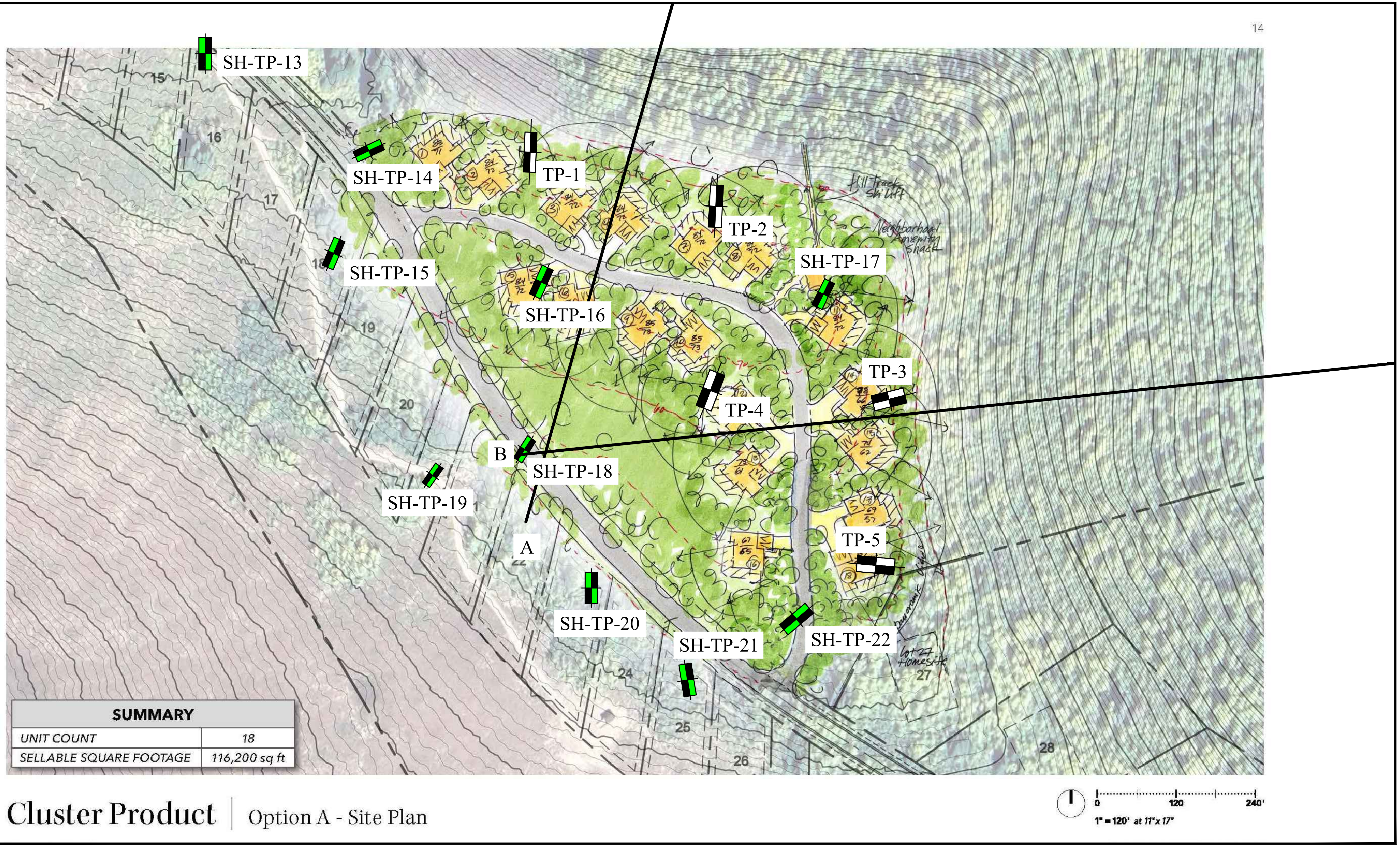
0 250 500
FEET
1" = 250'

IGES
Project No: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Slope Map

Figure
A-3



SUMMARY	
UNIT COUNT	18
SELLABLE SQUARE FOOTAGE	116,200 sq ft

Cluster Product | Option A - Site Plan

Basemap:

-Hart Howerton *Option A - Site Plan*,
dated September 20, 2024.

Legend

TP-5 Test Pit (This Study)

SH-TP-22 Test Pit (IGES, 2024)

B–B' Cross Section

N

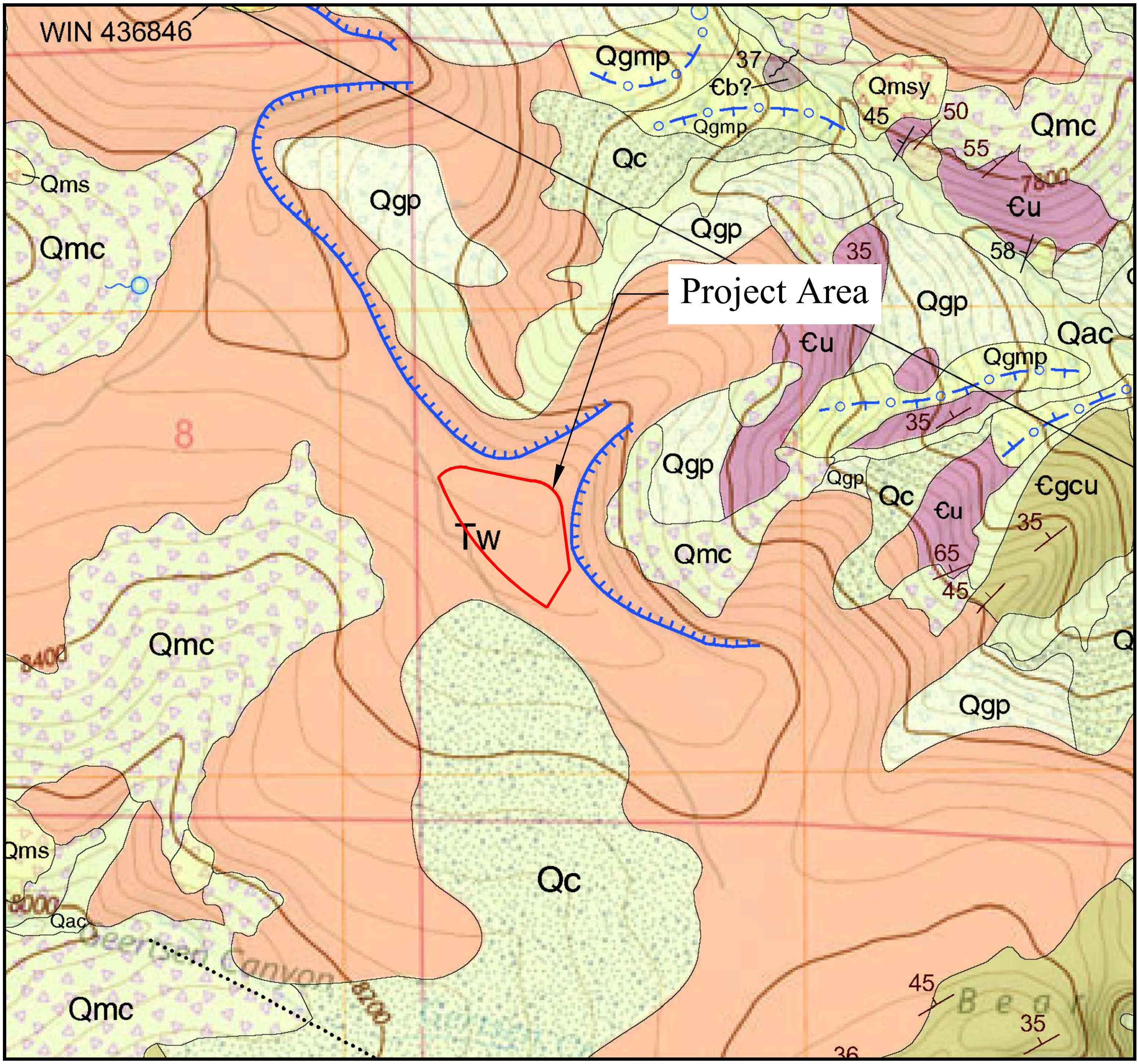
0 150 300
FEET
1" = 150'

IGES
Project No: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Site Plan

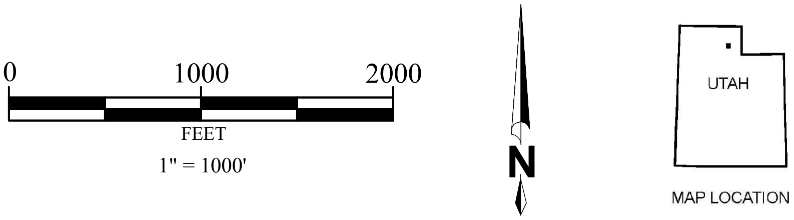
Figure
A-4



Base Map:

-UGS Interim Geologic Map of the *Browns Hole* 7.5-Minute Geologic Quadrangle, Open-File Report 760, Anderson, et al. (2023).

*Map Legend on Figure A-5b.



IGES

Project No: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Regional Geology Map

Figure

A-5a

Map Legend

Qc Colluvial deposits (Holocene to Late Pleistocene?) - Poorly sorted silt, sand, gravel, clay, cobbles, and boulders; angular to subangular clasts; rounded clasts derived from Tertiary Wasatch Formation (Tw) are common; massive to poorly bedded; composition depends on local bedrock source; mapped on moderate to steep slopes; includes slopewash and soil creep deposits and may include local mass-movement and talus deposits; includes residual deposits developed on Wasatch Formation; 6 to 50 feet (2-15 m) thick.

Qgp Glacial deposits, undivided, Pinedale age (Late Pleistocene) - Non-stratified, poorly sorted clay- to bouldersize sediment; glacial till and a component of outwash; primarily derived from rounded cobbles and boulders of Wasatch Formation (Tw); rare angular clasts derived from local Cambrian units; mapped as undivided glacial deposits because deposits lack distinct geomorphic shapes of end, recessional, and lateral moraines; likely deposited during Pinedale glaciation, which roughly correlates to the colder and wetter Marine Isotope Stage (MIS) 2 (14 to 29 ka; Lisiecki and Raymo, 2005); maximum ice extent in the Wasatch Range occurred between 17.5 and 22 ka (Laabs and Munroe, 2016; Quirk and others, 2018, 2020); estimated thickness up to 50 feet (15 m).

Qmc Undivided mass-movement and colluvial deposits (Holocene to Middle Pleistocene?) - Poorly sorted to unsorted, mostly clay, silt, sand, gravel, cobbles, and boulders; angular to rounded clasts; non-bedded; mapped on slopes where individual landslides, slumps, slopewash, and soil creep are difficult to distinguish from one another; often characterized by hummocky slopes composed of numerous slumps of various sizes and ages; includes soil creep, talus, slopewash, and debris-flow deposits but lacks clear landslide scarps and lateral margins to allow separate mapping; typically forms on slopes overlying clay-bearing, landslide-prone bedrock units; 0 to 40 feet (0-12 m) thick.

Tw, Tw? Wasatch Formation (Eocene to Paleocene) - Moderate reddish-orange to pale yellowish-orange, cobble to boulder conglomerate with varying amounts of mudstone and sandstone; forms cobble- and boulder-strewn slopes but does not crop out; unconsolidated to consolidated claystone, sandstone, limestone, and dolomite reported in lithologic logs from water wells drilled < 1 mile (0.6 km) west of the western quadrangle border near Powder Mountain ski resort (see logs for Well Identification Number [WIN] 436850 and 436926, Utah Division of Water Rights well database [UDWR], 2022); clasts are tan, gray, purple, and green quartzite and well-indurated sandstone, sourced dominantly from the Brigham Group; lower contact is sharp, unconformable; deposited over considerable paleotopography; queried where unit designation uncertain and may be older colluvium or alluvium; may include Cretaceous-age (Maastrichtian) deposits of the Hams Fork Member of the Evanston Formation in the southeast part of the map, as mapped by Coogan and King (2016); 0 to over 2000 feet (0-610+ m) thick.

Ꞓu Ute Formation (Middle Cambrian) - Light-gray to grayish-blue, thin- to medium-bedded limestone with interbedded shaley limestone and dark greenish brown to reddish-orange fissile shale; limestone beds commonly contain twiggy bodies (as described in Lochman-Balk [1976] and Yonkee and Lowe [2004]), bioturbation and fossil hash; resistant packages of medium-bedded limestone commonly oncolitic; marker interval about 600 feet (185 m) above base contains abundant trilobites from biozone *Ehmaniella* in beds of minor oolitic limestone, intraclast “flat pebble conglomerate,” and thinly bedded gray limestone; Rigo (1968) reported *Glossopleura* sp. from the basal Ute Formation in neighboring Huntsville quadrangle; shaley limestone is common with ribbons of tan to yellow shale; forms steep slopes with cliffs and ridges of limestone; top of unit contains karsts beneath the Wasatch Formation (Tw); lower contact conformable and mapped at first shale above Langston Formation; mapped by Crittenden (1972) as Ute and Blacksmith Limestones, undivided; we included resistant limestone beds that Coogan and King (2016) mapped as queried Blacksmith Formation because they are not dolomite, but rather oncolitic limestone within an overall shaley limestone sequence; thickness is about 2100 feet (640 m) near South Fork of Ogden River, and about 1700 feet (520 m) on the northwest side of Middle Fork of Ogden River.

┴┴┴┴┴ Headwall of Glacial Cirque

○~ Spring

IGES

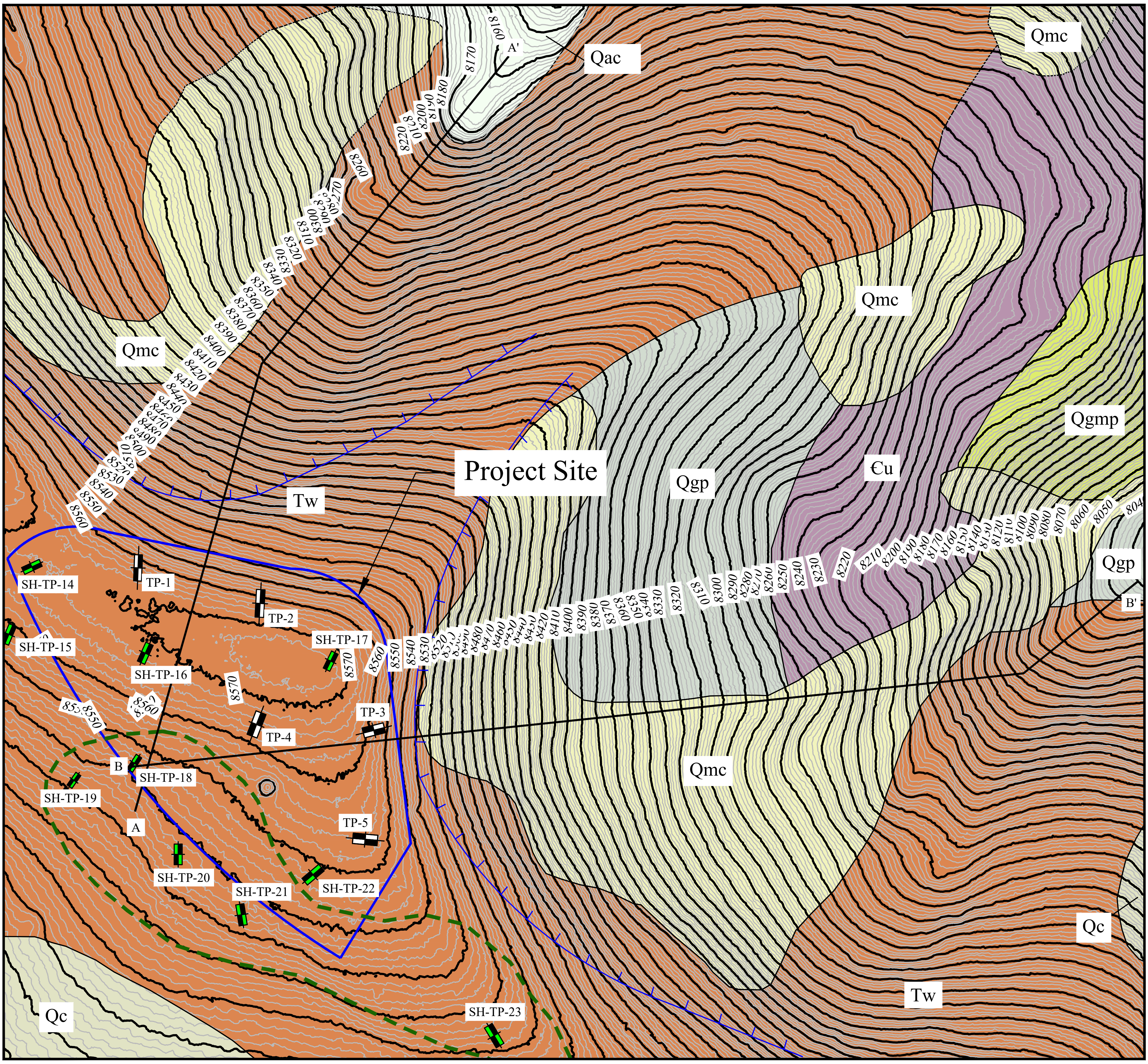
Project No: 01628-046

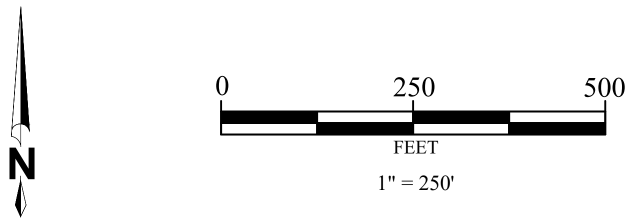
Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Regional Geology Map

Figure

A-5b





Base Map:

-UGS Interim Geologic Map of the *Browns Hole* 7.5-Minute Geologic Quadrangle, Open-File Report 760, Anderson, et al. (2023).

*All Geologic Contacts Approximately Located; modified from Anderson, et al. 2023.

Topo Data:

-State of Utah and Partners, 2019, Regional Utah high-resolution lidar data 2015 - 2017: Collected by Quantum Spatial, Inc., Digital Mapping, Inc., and Aero-Graphics, Inc. and distributed by OpenTopography, https://doi.org/10.5069/G9RV0KSQ. Accessed: 01-08-2025.

-Contour Interval: 2 ft

Legend

Qac Alluvium and Colluvium, Undivided (Holocene to Late Pleistocene)

Qc Colluvial Deposits (Holocene to Late Pleistocene)

Qmc Undivided Mass-Movement and Colluvial Deposits (Holocene to Middle Pleistocene)

Qgmp Glacial Moraine Deposits (Late Pleistocene)

Qgp Glacial Deposits, Undivided (Late Pleistocene)

Tw Wasatch Formation (Eocene to Paleocene)

Cu Ute Formation (Middle Cambrian)

TP-5 Test Pit (This Study)

SH-TP-23 Test Pit (IGES, 2024)

B B' Cross Section

Shallow Groundwater Area

Glacial Cirque

IGES

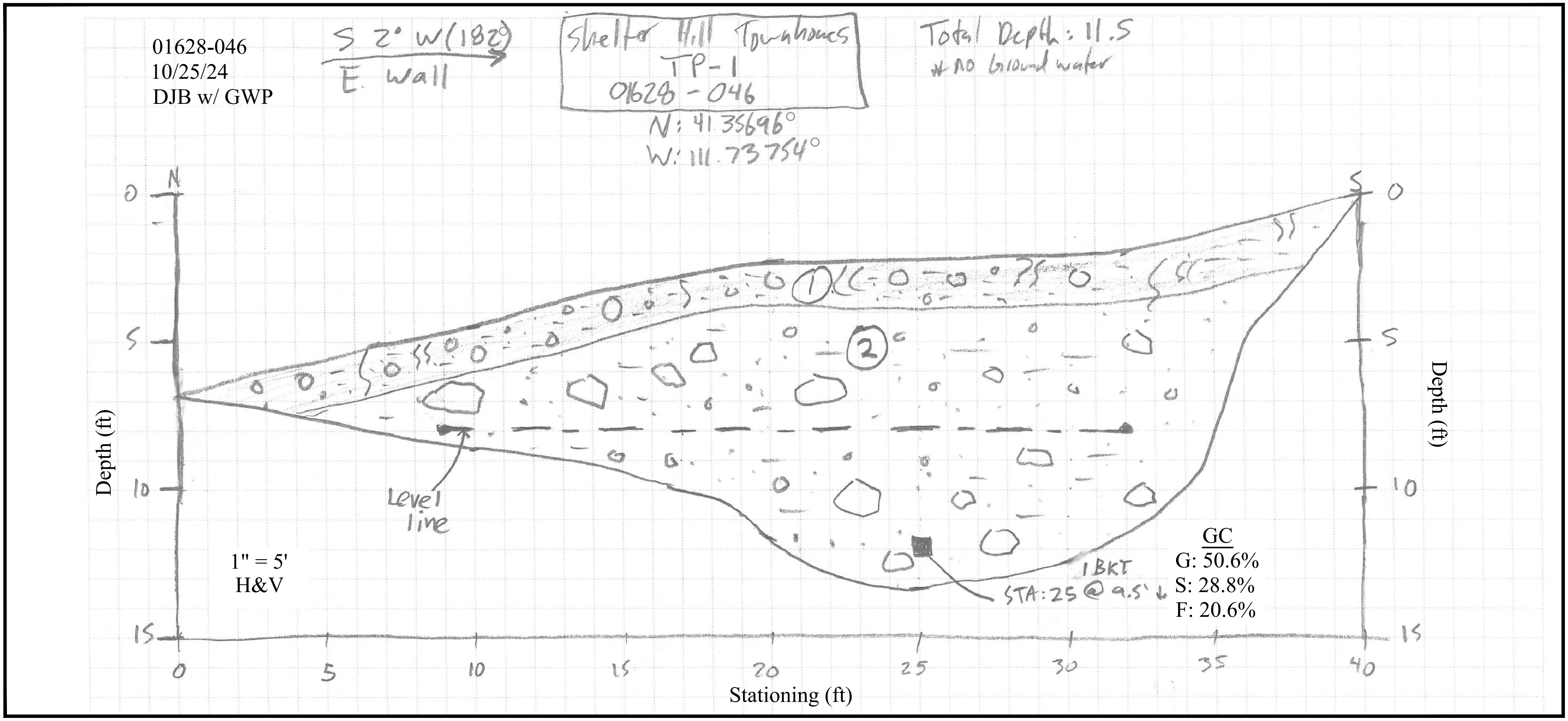
Project No: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Geotechnical and Local Geology Map

Figure

A-6



Lithologic Unit Descriptions

1. **Topsoil/Colluvium (Qc):** 1½-2' thick; brownish gray (5YR 4/1) clayey SAND with gravel (SC), loose, dry, low plasticity fines, massive; gravel and larger sized clasts comprise ~20-30% of the unit; clasts are subangular to subrounded medium gray (N5) quartzite and moderate reddish brown (10R 4/6) sandstone up to 1.5' in diameter, mode ~2-3"; sand component is fine-grained to medium-grained; stone line at base of unit; common cobbles; abundant plant and tree roots; sharp, planar basal contact.

2. **Wasatch Formation (Tw):** >9' thick; highly weathered conglomerate bedrock, largely altered to pale yellowish orange (10YR 8/6) silty GRAVEL with sand (GM), medium dense to dense, dry to slightly moist, low plasticity fines, massive to weakly bedded; gravel and larger sized clasts comprise ~65-75% of the unit; clasts are subangular to subrounded medium gray (N5) quartzite and moderate reddish brown (10R 4/6) sandstone up to 2' in diameter, mode ~½-1.5"; sand component is fine-grained to coarse-grained; common plant and tree roots.

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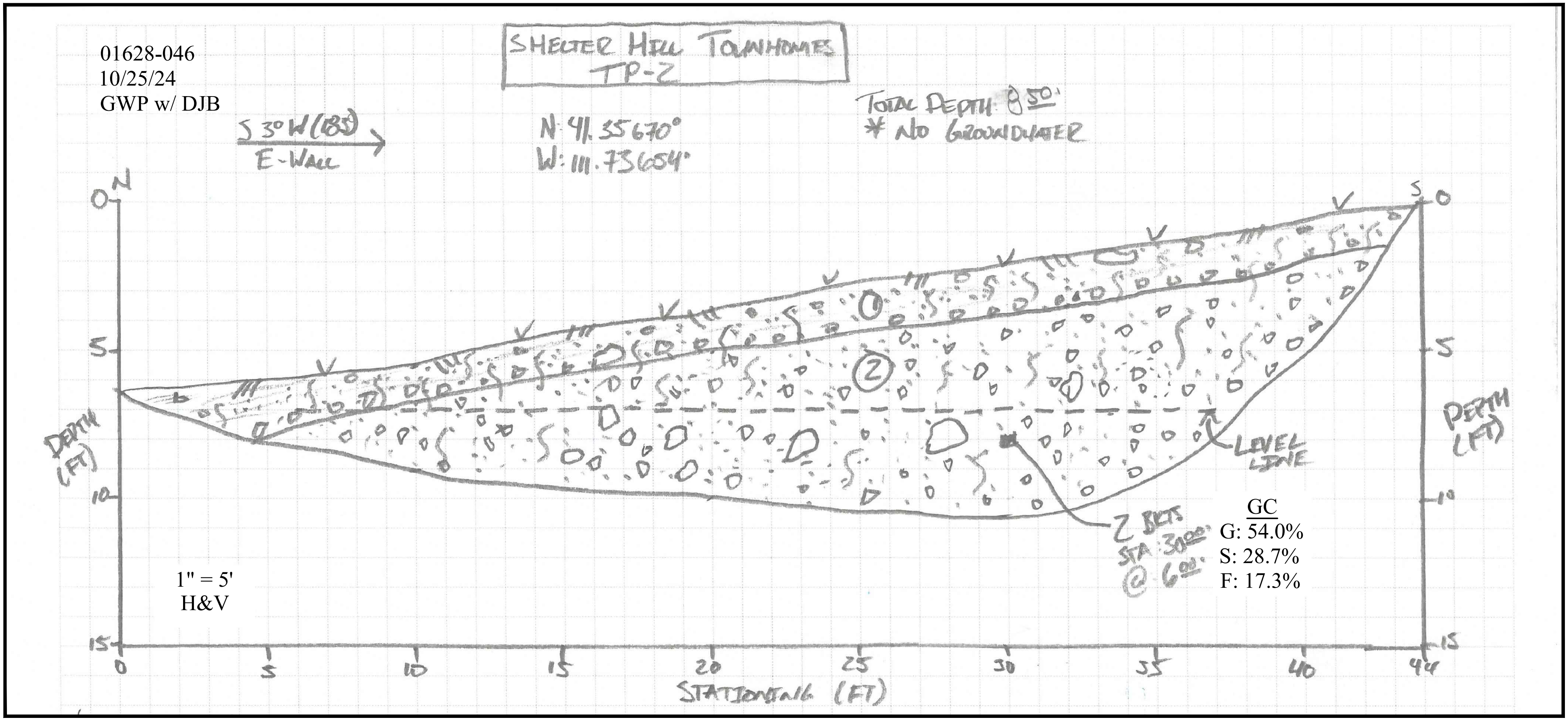
Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

TP-1 Log

Figure

A-7



Lithologic Unit Descriptions

1. **Topsoil/Colluvium (Qc):** 1½ -2' thick; brownish gray (5YR 4/1) clayey SAND with gravel (SC), loose, dry, low plasticity fines, massive; gravel and larger sized clasts comprise ~20-30% of the unit; clasts are subangular to subrounded medium gray (N5) quartzite and moderate reddish brown (10R 4/6) sandstone up to 1.5' in diameter, mode ~2-3"; sand component is fine-grained to medium-grained; stone line at base of unit; abundant plant and tree roots; sharp, planar basal contact.

2. **Wasatch Formation (Tw):** >6.5' thick; highly weathered conglomerate bedrock, largely altered to pale yellowish orange (10YR 8/6) silty GRAVEL with sand (GM), loose to medium dense, dry, low plasticity fines, massive; gravel and larger sized clasts comprise ~65-75% of the unit; clasts are subangular to subrounded medium gray (N5) quartzite and moderate reddish brown (10R 4/6) sandstone up to 2' in diameter, mode ~½-1.5"; sand component is fine-grained to coarse-grained; common plant and tree roots.

***Potholed at Station 30 to a depth of 13.5' below existing grade; all Unit 2 Wasatch Formation to total depth.**

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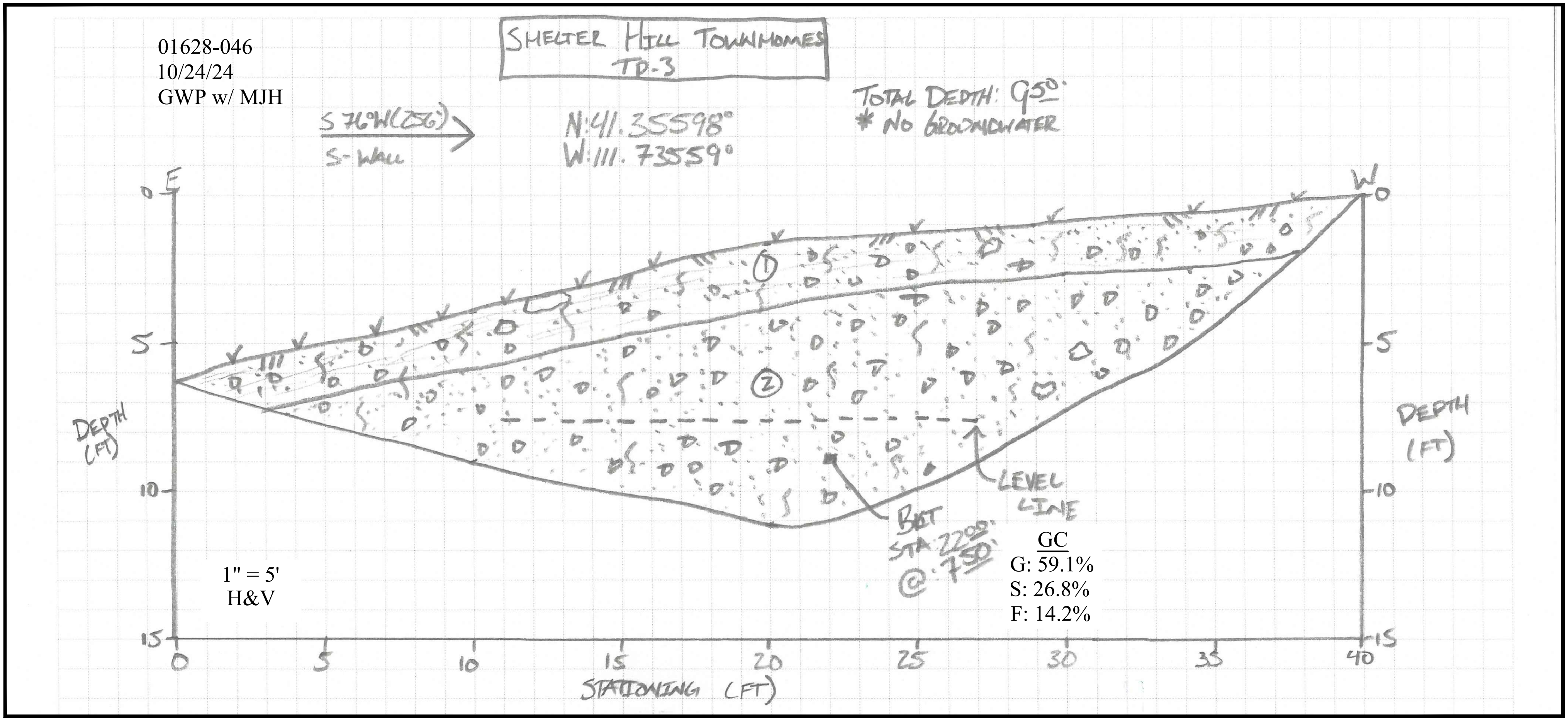
Powder Mountain Resort
Weber County, Utah

TP-2 Log

Figure

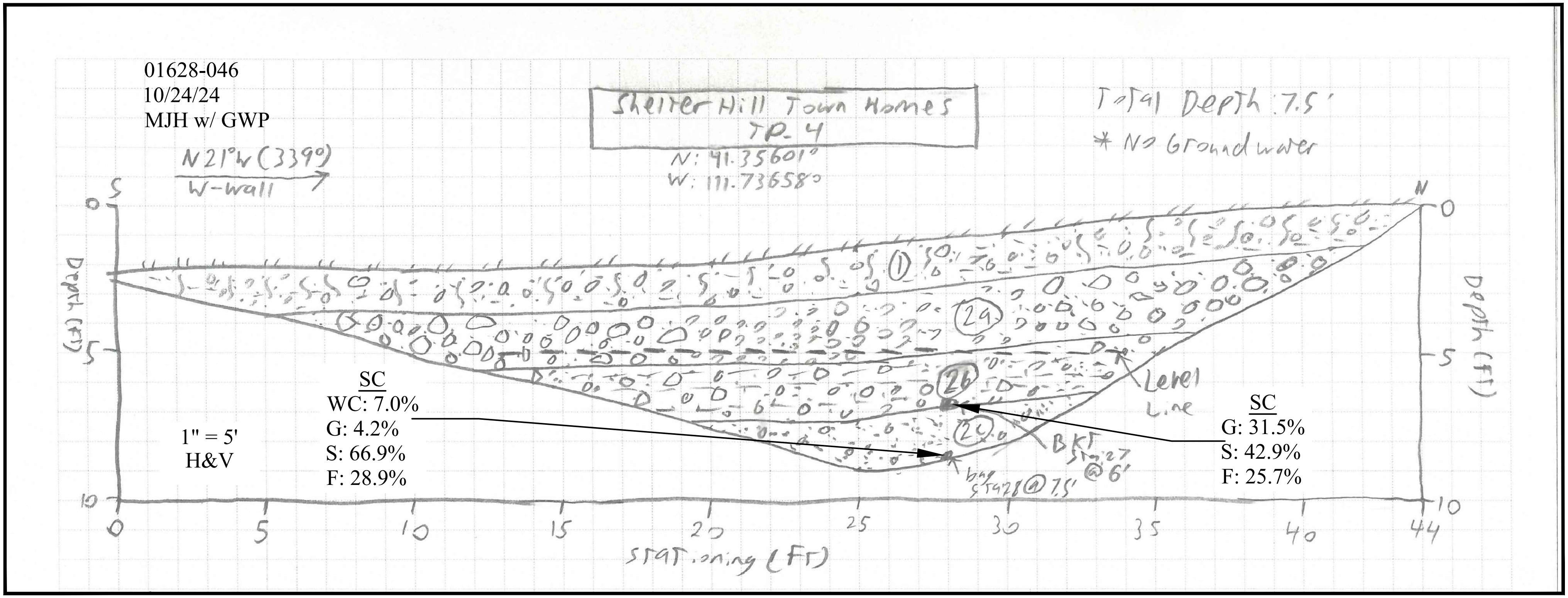
A-8



Lithologic Unit Descriptions

1. **Topsoil/Colluvium (Qc):** ~2' thick; light brown (5YR 6/4) to brownish black (5R 2/1) clayey SAND with gravel (SC), loose, slightly moist, low plasticity fines, massive; gravel and lager sized clasts comprise ~20-30% of the unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 1.75' diameter, mode ~1-3"; sand component is fine-grained to medium-grained; abundant plant and tree roots; sharp, planar basal contact.

2. **Wasatch Formation (Tw):** >7.5' thick; highly weathered conglomerate bedrock, largely altered to moderate reddish brown (10R 4/6) to pale yellowish orange (10YR 8/6) poorly-graded SAND with gravel (SP), loose to medium dense, dry to slightly moist, low plasticity fines, massive to weakly bedded; gravel and larger sized clasts comprise ~35-45% of the unit; clasts are subrounded to subangular medium gray (N5) to dark gray (N3) quartzite up to 10" in diameter, mode ~½-1.5" ; sand component is fine-grained to coarse-grained; occasional to abundant 1 mm diameter pinholes; occasional plant and tree roots.



01628-046
10/24/24
MJH w/ GWP

1" = 5'
H&V

SC
WC: 7.0%
G: 4.2%
S: 66.9%
F: 28.9%

SC
G: 31.5%
S: 42.9%
F: 25.7%

Lithologic Unit Descriptions

1. **A/B Topsoil:** ~1.5' thick; light brown (5YR 6/4) to brownish black (5R 2/1) clayey SAND with gravel (SC), loose, slightly moist, low plasticity fines, massive; gravel and lager sized clasts comprise ~20-30% of the unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 1.75' diameter, mode ~1-3"; sand component is fine-grained to medium-grained; abundant plant and tree roots; sharp, planar basal contact.

2. **Wasatch Formation:** >6' thick; highly weathered conglomerate bedrock; 3 subunits:
   a. ~2' thick; moderate reddish orange (10R 6/6) poorly-graded GRAVEL with sand (GP), medium dense, dry, low plasticity fines, massive; gravel and larger sized clasts comprise ~60-70% of the unit; clasts are subrounded to subangular medium gray (N5) to dark gray (N3) quartzite up to 18" in diameter, mode ~1-4"; sand component is coarse-grained; some calcium carbonate flour; common plant and tree roots; sharp, planar basal contact.
   b. ~2' thick; moderate reddish brown (10R 4/6) mottled with pale yellowish orange (10YR 8/6) clayey SAND with gravel (SC), dense, slightly moist, low plasticity fines, massive; gravel and larger sized clasts comprise ~25-30% of the unit; clasts are subrounded to subangular medium gray (N5) to dark gray (N3) quartzite up to 4" in diameter, mode ~½-1.5"; sand component is medium-grained to fine-grained; occasional calcium carbonate flour; occasional plant and tree roots; sharp, planar basal contact.
   c. >2' thick; moderate reddish brown (10R 4/6) poorly-graded SAND (SP), medium dense, dry to slightly moist, few to no low plasticity fines, massive; gravel and larger sized clasts comprise ~5% of the unit; clasts are subrounded to subangular medium gray (N5) to dark gray (N3) quartzite up to 3" in diameter, mode ~¼-½"; sand component is coarse-grained; subunit appears to be a weathered sandstone or conglomeratic sandstone.

***Potholed at Station 25 to a depth of 13' below existing grade; Unit 2C Wasatch Formation to a depth of 11', then Unit 2A Wasatch Formation to 13'.**

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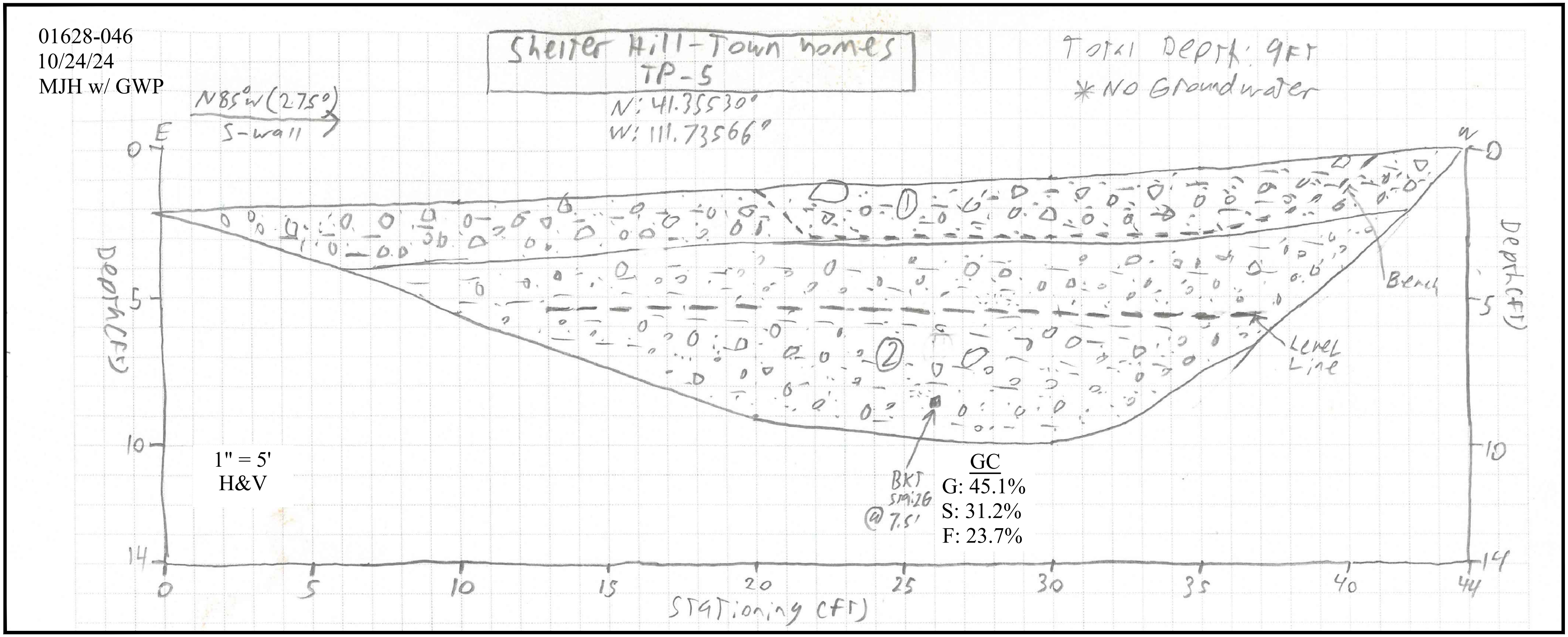
TP-4 Log

Figure

A-10



Lithologic Unit Descriptions

1. **Topsoil/Colluvium (Qc):** 2' thick; moderate brown (5YR 3/4) clayey SAND with gravel (SC), loose to medium dense, dry, low plasticity fines, massive; gravel and larger sized clasts comprise ~25-30% of unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 15" in diameter, mode ~1-3"; abundant plant and tree roots; sharp, planar basal contact.

2. **Wasatch Formation (Tw):** >7' thick; highly weathered conglomerate bedrock, largely altered to moderate reddish brown (10R 4/6) to dark reddish brown (10R 3/4) mottled with pale brown (5YR 5/2) clayey SAND with gravel (SC), medium dense, slightly moist, low plasticity fines, massive; gravel and larger sized clasts comprise ~20-25% of the unit; clasts are subrounded to subangular medium gray (N5) to dark gray (N3) quartzite up to 8" in diameter, mode ~1-4"; soil becomes lighter colored on the east end of the test pit; occasional 1 mm diameter pinholes; common lenses of gravelly sand; minor calcium carbonate flour in uppermost 3 feet of unit; occasional plant and tree roots.

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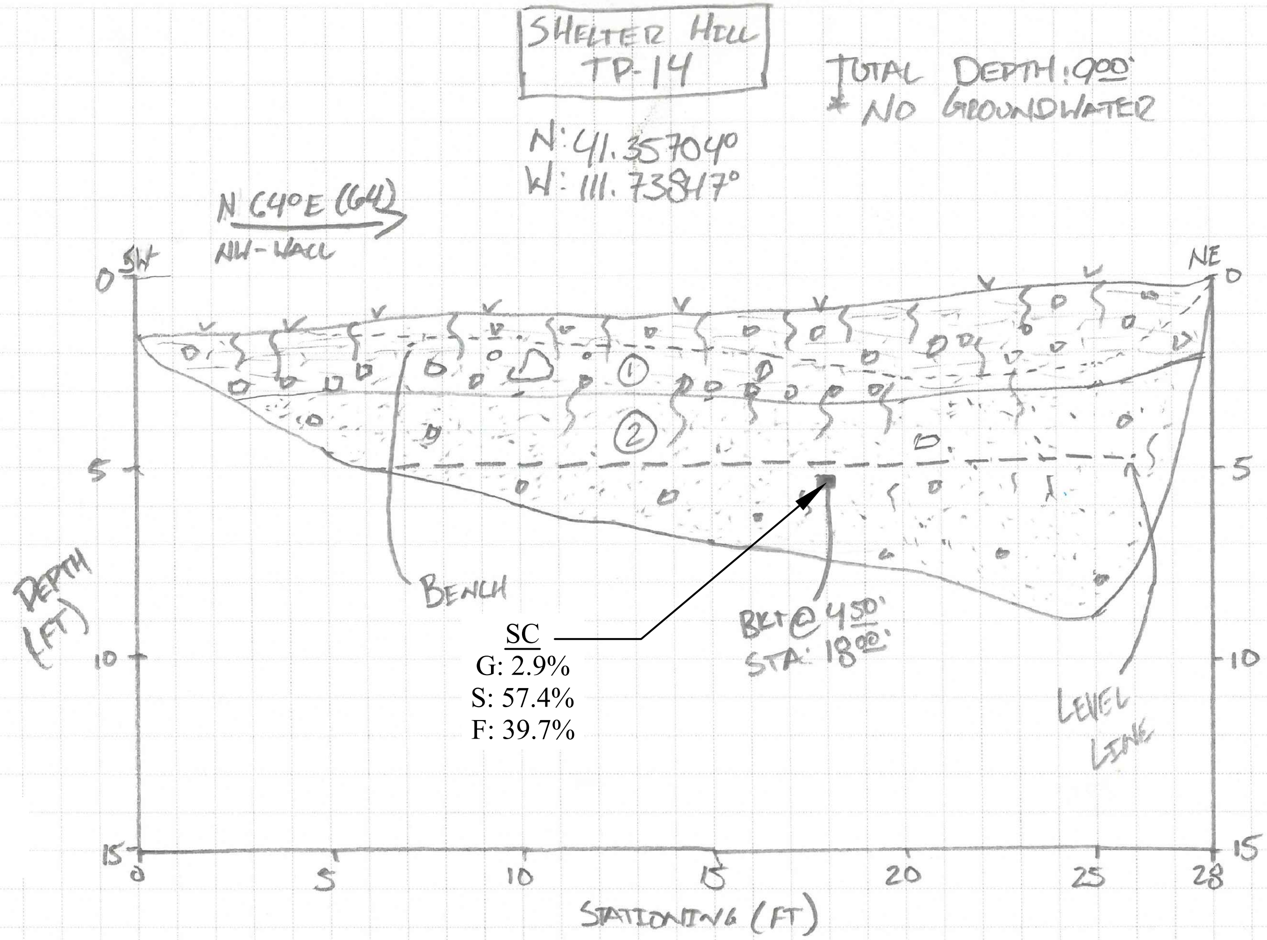
TP-5 Log

Figure

A-11

Project No. 01628-040

Date 6/27/24
GWP w/ MJH



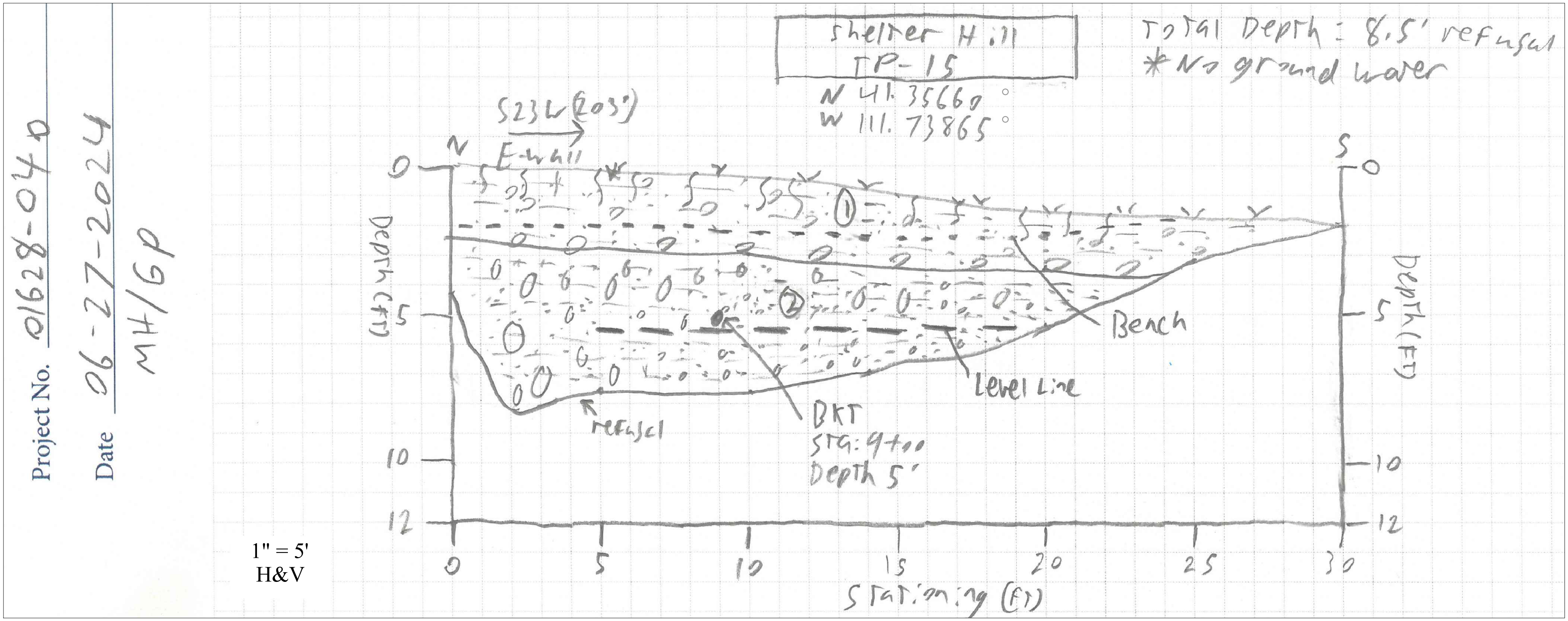
SC
G: 2.9%
S: 57.4%
F: 39.7%

1" = 5'
H&V

Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** Up to 2.75' thick; brownish black (5YR 2/1) sandy lean CLAY with gravel (CL), loose to medium stiff, slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30-40% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 2' in diameter, mode ~1/2-1"; abundant plant and tree roots; sharp, irregular basal contact.

2) **Wasatch Formation (Tw):** >6' thick; highly weathered conglomerate bedrock; moderate reddish brown (10R 4/6) to moderate brown (5YR 3/4) clayey SAND (SC) grading to silty SAND (SM) with depth, loose, slightly moist, low plasticity fines, massive; gravel and larger sized clasts comprise <5% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 4" in diameter, mode ~1-2; sand component is fine-grained to coarse-grained; common plant roots.



Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** 2.5' thick; grayish brown (5Y 3/2) sandy lean CLAY (CL) with gravel grading to clayey GRAVEL (GC) with sand, loose to medium stiff, dry to slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30-50% of unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 1.25' in diameter, mode ~2-4"; abundant plant and tree roots; no distinct stone line, just cobbly throughout; sharp, planar basal contact.

2) **Wasatch Formation (Tw):** >6' thick; highly weathered conglomerate bedrock; moderate reddish orange (10R 6/6) mottled with light brown (5YR 6/4) sandy lean CLAY with gravel (CL) grading to clayey SAND with gravel (SC), medium stiff to very stiff, moist, low to moderate plasticity, massive to weakly bedded; gravel and larger sized clasts comprise ~35-40% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 2.5' in diameter, mode ~1/2-1.5"; gravel grades smaller toward bottom of test pit; sand component is medium-grained to coarse-grained; trace roots.

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Weber County, Utah

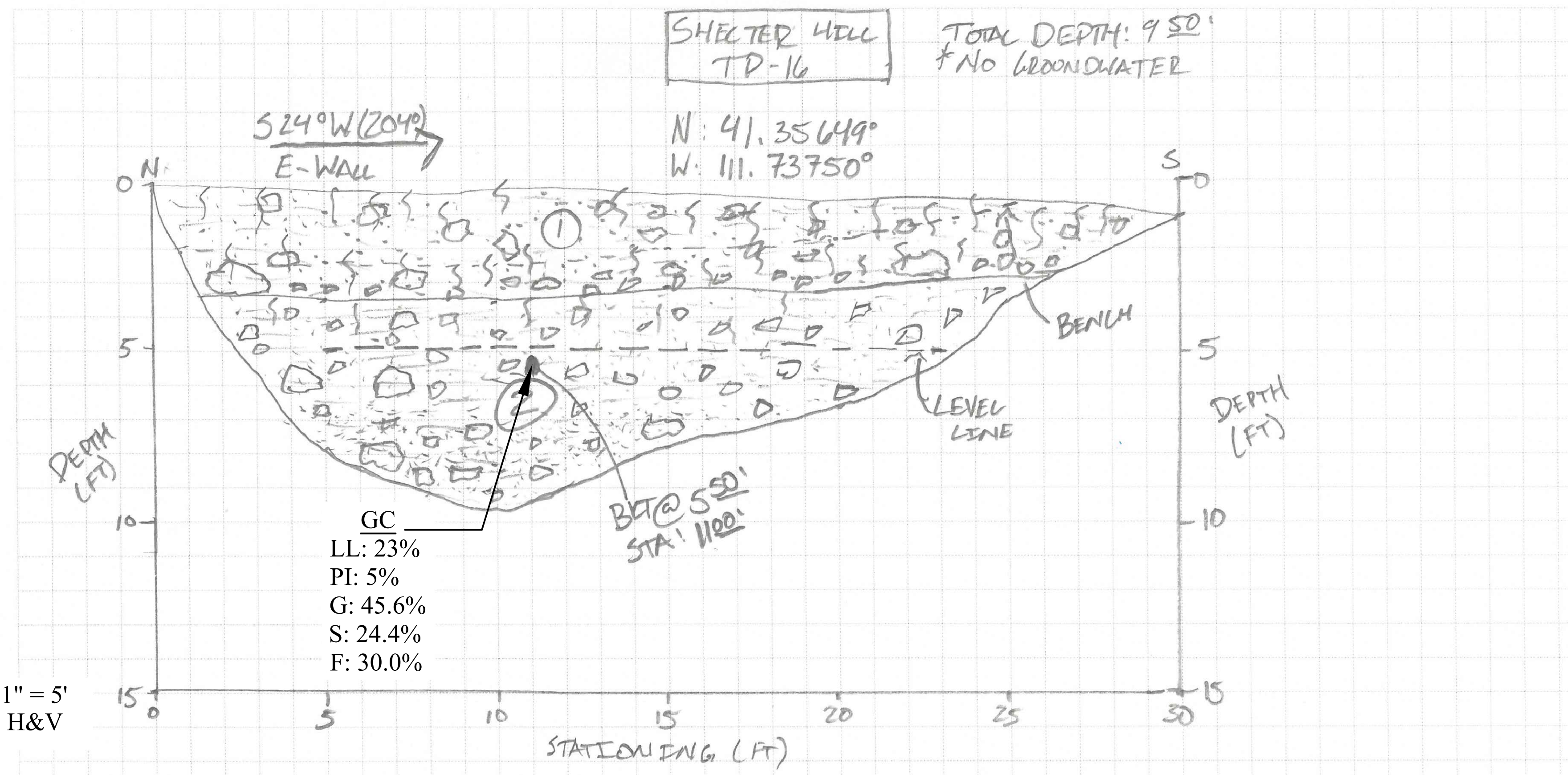
SH-TP-15 Log

Figure

A-13

Project No. 01628-040

Date 6/27/24
GWP w/ MJH



GC
LL: 23%
PI: 5%
G: 45.6%
S: 24.4%
F: 30.0%

1" = 5'
H&V

Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** Up to 3' thick; grayish brown (5Y 3/2) sandy lean CLAY (CL) with gravel grading to clayey GRAVEL (GC) with sand, loose to medium stiff, dry to slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30-50% of unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 1.25' in diameter, mode ~2-4"; abundant plant and tree roots; distinct stone line at basal contact; sharp, planar basal contact.

2) **Wasatch Formation (Tw):** >6' thick; highly weathered conglomerate bedrock; moderate reddish brown (10R 4/6) to dark yellowish orange (10YR 6/6) sandy lean CLAY with gravel (CL) grading to clayey SAND with gravel (SC), medium stiff to very stiff, moist, low to moderate plasticity, massive to weakly bedded; gravel and larger sized clasts comprise ~35-40% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 2.5' in diameter, mode ~1/2-1.5"; gravel grades smaller toward bottom of test pit; sand component is fine-grained to medium-grained; trace roots.

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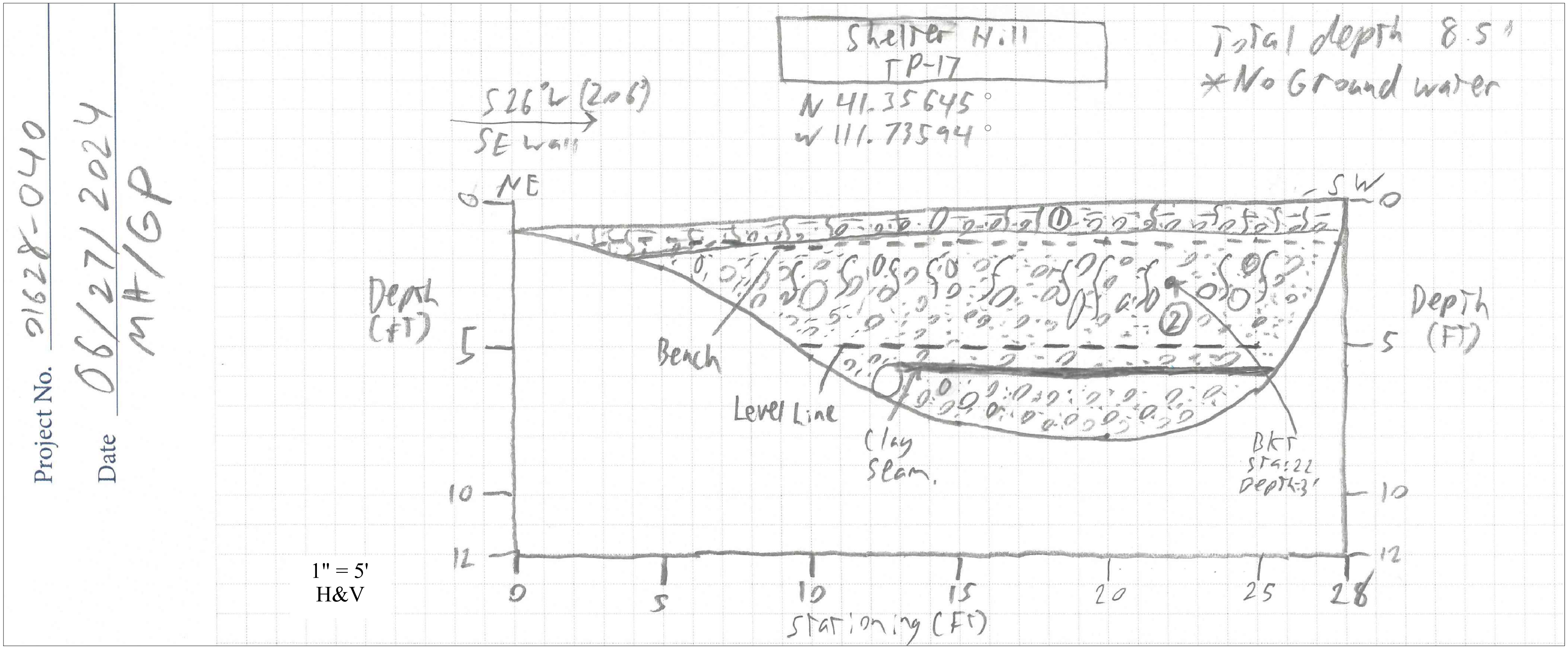
SH-TP-16 Log

Figure

A-14



Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** Up to 1' thick; grayish brown (5Y 3/2) clayey SAND with gravel (SC), medium dense, slightly moist to moist, low plasticity, massive; gravel and larger sized clasts comprise ~30-40% of unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 1' in diameter, mode ~1-2"; abundant plant and tree roots; distinct stone line at basal contact; sharp, planar basal contact.

2) **Wasatch Formation (Tw):** >7' thick; highly weathered conglomerate bedrock; pale yellowish orange (10YR 8/6) to light brown (5YR 6/4) poorly-graded SAND with gravel (SP), loose to medium dense, slightly moist to moist, low plasticity fines, massive; gravel and larger sized clasts comprise ~40-50% of unit; clasts are subrounded to subangular sandstone, quartzite, and weathered in place siltstone up to 2' in diameter, mode ~1-3"; clasts decrease in size with depth; unit includes a dark reddish brown (10R ¾) sandy lean clay seam that is ~2.5" thick and irregularly passes through the test pit; common plant and tree roots.

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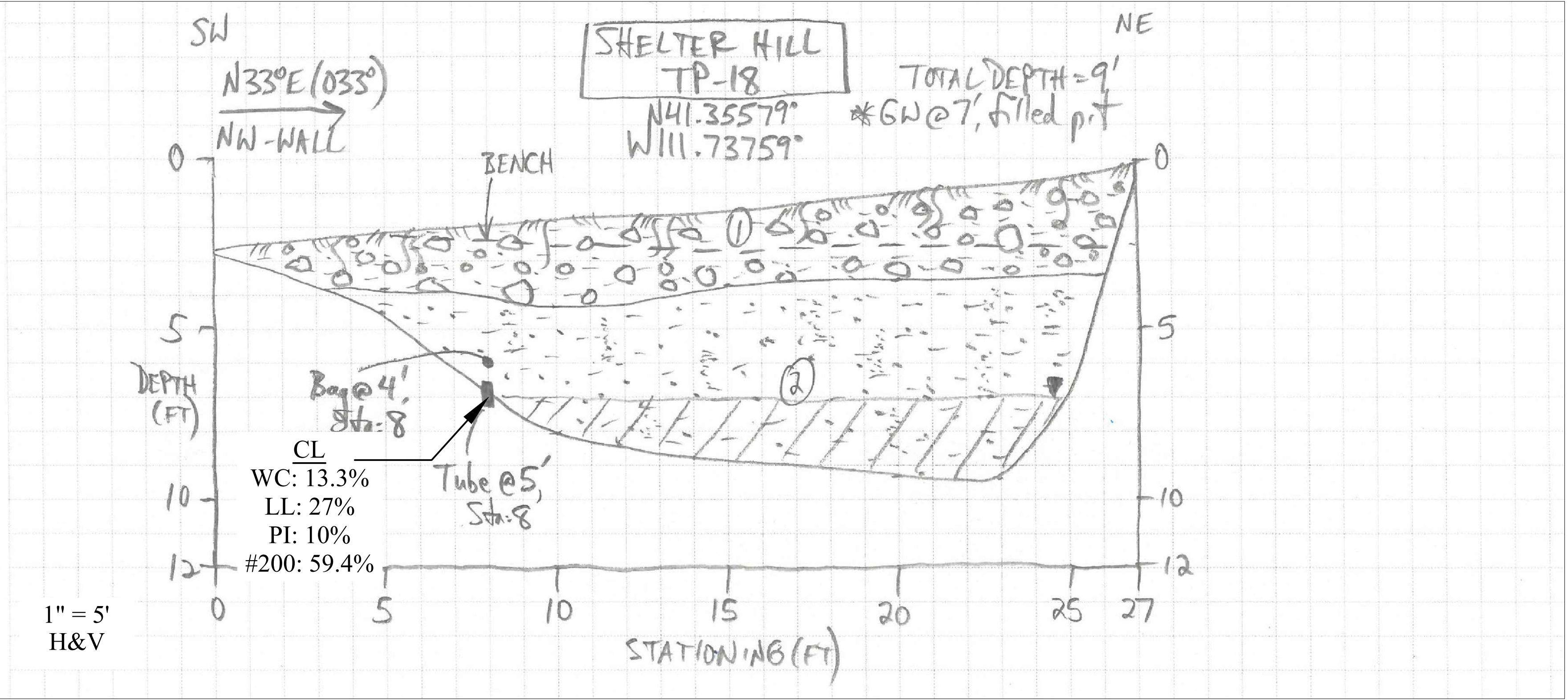
SH-TP-17 Log

Figure

A-15

Project No. 01628-040

Date 6-26-24
PED w/GWP



CL
WC: 13.3%
LL: 27%
PI: 10%
#200: 59.4%

1" = 5'
H&V

Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** ~2-2.75' thick; grayish brown (5Y 3/2) sandy lean CLAY with gravel (CL) grading to clayey GRAVEL with sand (GC), loose to medium stiff, dry to slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30-50% of unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 2' in diameter, mode ~3-5"; abundant plant and tree roots; no distinct stone line, just cobbly throughout; sharp, irregular basal contact.

2) **Wasatch Formation (Tw):** >6' thick; mottled moderate reddish brown (10R 4/6) and light brownish gray (5YR 6/1) sandy lean CLAY (CL) gradational to clayey SAND (SC), stiff to medium stiff, moist to wet, low to moderate plasticity, massive; devoid of clasts; mottled with light gray (N7) to light brownish gray (5YR 6/1) fine-grained sand in irregular subvertical lenses, usually associated with tree roots; calcium carbonate mottling along root traces near base of test pit; sand is fine-grained to very fine-grained; occasional to few plant and tree roots.

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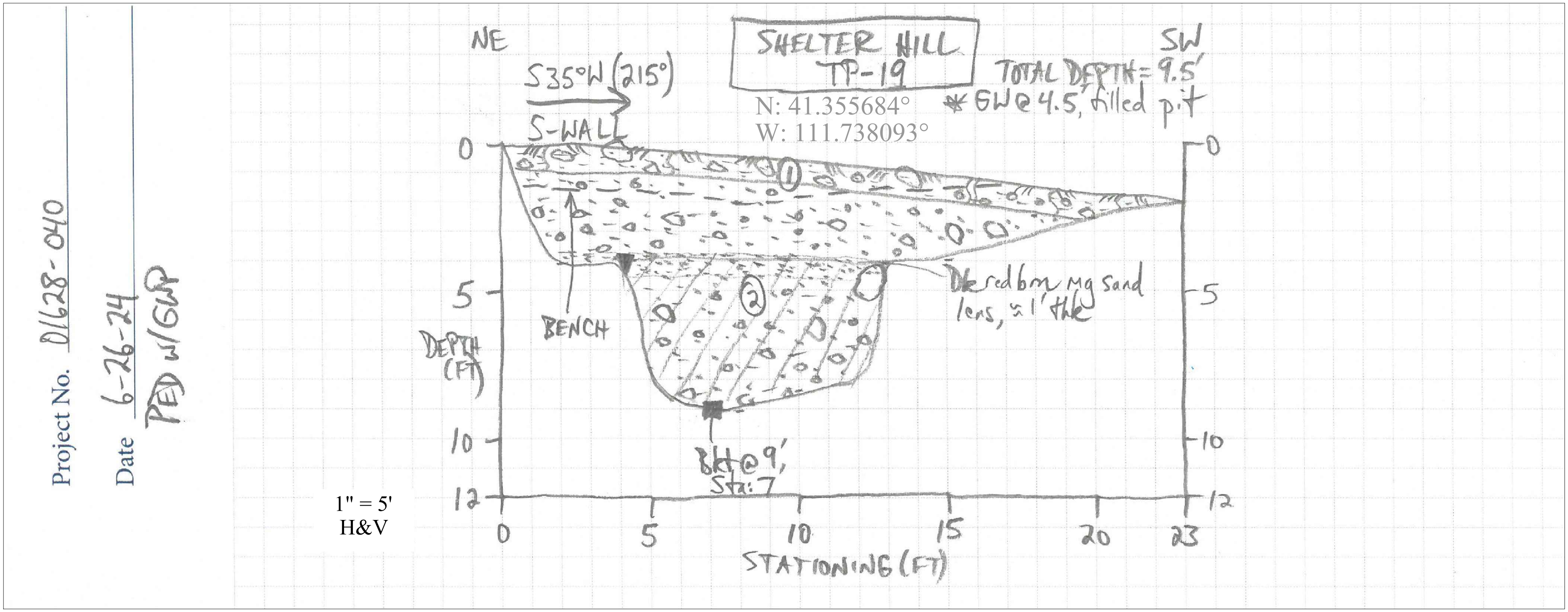
SH-TP-18 Log

Figure

A-16



Lithologic Unit Descriptions

1) **A/B Topsoil:** ~1' thick; brownish black (5YR 2/1) sandy lean CLAY with gravel (CL), loose to medium stiff, slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30-40% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 2' in diameter, mode ~1/2-1"; forming on underlying Wasatch Formation; abundant plant and tree roots; sharp, irregular basal contact.

2) **Wasatch Formation (Tw):** >8 thick; moderate reddish brown (10R 4/6) to moderate reddish orange (10R 6/6) clayey SAND with gravel (SC) grading to clayey GRAVEL with sand (GC), dense to medium dense, wet, low to moderate plasticity fines, massive to medium bedded; gravel and larger sized clasts comprise ~30-40% of unit; clasts are subrounded to rounded to subangular medium gray (N5) to light gray (N7) to purple quartzite and angular dark gray (N3) siltstone up to 3' in diameter, mode ~4-6"; sand is fine-grained to medium-grained; medium-grained coarse-grained sand lens in middle of unit heavily water bearing; more clayey in uppermost ~2' of unit.

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Weber County, Utah

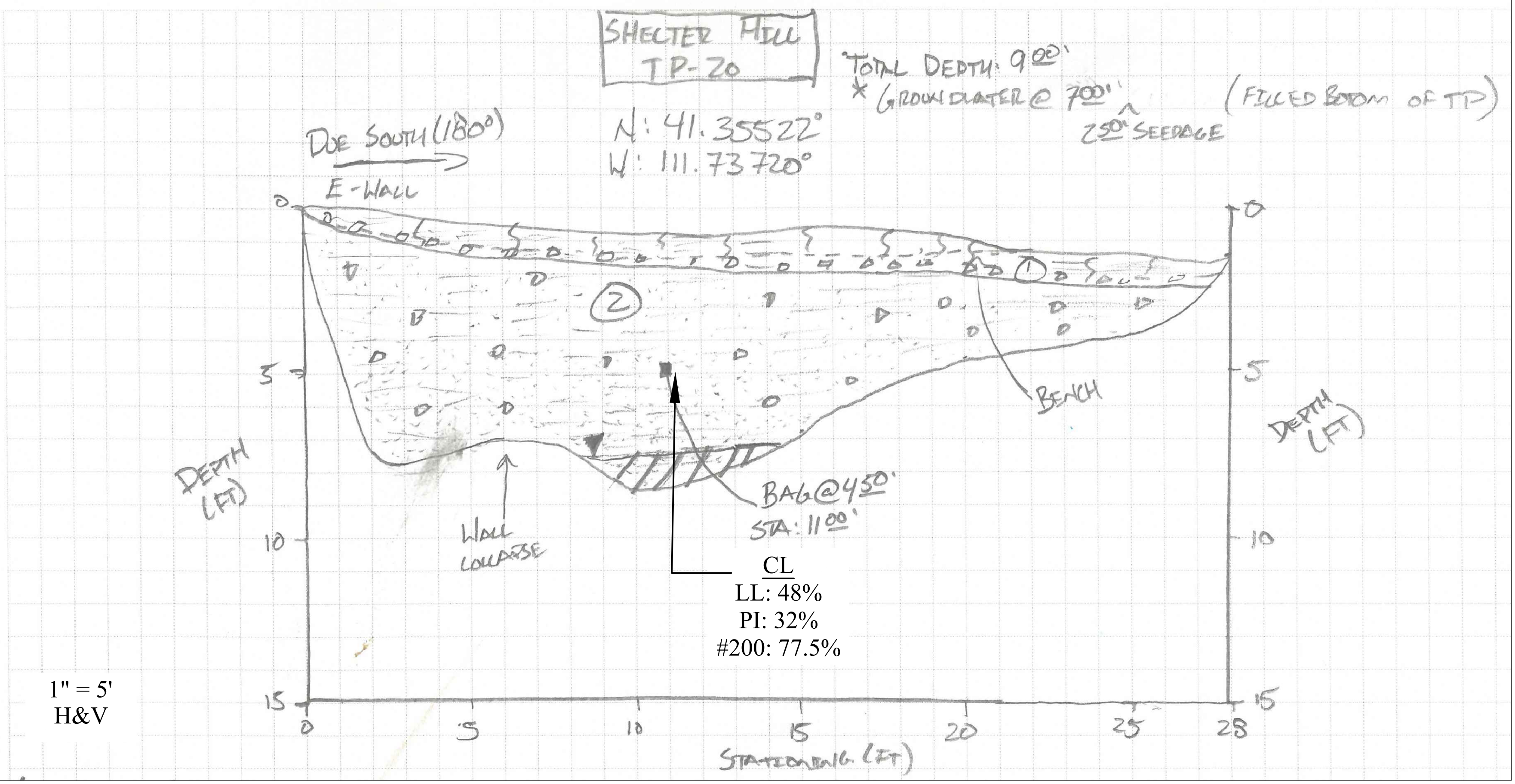
SH-TP-19 Log

Figure

A-17

Project No. 01628-040

Date 6/26/24
GWP w/ PED



Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** Up to 1.5' thick; brownish black (5YR 2/1) sandy lean CLAY with gravel (CL), loose to medium stiff, slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30-40% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 2' in diameter, mode ~1/2-1"; stone line along basal contact; abundant plant and tree roots; sharp, irregular basal contact.

2) **Wasatch Formation (Tw):** >6' thick; mottled moderate reddish brown (10R 4/6) and pale brown (5YR 5/2) sandy fat CLAY with gravel (CH), medium stiff to stiff, wet, moderate to high plasticity, massive to weakly bedded; gravel and larger sized clasts comprise ~10-20% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 6" in diameter, mode ~1/2-1"; sand component is fine-grained to medium-grained; common plant and tree roots.

*Major sluffing/collapse of sidewalls, logged outside of trench.

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Geotechnical and Geologic Hazard Study
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Weber County, Utah

SH-TP-20 Log

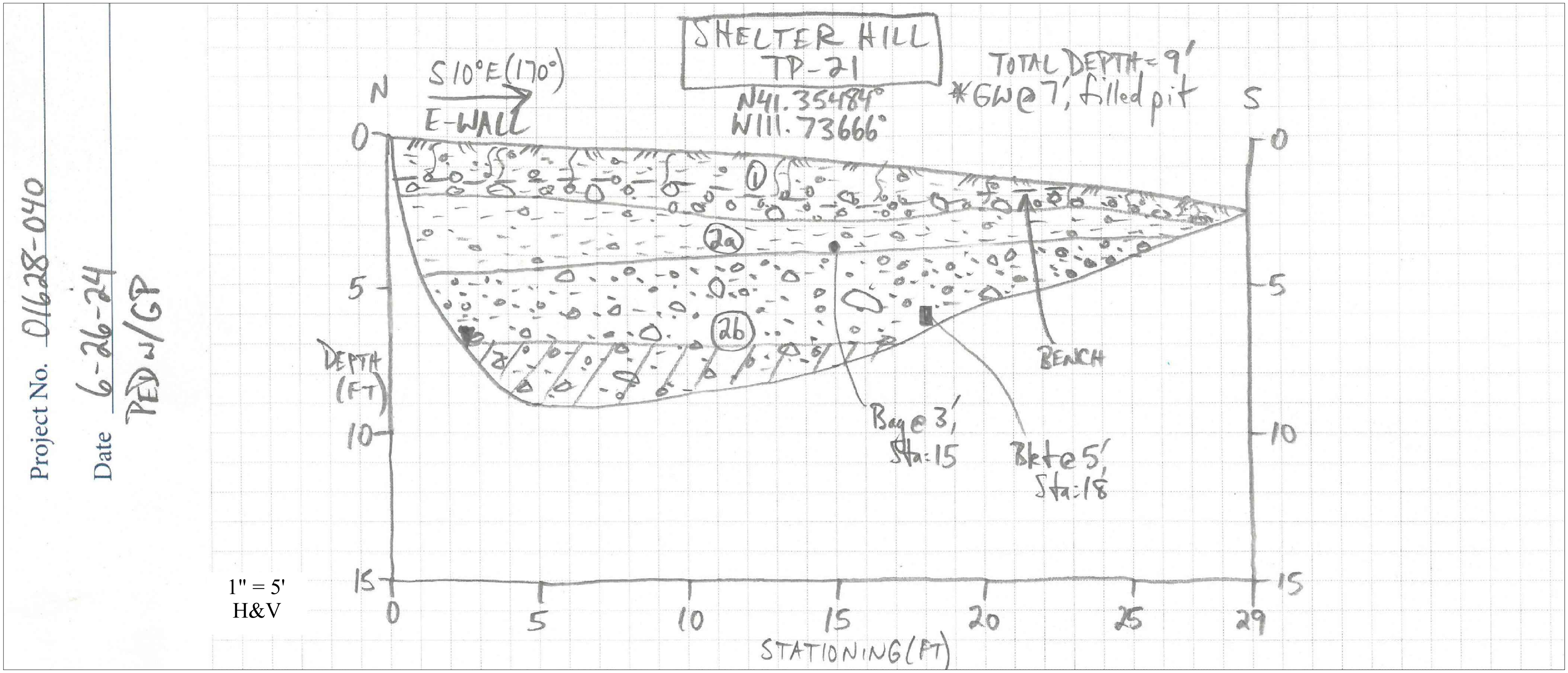
Figure

A-18

Project No. 01628-040

Date 6-26-24

PED w/GP



Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** 1-2' thick; brownish black (5YR 2/1) sandy lean CLAY with gravel (CL), loose to medium stiff, slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 10” in diameter, mode ~3-4”; stone line in basal ~1' of unit with ~50% gravel and larger sized clasts; abundant plant and tree roots; sharp, irregular basal contact.

2) **Wasatch Formation (Tw):** >7' thick; highly weathered conglomerate bedrock; 2 subunits:

2a. Up to 2.5' thick; moderate reddish brown (10R 4/6) sandy fat CLAY with gravel (CH), stiff to very stiff, moist, high plasticity, massive; gravel and larger sized clasts comprise ~15-20% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 6” in diameter, mode ~2-3”; slickensided in places, and brownish gray (5YR 4/1) where slickensided; thins to south; common to abundant plant and tree roots; sharp, planar basal contact.

2b. >4.5' thick; moderate reddish brown (10R 4/6) to moderate reddish orange (10R 6/6) clayey GRAVEL with sand (GC) grading to clayey SAND with gravel (SC), dense, moist to wet, moderate plasticity fines, massive; gravel and larger sized clasts comprise ~40% of unit; clasts are subrounded to subangular medium gray (N5) quartzite up to 2' in diameter, mode ~3-5”; occasional plant and tree roots.

IGES

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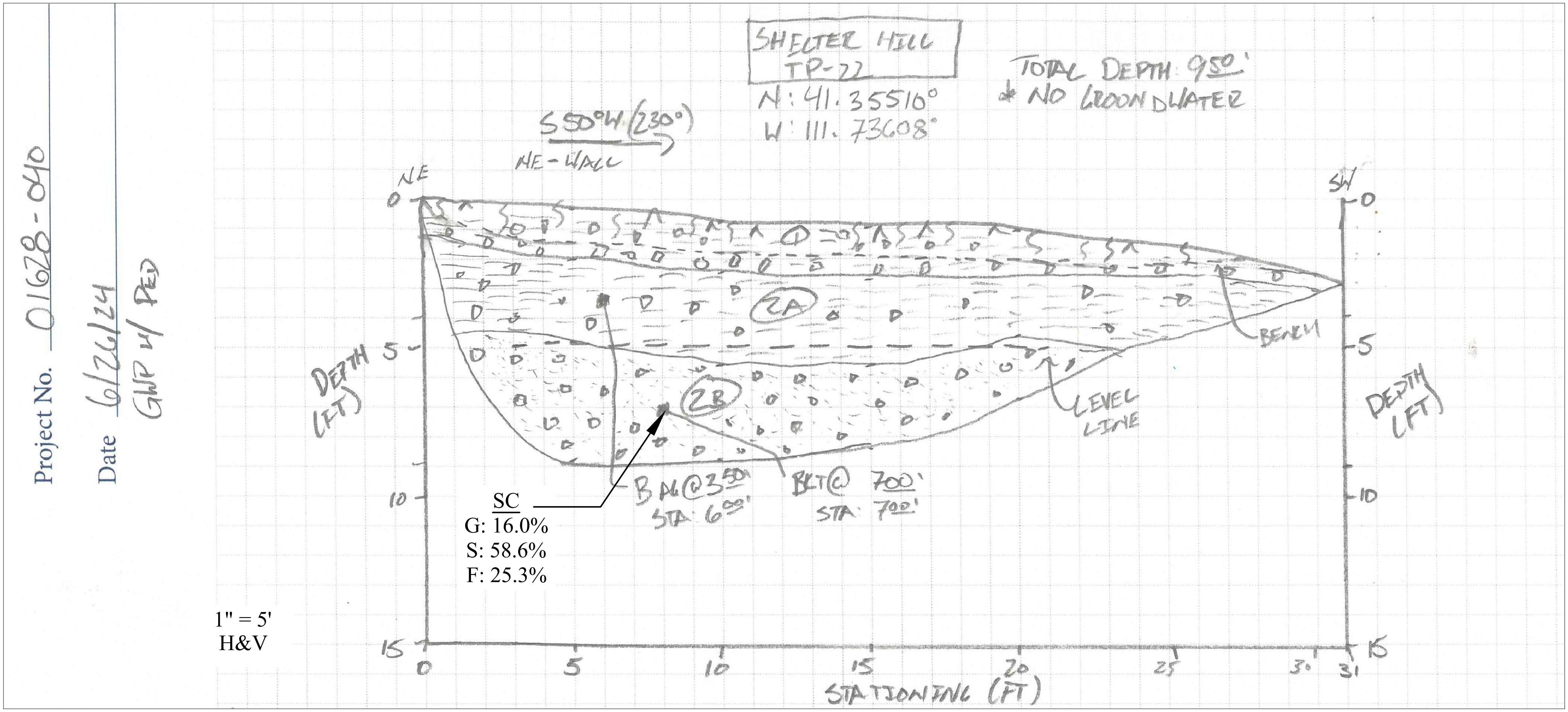
SH-TP-21 Log

Figure

A-19



Lithologic Unit Descriptions

1) **A/B Topsoil/Colluvium (Qc):** Up to 2' thick; brownish black (5YR 2/1) sandy lean CLAY with gravel (CL), loose to medium stiff, slightly moist, low plasticity, massive; gravel and larger sized clasts comprise ~30% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 10" in diameter, mode ~3-4"; stone line in basal ~1' of unit with ~50% gravel and larger sized clasts; abundant plant and tree roots; sharp, irregular basal contact.

2) **Wasatch Formation (Tw):** >7' thick; highly weathered conglomerate bedrock; 2 subunits:

2a. Up to 3.5' thick; moderate reddish brown (10R 4/6) mottled with light brownish gray (5YR 6/1) and light gray (N7) sandy fat CLAY with gravel (CH), stiff to very stiff, moist, high plasticity, massive; gravel and larger sized clasts comprise ~15-20% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 6" in diameter, mode ~2-3"; abundant slickensides and brownish gray (5YR 4/1) where slickensided; occasional pinholes <1mm diameter; common to abundant plant and tree roots; sharp, wavy basal contact.

2b. >3.5' thick; moderate reddish brown (10R 4/6) poorly-graded SAND with gravel (SP), loose to medium dense, slightly moist, moderate plasticity fines, massive to weakly bedded; gravel and larger sized clasts comprise ~20-30% of unit; clasts are subangular to subrounded medium gray (N5) quartzite up to 12" in diameter, mode ~1-2"; sand component is medium-grained to coarse-grained; some silty lean clay lenses; occasional plant and tree roots.

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Geotechnical and Geologic Hazard Study
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Powder Mountain Resort
Weber County, Utah

SH-TP-22 Log

Figure

A-20

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

⊕	BORING SAMPLE LOCATION	⧗	TEST-PIT SAMPLE LOCATION
▼	WATER LEVEL (level after completion)	▽	WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKLY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBURG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2"
LAYER	1/2 - 12"

DESCRIPTION	THICKNESS
OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY A FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

CONSISTENCY - FINE-GRAINED SOIL

		TORVANE	POCKET PENETROMETER	FIELD TEST
CONSISTENCY	SPT (blows/ft)	UNTRAINED SHEAR STRENGTH (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

IGES

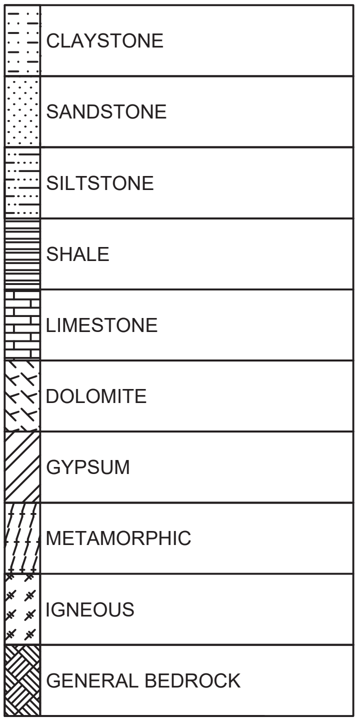
KEY TO SOIL SYMBOLS AND TERMINOLOGY

Project Number - 01628-046

Figure

A- 21

TYPICAL ROCK DESCRIPTION AND GRAPHICAL SYMBOLS



LOG KEY SYMBOLS

⊕	BORING OR CORE SAMPLE LOCATION	⧗	TEST-PIT SAMPLE LOCATION
▼	WATER LEVEL (level after completion)	▽	WATER LEVEL (level where first encountered)

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBURG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD
P	POINT LOAD		

FRACTURING

SPACING	DESCRIPTION
>6 FT	VERY WIDELY
2-6 FT	WIDELY
8-24 IN	MODERATELY
2 1/2 -8 IN	CLOSELY
3/4 - 2 1/2 IN	VERY CLOSELY

WEATHERING

WEATHERING	FIELD TEST
FRESH	NO VISIBLE SIGN OF DECOMPOSITION OR DISCOLORATION. RINGS UNDER HAMMER IMPACT.
SLIGHTLY WEATHERED	SLIGHT DISCOLORATION INWARDS FROM OPEN FRACTURES, OTHERWISE SIMILAR TO FRESH.
MODERATELY WEATHERED	DISCOLORATION THROUGHOUT. WEAKER MINERALS SUCH AS FELDSPAR ARE DECOMPOSED. STRENGTH SOMEWHAT LESS THAN FRESH ROCK BUT CORES CANNOT BE BROKEN BY HAND OR SCRAPED WITH A KNIFE.
HIGHLY WEATHERED	MOST MINERALS SOMEWHAT DECOMPOSED. SPECIMENS CAN BE BROKEN BY HAND WITH EFFORT OR SHAVED WITH A KNIFE. TEXTURE PRESERVED.
COMPLETELY WEATHERED	MINERALS DECOMPOSED TO SOIL BUT FABRIC AND STRUCTURE PRESERVED. SPECIMENS EASILY CRUMBLE OR PENETRATED.

RQD

RQD (%)	ROCK QUALITY
90-100	EXCELLENT
75-90	GOOD
50-75	FAIR
25-50	POOR
0-25	VERY POOR

COMPETENCY

CLASS	STRENGTH	FIELD TEST	APPROXIMATE RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TSF)
I	EXTREMELY STRONG	MANY BLOWS WITH GEOLOGIC HAMMER REQUIRED TO BREAK INTACT SPECIMEN.	>2000
II	VERY STRONG	HAND-HELD SPECIMEN BREAKS WITH PICK END OF HAMMER UNDER MORE THAN ONE BLOW.	2000-1000
III	STRONG	CANNOT BE SCRAPED OR PEELED WITH KNIFE, HAND-HELD SPECIMEN CAN BE BROKEN WITH SINGLE MODERATE BLOW WITH PICK END OF HAMMER	1000-500
IV	MODERATELY STRONG	CAN JUST BE SCRAPED OR PEELED WITH KNIFE. INDENTATIONS 1-3 mm SHOW IN SPECIMEN WITH MODERATE BLOW WITH PICK END OF HAMMER	500-250
V	WEAK	MATERIAL CRUMBLES UNDER MODERATE BLOW WITH PICK END OF HAMMER AND CAN BE PEELED WITH KNIFE, BUT IS HARD TO HAND-TRIM FOR TRIAXIAL TEST SPECIMEN.	250-10
VI	FRIABLE	MATERIAL CRUMBLES IN HAND.	N/A

BEDDING OF SEDIMENTARY ROCKS

SPLITTING PROPERTY	THICKNESS	STRATIFICATION
MASSIVE	>4.0 FT	VERY THICK BEDDED
BLOCKY	2.0-4.0 FT	THICK-BEDDED
SLABBY	2 1/2-24 IN	THIN-BEDDED
FLAGGY	1/2-2 1/2 IN	VERY THIN-BEDDED
SHALY OR PLATY	1/8-1/2 IN	LAMINATED
PAPERY	<1/8 IN	THINLY LAMINATED

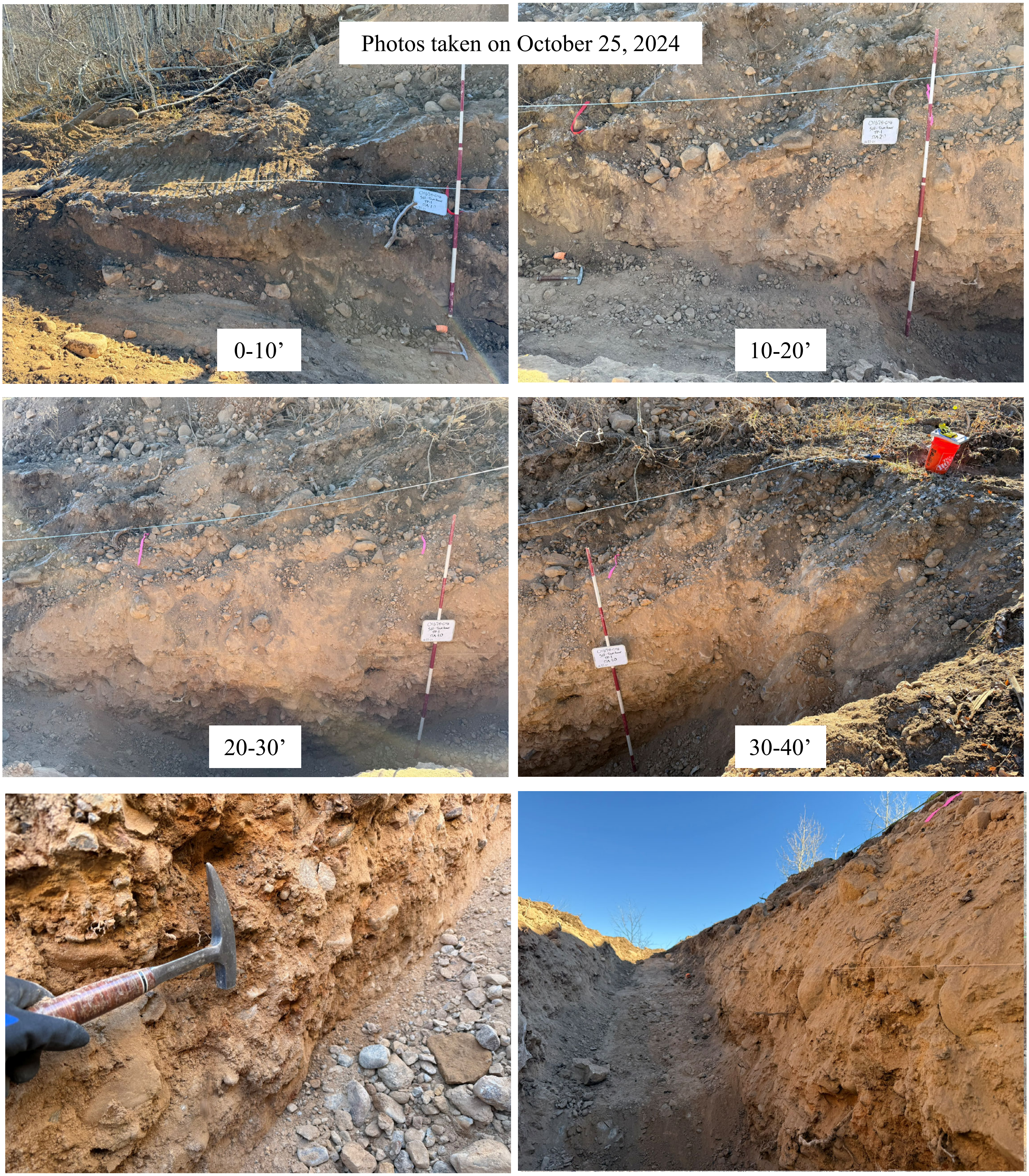
IGES

KEY TO PHYSICAL ROCK PROPERTIES

Project Number -01628-046

Figure

A-22


Photos taken on October 25, 2024

0-10’

10-20’

20-30’

30-40’

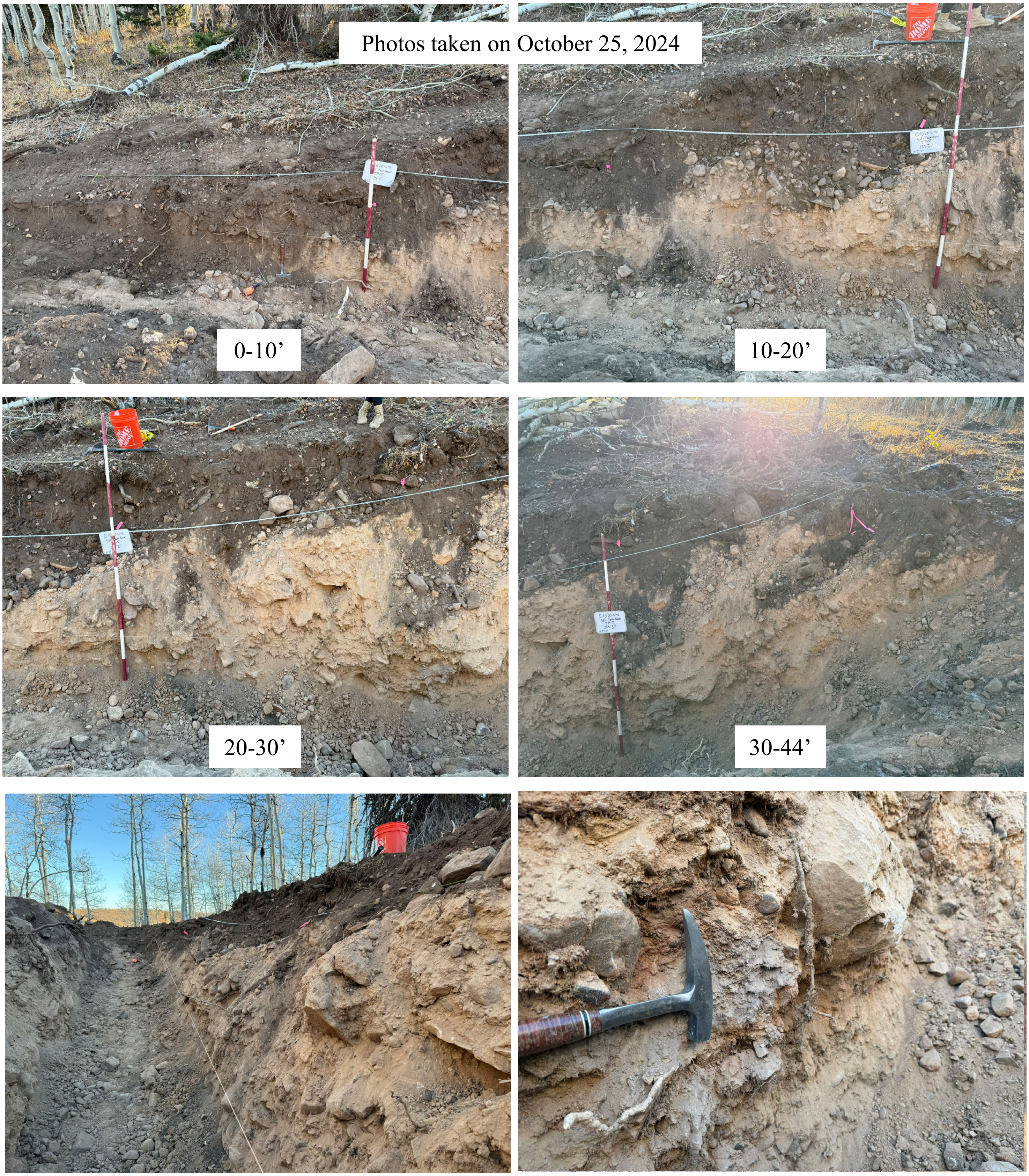
TP-1

Project Number: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

SELECT TEST PIT PHOTOS

Figure A-23a



TP-2

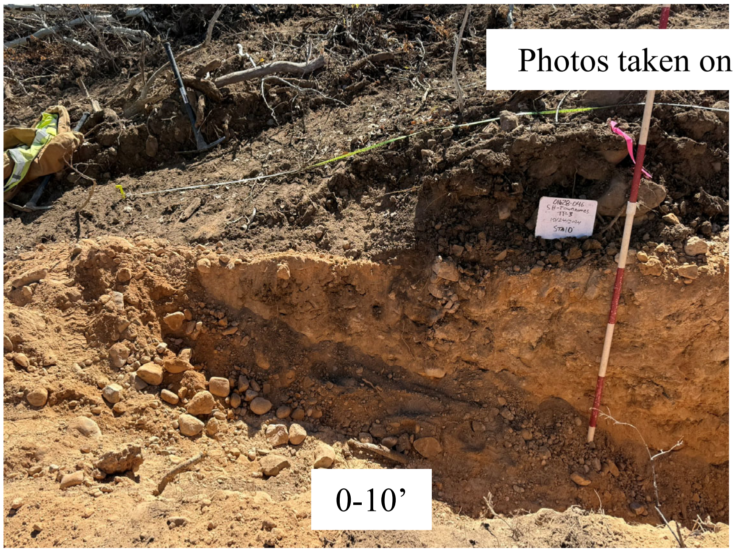
Project Number: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

SELECT TEST PIT PHOTOS

Figure A-23b

Photos taken on October 24, 2024


0-10’


10-20’


20-30’


30-40’

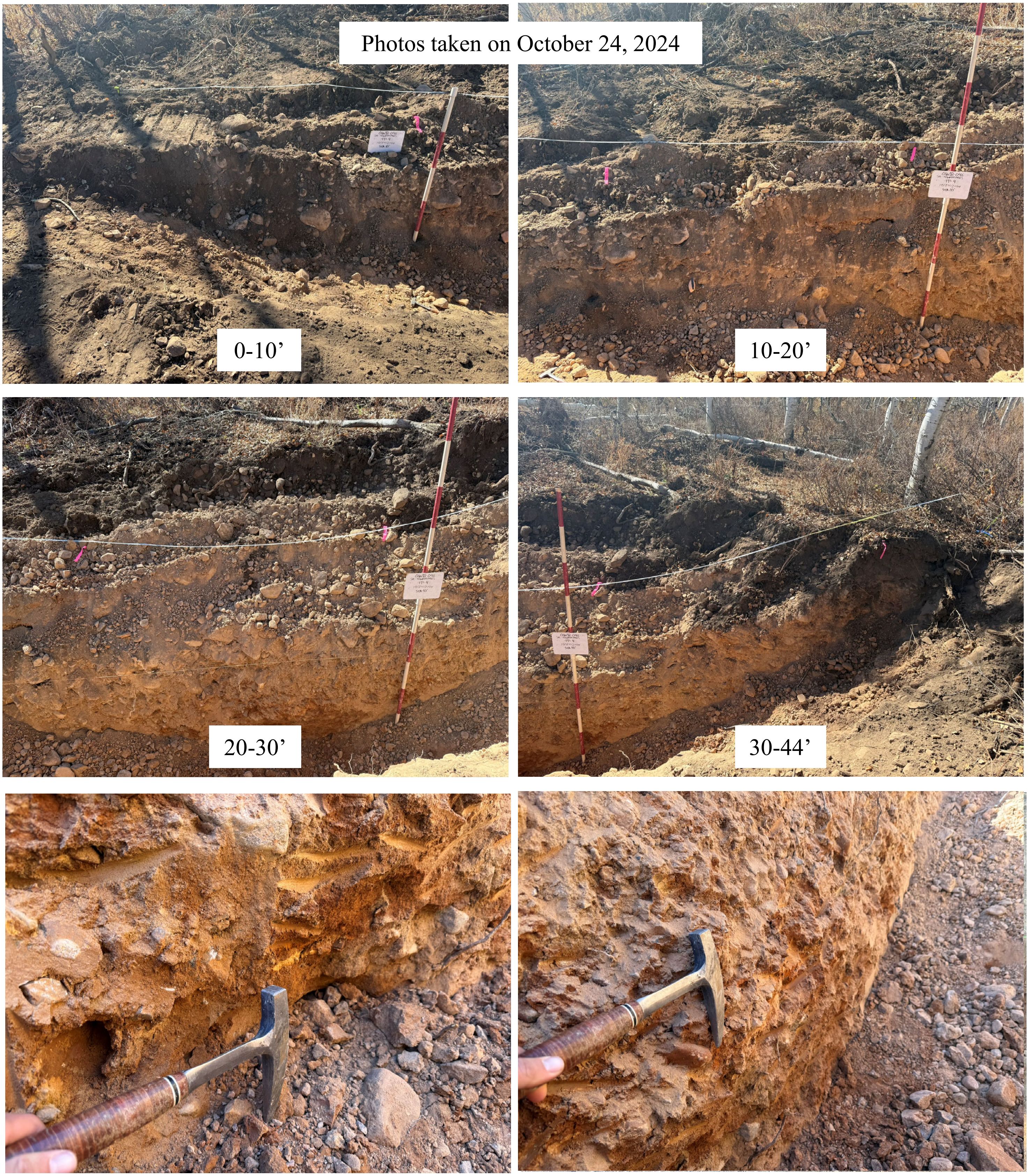
TP-3

Project Number: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

SELECT TEST PIT PHOTOS

Figure A-23c


Photos taken on October 24, 2024

TP-4

Project Number: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

SELECT TEST PIT PHOTOS

Figure A-23d

TP-5

Project Number: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

SELECT TEST PIT PHOTOS

Figure A-23e

APPENDIX B

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: Shelter Hill- Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/4/2024
By: JG

Sample Info.	Boring No.	TP-4							
	Station	28							
	Depth	7.5'							
	Split	Yes							
	Split sieve	3/8"							
Total sample (g)		4565.3							
Moist coarse fraction (g)		125.11							
Moist split fraction (g)		4440.19							
	Sample height, *H* (in)								
	Sample diameter, *D* (in)								
	Mass rings + wet soil (g)								
	Mass rings/tare (g)								
	Total unit wt., γ (pcf)								
Coarse Fraction	Wet soil + tare (g)	251.48							
	Dry soil + tare (g)	248.25							
	Tare (g)	126.38							
	Water content (%)	2.7							
Split Fraction	Wet soil + tare (g)	401.36							
	Dry soil + tare (g)	385.32							
	Tare (g)	160.36							
	Water content (%)	7.1							
Water content, ω (%)		**7.0**							
Dry unit weight, γ_d (pcf)									

Entered by:___________

Reviewed:___________

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

(In general accordance with ASTM D6913)

Project: **Shelter Hill- Townhomes**
No: **01628-046**
Location: Powder Mountain
Date: 12/4/2024
By: JG

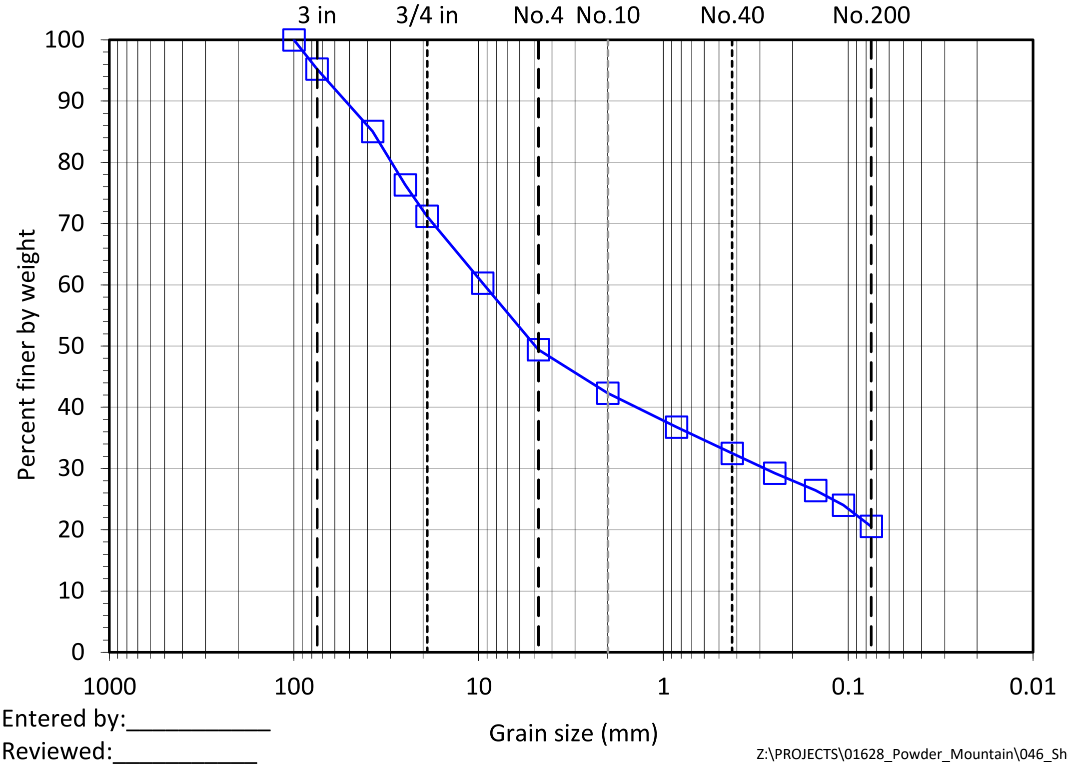
Boring No.: **TP-1**
Station: **25**
Depth: **9.5'**
Description: Light brown clayey gravel with sand

	Moist	Dry
Split:	Yes	
First Split sieve:	3/4"	
Total sample wt. (g):	26869.4	26352.4
+3/4" Coarse fraction (g):	7697.19	7591.15
-3/4" Split fraction (g):	1849.82	1810.17
-3/8" Split fraction (g):	433.77	433.77
First Split fraction:	0.712	

Water content data	C.F.1(+3/4")	S.F.1(-3/4")	C.F.2(+3/8")	S.F.2(-3/8")
Moist soil + tare (g):	1049.49	2164.79	402.15	561.35
Dry soil + tare (g):	1038.00	2125.14	402.15	561.35
Tare (g):	215.43	314.97	124.51	127.58
Water content (%):	1.40	2.19	0.00	0.00

Second Split Data
Second split: Yes
Second split sieve: 3/8"
Second Split fraction: 0.603

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	100.0	
3"	1249.98	75	95.3	
1.5"	3943.37	37.5	85.0	
1"	6236.63	25	76.3	
3/4"	7591.15	19	71.2	<=1st Split
3/8"	277.64	9.5	60.3	<=2nd Split
No.4	78.02	4.75	49.4	
No.10	129.37	2	42.3	
No.20	169.10	0.85	36.8	
No.40	200.05	0.425	32.5	
No.60	223.04	0.25	29.3	
No.100	243.63	0.15	26.4	
No.140	260.86	0.106	24.0	
No.200	285.64	0.075	20.6	



Gravel (%): 50.6
Sand (%): 28.8
Fines (%): 20.6

Comments:

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

Entered by:___________
Reviewed:___________

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

(ASTM D6913)

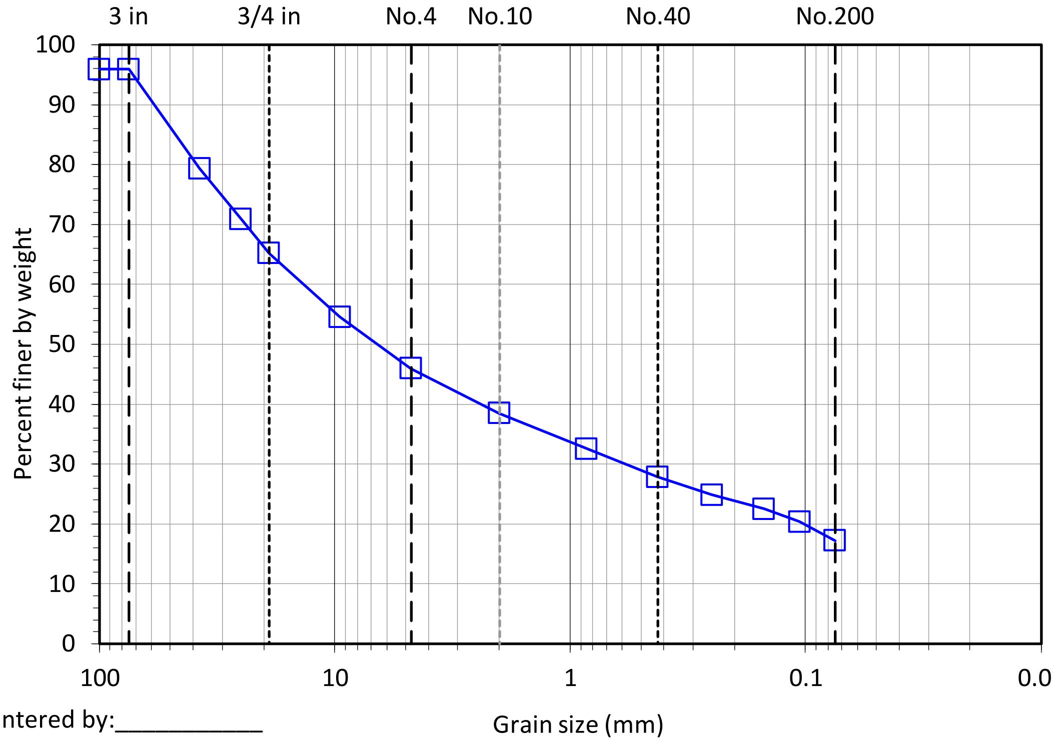
Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/4/2024
By: JG

Boring No.: TP-2
Station: 30
Depth: 6.0'
Description: Brown clayey gravel with sand

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	52504.9	51973.7
+3/8" Coarse fraction (g):	23785.41	23604.63
-3/8" Split fraction (g):	342.54	338.36
Split fraction:	0.546	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	1730.14	469.19
Dry soil + tare (g):	1719.35	465.01
Tare (g):	310.52	126.65
Water content (%):	0.8	1.2

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	100.0	
4"	2111.68	100	95.9	
3"	2111.68	75	95.9	
1.5"	10740.10	37.5	79.3	
1"	15127.24	25	70.9	
3/4"	18079.45	19	65.2	
3/8"	23604.63	9.5	54.6	←Split
No.4	53.33	4.75	46.0	
No.10	99.75	2	38.5	
No.20	136.52	0.85	32.6	
No.40	165.81	0.425	27.8	
No.60	184.15	0.25	24.9	
No.100	198.83	0.15	22.5	
No.140	212.06	0.106	20.4	
No.200	231.25	0.075	17.3	



Gravel (%): 54.0
Sand (%): 28.7
Fines (%): 17.3

Comments:

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

Entered by:____________
Reviewed:____________

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

(In general accordance with ASTM D6913)

Project: Shelter Hill- Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/5/2024
By: JG

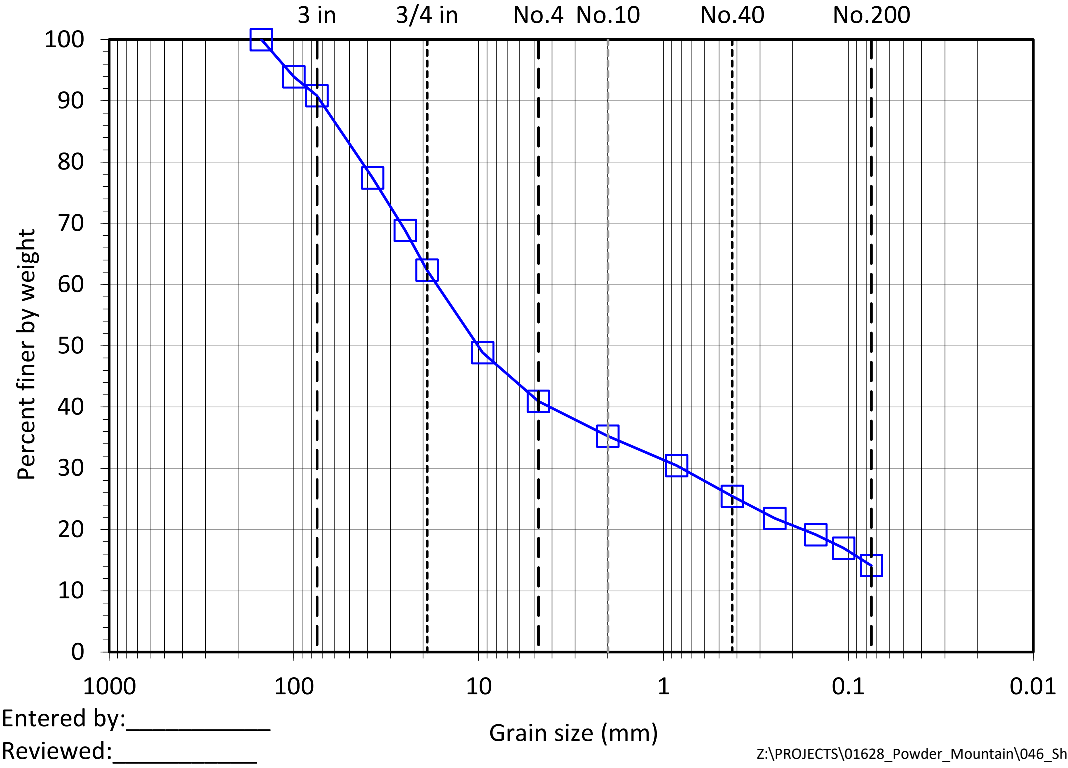
Boring No.: TP-3
Station: 22
Depth: 7.5'
Description: Brown clayey gravel with sand

Split:	Yes	
First Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	28467.6	27871.0
+3/4" Coarse fraction (g):	10588.19	10484.46
-3/4" Split fraction (g):	1655.56	1609.92
-3/8" Split fraction (g):	271.12	271.12
First Split fraction:	0.624	

Water content data	C.F.1(+3/4")	S.F.1(-3/4")	C.F.2(+3/8")	S.F.2(-3/8")
Moist soil + tare (g):	1793.58	1987.71	573.92	399.53
Dry soil + tare (g):	1779.22	1942.07	573.92	399.53
Tare (g):	327.81	332.15	226.60	128.41
Water content (%):	0.99	2.83	0.00	0.00

Second Split Data
Second split: Yes
Second split sieve: 3/8"
Second Split fraction: 0.489

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	100.0	
4"	1686.41	100	93.9	
3"	2542.04	75	90.9	
1.5"	6287.47	37.5	77.4	
1"	8683.60	25	68.8	
3/4"	10484.46	19	62.4	<=1st Split
3/8"	347.33	9.5	48.9	<=2nd Split
No.4	44.25	4.75	40.9	
No.10	75.76	2	35.3	
No.20	102.23	0.85	30.5	
No.40	130.19	0.425	25.4	
No.60	149.97	0.25	21.9	
No.100	164.72	0.15	19.2	
No.140	177.02	0.106	17.0	
No.200	192.70	0.075	14.2	



Gravel (%): 59.1
Sand (%): 26.8
Fines (%): 14.2

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

Entered by:___________
Reviewed:___________

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

(In general accordance with ASTM D6913)

Project: Shelter Hill- Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/5/2024
By: JG

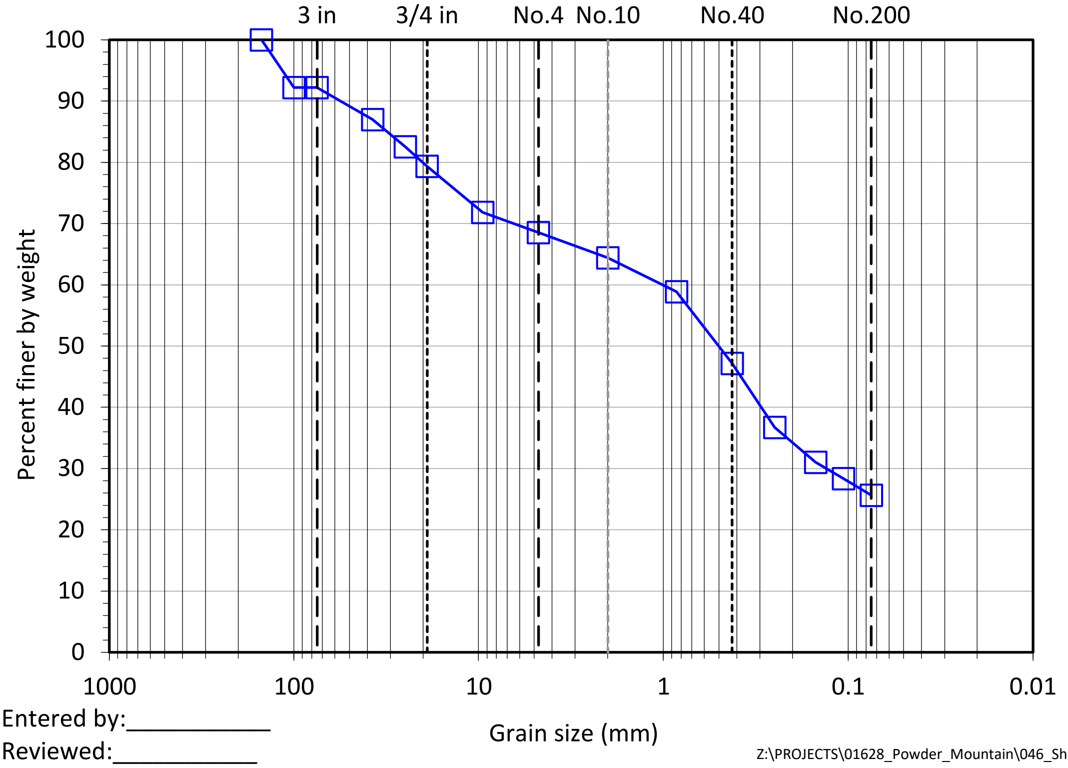
Boring No.: TP-4
Station: 27
Depth: 6.0'
Description: Brown clayey sand with gravel

Split:	Yes	
First Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	23624.1	22676.4
+3/4" Coarse fraction (g):	4707.08	4676.31
-3/4" Split fraction (g):	1556.15	1480.72
-3/8" Split fraction (g):	255.79	255.79
First Split fraction:	0.794	

Water content data	C.F.1(+3/4")	S.F.1(-3/4")	C.F.2(+3/8")	S.F.2(-3/8")
Moist soil + tare (g):	948.99	1867.07	266.81	470.79
Dry soil + tare (g):	944.22	1791.64	266.81	470.79
Tare (g):	219.38	310.92	126.63	215.00
Water content (%):	0.66	5.09	0.00	0.00

Second Split Data
Second split: Yes
Second split sieve: 3/8"
Second Split fraction: 0.719

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	100.0	
4"	1763.67	100	92.2	
3"	1763.67	75	92.2	
1.5"	2948.60	37.5	87.0	
1"	3951.31	25	82.6	
3/4"	4676.31	19	79.4	<=1st Split
3/8"	140.22	9.5	71.9	<=2nd Split
No.4	11.81	4.75	68.5	
No.10	26.47	2	64.4	
No.20	46.12	0.85	58.9	
No.40	87.78	0.425	47.2	
No.60	125.06	0.25	36.7	
No.100	145.39	0.15	31.0	
No.140	154.72	0.106	28.4	
No.200	164.39	0.075	25.7	



Gravel (%): 31.5
Sand (%): 42.9
Fines (%): 25.7

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

Entered by:____________
Reviewed:____________

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

(ASTM D6913)

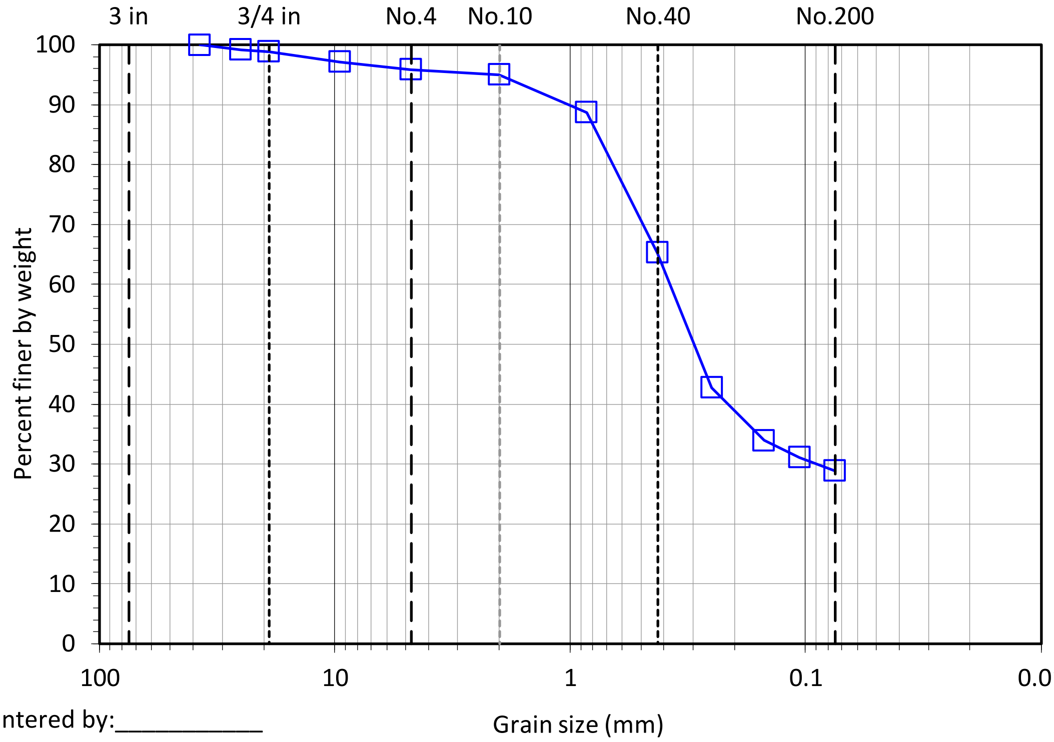
Project: **Shelter Hill-Townhomes**
No: **01628-046**
Location: Powder Mountain
Date: 12/5/2024
By: JG

Boring No.: **TP-4**
Station: **28**
Depth: **7.5'**
Description: Reddish brown clayey sand

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	4565.3	4266.5
+3/8" Coarse fraction (g):	125.11	121.88
-3/8" Split fraction (g):	241.00	224.96
Split fraction:	0.971	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	251.48	401.36
Dry soil + tare (g):	248.25	385.32
Tare (g):	126.38	160.36
Water content (%):	2.7	7.1

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	100.0	
1"	35.17	25	99.2	
3/4"	48.97	19	98.9	
3/8"	121.88	9.5	97.1	←Split
No.4	3.03	4.75	95.8	
No.10	4.95	2	95.0	
No.20	19.60	0.85	88.7	
No.40	73.68	0.425	65.3	
No.60	125.90	0.25	42.8	
No.100	146.39	0.15	33.9	
No.140	152.95	0.106	31.1	
No.200	157.99	0.075	28.9	



Gravel (%): 4.2
Sand (%): 66.9
Fines (%): 28.9

Entered by:___________
Reviewed:___________

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

(In general accordance with ASTM D6913)

Project: Shelter Hill- Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/5/2024
By: JG

Boring No.: TP-5
Station: 26
Depth: 7.5'
Description: Brown clayey gravel with sand

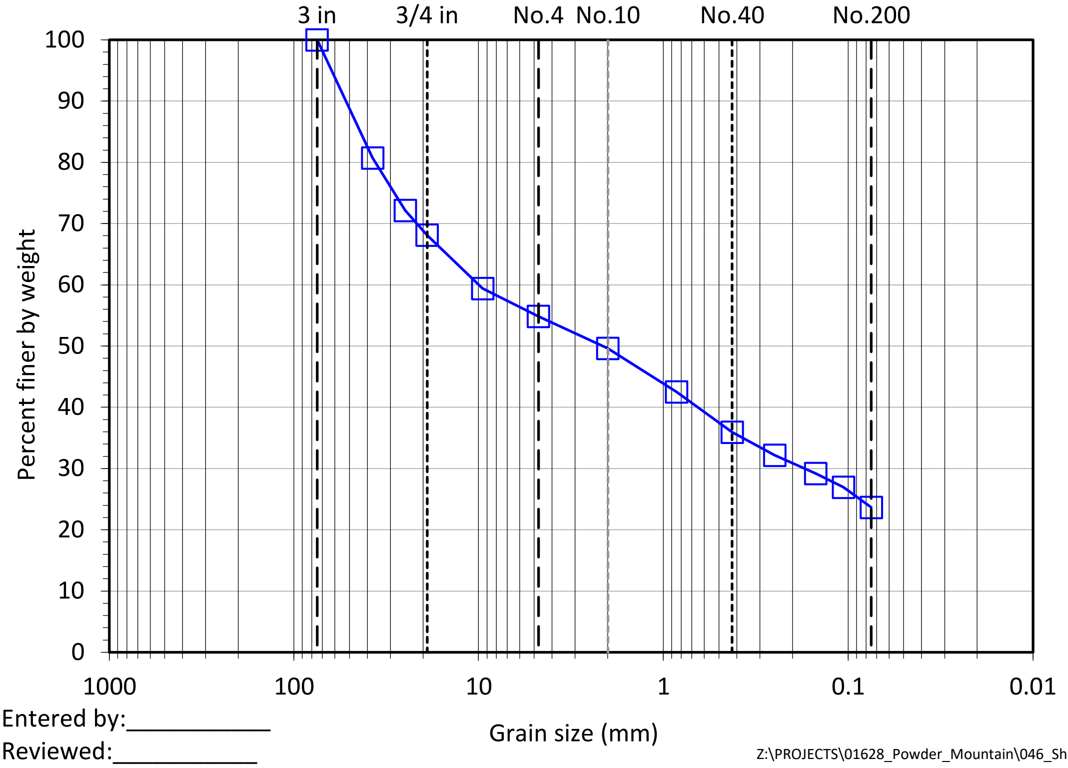
Split:	Yes	
First Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	25602.7	24339.1
+3/4" Coarse fraction (g):	7888.00	7754.85
-3/4" Split fraction (g):	1510.01	1413.65
-3/8" Split fraction (g):	340.89	340.89
First Split fraction:	0.681	

Water content data	C.F.1(+3/4")	S.F.1(-3/4")	C.F.2(+3/8")	S.F.2(-3/8")
Moist soil + tare (g):	1365.45	1918.40	309.62	467.60
Dry soil + tare (g):	1349.02	1822.04	309.62	467.60
Tare (g):	392.09	408.39	128.60	126.71
Water content (%):	1.72	6.82	0.00	0.00

Second Split Data

Second split:	Yes
Second split sieve:	3/8"
Second Split fraction:	0.594

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	4690.75	37.5	80.7	
1"	6780.86	25	72.1	
3/4"	7754.85	19	68.1	<=1st Split
3/8"	181.08	9.5	59.4	<=2nd Split
No.4	26.13	4.75	54.9	
No.10	56.05	2	49.6	
No.20	96.95	0.85	42.5	
No.40	134.71	0.425	35.9	
No.60	156.14	0.25	32.2	
No.100	173.28	0.15	29.2	
No.140	186.23	0.106	27.0	
No.200	204.97	0.075	23.7	



Gravel (%): 45.1
Sand (%): 31.2
Fines (%): 23.7

Comments:

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

Entered by:___________

Reviewed:___________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/5/2024
By: RH

Boring No.: TP-2
Station: 30
Depth: 6.0'
Sample Description: Brown clayey gravel with sand
Engineering Classification: Not requested
As-received water content (%): Not requested

Method: ASTM D1557 C
Mold Id. INC 7
Mold volume (ft^3): 0.0752

Preparation method: Moist
Rammer: Mechanical-sector face
Rock Correction: Yes * See results below
Percent fraction retained, Pc (%) 30.0
Percent fraction passing, Pf (%) 70.0

Optimum water content (%): 9.7
Maximum dry unit weight (pcf): 122.4

Point Number	+10%	+12%	+8%	+6%				
Wt. Sample + Mold (g)	11016.6	11006.2	11013.3	10852.0				
Wt. of Mold (g)	6453.8	6453.8	6453.8	6453.8				
Total Unit Wt., γ (pcf)	133.7	133.4	133.6	128.9				
Wet Soil + Tare (g)	1802.52	1921.70	1880.67	1724.69				
Dry Soil + Tare (g)	1653.12	1750.90	1747.99	1632.75				
Tare (g)	312.78	410.33	331.45	324.12				
Water Content, w (%)	**11.1**	**12.7**	**9.4**	**7.0**				
Dry Unit Wt., γ_d (pcf)	**120.3**	**118.3**	**122.2**	**120.4**				

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

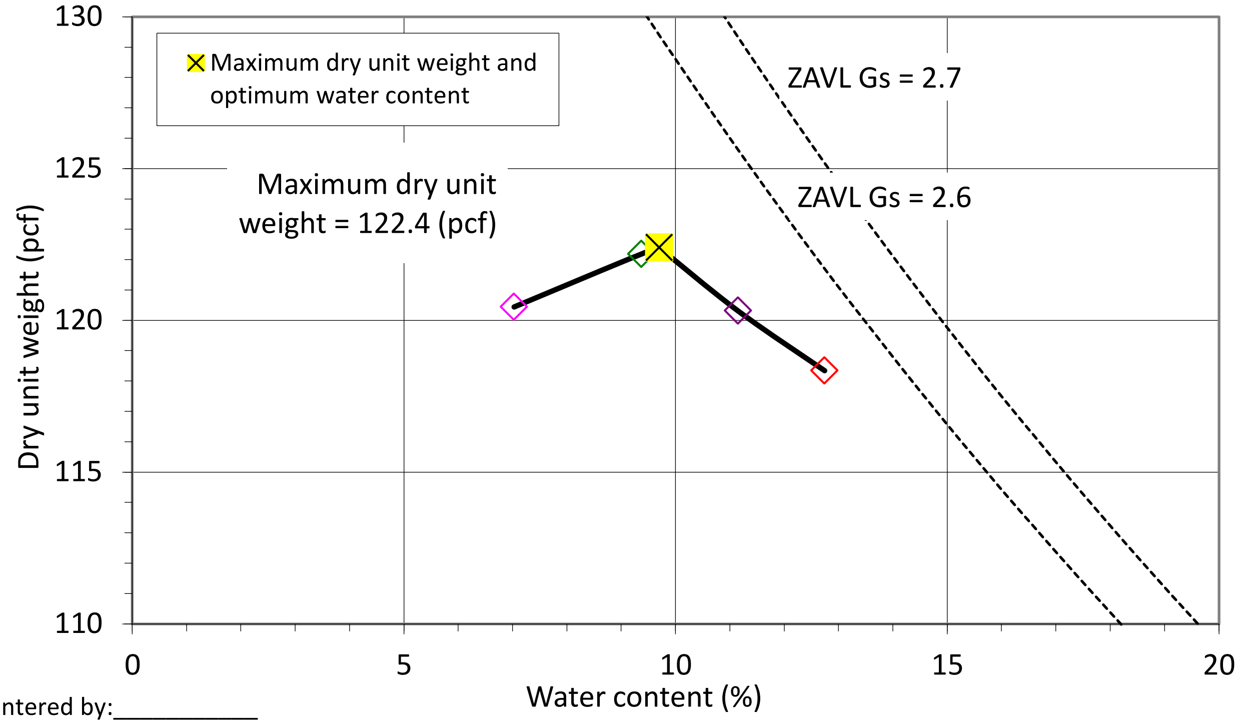
(ASTM D4718)

Oversized fraction, +3/4-in. (%): 30.0
Water content, +3/4-in. (%): 0.8
Sieve for oversized fraction: 3/4-in.
Bulk specific gravity, Gs: 2.65 Assumed

Corrected water content (%): 7.0
Corrected dry unit weight (pcf): 132.8

Comments:

According to ASTM D4718 the maximum allowable 3/4" oversized fraction is 30%. The actual 3/4" oversized fraction is 34.8%.



Entered by:___________

Reviewed:___________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/6/2024
By: RH

Boring No.: TP-3
Station: 22
Depth: 7.5'
Sample Description: Brown clayey gravel with sand
Engineering Classification: Not requested
As-received water content (%): Not requested

Method: ASTM D1557 C
Mold Id. INC 7
Mold volume (ft^3): 0.0752

Preparation method: Moist
Rammer: Mechanical-sector face
Rock Correction: Yes * See results below
Percent fraction retained, Pc (%) 30.0
Percent fraction passing, Pf (%) 70.0

Optimum water content (%): 7.0
Maximum dry unit weight (pcf): 130.0

Point Number	8%	+6%*	+4%*	+2%*				
Wt. Sample + Mold (g)	11121.2	11214.8	11097.4	10848.0				
Wt. of Mold (g)	6453.8	6453.8	6453.8	6453.8				
Total Unit Wt., γ (pcf)	136.8	139.5	136.1	128.8				
Wet Soil + Tare (g)	1361.50	1439.59	1474.19	1494.93				
Dry Soil + Tare (g)	1260.08	1352.95	1418.12	1452.21				
Tare (g)	328.29	312.29	464.51	446.46				
Water Content, w (%)	10.9	8.3	5.9	4.2				
Dry Unit Wt., γ_d (pcf)	123.4	128.8	128.5	123.5				

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

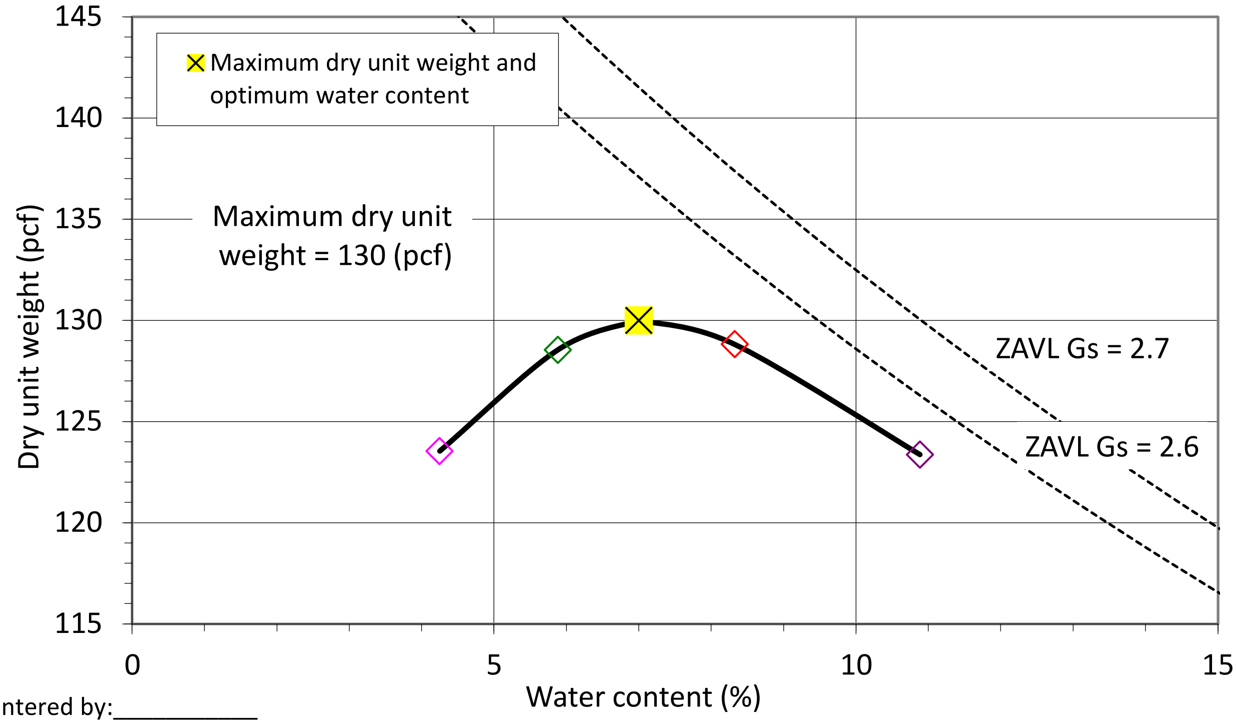
(ASTM D4718)

Oversized fraction, +3/4-in. (%): 30.0
Water content, +3/4-in. (%): 1.0
Sieve for oversized fraction: 3/4-in.
Bulk specific gravity, Gs: 2.65 Assumed

Corrected water content (%): 5.2
Corrected dry unit weight (pcf): 138.9

Comments:

According to ASTM D4718 the maximum allowable 3/4" oversized fraction is 30%. The actual 3/4" oversized fraction is 37.6%. *Due to insufficient sample quantity, points 2, 3, and 4 contained previously compacted material.



Entered by:___________
Reviewed:___________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/10/2024
By: RH

Boring No.: TP-5
Station: 26
Depth: 7.5'
Sample Description: Brown clayey gravel with sand
Engineering Classification: Not requested
As-received water content (%): Not requested

Method: ASTM D1557 C
Mold Id. INC 6
Mold volume (ft^3): 0.0750

Preparation method: Moist
Rammer: Mechanical-sector face
Rock Correction: Yes * See results below
Percent fraction retained, Pc (%) 30.0
Percent fraction passing, Pf (%) 70.0

Optimum water content (%): 9.0
Maximum dry unit weight (pcf): 125.3

Point Number	+2%	+4%	As Is	+6%*				
Wt. Sample + Mold (g)	10983.7	11095.4	10757.6	11084.0				
Wt. of Mold (g)	6431.4	6431.4	6431.4	6431.4				
Total Unit Wt., γ (pcf)	133.8	137.1	127.2	136.8				
Wet Soil + Tare (g)	1174.07	1280.32	1306.16	1054.64				
Dry Soil + Tare (g)	1109.98	1188.91	1247.20	972.86				
Tare (g)	330.68	330.77	409.71	310.16				
Water Content, w (%)	**8.2**	**10.7**	**7.0**	**12.3**				
Dry Unit Wt., γ_d (pcf)	**123.6**	**123.9**	**118.8**	**121.7**				

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

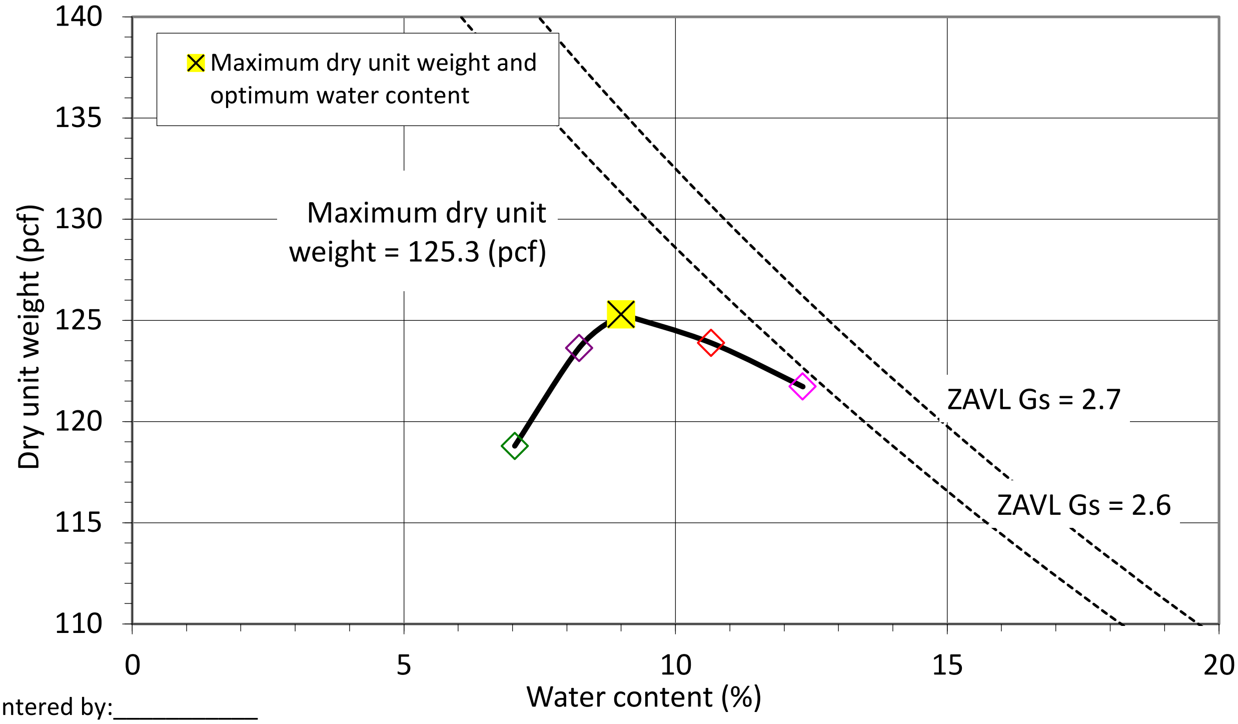
(ASTM D4718)

Oversized fraction, +3/4-in. (%): 30.0
Water content, +3/4-in. (%): 1.7
Sieve for oversized fraction: 3/4-in.
Bulk specific gravity, Gs: 2.65 Assumed

Corrected water content (%): 6.8
Corrected dry unit weight (pcf): 135.1

Comments:

According to ASTM D4718 the maximum allowable 3/4" oversized fraction is 30%. The actual 3/4" oversized fraction is 31.9%. *Due to insufficient sample quantity, point "+6%" contained previously compacted material.



Entered by:___________
Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: **Shelter Hill-Townhomes**
No: **01628-046**
Location: Powder Mountain
Date: 12/9/2024
By: CJ

Boring No.: **TP-2**
Station: **30**
Depth: **6.0'**
Sample Description: Brown clayey gravel with sand
Sample type: Laboratory compacted

Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0086
Specific gravity, Gs: 2.70 Assumed

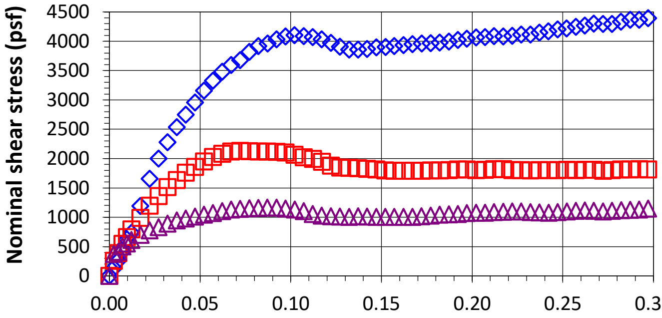
Dry unit weight 113.8 pcf
at 9.7 (%) w
Compaction specifications: 93% of ASTM D1557C

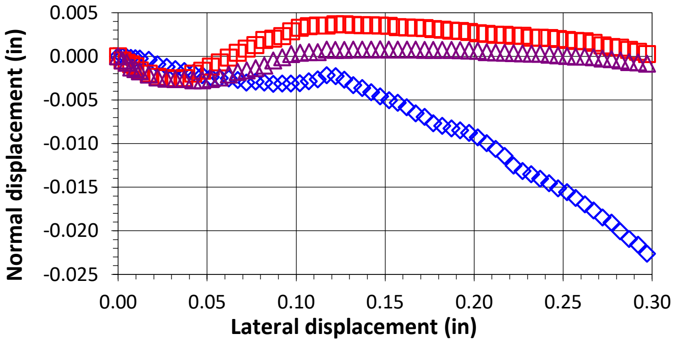
	Specimen 1		Specimen 2		Specimen 3	
Nominal normal stress (psf)	4000		2000		1000	
Peak shear stress (psf)	4393		2129		1165	
Lateral displacement at peak (in)	0.297		0.072		0.087	
Load Duration (min)	4008		4025		4036	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Specimen height (in)	0.999	0.964	1.001	0.947	0.997	0.918
Specimen diameter (in)	2.404	2.404	2.414	2.414	2.411	2.411
Wt. rings + wet soil (g)	191.04	199.32	195.78	202.80	194.80	199.86
Wt. rings (g)	42.29	42.29	45.47	45.47	45.48	45.48
Wet soil + tare (g)	238.32		238.32		238.32	
Dry soil + tare (g)	228.52		228.52		228.52	
Tare (g)	127.60		127.60		127.60	
Water content (%)	9.7	15.8	9.7	14.8	9.7	13.4
Dry unit weight (pcf)	113.9	118.1	113.9	120.3	113.9	123.6
Void ratio, e, for assumed Gs	0.48	0.43	0.48	0.40	0.48	0.36
Saturation (%)*	54.7	100.0	54.7	100.0	54.7	100.0

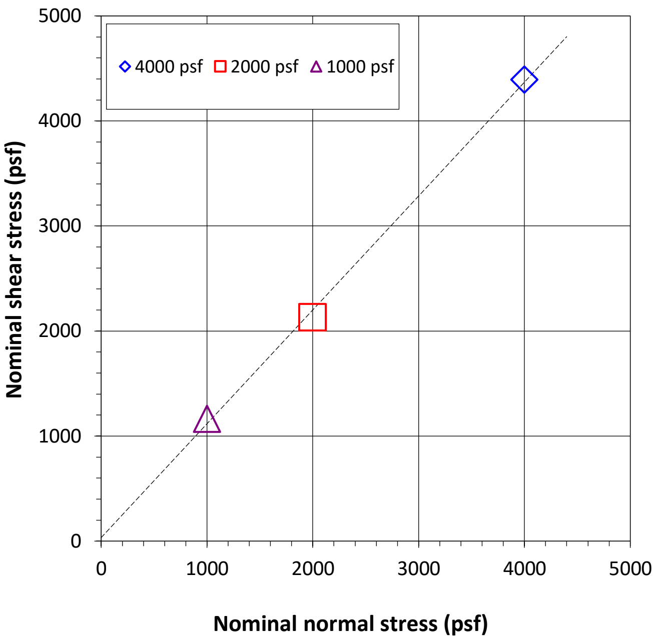
ϕ' (deg)	47
c' (psf)	33

Average of 3 specimens	Initial	Pre-shear
Water content (%)	9.7	14.7
Dry unit weight (pcf)	113.9	120.7

*Pre-shear saturation set to 100% for phase calculations







Entered by:____________
Reviewed:____________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain

Boring No.: TP-2
Station: 30
Depth: 6.0'

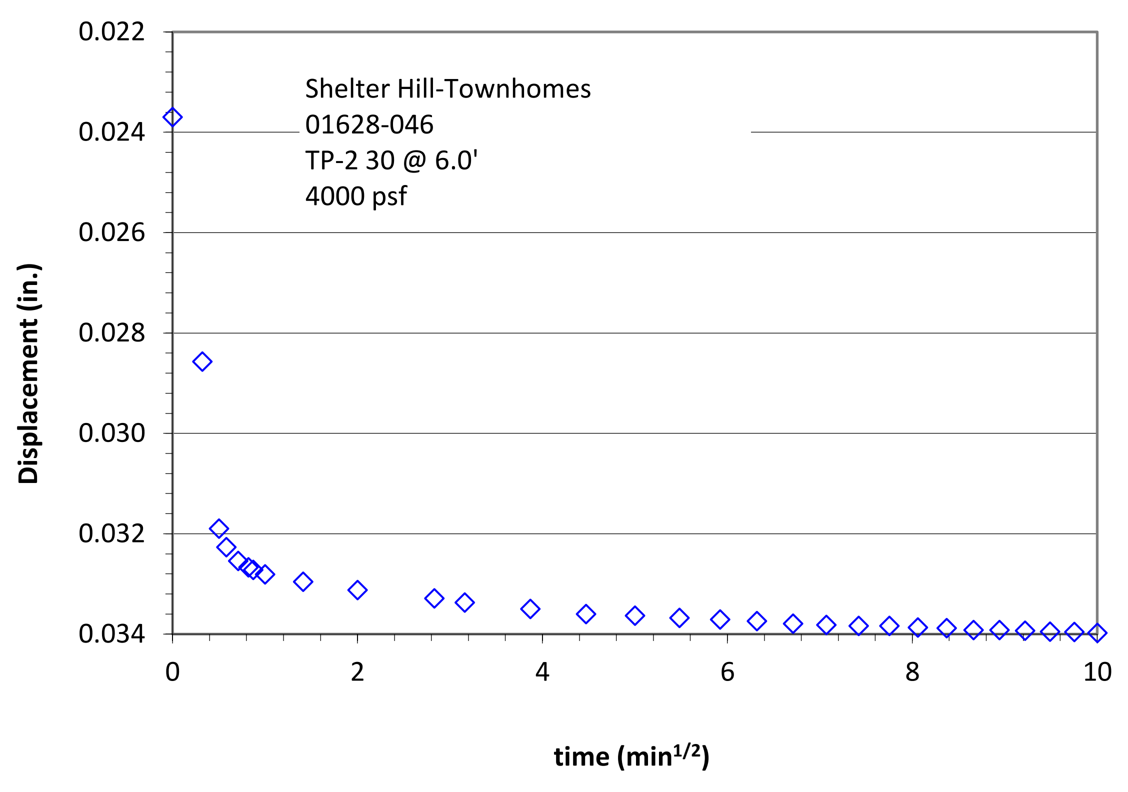
Nominal normal stress = 4000 psf			Nominal normal stress = 2000 psf			Nominal normal stress = 1000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	133	0.000	0.002	259	0.000	0.002	370	0.000
0.005	261	0.000	0.005	390	-0.001	0.005	409	-0.001
0.007	417	0.000	0.007	549	-0.001	0.007	503	-0.001
0.010	621	0.000	0.010	660	-0.001	0.010	551	-0.001
0.012	730	0.000	0.012	794	-0.002	0.012	614	-0.002
0.017	1189	0.000	0.017	987	-0.002	0.017	701	-0.002
0.022	1656	-0.001	0.022	1199	-0.002	0.022	779	-0.002
0.027	2000	-0.001	0.027	1358	-0.003	0.027	833	-0.003
0.032	2276	-0.001	0.032	1515	-0.003	0.032	889	-0.003
0.037	2537	-0.002	0.037	1635	-0.002	0.037	943	-0.003
0.042	2751	-0.002	0.042	1760	-0.002	0.042	981	-0.003
0.047	2954	-0.002	0.047	1860	-0.002	0.047	1011	-0.003
0.052	3160	-0.002	0.052	1952	-0.001	0.052	1045	-0.003
0.057	3330	-0.003	0.057	2027	-0.001	0.057	1070	-0.002
0.062	3478	-0.003	0.062	2081	0.000	0.062	1103	-0.002
0.067	3593	-0.003	0.067	2119	0.000	0.067	1129	-0.002
0.072	3676	-0.003	0.072	2129	0.001	0.072	1141	-0.002
0.077	3817	-0.003	0.077	2123	0.001	0.077	1152	-0.001
0.082	3916	-0.003	0.082	2118	0.002	0.082	1157	-0.001
0.087	3961	-0.003	0.087	2122	0.002	0.087	1165	0.000
0.092	4034	-0.003	0.092	2117	0.002	0.092	1163	0.000
0.097	4083	-0.003	0.097	2103	0.003	0.097	1150	0.000
0.102	4104	-0.003	0.102	2065	0.003	0.102	1129	0.000
0.107	4088	-0.003	0.107	2023	0.003	0.107	1106	0.000
0.112	4073	-0.003	0.112	1995	0.004	0.112	1056	0.000
0.117	4034	-0.002	0.117	1945	0.004	0.117	1028	0.001
0.122	3974	-0.002	0.122	1881	0.004	0.122	1014	0.001
0.127	3906	-0.003	0.127	1847	0.004	0.127	1013	0.001
0.132	3856	-0.003	0.132	1840	0.004	0.132	1006	0.001
0.137	3856	-0.004	0.137	1835	0.004	0.137	1015	0.001
0.142	3869	-0.004	0.142	1826	0.004	0.142	1012	0.001
0.147	3895	-0.005	0.147	1813	0.004	0.147	1007	0.001
0.152	3903	-0.005	0.152	1797	0.003	0.152	1005	0.001
0.157	3919	-0.005	0.157	1790	0.003	0.157	1006	0.001
0.162	3932	-0.006	0.162	1791	0.003	0.162	1008	0.001
0.167	3953	-0.007	0.167	1791	0.003	0.167	1008	0.001
0.172	3963	-0.007	0.172	1791	0.003	0.172	1019	0.001
0.177	3966	-0.008	0.177	1799	0.003	0.177	1029	0.001
0.182	3979	-0.008	0.182	1800	0.003	0.182	1042	0.001
0.187	3992	-0.008	0.187	1805	0.003	0.187	1049	0.001
0.192	4023	-0.008	0.192	1816	0.003	0.192	1057	0.001
0.197	4044	-0.009	0.197	1816	0.003	0.197	1071	0.001
0.202	4065	-0.009	0.202	1802	0.003	0.202	1076	0.001
0.207	4073	-0.010	0.207	1809	0.003	0.207	1077	0.000
0.212	4088	-0.011	0.212	1820	0.002	0.212	1085	0.000
0.217	4083	-0.011	0.217	1818	0.002	0.217	1094	0.000
0.222	4091	-0.013	0.222	1805	0.002	0.222	1096	0.000
0.227	4112	-0.013	0.227	1802	0.002	0.227	1098	0.000
0.232	4112	-0.014	0.232	1798	0.002	0.232	1085	0.000
0.237	4146	-0.014	0.237	1803	0.002	0.237	1084	0.000
0.242	4169	-0.015	0.242	1804	0.002	0.242	1079	0.000
0.247	4203	-0.015	0.247	1804	0.002	0.247	1086	0.000
0.252	4216	-0.016	0.252	1809	0.002	0.252	1096	0.000
0.257	4245	-0.016	0.257	1803	0.002	0.257	1108	0.000
0.262	4268	-0.017	0.262	1809	0.002	0.262	1114	0.000
0.267	4300	-0.018	0.267	1809	0.002	0.267	1107	0.000
0.272	4292	-0.018	0.272	1792	0.001	0.272	1099	0.000
0.277	4292	-0.019	0.277	1802	0.001	0.277	1110	0.000
0.282	4333	-0.020	0.282	1812	0.001	0.282	1122	0.000
0.287	4367	-0.021	0.287	1814	0.001	0.287	1125	-0.001
0.292	4367	-0.022	0.292	1818	0.001	0.292	1129	-0.001
0.297	4393	-0.023	0.297	1816	0.000	0.297	1145	-0.001

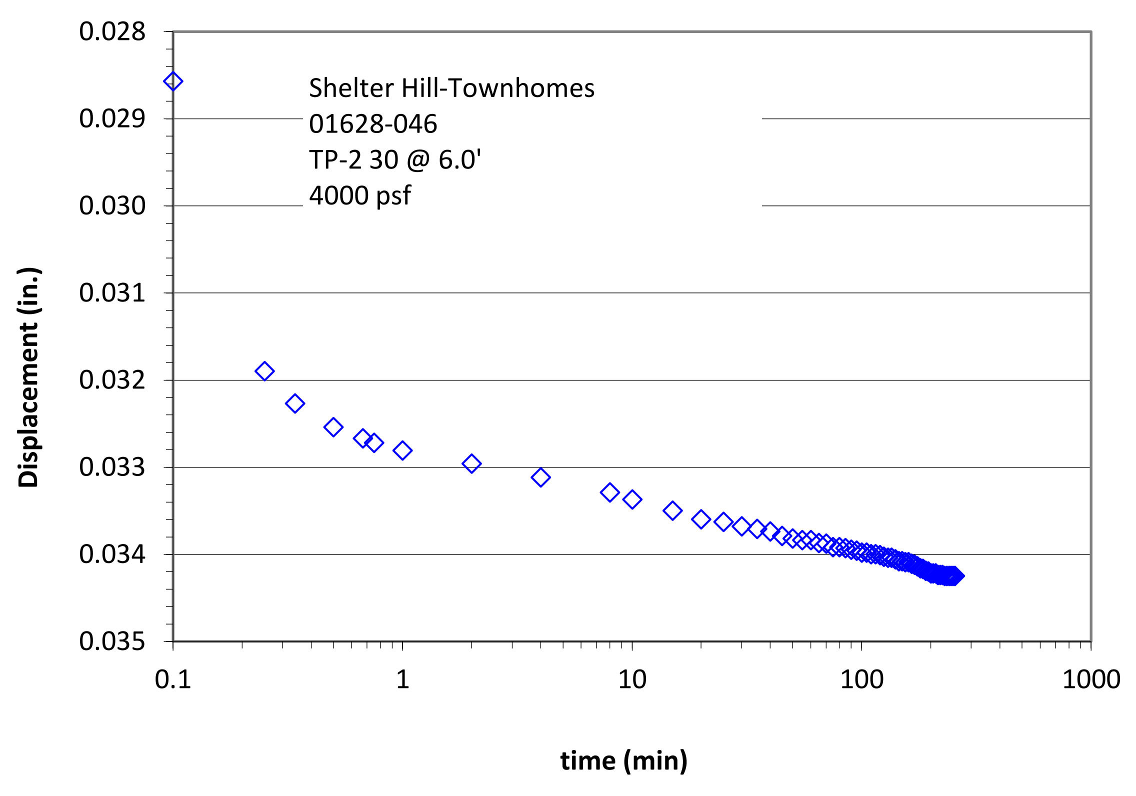
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain

Boring No.: TP-2
Station: 30
Depth: 6.0'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: **Shelter Hill-Townhomes**
No: **01628-046**
Location: Powder Mountain
Date: 12/12/2024
By: PW

Boring No.: **TP-3**
Station: **22**
Depth: **7.5'**
Sample Description: Brown clayey gravel with sand
Sample type: Laboratory compacted

Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0157
Specific gravity, Gs: 2.70 Assumed

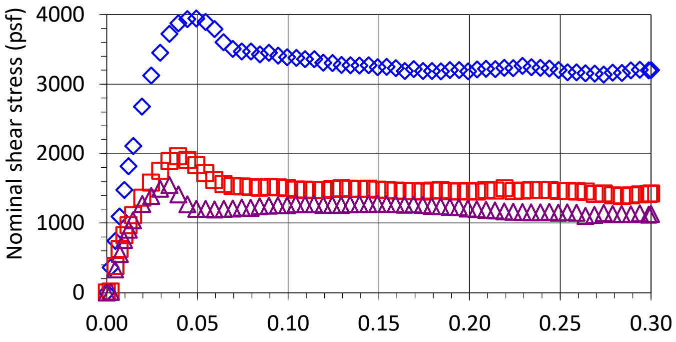
Dry unit weight 120.9 pcf
at 7.0 (%) w
Compaction specifications: 93% of ASTM D1557C

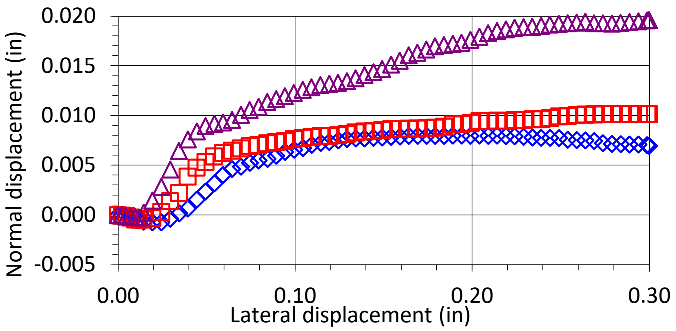
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	4000		2000		1000	
Peak shear stress (psf)	3943		1960		1548	
Lateral displacement at peak (in)	0.049		0.039		0.035	
Load Duration (min)	1065		1080		1095	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	0.999	0.979	1.003	0.986	0.995	0.992
Sample diameter (in)	2.410	2.410	2.421	2.421	2.414	2.414
Wt. rings + wet soil (g)	197.31	206.58	202.66	212.31	198.96	209.52
Wt. rings (g)	42.28	42.28	45.58	45.58	44.05	44.05
Wet soil + tare (g)	286.30		286.30		286.30	
Dry soil + tare (g)	278.73		278.73		278.73	
Tare (g)	172.16		172.16		172.16	
Water content (%)	7.1	13.5	7.1	13.7	7.1	14.4
Dry unit weight (pcf)	121.0	123.5	121.0	123.0	121.0	121.3
Void ratio, e, for assumed Gs	0.39	0.36	0.39	0.37	0.39	0.39
Saturation (%)*	48.8	100.0	48.8	100.0	48.8	100.0

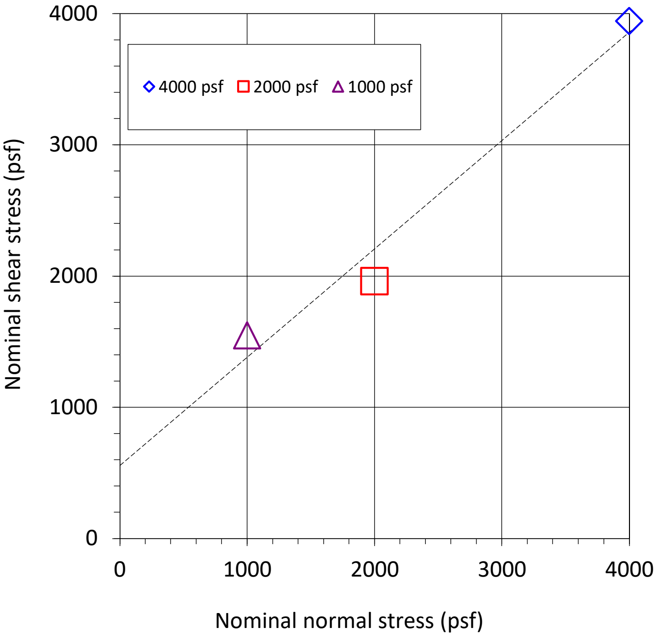
ϕ' (deg)	40
c' (psf)	556

Average of 3 samples	Initial	Pre-shear
Water content (%)	7.1	13.9
Dry unit weight (pcf)	121.0	122.6

*Pre-shear saturation set to 100% for phase calculations







Comments:

Test specimens remolded to 93% of maximum dry unit weight at optimum water content using material passing the No. 4 sieve. Test specimens swelled upon inundation and at 100 psf load step.

Entered by:___________
Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain

Boring No.: TP-3
Station: 22
Depth: 7.5'

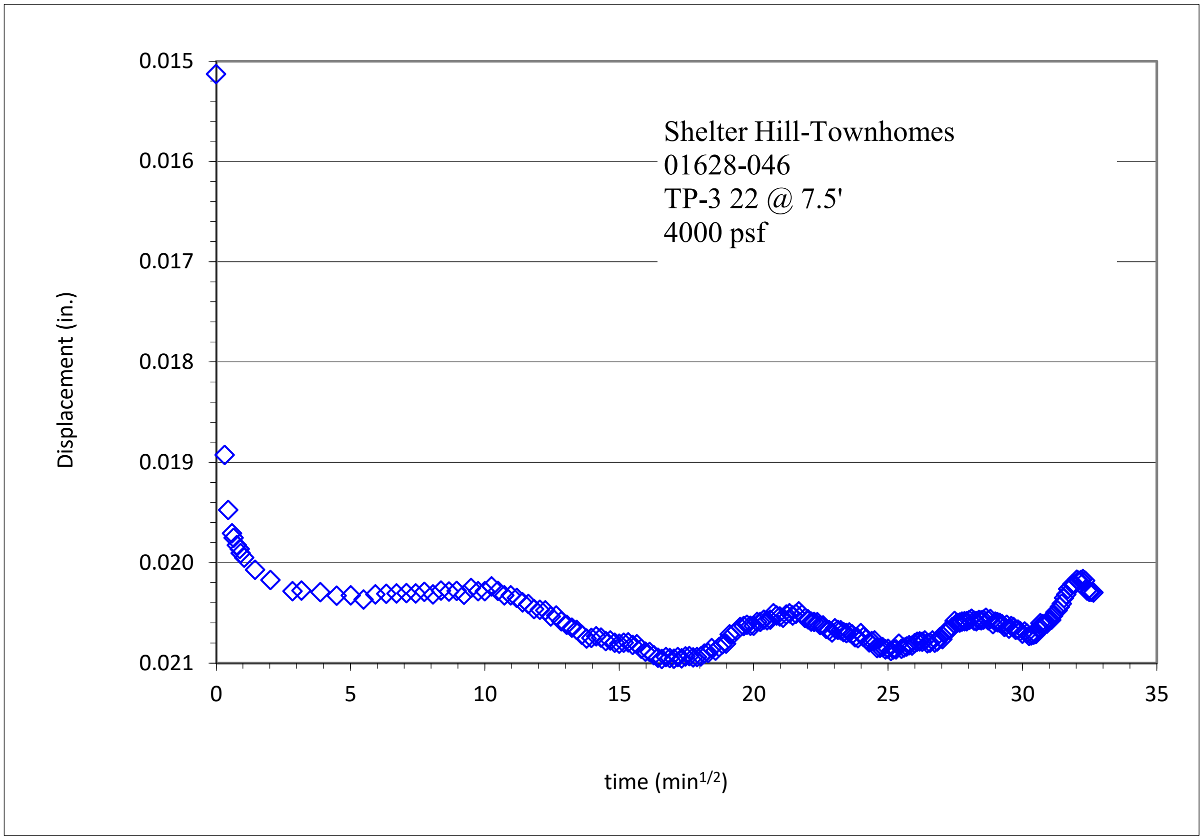
Nominal normal stress = 4000 psf			Nominal normal stress = 2000 psf			Nominal normal stress = 1000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	363	0.000	0.002	16	0.000	0.002	12	0.000
0.005	745	0.000	0.005	384	0.000	0.005	333	0.000
0.007	1095	0.000	0.007	630	0.000	0.007	554	0.000
0.010	1476	0.000	0.010	825	0.000	0.010	756	0.000
0.012	1816	-0.001	0.012	971	0.000	0.012	903	0.000
0.015	2111	-0.001	0.014	1113	0.000	0.015	1039	0.000
0.019	2675	-0.001	0.020	1368	0.000	0.020	1273	0.001
0.025	3123	-0.001	0.024	1585	0.000	0.025	1389	0.003
0.030	3451	0.000	0.029	1752	0.001	0.029	1498	0.005
0.035	3721	0.000	0.035	1893	0.002	0.035	1548	0.006
0.039	3874	0.001	0.039	1960	0.004	0.039	1413	0.008
0.045	3935	0.002	0.044	1910	0.005	0.045	1271	0.008
0.049	3943	0.002	0.049	1832	0.005	0.049	1207	0.009
0.054	3893	0.003	0.054	1718	0.006	0.054	1204	0.009
0.059	3793	0.004	0.059	1618	0.006	0.059	1195	0.009
0.064	3602	0.005	0.064	1561	0.007	0.064	1204	0.010
0.069	3508	0.005	0.069	1535	0.007	0.069	1212	0.010
0.074	3469	0.005	0.074	1526	0.007	0.074	1225	0.011
0.080	3469	0.005	0.079	1520	0.007	0.079	1220	0.011
0.084	3429	0.006	0.084	1510	0.007	0.084	1243	0.011
0.089	3450	0.006	0.089	1524	0.007	0.089	1250	0.012
0.095	3411	0.006	0.094	1512	0.007	0.094	1255	0.012
0.099	3385	0.007	0.099	1506	0.008	0.099	1253	0.012
0.105	3379	0.007	0.104	1484	0.008	0.104	1274	0.013
0.109	3360	0.007	0.109	1483	0.008	0.109	1269	0.013
0.114	3359	0.007	0.114	1478	0.008	0.114	1273	0.013
0.119	3308	0.007	0.119	1476	0.008	0.119	1259	0.013
0.124	3304	0.008	0.124	1492	0.008	0.124	1264	0.013
0.129	3277	0.008	0.129	1501	0.008	0.129	1258	0.013
0.134	3273	0.008	0.134	1497	0.008	0.134	1270	0.014
0.139	3264	0.008	0.139	1492	0.008	0.139	1273	0.014
0.144	3272	0.008	0.144	1494	0.008	0.144	1274	0.014
0.149	3244	0.008	0.149	1482	0.009	0.149	1278	0.015
0.154	3250	0.008	0.154	1474	0.009	0.154	1275	0.015
0.159	3229	0.008	0.159	1469	0.009	0.159	1275	0.016
0.164	3186	0.008	0.164	1464	0.009	0.164	1267	0.016
0.169	3217	0.008	0.169	1464	0.009	0.169	1269	0.016
0.174	3187	0.008	0.174	1454	0.009	0.174	1262	0.017
0.179	3189	0.008	0.179	1468	0.009	0.179	1246	0.017
0.184	3183	0.008	0.184	1474	0.009	0.184	1240	0.017
0.189	3203	0.008	0.189	1460	0.009	0.189	1232	0.017
0.194	3201	0.008	0.194	1453	0.009	0.194	1230	0.017
0.199	3183	0.008	0.199	1462	0.009	0.199	1209	0.018
0.204	3210	0.008	0.204	1456	0.009	0.204	1200	0.018
0.209	3220	0.008	0.209	1476	0.009	0.209	1193	0.018
0.214	3217	0.008	0.214	1468	0.010	0.214	1180	0.019
0.219	3234	0.008	0.219	1501	0.009	0.219	1168	0.019
0.224	3228	0.008	0.224	1457	0.010	0.224	1163	0.019
0.229	3263	0.008	0.229	1469	0.010	0.229	1157	0.019
0.234	3243	0.008	0.234	1472	0.010	0.234	1156	0.019
0.239	3234	0.008	0.239	1478	0.010	0.239	1155	0.019
0.244	3224	0.008	0.244	1476	0.010	0.244	1162	0.019
0.249	3204	0.008	0.249	1462	0.010	0.249	1150	0.019
0.254	3169	0.008	0.254	1464	0.010	0.254	1154	0.019
0.259	3169	0.008	0.259	1453	0.010	0.259	1150	0.019
0.264	3155	0.008	0.264	1452	0.010	0.264	1106	0.019
0.269	3153	0.007	0.269	1423	0.010	0.269	1119	0.019
0.274	3138	0.007	0.274	1428	0.010	0.274	1146	0.019
0.279	3164	0.007	0.279	1399	0.010	0.279	1130	0.019
0.284	3161	0.007	0.284	1387	0.010	0.284	1132	0.019
0.289	3198	0.007	0.289	1397	0.010	0.289	1125	0.019
0.294	3205	0.007	0.294	1411	0.010	0.294	1139	0.019
0.299	3200	0.007	0.299	1424	0.010	0.299	1123	0.020
0.300	3202	0.007	0.300	1425	0.010	0.300	1132	0.020

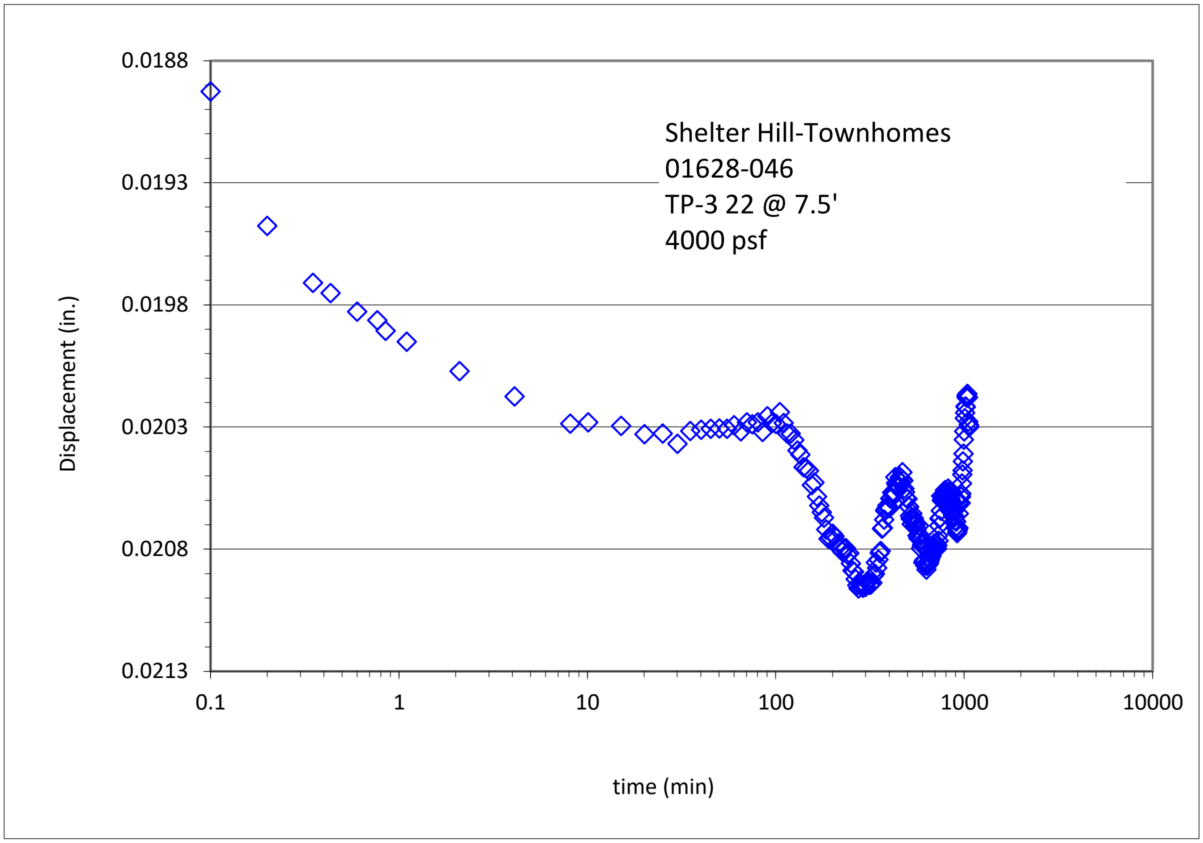
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain

Boring No.: TP-3
Station: 22
Depth: 7.5'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain
Date: 12/13/2024
By: PW

Boring No.: TP-5
Station: 26
Depth: 7.5'
Sample Description: Brown clayey gravel with sand
Sample type: Laboratory compacted
Dry unit weight 116.5 pcf
at 9.0 (%) w
Compaction specifications: 93% of ASTM D1557C

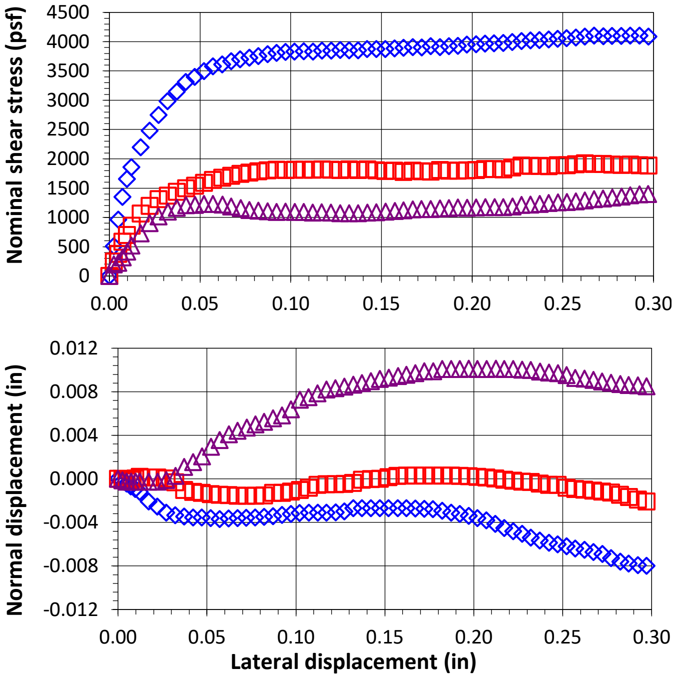
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0172
Specific gravity, Gs: 2.70 Assumed

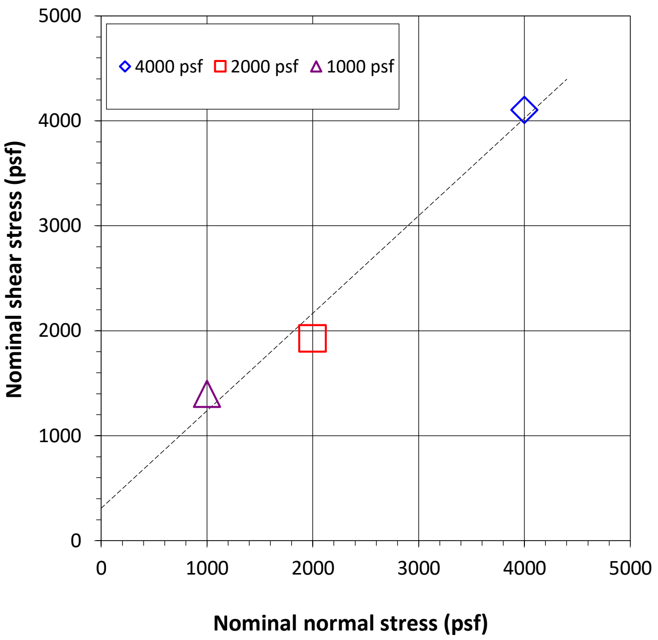
	Specimen 1		Specimen 2		Specimen 3	
Nominal normal stress (psf)	4000		2000		1000	
Peak shear stress (psf)	4105		1925		1399	
Lateral displacement at peak (in)	0.287		0.262		0.297	
Load Duration (min)	1489		1489		1512	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Specimen height (in)	1.002	0.981	0.995	0.975	0.999	0.988
Specimen diameter (in)	2.412	2.412	2.407	2.407	2.414	2.414
Wt. rings + wet soil (g)	198.09	207.10	196.82	205.85	198.10	207.87
Wt. rings (g)	45.45	45.45	45.88	45.88	45.64	45.64
Wet soil + tare (g)	230.05		230.05		230.05	
Dry soil + tare (g)	221.72		221.72		221.72	
Tare (g)	128.64		128.64		128.64	
Water content (%)	8.9	15.4	8.9	15.5	8.9	15.9
Dry unit weight (pcf)	116.6	119.0	116.6	118.9	116.6	117.8
Void ratio, e, for assumed Gs	0.45	0.42	0.45	0.42	0.45	0.43
Saturation (%)*	54.2	100.0	54.2	100.0	54.2	100.0

ϕ' (deg)	43
c' (psf)	309

Average of 3 specimens	Initial	Pre-shear
Water content (%)	8.9	15.6
Dry unit weight (pcf)	116.6	118.6

*Pre-shear saturation set to 100% for phase calculations





Comments:

Test specimens remolded to 93% of maximum dry unit weight at optimum water content using material passing the No. 4 sieve. Test specimens swelled upon inundation and at the 100 and 250 psf load steps.

Entered by:___________

Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain

Boring No.: TP-5
Station: 26
Depth: 7.5'

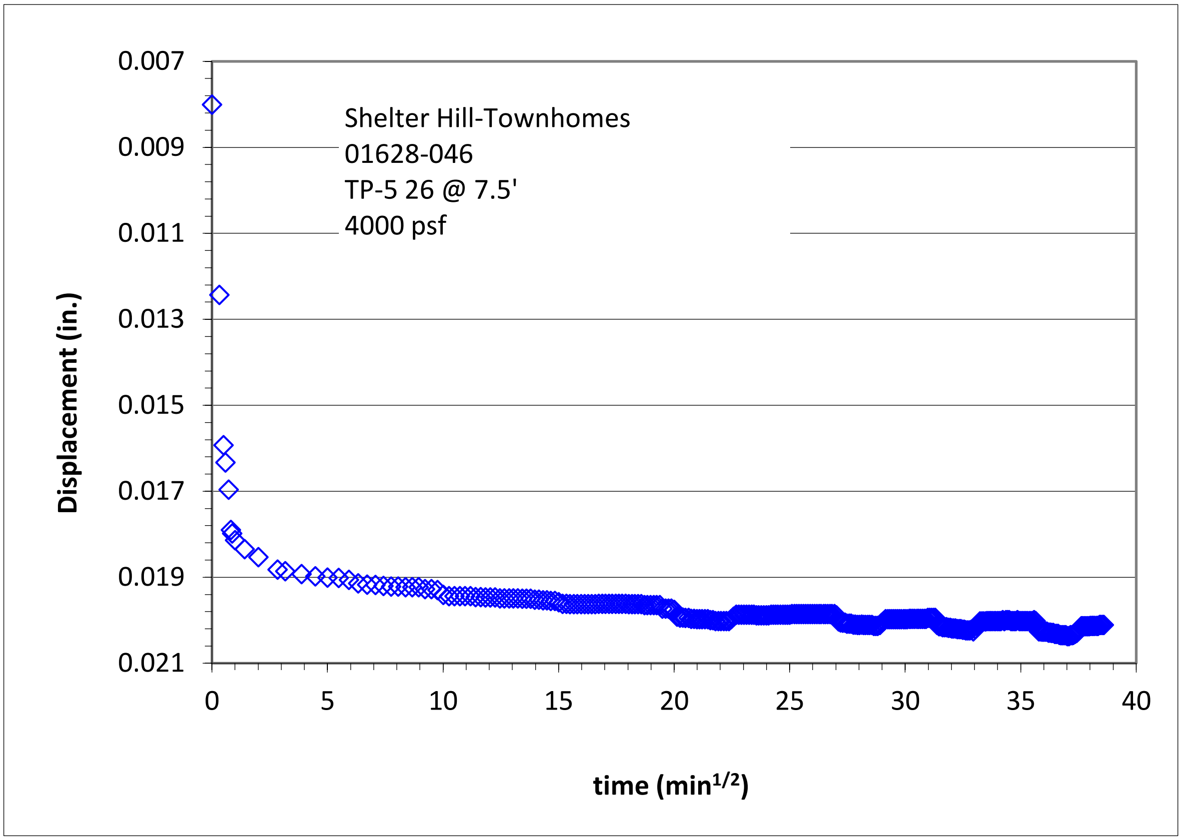
Nominal normal stress = 4000 psf			Nominal normal stress = 2000 psf			Nominal normal stress = 1000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	508	0.000	0.002	248	0.000	0.002	195	0.000
0.005	961	0.000	0.005	380	0.000	0.005	226	0.000
0.007	1352	-0.001	0.007	586	0.000	0.007	317	0.000
0.010	1655	-0.001	0.010	702	0.000	0.010	413	0.000
0.012	1860	-0.001	0.012	857	0.000	0.012	522	0.000
0.017	2199	-0.002	0.017	1068	0.000	0.017	729	0.000
0.022	2481	-0.003	0.022	1195	0.000	0.022	902	0.000
0.027	2751	-0.003	0.027	1312	0.000	0.027	1018	0.000
0.032	2981	-0.003	0.032	1370	0.000	0.032	1097	0.000
0.037	3147	-0.003	0.037	1437	-0.001	0.037	1164	0.001
0.042	3313	-0.004	0.042	1496	-0.001	0.042	1210	0.002
0.047	3398	-0.004	0.047	1543	-0.001	0.047	1213	0.002
0.052	3496	-0.004	0.052	1590	-0.001	0.052	1229	0.003
0.057	3579	-0.004	0.057	1637	-0.001	0.057	1231	0.004
0.062	3613	-0.004	0.062	1679	-0.001	0.062	1221	0.004
0.067	3665	-0.004	0.067	1708	-0.002	0.067	1185	0.004
0.072	3701	-0.004	0.072	1745	-0.002	0.072	1158	0.005
0.077	3727	-0.004	0.077	1766	-0.002	0.077	1128	0.005
0.082	3753	-0.003	0.082	1787	-0.002	0.082	1113	0.005
0.087	3789	-0.003	0.087	1804	-0.001	0.087	1103	0.006
0.092	3810	-0.003	0.092	1814	-0.001	0.092	1095	0.006
0.097	3825	-0.003	0.097	1809	-0.001	0.097	1097	0.006
0.102	3831	-0.003	0.102	1813	-0.001	0.102	1094	0.007
0.107	3836	-0.003	0.107	1813	-0.001	0.107	1095	0.008
0.112	3828	-0.003	0.112	1813	-0.001	0.112	1084	0.008
0.117	3849	-0.003	0.117	1819	-0.001	0.117	1087	0.008
0.122	3849	-0.003	0.122	1812	-0.001	0.122	1083	0.008
0.127	3859	-0.003	0.127	1811	0.000	0.127	1071	0.008
0.132	3854	-0.003	0.132	1820	0.000	0.132	1069	0.009
0.137	3854	-0.003	0.137	1811	0.000	0.137	1073	0.009
0.142	3872	-0.003	0.142	1822	0.000	0.142	1081	0.009
0.147	3872	-0.003	0.147	1803	0.000	0.147	1087	0.009
0.152	3872	-0.003	0.152	1794	0.000	0.152	1100	0.009
0.157	3882	-0.003	0.157	1796	0.000	0.157	1111	0.009
0.162	3898	-0.003	0.162	1778	0.000	0.162	1121	0.010
0.167	3906	-0.003	0.167	1800	0.000	0.167	1136	0.010
0.172	3903	-0.003	0.172	1788	0.000	0.172	1143	0.010
0.177	3921	-0.003	0.177	1781	0.000	0.177	1142	0.010
0.182	3908	-0.003	0.182	1807	0.000	0.182	1152	0.010
0.187	3921	-0.003	0.187	1798	0.000	0.187	1160	0.010
0.192	3929	-0.003	0.192	1798	0.000	0.192	1170	0.010
0.197	3952	-0.003	0.197	1803	0.000	0.197	1164	0.010
0.202	3958	-0.004	0.202	1807	0.000	0.202	1168	0.010
0.207	3965	-0.004	0.207	1826	0.000	0.207	1174	0.010
0.212	3973	-0.004	0.212	1827	0.000	0.212	1175	0.010
0.217	3978	-0.005	0.217	1820	0.000	0.217	1173	0.010
0.222	3996	-0.005	0.222	1855	0.000	0.222	1185	0.010
0.227	4009	-0.005	0.227	1885	0.000	0.227	1211	0.010
0.232	4022	-0.005	0.232	1880	0.000	0.232	1217	0.010
0.237	4025	-0.006	0.237	1882	0.000	0.237	1231	0.010
0.242	4040	-0.006	0.242	1875	-0.001	0.242	1246	0.010
0.247	4048	-0.006	0.247	1892	-0.001	0.247	1258	0.010
0.252	4061	-0.006	0.252	1888	-0.001	0.252	1265	0.010
0.257	4071	-0.006	0.257	1908	-0.001	0.257	1273	0.009
0.262	4087	-0.007	0.262	1925	-0.001	0.262	1291	0.009
0.267	4103	-0.007	0.267	1912	-0.001	0.267	1309	0.009
0.272	4092	-0.007	0.272	1914	-0.001	0.272	1324	0.009
0.277	4100	-0.007	0.277	1903	-0.001	0.277	1340	0.009
0.282	4100	-0.008	0.282	1896	-0.001	0.282	1355	0.009
0.287	4105	-0.008	0.287	1901	-0.002	0.287	1378	0.009
0.292	4103	-0.008	0.292	1889	-0.002	0.292	1394	0.009
0.297	4087	-0.008	0.297	1885	-0.002	0.297	1399	0.008

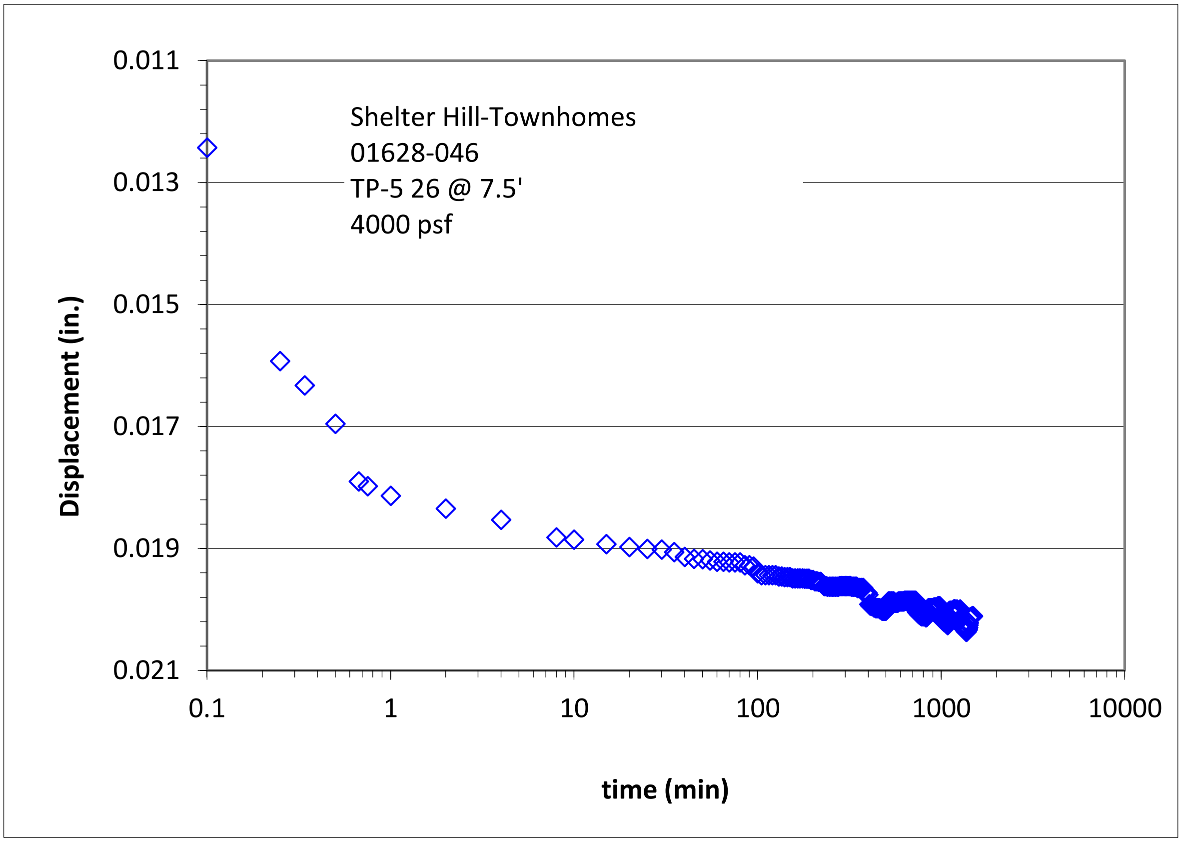
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Shelter Hill-Townhomes
No: 01628-046
Location: Powder Mountain

Boring No.: TP-5
Station: 26
Depth: 7.5'





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

Project: **Shelter Hill - Townhomes**
No: **01628-046**
Location: Powder Mountain
Date: 12/6/2024
By: LM/JJ

Sample info.	Boring No.	TP-4							
	Sample	27							
	Depth	6.0'							
Water content data	Wet soil + tare (g)	42.65							
	Dry soil + tare (g)	40.74							
	Tare (g)	22.53							
	Water content (%)	10.5							
Chem. data	pH	4.9							
	Soluble chloride (ppm)	<50							
	Soluble sulfate (ppm)	<50							
Resistivity data	Pin method	2							
	Soil box	Miller Small							
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As is	35380	0.67	23705				
		+3	22910	0.67	15350				
		+6	19200	0.67	12864				
		+9	20350	0.67	13635				
	Minimum resistivity (Ω-cm)	**12864**							

Entered by:____________

Reviewed:____________

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Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: Shelter Hill, Summit LLC
No: 01628-040
Location: Powder Mountain, UT
Date: 8/5/2024
By: CJ/SE

Sample Info.	Boring No.		TP-18			
	Station		8			
	Depth		5.0'			
	Split		No			
	Split sieve					
	Total sample (g)					
	Moist coarse fraction (g)					
	Moist split fraction (g)					
Unit Weight Data	Sample height, *H* (in)		5.757			
	Sample diameter, *D* (in)		2.404			
	Mass rings + wet soil (g)		1112.87			
	Mass rings/tare (g)		237.22			
	Total unit wt., γ (pcf)		127.7			
Coarse Fraction	Wet soil + tare (g)					
	Dry soil + tare (g)					
	Tare (g)					
	Water content (%)					
Split Fraction	Wet soil + tare (g)		469.42			
	Dry soil + tare (g)		440.92			
	Tare (g)		226.25			
	Water content (%)		13.3			
	Water content, ω (%)		**13.3**			
	Dry unit weight, γ_d (pcf)		**112.7**			

Entered by:___________

Reviewed:___________

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Shelter Hill, Summit LLC
No: 01628-040
Location: Powder Mountain, UT
Date: 8/6/2024
By: RH
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: TP-20
Station: 11
Depth: 4.5'
Description: Red lean clay
Preparation method: Air Dry
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Dry sieved

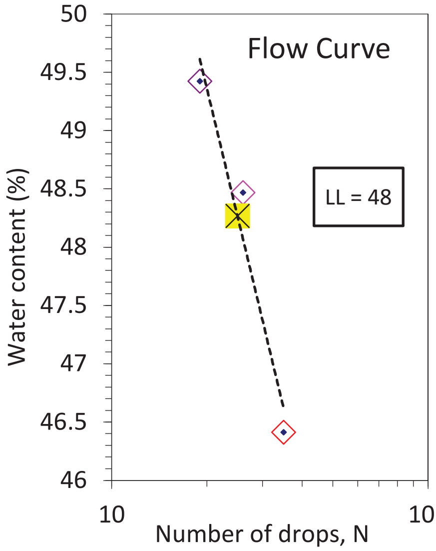
Plastic Limit

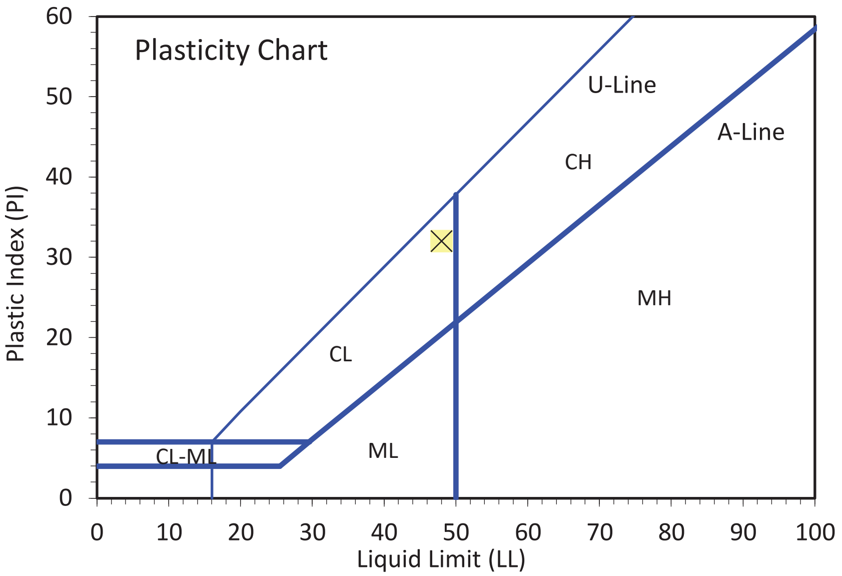
Determination No	1	2				
Wet Soil + Tare (g)	13.69	14.60				
Dry Soil + Tare (g)	12.81	13.56				
Water Loss (g)	0.88	1.04				
Tare (g)	7.07	7.10				
Dry Soil (g)	5.74	6.46				
Water Content, w (%)	15.33	16.10				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	26	19			
Wet Soil + Tare (g)	13.96	15.30	13.99			
Dry Soil + Tare (g)	11.89	12.61	11.85			
Water Loss (g)	2.07	2.69	2.14			
Tare (g)	7.43	7.06	7.52			
Dry Soil (g)	4.46	5.55	4.33			
Water Content, w (%)	46.41	48.47	49.42			
One-Point LL (%)		49				

Liquid Limit, LL (%)	**48**
Plastic Limit, PL (%)	**16**
Plasticity Index, PI (%)	**32**





Entered by:____________
Reviewed:____________

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Shelter Hill, Summit LLC
No: 01628-040
Location: Powder Mountain, UT
Date: 8/6/2024
By: RH
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: TP-18
Station: 8
Depth: 5.0'
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Dry sieved

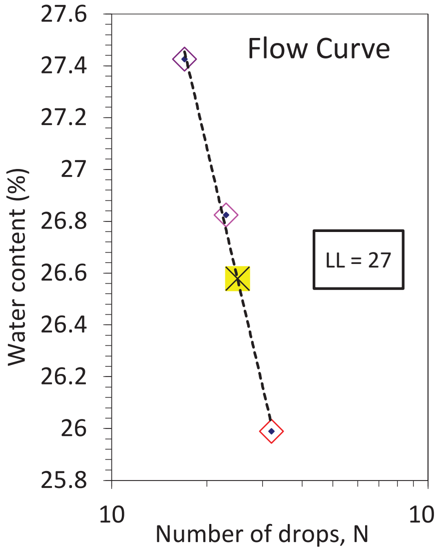
Plastic Limit

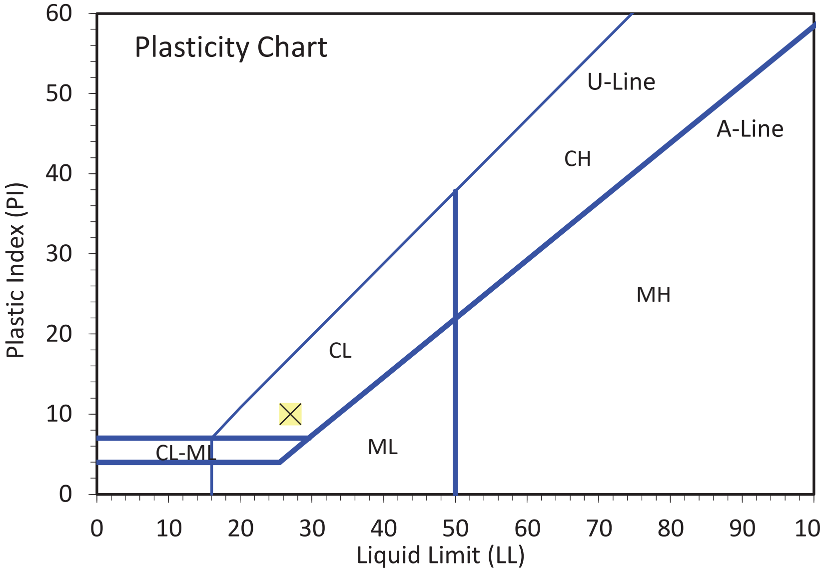
Determination No	1	2				
Wet Soil + Tare (g)	13.79	14.57				
Dry Soil + Tare (g)	12.81	13.45				
Water Loss (g)	0.98	1.12				
Tare (g)	7.06	7.02				
Dry Soil (g)	5.75	6.43				
Water Content, w (%)	17.04	17.42				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	23	17			
Wet Soil + Tare (g)	14.36	13.88	14.30			
Dry Soil + Tare (g)	12.85	12.52	12.83			
Water Loss (g)	1.51	1.36	1.47			
Tare (g)	7.04	7.45	7.47			
Dry Soil (g)	5.81	5.07	5.36			
Water Content, w (%)	25.99	26.82	27.43			
One-Point LL (%)		27				

Liquid Limit, LL (%)	**27**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**10**





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Reviewed:____________

Z:\PROJECTS\01628_Powder_Mountain\040_Shelter_Hill_Summit_LLC\[ALv2.xlsm]7

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Shelter Hill, Summit LLC
No: 01628-040
Location: Powder Mountain, UT
Date: 8/7/2024
By: RH
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: TP-16
Station: 11
Depth: 5.5'
Description: Red silty clay

Preparation method: Air Dry
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Dry sieved

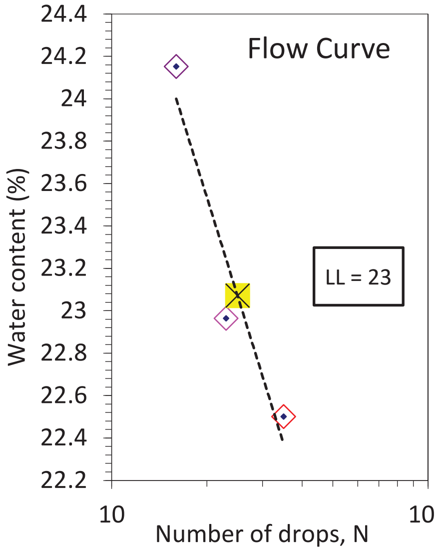
Plastic Limit

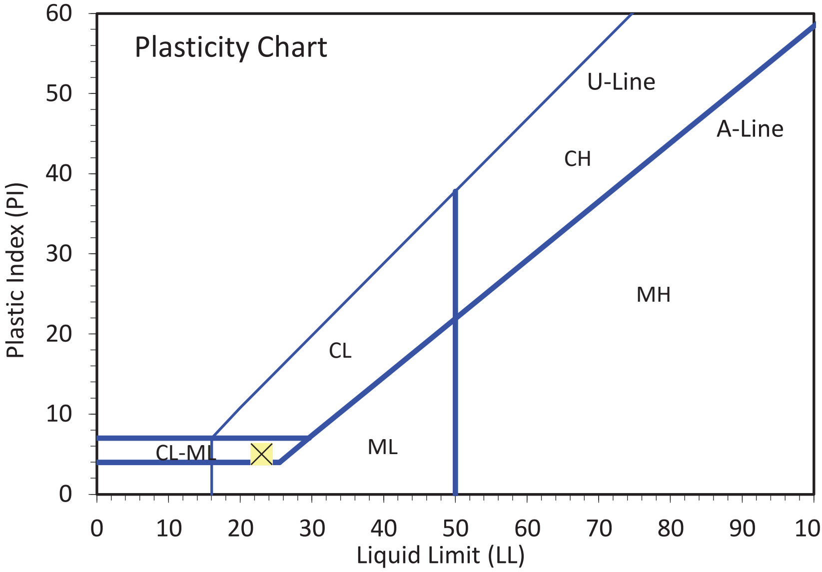
Determination No	1	2				
Wet Soil + Tare (g)	14.34	13.37				
Dry Soil + Tare (g)	13.22	12.40				
Water Loss (g)	1.12	0.97				
Tare (g)	7.09	7.02				
Dry Soil (g)	6.13	5.38				
Water Content, w (%)	18.27	18.03				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	23	16			
Wet Soil + Tare (g)	14.70	12.95	13.56			
Dry Soil + Tare (g)	13.35	11.85	12.35			
Water Loss (g)	1.35	1.10	1.21			
Tare (g)	7.35	7.06	7.34			
Dry Soil (g)	6.00	4.79	5.01			
Water Content, w (%)	22.50	22.96	24.15			
One-Point LL (%)		23				

Liquid Limit, LL (%)	**23**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**5**





Entered by:____________
Reviewed:____________

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

(In general accordance with ASTM D6913)

Project: Shelter Hill, Summit LLC
No: 01628-040
Location: Powder Mountain, UT
Date: 7/31/2024
By: KC

Boring No.: TP-23
Station: 22
Depth: 2.5'
Description: Reddish brown clayey gravel with sand

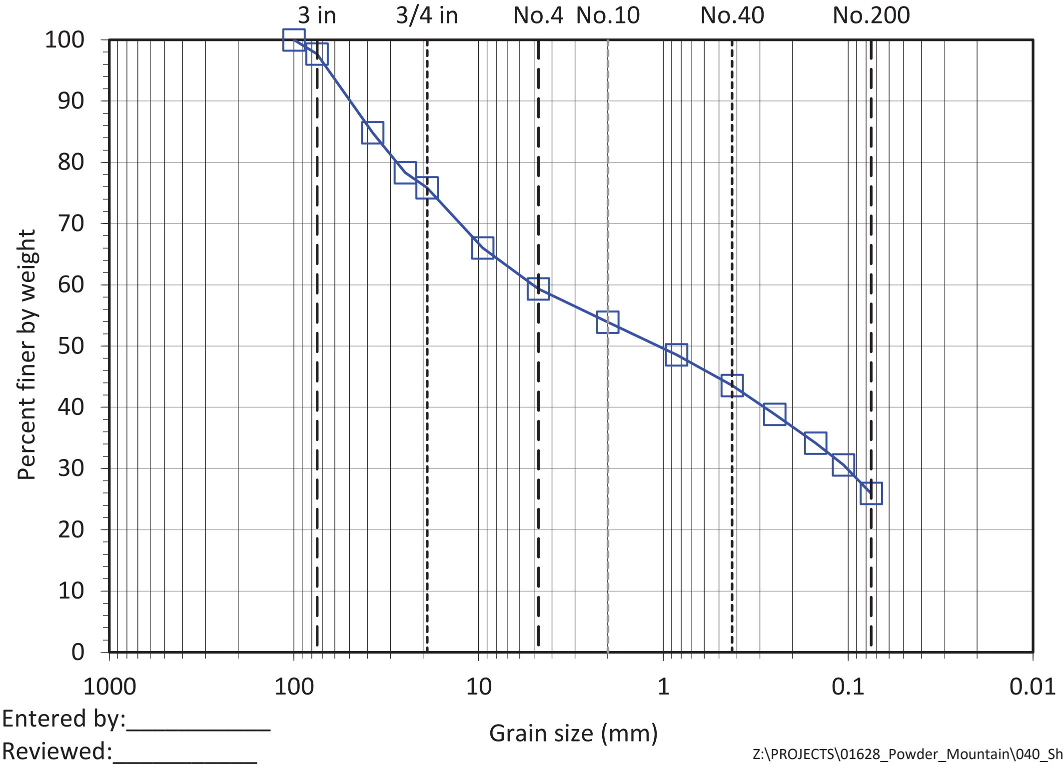
Split:	Yes	
First Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	28580.5	25570.0
+3/4" Coarse fraction (g):	6763.9	6178.2
-3/4" Split fraction (g):	2316.6	2059.1
-3/8" Split fraction (g):	221.59	221.59
First Split fraction:	0.758	

Water content data	C.F.1(+3/4")	S.F.1(-3/4")	C.F.2(+3/8")	S.F.2(-3/8")
Moist soil + tare (g):	2872.18	2627.07	575.90	349.03
Dry soil + tare (g):	2662.16	2369.58	575.90	349.03
Tare (g):	446.64	310.44	310.44	127.44
Water content (%):	9.48	12.50	0.00	0.00

Second Split Data

Second split:	Yes
Second split sieve:	3/8"
Second Split fraction:	0.661

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	100.0	
3"	583.0	75	97.7	
1.5"	3872.5	37.5	84.9	
1"	5538.0	25	78.3	
3/4"	6178.2	19	75.8	<=1st Split
3/8"	265.46	9.5	66.1	<=2nd Split
No.4	22.43	4.75	59.4	
No.10	40.74	2	53.9	
No.20	58.59	0.85	48.6	
No.40	75.39	0.425	43.6	
No.60	91.22	0.25	38.9	
No.100	106.98	0.15	34.2	
No.140	118.87	0.106	30.6	
No.200	134.53	0.075	26.0	



Gravel (%): 40.6
Sand (%): 33.4
Fines (%): 26.0

Comments:

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

Entered by:___________
Reviewed:___________

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

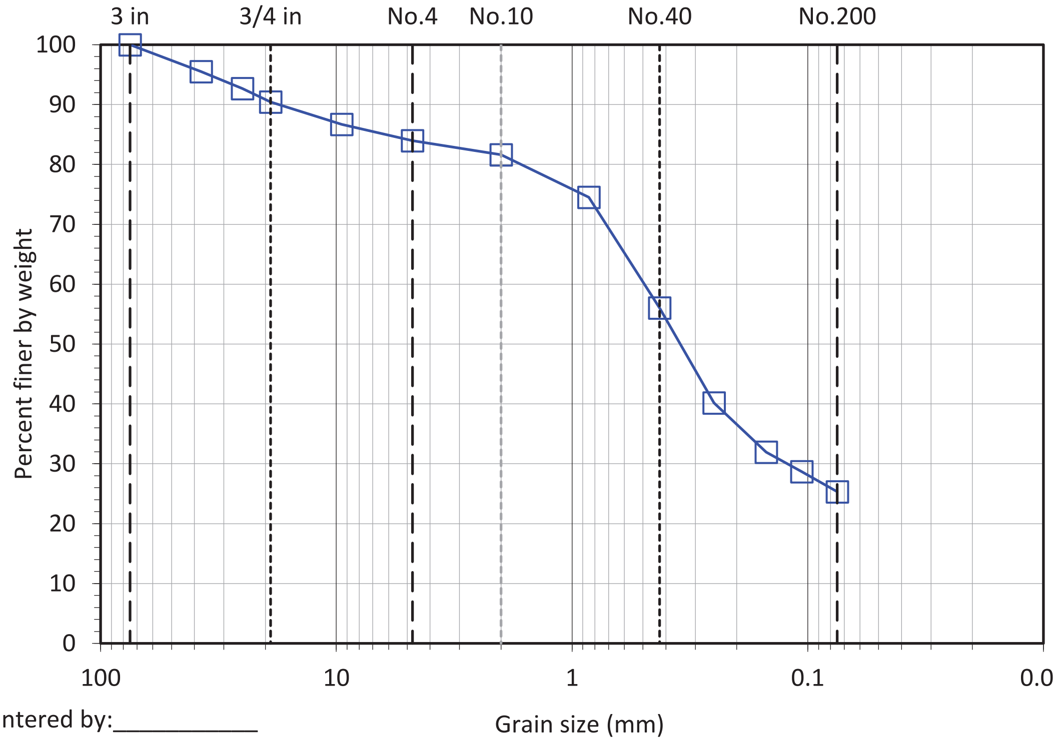
(ASTM D6913)

Project:	**Shelter Hill, Summit LLC**	**Boring No.:**	**TP-22**
No:	**01628-040**	**Station:**	**7**
Location:	Powder Mountain, UT	**Depth:**	**7.0'**
Date:	8/5/2024	Description:	Red clayey sand with gravel
By:	SE		

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	26969.8	24692.3
+3/8" Coarse fraction (g):	3389.4	3284.2
-3/8" Split fraction (g):	278.75	253.07
Split fraction:	0.867	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	2085.94	405.60
Dry soil + tare (g):	2035.64	379.92
Tare (g):	465.05	126.85
Water content (%):	3.2	10.1

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	1102.8	37.5	95.5	
1"	1811.3	25	92.7	
3/4"	2361.3	19	90.4	
3/8"	3284.2	9.5	86.7	←Split
No.4	7.97	4.75	84.0	
No.10	14.88	2	81.6	
No.20	35.56	0.85	74.5	
No.40	89.53	0.425	56.0	
No.60	135.80	0.25	40.2	
No.100	159.81	0.15	31.9	
No.140	169.41	0.106	28.7	
No.200	179.11	0.075	25.3	



Gravel (%): 16.0
Sand (%): 58.6
Fines (%): 25.3

Comments:

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

Entered by:____________

Reviewed:____________

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

(ASTM D6913)

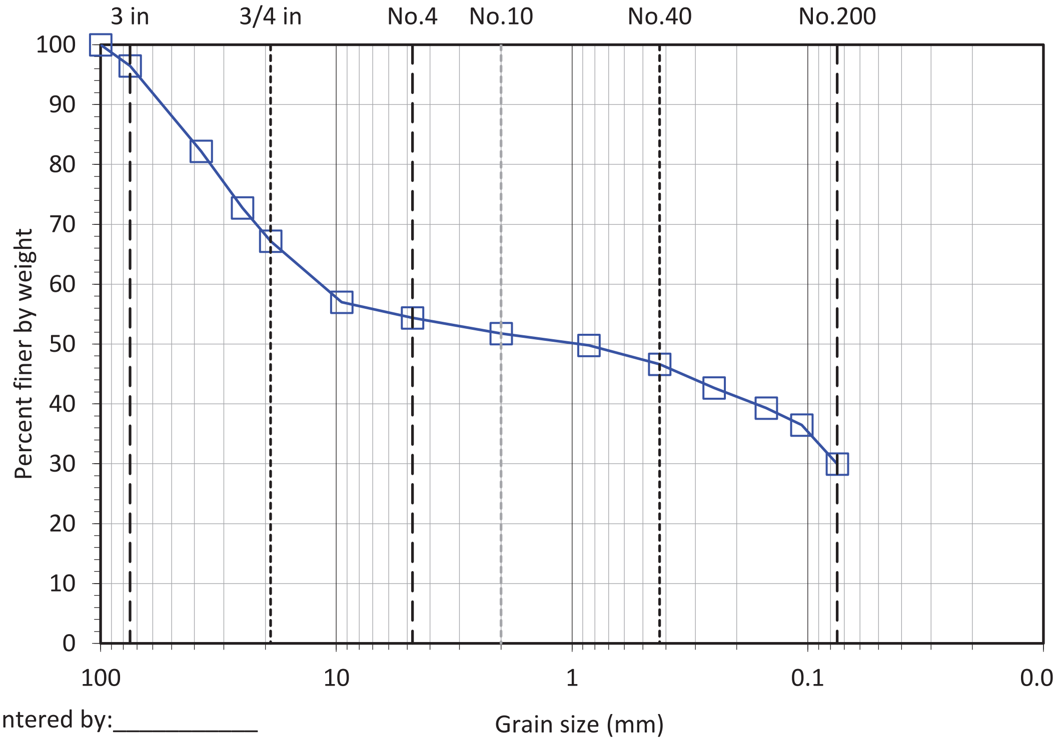
Project: Shelter Hill, Summit LLC
No: 01628-040
Location: Powder Mountain, UT
Date: 8/8/2024
By: RH

Boring No.: TP-16
Station: 11
Depth: 5.5'
Description: Red silty, clayey gravel with sand

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	24445.8	22364.2
+3/8" Coarse fraction (g):	10043.6	9616.2
-3/8" Split fraction (g):	289.93	256.63
Split fraction:	0.570	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	1811.98	412.99
Dry soil + tare (g):	1749.01	379.69
Tare (g):	332.22	123.06
Water content (%):	4.4	13.0

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	100.0	
3"	783.6	75	96.5	
1.5"	3977.0	37.5	82.2	
1"	6090.6	25	72.8	
3/4"	7337.9	19	67.2	
3/8"	9616.2	9.5	57.0	←Split
No.4	11.90	4.75	54.4	
No.10	23.70	2	51.7	
No.20	32.44	0.85	49.8	
No.40	46.75	0.425	46.6	
No.60	64.38	0.25	42.7	
No.100	79.65	0.15	39.3	
No.140	92.28	0.106	36.5	
No.200	121.72	0.075	30.0	



Gravel (%): 45.6
Sand (%): 24.4
Fines (%): 30.0

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

Entered by:___________
Reviewed:___________

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

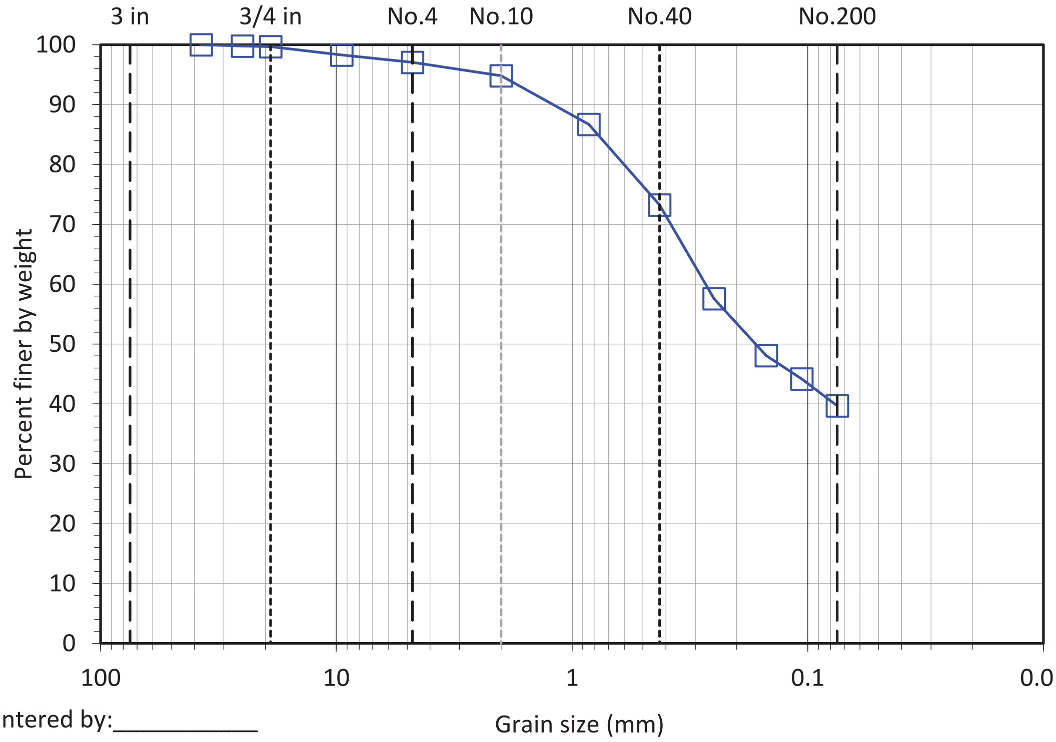
(ASTM D6913)

Project:	**Shelter Hill, Summit LLC**	**Boring No.:**	**TP-14**
No:	**01628-040**	**Station:**	**18**
Location:	Powder Mountain, UT	**Depth:**	**4.5'**
Date:	8/8/2024	Description:	Light brown clayey sand
By:	KC		

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	23991.9	22645.4
+3/8" Coarse fraction (g):	395.18	391.98
-3/8" Split fraction (g):	309.00	291.41
Split fraction:	0.983	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	534.99	437.41
Dry soil + tare (g):	531.79	419.82
Tare (g):	139.87	128.41
Water content (%):	0.8	6.0

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	100.0	
1"	49.92	25	99.8	
3/4"	72.95	19	99.7	
3/8"	391.98	9.5	98.3	←Split
No.4	3.53	4.75	97.1	
No.10	10.22	2	94.8	
No.20	34.27	0.85	86.7	
No.40	74.24	0.425	73.2	
No.60	120.66	0.25	57.6	
No.100	148.84	0.15	48.1	
No.140	160.38	0.106	44.2	
No.200	173.70	0.075	39.7	



Gravel (%): 2.9
Sand (%): 57.4
Fines (%): 39.7

Entered by:___________
Reviewed:___________

Amount of Material in Soil Finer than the No. 200 (75mm) Sieve

(ASTM D1140)

Project: **Shelter Hill, Summit LLC**
No: **01628-040**
Location: Powder Mountain, UT
Date: 8/6/2024
By: RH/CJ

Sample Info.	Boring No.				TP-20	TP-18			
	Station				11	8			
	Depth				4.5'	5.0'			
	Split				Yes	No			
	Split Sieve*				3/8"				
	Method				B	B			
	Specimen soak time (min)				510	480			
	Moist total sample wt. (g)				2721.00	243.17			
	Moist coarse fraction (g)				17.89				
	Moist split fraction + tare (g)				373.04				
	Split fraction tare (g)				153.21				
	Dry split fraction (g)				183.80				
	Dry retained No. 200 + tare (g)				193.52	313.31			
	Wash tare (g)				153.21	226.25			
	No. 200 Dry wt. retained (g)				40.31	87.06			
	Split sieve* Dry wt. retained (g)				17.73				
	Dry total sample wt. (g)				2277.80	214.67			
Coarse Fraction	Moist soil + tare (g)				40.38				
	Dry soil + tare (g)				40.22				
	Tare (g)				22.48				
	Water content (%)				0.90				
Split Fraction	Moist soil + tare (g)				373.04	469.42			
	Dry soil + tare (g)				337.01	440.92			
	Tare (g)				153.21	226.25			
	Water content (%)				19.60	13.28			
	Percent passing split sieve* (%)				**99.2**				
	Percent passing No. 200 sieve (%)				**77.5**	**59.4**			

Entered by:____________

Reviewed:____________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Shelter Hill, Summit LLC
No: 01628-040
Location: Powder Mountain, UT
Date: 8/6/2024
By: KC

Boring No.: TP-14
Station: 18
Depth: 4.5'
Sample Description: Light brown clayey sand
Engineering Classification: Not requested
As-received water content (%): Not requested

Method: ASTM D1557 B
Mold Id. IGES-8
Mold volume (ft^3): 0.0333

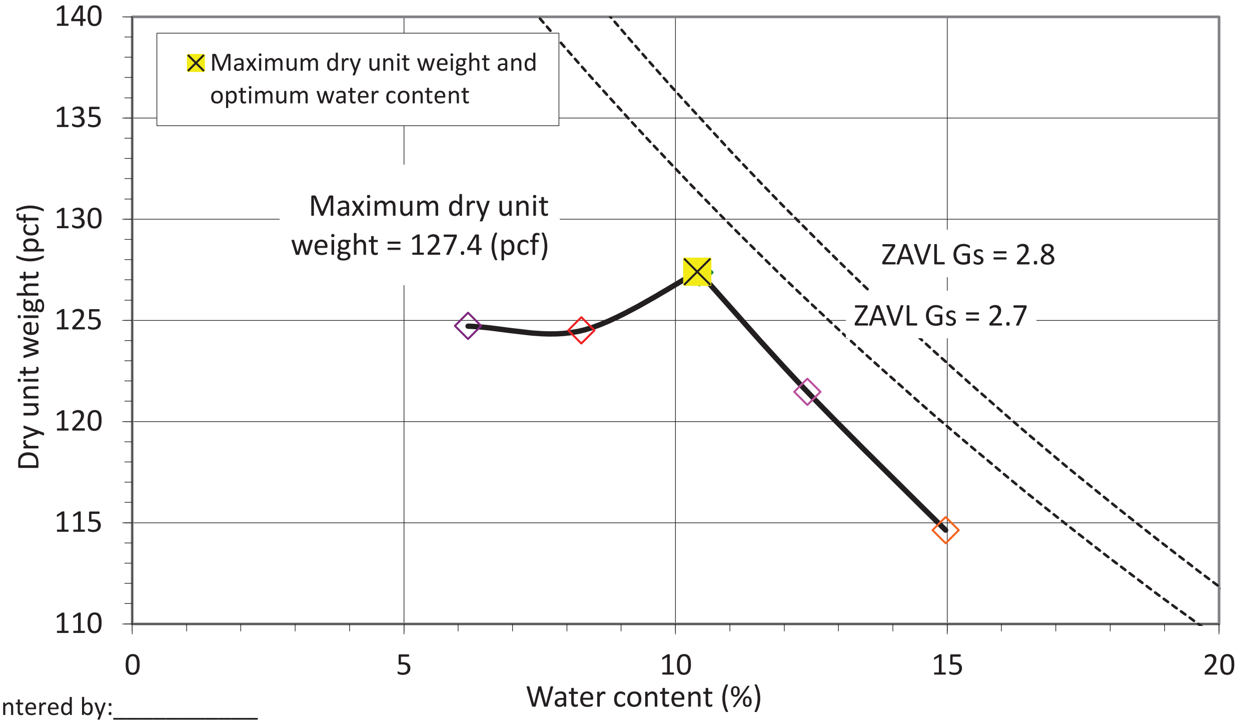
Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum water content (%): 10.4
Maximum dry unit weight (pcf): 127.4

Point Number	As is	+2%	+4%	+6%	*+8%			
Wt. Sample + Mold (g)	6127.8	6163.5	6252.2	6190.1	6118.2			
Wt. of Mold (g)	4127.5	4127.5	4127.5	4127.5	4127.5			
Total Unit Wt., γ (pcf)	132.4	134.8	140.7	136.6	131.8			
Wet Soil + Tare (g)	601.46	553.17	621.69	504.41	587.85			
Dry Soil + Tare (g)	573.57	520.63	574.98	462.32	527.15			
Tare (g)	122.19	126.97	127.50	123.62	121.72			
Water Content, w (%)	**6.2**	**8.3**	**10.4**	**12.4**	**15.0**			
Dry Unit Wt., γ_d (pcf)	**124.7**	**124.5**	**127.4**	**121.5**	**114.6**			

Comments:

*Previously compacted material was used to create point '+8%'



Entered by:___________

Reviewed:___________

California Bearing Ratio

(ASTM D 1883)

Project: Shelter Hill, Summit LLC
Number: 01628-040
Location: Powder Mountain, UT
Date: 8/13/2024
By: KC

Boring No.: TP-14
Station: 18
Depth: 4.5'
Original Method: ASTM D1557 C
Engineering Classification: Not requested
Condition of Sample: Soaked
Scalp and Replace: No

Maximum Dry Unit Weight (pcf): 127.4
Optimum Water Content (%): 10.4
Relative Compaction (%): 100.0
0.1 in. Corrected CBR (%): 16.7
0.2 in. Corrected CBR (%): 20.4

As Compacted Data			Before	After
Mold Id.	B	Wet Soil + Tare (g)	2050.80	1160.73
Wt. of Mold + Sample (g)	11976.5	Dry Soil + Tare (g)	1893.59	1070.85
Wt. of Mold (g)	7186.7	Tare (g)	385.71	219.36
Dry Unit Weight (pcf)	127.4	Water Content (%)	10.4	10.6
After Soaking Data			**Average**	**Top 1 in.**
Wt. of Mold + Sample (g)	12003.9	Wet Soil + Tare (g)	1276.09	814.89
Dry Unit Weight (pcf)	127.8	Dry Soil + Tare (g)	1175.31	755.28
		Tare (g)	221.72	211.54
		Water Content (%)	10.6	11.0

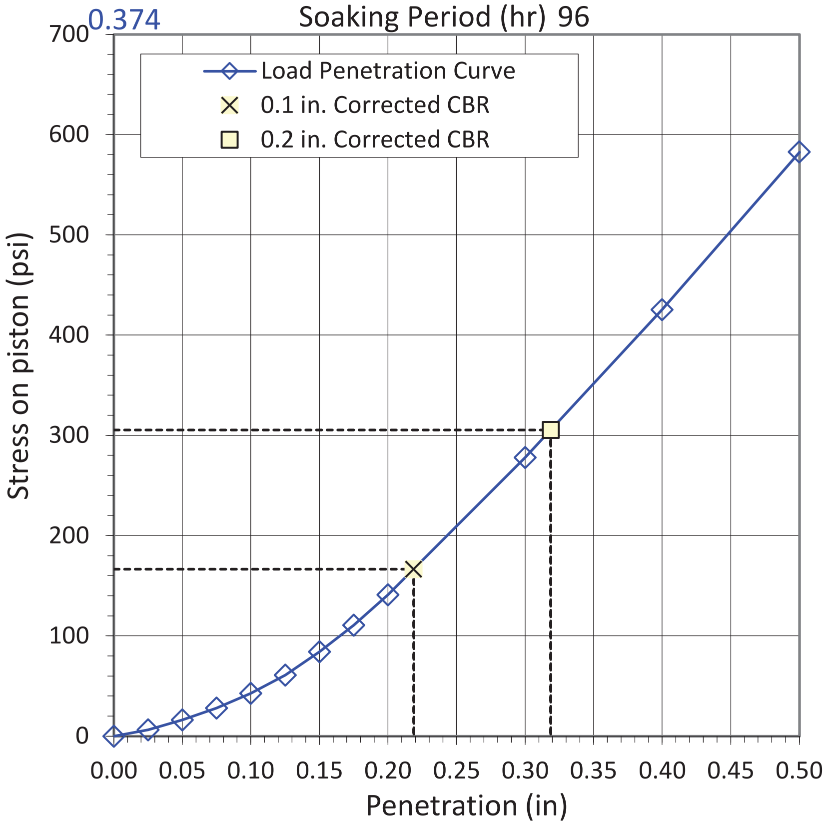
Swell Data

Date	Time	Dial	Surcharge (psf)	50
8/8/2024	9:50	0.366	Swell (%)	0.17
8/12/2024	9:50	0.374	Soaking Period (hr)	96

Penetration Data | Piston ID | CBR T1

Zero load (lb) = 0
Area of Piston (in^2) = 3.0

Penetration (in.)	Raw Load (lb)	Piston Stress (psi)	Std. Stress (psi)
0.000	0	0	
0.025	19	6	
0.050	49	16	
0.075	84	28	
0.100	128	43	1000
0.125	182	61	1125
0.150	252	84	1250
0.175	332	111	1375
0.200	423	141	1500
0.300	834	278	1900
0.400	1276	425	2300
0.500	1748	583	2600



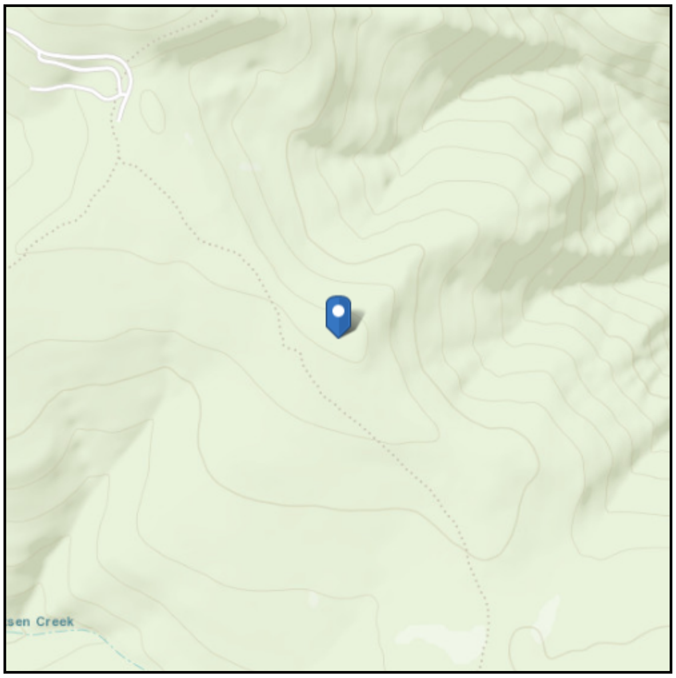
Entered By:___________
Reviewed:___________

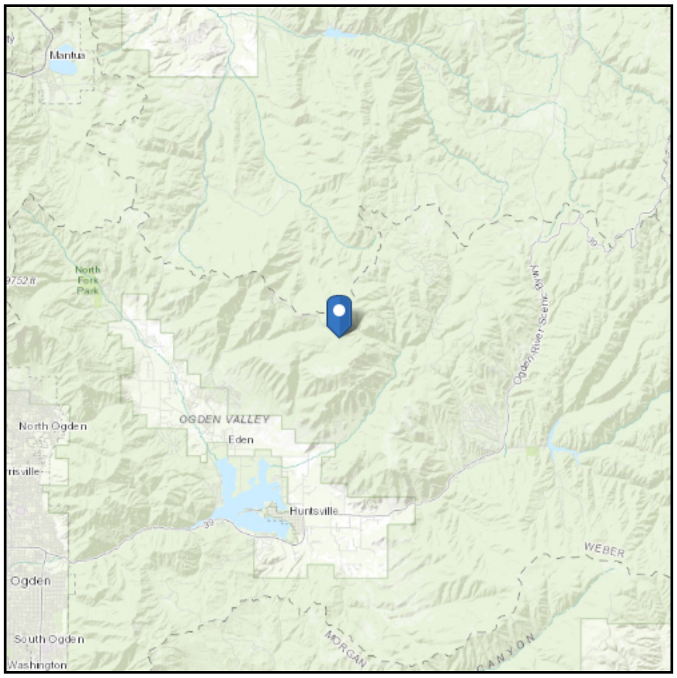
APPENDIX C

ASCE Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-16	**Latitude:**	41.356
Risk Category:	II	**Longitude:**	-111.7366
Soil Class:	C - Very Dense Soil and Soft Rock	**Elevation:**	8562.13454364381 ft (NAVD 88)





Seismic

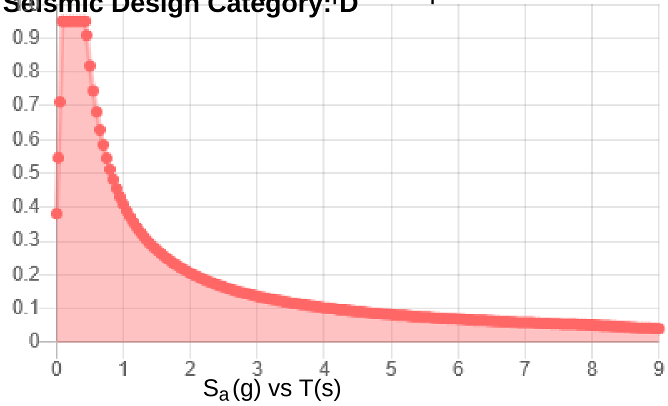
Site Soil Class: C - Very Dense Soil and Soft Rock

Results:

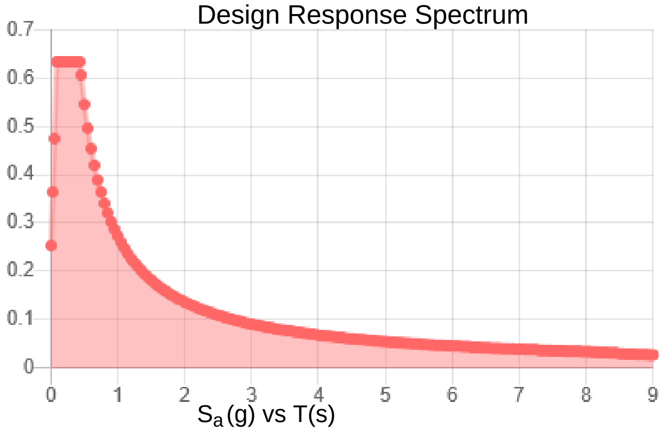
S_S :	0.792	S_{D1} :	0.273
S_1 :	0.273	T_L :	8
F_a :	1.2	PGA :	0.345
F_v :	1.5	PGA_M :	0.414
S_{MS} :	0.95	F_{PGA} :	1.2
S_{M1} :	0.409	I_e :	1
S_{DS} :	0.633	C_v :	1.048

Seismic Design Category: D

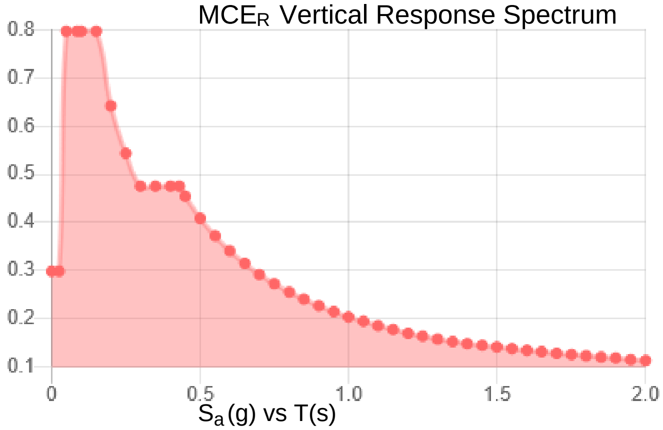
MCE$_R$ Response Spectrum



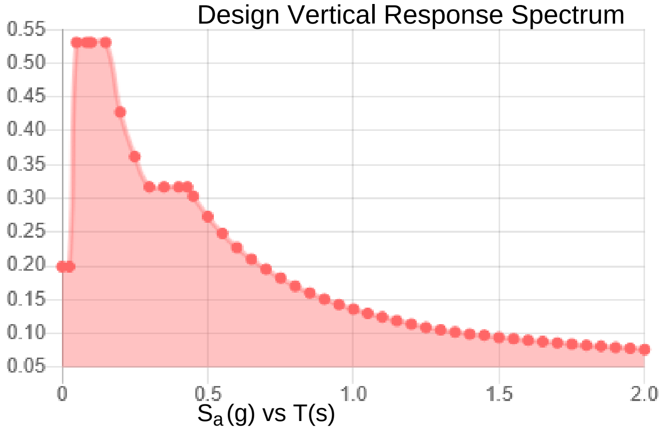
Design Response Spectrum



MCE$_R$ Vertical Response Spectrum



Design Vertical Response Spectrum



Data Accessed: **Fri Feb 07 2025**

Date Source:

USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

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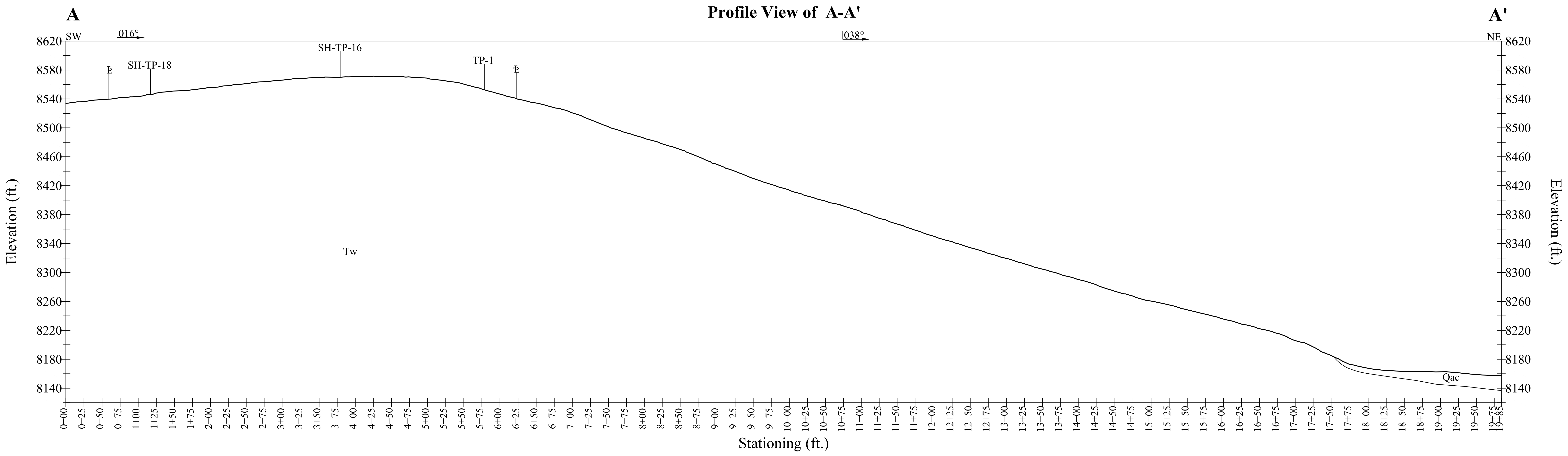
APPENDIX D



Profile View of A-A'

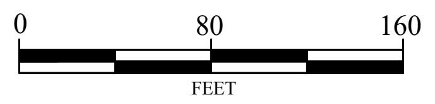
Profile View of B-B'

Topo Data:

-State of Utah and Partners, 2019, Regional Utah high-resolution lidar data 2015 - 2017: Collected by Quantum Spatial, Inc., Digital Mapping, Inc., and Aero-Graphics, Inc. and distributed by OpenTopography, https://doi.org/10.5069/G9RV0KSQ. Accessed: 01-08-2025.

Legend

Qmc	Undivided Mass-Movement and Colluvial Deposits (Holocene to middle Pleistocene)
Qac	Undivided Alluvium and Colluvium (Holocene to late Pleistocene)
Qgp	Glacial Deposits, Undivided (Late Pleistocene)
SH-TP-18	Test Pit (IGES, 2024)
Tw	Wasatch Formation (Eocene to Paleocene)
℄	Property Line
TP-4	Test Pit (This Study)



1" = 80'

Paper Size: 24" x 36"

*No Vertical Exaggeration

Project No: 01628-046

Geotechnical and Geologic Hazard Study
Shelter Hill-Townhomes
Powder Mountain Resort
Weber County, Utah

Cross Sections A-A' & B-B'

Figure

D-1

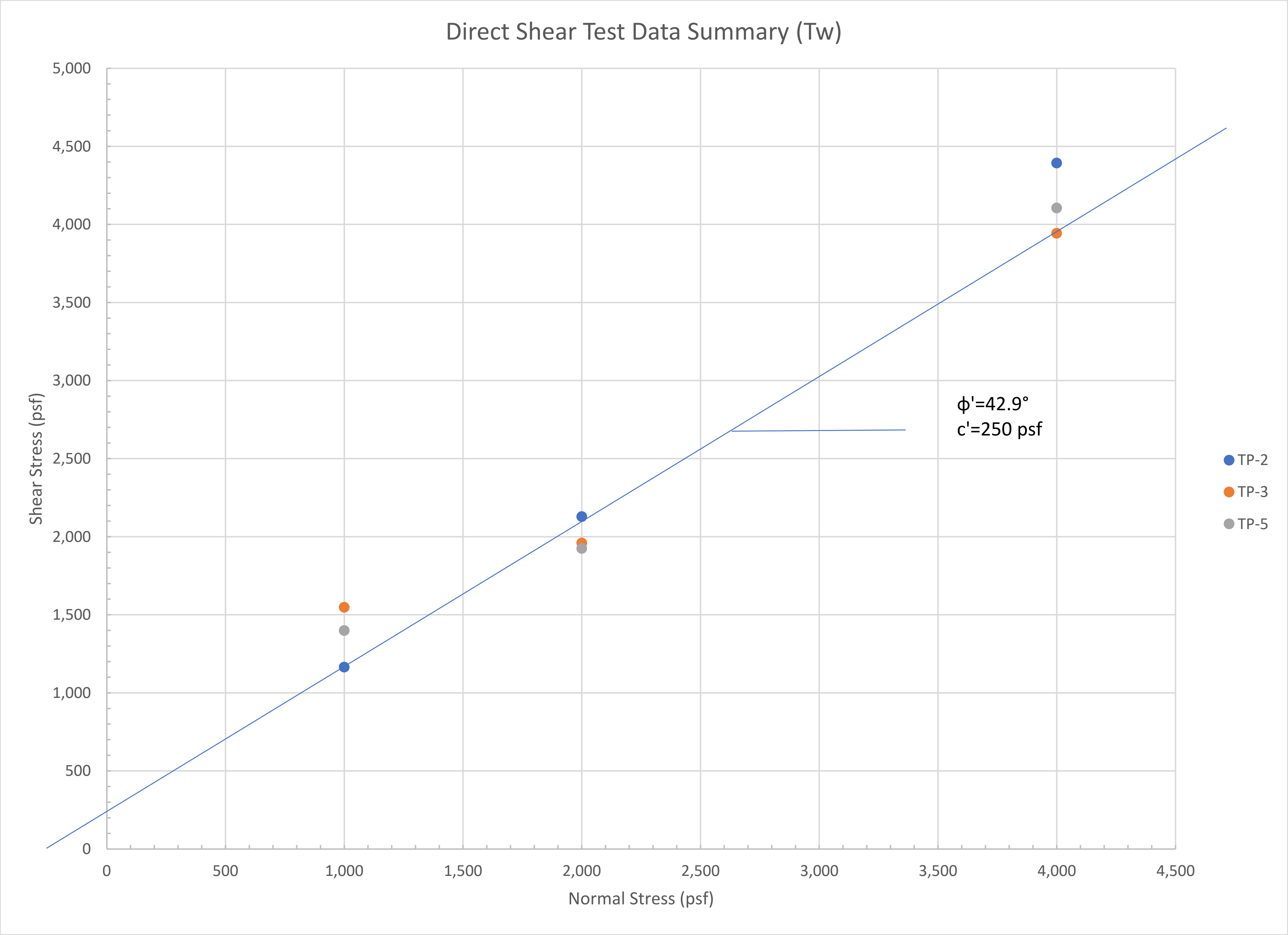
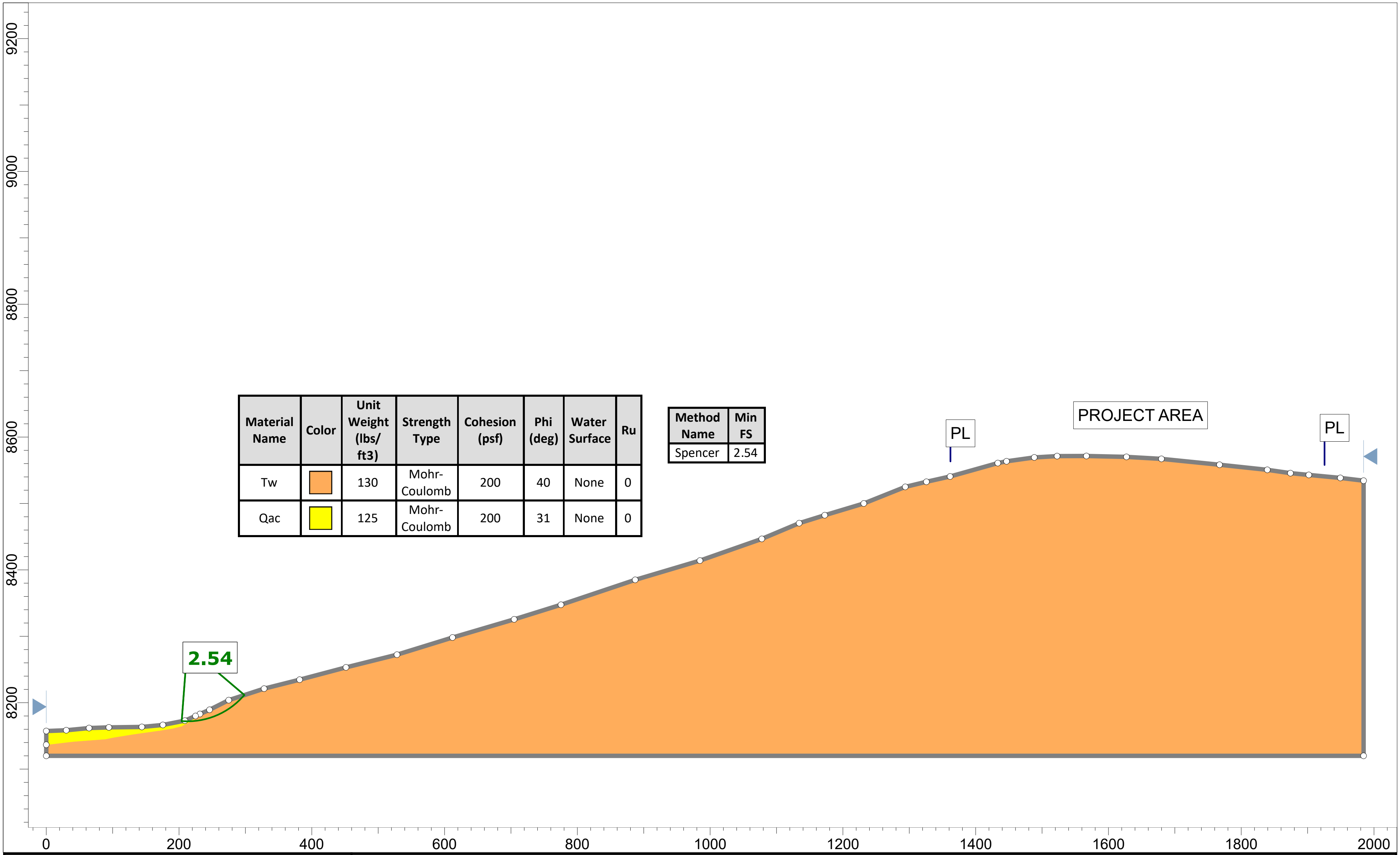

Direct Shear Test Data Summary (Tw)
Shear Stress (psf)
Normal Stress (psf)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
ϕ'=42.9°
c'=250 psf
TP-2
TP-3
TP-5

FIGURE D-2

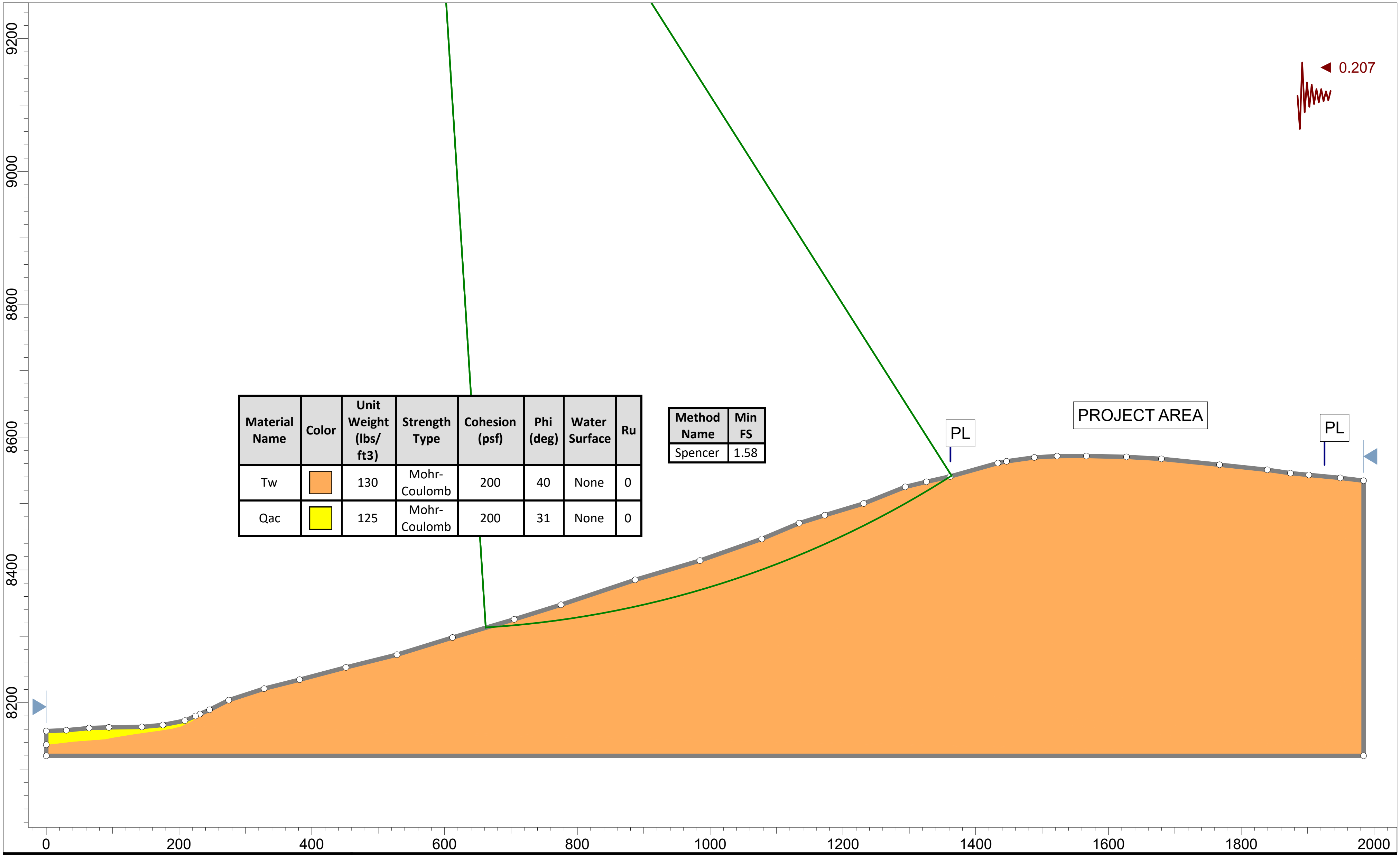


Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Tw	🟧	130	Mohr-Coulomb	200	40	None	0
Qac	🟨	125	Mohr-Coulomb	200	31	None	0

Method Name	Min FS
Spencer	2.54

Project	Powder Mtn./Shelter Hill Townhomes		
Group	A-A'	*Scenario*	Static
Drawn By	DAG	*Company*	IGES Inc.
Date	02-07-25	*File Name*	SHT-1.slmd

SLIDEINTERPRET 9.018

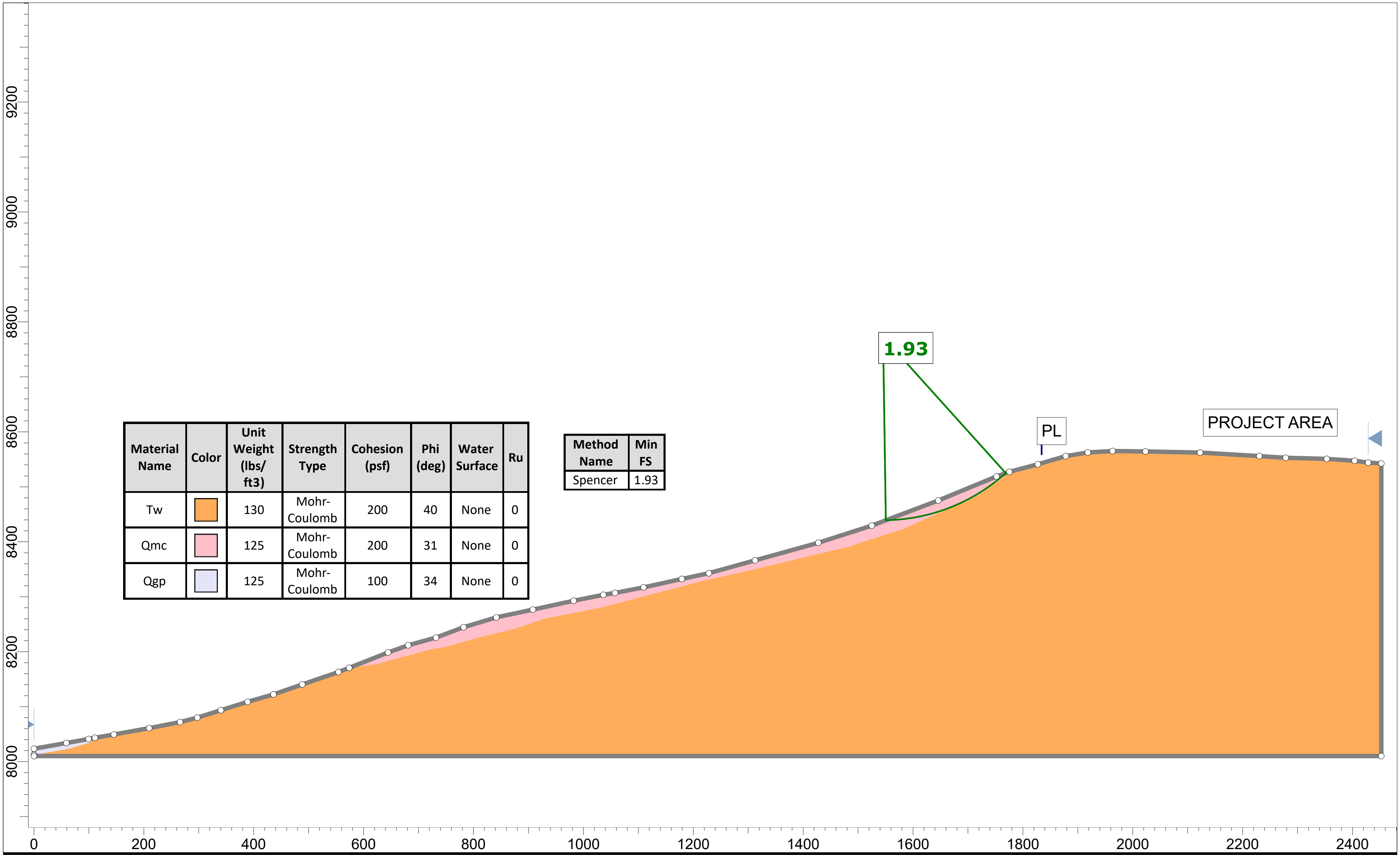


Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Tw	🟧	130	Mohr-Coulomb	200	40	None	0
Qac	🟨	125	Mohr-Coulomb	200	31	None	0

Method Name	Min FS
Spencer	1.58

SLIDEINTERPRET 9.018

Project	Powder Mtn./Shelter Hill Townhomes		
Group	A-A'	*Scenario*	Seismic
Drawn By	DAG	*Company*	IGES Inc.
Date	02-07-25	*File Name*	SHT-1.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Tw	🟧	130	Mohr-Coulomb	200	40	None	0
Qmc	🟥	125	Mohr-Coulomb	200	31	None	0
Qgp	⬜	125	Mohr-Coulomb	100	34	None	0

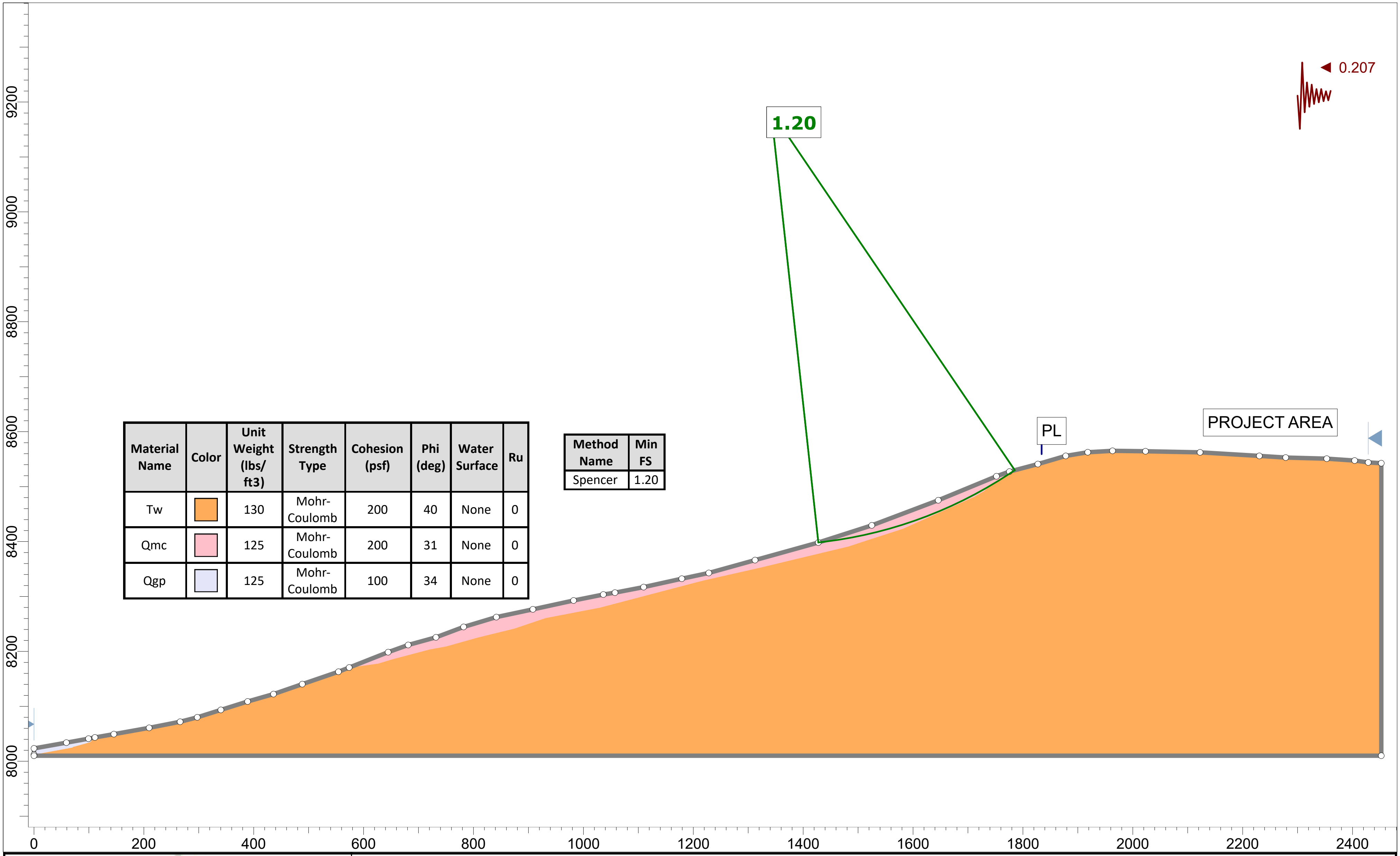
Method Name	Min FS
Spencer	1.93

IGES

SLIDEINTERPRET 9.018

Project	Powder Mtn./Shelter Hill Townhomes

Group	B-B'	*Scenario*	Static
Drawn By	DAG	*Company*	IGES Inc.
Date	02-07-25	*File Name*	SHT-1.slmd



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Tw	🟧	130	Mohr-Coulomb	200	40	None	0
Qmc	🟪	125	Mohr-Coulomb	200	31	None	0
Qgp	⬜	125	Mohr-Coulomb	100	34	None	0

Method Name	Min FS
Spencer	1.20

Project	Powder Mtn./Shelter Hill Townhomes		
Group	B-B'	*Scenario*	Seismic
Drawn By	DAG	*Company*	IGES Inc.
Date	02-07-25	*File Name*	SHT-1.slmd

SLIDEINTERPRET 9.018

SHT-1
Powder Mtn./Shelter Hill Townhomes
IGES Inc.
Date Created: 02-07-25
Software Version: 9.018

Table of Contents

Slide Analysis Information

SHT-1

Project Summary

File Name:	SHT-1.slmd
Slide Modeler Version:	9.018
Project Title:	Powder Mtn./Shelter Hill Townhomes
Analysis:	Section B-B' Seismic
Author:	DAG
Company:	IGES Inc.
Date Created:	02-07-25
Comments	
	01628-046

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
A-A' ◆	Static	Spencer: 2.535050	00h:00m:00.498s
	Seismic	Spencer: 1.583290	00h:00m:00.549s
B-B' ◆	Static	Spencer: 1.934140	00h:00m:00.563s
	Seismic	Spencer: 1.199650	00h:00m:00.516s

General Settings

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

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
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

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
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

A-A' - Static

Advanced seismic analysis: No
Staged pseudostatic analysis: No

A-A' - Seismic

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

B-B' - Static

Advanced seismic analysis: No
Staged pseudostatic analysis: No

B-B' - Seismic

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

Materials

Tw

Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	130
Cohesion [psf]	200
Friction Angle [deg]	40
Water Surface	Assigned per scenario
Ru Value	0

Qmc

Color	🟥
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	31
Water Surface	Assigned per scenario
Ru Value	0

Qgp

Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	100
Friction Angle [deg]	34
Water Surface	Assigned per scenario
Ru Value	0

Qac

Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	31
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material		Static	Seismic	Static	Seismic
Tw	🟧	✓	✓	✓	✓
Qmc	🟥	✗	✗	✓	✓
Qgp	⬜	✗	✗	✓	✓
Qac	🟨	✓	✓	✗	✗

Global Minimums

A-A' - Static

Method: spencer

FS	2.535050
Center:	212.423, 8284.764
Radius:	112.972
Left Slip Surface Endpoint:	203.952, 8172.110
Right Slip Surface Endpoint:	298.438, 8211.522
Resisting Moment:	1.23093e+07 lb-ft
Driving Moment:	4.85562e+06 lb-ft
Resisting Horizontal Force:	98556.5 lb
Driving Horizontal Force:	38877.5 lb
Total Slice Area:	869.658 ft2
Surface Horizontal Width:	94.4854 ft
Surface Average Height:	9.20415 ft

A-A' - Seismic

Method: spencer

FS	1.583290
Center:	568.067, 9794.779
Radius:	1484.805
Left Slip Surface Endpoint:	661.948, 8312.945
Right Slip Surface Endpoint:	1364.031, 8541.349
Resisting Moment:	3.54603e+09 lb-ft
Driving Moment:	2.23966e+09 lb-ft
Resisting Horizontal Force:	2.26405e+06 lb
Driving Horizontal Force:	1.42996e+06 lb
Total Slice Area:	23000.4 ft2
Surface Horizontal Width:	702.083 ft
Surface Average Height:	32.7603 ft

B-B' - Static

Method: spencer

FS	1.934140
Center:	1545.508, 8772.739
Radius:	333.698
Left Slip Surface Endpoint:	1550.494, 8439.079
Right Slip Surface Endpoint:	1768.793, 8524.752
Resisting Moment:	9.3022e+07 lb-ft
Driving Moment:	4.80948e+07 lb-ft
Resisting Horizontal Force:	257105 lb
Driving Horizontal Force:	132930 lb
Total Slice Area:	3243.03 ft2
Surface Horizontal Width:	218.299 ft
Surface Average Height:	14.8559 ft

B-B' - Seismic

Method: spencer

FS	1.199650
Center:	1341.628, 9183.256
Radius:	789.883
Left Slip Surface Endpoint:	1427.626, 8398.069
Right Slip Surface Endpoint:	1785.231, 8529.703
Resisting Moment:	3.30989e+08 lb-ft
Driving Moment:	2.75905e+08 lb-ft
Resisting Horizontal Force:	391297 lb
Driving Horizontal Force:	326177 lb
Total Slice Area:	5180.39 ft2
Surface Horizontal Width:	357.605 ft
Surface Average Height:	14.4863 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

A-A' - Static

Method: spencer

Number of Valid Surfaces: 12458
Number of Invalid Surfaces: 0

A-A' - Seismic

Method: spencer

Number of Valid Surfaces: 14220
Number of Invalid Surfaces: 0

B-B' - Static

Method: spencer

Number of Valid Surfaces: 12772
Number of Invalid Surfaces: 0

B-B' - Seismic

Method: spencer

Number of Valid Surfaces: 11269
Number of Invalid Surfaces: 0

Slice Data

A-A' - Static

Global Minimum Query (spencer) - Safety Factor: 2.53505

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	1.96273	63.3482	-3.80155	Qac	200	31	97.1519	246.285	77.0312	0	77.0312	70.5757	70.5757
2	1.96273	185.84	-2.80441	Qac	200	31	113.359	287.371	145.41	0	145.41	139.857	139.857
3	1.96273	318.191	-1.80812	Qac	200	31	130.519	330.873	217.809	0	217.809	213.688	213.688
4	1.96273	528.14	-0.812378	Qac	200	31	157.664	399.686	332.334	0	332.334	330.098	330.098
5	1.96273	740.729	0.183121	Qac	200	31	184.529	467.791	445.68	0	445.68	446.27	446.27
6	1.96273	944.949	1.17868	Qac	200	31	209.683	531.556	551.803	0	551.803	556.117	556.117
7	1.96273	1140.8	2.17459	Qac	200	31	233.178	591.117	650.929	0	650.929	659.783	659.783
8	1.96273	1328.26	3.17115	Qac	200	31	255.064	646.601	743.271	0	743.271	757.403	757.403
9	1.8758	1440.54	4.14657	Tw	200	40	361.717	916.971	854.454	0	854.454	880.678	880.678
10	1.8758	1607.81	5.10106	Tw	200	40	389.167	986.558	937.381	0	937.381	972.121	972.121
11	1.8758	1772.7	6.05698	Tw	200	40	415.465	1053.22	1016.83	0	1016.83	1060.92	1060.92
12	1.8758	1929.89	7.01459	Tw	200	40	439.67	1114.59	1089.96	0	1089.96	1144.06	1144.06
13	1.8758	2079.3	7.97418	Tw	200	40	461.837	1170.78	1156.93	0	1156.93	1221.62	1221.62
14	1.8758	2220.9	8.93602	Tw	200	40	482.018	1221.94	1217.9	0	1217.9	1293.7	1293.7
15	1.8758	2352.3	9.90041	Tw	200	40	499.86	1267.17	1271.8	0	1271.8	1359.04	1359.04
16	1.8758	2468.43	10.8676	Tw	200	40	514.546	1304.4	1316.17	0	1316.17	1414.96	1414.96
17	1.8758	2576.02	11.838	Tw	200	40	527.339	1336.83	1354.82	0	1354.82	1465.35	1465.35
18	1.8758	2675.49	12.8119	Tw	200	40	538.376	1364.81	1388.16	0	1388.16	1510.59	1510.59
19	1.8758	2766.78	13.7895	Tw	200	40	547.689	1388.42	1416.3	0	1416.3	1550.72	1550.72
20	1.8758	2849.77	14.7712	Tw	200	40	555.318	1407.76	1439.36	0	1439.36	1585.78	1585.78
21	1.8758	2924.36	15.7574	Tw	200	40	561.295	1422.91	1457.41	0	1457.41	1615.79	1615.79
22	1.8758	2990.43	16.7484	Tw	200	40	565.65	1433.95	1470.57	0	1470.57	1640.79	1640.79
23	1.8758	3062.05	17.7446	Tw	200	40	570.687	1446.72	1485.78	0	1485.78	1668.4	1668.4
24	1.8758	3142.34	18.7463	Tw	200	40	576.86	1462.37	1504.43	0	1504.43	1700.21	1700.21
25	1.8758	3213.73	19.7541	Tw	200	40	581.373	1473.81	1518.06	0	1518.06	1726.84	1726.84
26	1.8758	3276	20.7683	Tw	200	40	584.241	1481.08	1526.73	0	1526.73	1748.29	1748.29
27	1.8758	3328.98	21.7893	Tw	200	40	585.484	1484.23	1530.49	0	1530.49	1764.54	1764.54
28	1.8758	3372.47	22.8176	Tw	200	40	585.128	1483.33	1529.41	0	1529.41	1775.59	1775.59
29	1.8758	3406.26	23.8538	Tw	200	40	583.184	1478.4	1523.54	0	1523.54	1781.41	1781.41
30	1.8758	3430.12	24.8983	Tw	200	40	579.673	1469.5	1512.93	0	1512.93	1781.99	1781.99
31	1.8758	3443.8	25.9517	Tw	200	40	574.608	1456.66	1497.63	0	1497.63	1777.28	1777.28
32	1.8758	3447.02	27.0147	Tw	200	40	568.001	1439.91	1477.66	0	1477.66	1767.26	1767.26
33	1.8758	3439.5	28.0878	Tw	200	40	559.863	1419.28	1453.08	0	1453.08	1751.87	1751.87
34	1.8758	3420.91	29.1718	Tw	200	40	550.206	1394.8	1423.92	0	1423.92	1731.06	1731.06
35	1.8758	3390.91	30.2673	Tw	200	40	539.043	1366.5	1390.18	0	1390.18	1704.76	1704.76
36	1.8758	3349.11	31.3752	Tw	200	40	526.368	1334.37	1351.9	0	1351.9	1672.88	1672.88
37	1.8758	3295.09	32.4963	Tw	200	40	512.203	1298.46	1309.09	0	1309.09	1635.35	1635.35
38	1.8758	3214.45	33.6316	Tw	200	40	494.708	1254.11	1256.24	0	1256.24	1585.31	1585.31
39	1.8758	3059.09	34.7821	Tw	200	40	467.827	1185.96	1175.03	0	1175.03	1499.96	1499.96
40	1.8758	2882.74	35.9489	Tw	200	40	438.832	1112.46	1087.43	0	1087.43	1405.66	1405.66
41	1.8758	2692.06	37.1331	Tw	200	40	408.681	1036.03	996.341	0	996.341	1305.8	1305.8
42	1.8758	2486.38	38.3362	Tw	200	40	377.38	956.678	901.771	0	901.771	1200.2	1200.2
43	1.8758	2264.94	39.5596	Tw	200	40	344.934	874.424	803.749	0	803.749	1088.69	1088.69
44	1.8758	2026.91	40.8051	Tw	200	40	311.347	789.279	702.276	0	702.276	971.071	971.071
45	1.8758	1771.35	42.0743	Tw	200	40	276.625	701.259	597.379	0	597.379	847.104	847.104
46	1.8758	1497.18	43.3696	Tw	200	40	240.776	610.379	489.071	0	489.071	716.519	716.519
47	1.8758	1203.22	44.6931	Tw	200	40	203.806	516.659	377.38	0	377.38	579.014	579.014
48	1.8758	888.069	46.0476	Tw	200	40	165.726	420.124	262.334	0	262.334	434.233	434.233
49	1.8758	550.16	47.4362	Tw	200	40	126.547	320.804	143.969	0	143.969	281.763	281.763
50	1.8758	187.651	48.8625	Tw	200	40	86.6608	219.689	23.4649	0	23.4649	122.675	122.675

A-A' - Seismic

Global Minimum Query (spencer) - Safety Factor: 1.58329

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	14.0417	2904.33	3.89666	Tw	200	40	271.379	429.671	273.711	0	273.711	292.196	292.196
2	14.0417	8590.83	4.43994	Tw	200	40	498.59	789.413	702.435	0	702.435	741.149	741.149
3	14.0417	14032.7	4.98363	Tw	200	40	711.397	1126.35	1103.98	0	1103.98	1166.01	1166.01
4	14.0417	19420.7	5.52777	Tw	200	40	917.741	1453.05	1493.33	0	1493.33	1582.15	1582.15
5	14.0417	24791.9	6.0724	Tw	200	40	1119.25	1772.09	1873.55	0	1873.55	1992.62	1992.62
6	14.0417	29917.1	6.61759	Tw	200	40	1307.15	2069.59	2228.09	0	2228.09	2379.74	2379.74
7	14.0417	34794.9	7.16338	Tw	200	40	1481.76	2346.06	2557.57	0	2557.57	2743.8	2743.8
8	14.0417	39424.6	7.70983	Tw	200	40	1643.43	2602.02	2862.62	0	2862.62	3085.1	3085.1
9	14.0417	44068.2	8.25698	Tw	200	40	1802.35	2853.64	3162.48	0	3162.48	3424.04	3424.04
10	14.0417	48804.2	8.80489	Tw	200	40	1961.5	3105.62	3462.78	0	3462.78	3766.61	3766.61
11	14.0417	53290.4	9.35362	Tw	200	40	2108.23	3337.94	3739.65	0	3739.65	4086.91	4086.91
12	14.0417	57524.3	9.90321	Tw	200	40	2242.77	3550.96	3993.52	0	3993.52	4385.07	4385.07
13	14.0417	61504.5	10.4537	Tw	200	40	2365.41	3745.13	4224.92	0	4224.92	4661.35	4661.35
14	14.0417	65229.9	11.0052	Tw	200	40	2476.41	3920.87	4434.36	0	4434.36	4915.96	4915.96
15	14.0417	68699	11.5577	Tw	200	40	2576.03	4078.6	4622.33	0	4622.33	5149.13	5149.13
16	14.0417	71910.3	12.1114	Tw	200	40	2664.51	4218.69	4789.29	0	4789.29	5361.07	5361.07
17	14.0417	74434.1	12.6661	Tw	200	40	2727.21	4317.96	4907.6	0	4907.6	5520.51	5520.51
18	14.0417	76200.8	13.2221	Tw	200	40	2762.45	4373.76	4974.09	0	4974.09	5623.14	5623.14
19	14.0417	77704.1	13.7794	Tw	200	40	2787.83	4413.94	5021.98	0	5021.98	5705.67	5705.67
20	14.0417	78942.8	14.3379	Tw	200	40	2803.57	4438.87	5051.69	0	5051.69	5768.29	5768.29
21	14.0417	79915	14.8979	Tw	200	40	2809.89	4448.87	5063.6	0	5063.6	5811.15	5811.15
22	14.0417	80618.5	15.4594	Tw	200	40	2806.95	4444.22	5058.06	0	5058.06	5834.35	5834.35
23	14.0417	81051.5	16.0223	Tw	200	40	2794.96	4425.23	5035.43	0	5035.43	5838.05	5838.05
24	14.0417	81888.7	16.5869	Tw	200	40	2796.09	4427.02	5037.57	0	5037.57	5870.42	5870.42
25	14.0417	83078.2	17.1531	Tw	200	40	2808.3	4446.35	5060.61	0	5060.61	5927.4	5927.4
26	14.0417	83989.8	17.721	Tw	200	40	2811.16	4450.88	5066.01	0	5066.01	5964.3	5964.3
27	14.0417	84620.9	18.2908	Tw	200	40	2804.84	4440.88	5054.08	0	5054.08	5981.19	5981.19
28	14.0417	84968.8	18.8624	Tw	200	40	2789.51	4416.6	5025.15	0	5025.15	5978.17	5978.17
29	14.0417	85030.6	19.436	Tw	200	40	2765.32	4378.31	4979.52	0	4979.52	5955.29	5955.29
30	14.0417	84940.5	20.0116	Tw	200	40	2736.65	4332.91	4925.4	0	4925.4	5922.09	5922.09
31	14.0417	85909.4	20.5894	Tw	200	40	2740.42	4338.88	4932.53	0	4932.53	5962	5962
32	14.0417	86927.3	21.1693	Tw	200	40	2745.3	4346.61	4941.73	0	4941.73	6004.87	6004.87
33	14.0417	87646.2	21.7515	Tw	200	40	2740.86	4339.57	4933.35	0	4933.35	6026.93	6026.93
34	14.0417	87871.5	22.3361	Tw	200	40	2721.61	4309.09	4897.02	0	4897.02	6015.23	6015.23
35	14.0417	85754.2	22.9232	Tw	200	40	2633.88	4170.2	4731.5	0	4731.5	5845.35	5845.35
36	14.0417	82777.4	23.5128	Tw	200	40	2522.63	3994.06	4521.58	0	4521.58	5619.12	5619.12
37	14.0417	79420.8	24.105	Tw	200	40	2402.32	3803.57	4294.57	0	4294.57	5369.43	5369.43
38	14.0417	75505.9	24.7	Tw	200	40	2268.18	3591.18	4041.45	0	4041.45	5084.7	5084.7
39	14.0417	71245.6	25.2979	Tw	200	40	2126.63	3367.07	3774.37	0	3774.37	4779.53	4779.53
40	14.0417	66657.3	25.8987	Tw	200	40	1978.42	3132.42	3494.73	0	3494.73	4455.34	4455.34
41	14.0417	61979.9	26.5026	Tw	200	40	1830.4	2898.05	3215.41	0	3215.41	4128.12	4128.12
42	14.0417	58827.7	27.1097	Tw	200	40	1726.66	2733.8	3019.66	0	3019.66	3903.61	3903.61
43	14.0417	55720.3	27.7201	Tw	200	40	1625.92	2574.3	2829.58	0	2829.58	3683.94	3683.94
44	14.0417	52263.4	28.334	Tw	200	40	1517.6	2402.8	2625.19	0	2625.19	3443.5	3443.5
45	14.0417	48451	28.9514	Tw	200	40	1401.8	2219.45	2406.69	0	2406.69	3182.17	3182.17
46	14.0417	42323.8	29.5725	Tw	200	40	1227.48	1943.45	2077.76	0	2077.76	2774.28	2774.28
47	14.0417	33780.7	30.1975	Tw	200	40	993.861	1573.57	1636.95	0	1636.95	2215.34	2215.34
48	14.0417	24748.9	30.8264	Tw	200	40	752.348	1191.18	1181.25	0	1181.25	1630.21	1630.21
49	14.0417	15028.5	31.4595	Tw	200	40	498.238	788.855	701.772	0	701.772	1006.61	1006.61
50	14.0417	4924.09	32.0969	Tw	200	40	230.106	364.325	195.834	0	195.834	340.163	340.163

B-B' - Static

Global Minimum Query (spencer) - Safety Factor: 1.93414

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	4.38886	428.125	1.23305	Qmc	200	31	148.944	288.078	146.586	0	146.586	149.792	149.792
2	4.38886	1268.52	1.98693	Qmc	200	31	213.295	412.542	353.728	0	353.728	361.128	361.128
3	4.38886	2077.19	2.74116	Qmc	200	31	273.98	529.915	549.071	0	549.071	562.189	562.189
4	4.38886	2854.08	3.49587	Qmc	200	31	331.092	640.379	732.915	0	732.915	753.141	753.141
5	4.38886	3599.12	4.25118	Qmc	200	31	384.722	744.106	905.543	0	905.543	934.141	934.141
6	4.38886	4312.22	5.00724	Qmc	200	31	434.95	841.255	1067.23	0	1067.23	1105.34	1105.34
7	4.38886	4993.29	5.76417	Qmc	200	31	481.859	931.982	1218.22	0	1218.22	1266.86	1266.86
8	4.38886	5642.2	6.52211	Qmc	200	31	525.52	1016.43	1358.77	0	1358.77	1418.85	1418.85
9	4.38886	6258.82	7.2812	Qmc	200	31	566.007	1094.74	1489.09	0	1489.09	1561.41	1561.41
10	4.38886	6842.99	8.04158	Qmc	200	31	603.385	1167.03	1609.41	0	1609.41	1694.66	1694.66
11	4.38886	7394.54	8.80338	Qmc	200	31	637.72	1233.44	1719.93	0	1719.93	1818.69	1818.69
12	4.38886	7913.26	9.56676	Qmc	200	31	669.067	1294.07	1820.85	0	1820.85	1933.61	1933.61
13	4.38886	8398.96	10.3319	Qmc	200	31	697.493	1349.05	1912.34	0	1912.34	2039.49	2039.49
14	4.38886	8851.39	11.0988	Qmc	200	31	723.045	1398.47	1994.58	0	1994.58	2136.42	2136.42
15	4.38886	9270.31	11.8678	Qmc	200	31	745.773	1442.43	2067.74	0	2067.74	2224.46	2224.46
16	4.38886	9655.43	12.639	Qmc	200	31	765.725	1481.02	2131.98	0	2131.98	2303.69	2303.69
17	4.38886	10006.5	13.4125	Qmc	200	31	782.958	1514.35	2187.44	0	2187.44	2374.15	2374.15
18	4.38886	10323.1	14.1884	Qmc	200	31	797.502	1542.48	2234.26	0	2234.26	2435.89	2435.89
19	4.38886	10605	14.9671	Qmc	200	31	809.409	1565.51	2272.58	0	2272.58	2488.96	2488.96
20	4.38886	10851.7	15.7486	Qmc	200	31	818.71	1583.5	2302.52	0	2302.52	2533.4	2533.4
21	4.38886	11062.9	16.5331	Qmc	200	31	825.447	1596.53	2324.22	0	2324.22	2569.24	2569.24
22	4.38886	11241.2	17.3208	Qmc	200	31	829.857	1605.06	2338.42	0	2338.42	2597.22	2597.22
23	4.38886	11442.9	18.112	Qmc	200	31	835.581	1616.13	2356.84	0	2356.84	2630.14	2630.14
24	4.38886	11630.8	18.9067	Qmc	200	31	840.234	1625.13	2371.81	0	2371.81	2659.6	2659.6
25	4.38886	11781.3	19.7052	Qmc	200	31	842.349	1629.22	2378.62	0	2378.62	2680.31	2680.31
26	4.38886	11893.9	20.5077	Qmc	200	31	841.956	1628.46	2377.36	0	2377.36	2692.28	2692.28
27	4.38886	11967.9	21.3144	Qmc	200	31	839.081	1622.9	2368.11	0	2368.11	2695.49	2695.49
28	4.38886	12002.7	22.1256	Qmc	200	31	833.756	1612.6	2350.97	0	2350.97	2689.96	2689.96
29	4.38886	11997.7	22.9415	Qmc	200	31	826	1597.6	2326	0	2326	2675.62	2675.62
30	4.38886	11952.1	23.7623	Qmc	200	31	815.841	1577.95	2293.28	0	2293.28	2652.47	2652.47
31	2.60381	7053.85	24.4195	Qmc	200	31	806.245	1559.39	2262.4	0	2262.4	2628.46	2628.46
32	4.42258	11883.8	25.0842	Qmc	200	31	794.668	1537	2225.13	0	2225.13	2597.11	2597.11
33	4.42258	11726.7	25.9256	Qmc	200	31	778.217	1505.18	2172.18	0	2172.18	2550.49	2550.49
34	4.42258	11525	26.773	Qmc	200	31	759.392	1468.77	2111.59	0	2111.59	2494.73	2494.73
35	4.42258	11277.7	27.6269	Qmc	200	31	738.214	1427.81	2043.41	0	2043.41	2429.78	2429.78
36	4.42258	10983.9	28.4874	Qmc	200	31	714.695	1382.32	1967.71	0	1967.71	2355.56	2355.56
37	4.42258	10642.3	29.355	Qmc	200	31	688.854	1332.34	1884.53	0	1884.53	2271.97	2271.97
38	4.42258	10251.8	30.23	Qmc	200	31	660.702	1277.89	1793.91	0	1793.91	2178.91	2178.91
39	4.42258	9810.95	31.1129	Qmc	200	31	630.254	1219	1695.9	0	1695.9	2076.28	2076.28
40	4.42258	9318.5	32.0042	Qmc	200	31	597.517	1155.68	1590.52	0	1590.52	1963.95	1963.95
41	4.42258	8772.89	32.9041	Qmc	200	31	562.508	1087.97	1477.83	0	1477.83	1841.79	1841.79
42	4.42258	8172.5	33.8133	Qmc	200	31	525.234	1015.88	1357.85	0	1357.85	1709.64	1709.64
43	4.42258	7515.6	34.7323	Qmc	200	31	485.707	939.425	1230.61	0	1230.61	1567.33	1567.33
44	4.42258	6800.28	35.6616	Qmc	200	31	443.934	858.63	1096.14	0	1096.14	1414.69	1414.69
45	4.42258	6024.52	36.6019	Qmc	200	31	399.924	773.509	954.48	0	954.48	1251.51	1251.51
46	4.42258	5186.09	37.5538	Qmc	200	31	353.686	684.078	805.641	0	805.641	1077.56	1077.56
47	4.42258	4231.04	38.5179	Qmc	200	31	302.677	585.42	641.447	0	641.447	882.362	882.362
48	4.42258	3111.17	39.4952	Qmc	200	31	244.778	473.434	455.071	0	455.071	656.816	656.816
49	4.42258	1918.47	40.4865	Qmc	200	31	184.755	357.343	261.861	0	261.861	419.582	419.582
50	4.42258	652.048	41.4926	Qmc	200	31	125.958	243.62	72.5953	0	72.5953	184.004	184.004

B-B' - Seismic

Global Minimum Query (spencer) - Safety Factor: 1.19965

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	7.18971	670.081	6.51286	Qmc	200	31	244.825	293.704	155.949	0	155.949	183.899	183.899
2	7.18971	1985.36	7.03805	Qmc	200	31	336.211	403.335	338.406	0	338.406	379.914	379.914
3	7.18971	3240.49	7.56385	Qmc	200	31	421.628	505.806	508.946	0	508.946	564.932	564.932
4	7.18971	4435.23	8.09028	Qmc	200	31	501.218	601.286	667.852	0	667.852	739.099	739.099
5	7.18971	5569.37	8.6174	Qmc	200	31	575.117	689.939	815.395	0	815.395	902.552	902.552
6	7.18971	6642.65	9.14525	Qmc	200	31	643.456	771.922	951.839	0	951.839	1055.42	1055.42
7	7.18971	7654.81	9.67389	Qmc	200	31	706.362	847.387	1077.43	0	1077.43	1197.84	1197.84
8	7.18971	8605.58	10.2034	Qmc	200	31	763.955	916.479	1192.42	0	1192.42	1329.93	1329.93
9	7.18971	9494.64	10.7337	Qmc	200	31	816.355	979.34	1297.04	0	1297.04	1451.79	1451.79
10	7.18971	10321.7	11.265	Qmc	200	31	863.671	1036.1	1391.51	0	1391.51	1563.54	1563.54
11	7.18971	11086.4	11.7973	Qmc	200	31	906.014	1086.9	1476.05	0	1476.05	1665.29	1665.29
12	7.18971	11788.4	12.3306	Qmc	200	31	943.488	1131.86	1550.87	0	1550.87	1757.11	1757.11
13	7.18971	12427.3	12.865	Qmc	200	31	976.194	1171.09	1616.17	0	1616.17	1839.12	1839.12
14	7.18971	13042.8	13.4005	Qmc	200	31	1006.76	1207.76	1677.19	0	1677.19	1917.04	1917.04
15	7.18971	13859.6	13.9372	Qmc	200	31	1049.28	1258.77	1762.09	0	1762.09	2022.49	2022.49
16	7.18971	14660.8	14.4752	Qmc	200	31	1089.98	1307.6	1843.36	0	1843.36	2124.74	2124.74
17	7.18971	15397.1	15.0145	Qmc	200	31	1125.89	1350.67	1915.03	0	1915.03	2217.02	2217.02
18	7.18971	16068.1	15.5552	Qmc	200	31	1157.07	1388.08	1977.3	0	1977.3	2299.38	2299.38
19	7.18971	16673.4	16.0972	Qmc	200	31	1183.65	1419.96	2030.35	0	2030.35	2371.93	2371.93
20	7.18971	17212.3	16.6408	Qmc	200	31	1205.68	1446.39	2074.34	0	2074.34	2434.7	2434.7
21	7.18971	17684.4	17.1859	Qmc	200	31	1223.26	1467.48	2109.43	0	2109.43	2487.76	2487.76
22	7.18971	18089	17.7326	Qmc	200	31	1236.46	1483.32	2135.81	0	2135.81	2531.19	2531.19
23	7.18971	18425.5	18.281	Qmc	200	31	1245.36	1494	2153.58	0	2153.58	2564.99	2564.99
24	7.18971	18693.4	18.8311	Qmc	200	31	1250.05	1499.62	2162.93	0	2162.93	2589.24	2589.24
25	7.18971	18891.8	19.3831	Qmc	200	31	1250.58	1500.26	2163.99	0	2163.99	2603.98	2603.98
26	7.18971	19020.2	19.9369	Qmc	200	31	1247.03	1496	2156.91	0	2156.91	2609.24	2609.24
27	7.18971	19077.8	20.4927	Qmc	200	31	1239.47	1486.93	2141.81	0	2141.81	2605.05	2605.05
28	7.18971	19063.8	21.0504	Qmc	200	31	1227.96	1473.12	2118.82	0	2118.82	2591.43	2591.43
29	7.18971	18977.5	21.6103	Qmc	200	31	1212.56	1454.65	2088.08	0	2088.08	2568.42	2568.42
30	7.18971	18818	22.1724	Qmc	200	31	1193.34	1431.59	2049.71	0	2049.71	2536.03	2536.03
31	7.18971	18632.2	22.7367	Qmc	200	31	1172.93	1407.11	2008.97	0	2008.97	2500.5	2500.5
32	7.18971	18539.6	23.3034	Qmc	200	31	1157.76	1388.91	1978.68	0	1978.68	2477.37	2477.37
33	7.18971	18385.7	23.8724	Qmc	200	31	1139.5	1367	1942.21	0	1942.21	2446.51	2446.51
34	7.18971	18154.9	24.444	Qmc	200	31	1117.42	1340.51	1898.12	0	1898.12	2406.04	2406.04
35	7.18971	17846.2	25.0182	Qmc	200	31	1091.57	1309.5	1846.51	0	1846.51	2355.94	2355.94
36	7.18971	17458.4	25.5951	Qmc	200	31	1062.01	1274.04	1787.51	0	1787.51	2296.22	2296.22
37	7.18971	16990.4	26.1748	Qmc	200	31	1028.79	1234.19	1721.18	0	1721.18	2226.85	2226.85
38	7.18971	16441.1	26.7574	Qmc	200	31	991.973	1190.02	1647.67	0	1647.67	2147.83	2147.83
39	7.18971	15809.1	27.343	Qmc	200	31	951.598	1141.59	1567.06	0	1567.06	2059.12	2059.12
40	7.18971	15093.2	27.9317	Qmc	200	31	907.719	1088.95	1479.45	0	1479.45	1960.7	1960.7
41	7.18971	14292	28.5236	Qmc	200	31	860.382	1032.16	1384.94	0	1384.94	1852.55	1852.55
42	7.18971	13404	29.1189	Qmc	200	31	809.635	971.279	1283.62	0	1283.62	1734.6	1734.6
43	7.18971	12427.9	29.7176	Qmc	200	31	755.525	906.366	1175.59	0	1175.59	1606.84	1606.84
44	7.18971	11361.9	30.32	Qmc	200	31	698.098	837.473	1060.93	0	1060.93	1469.19	1469.19
45	7.18971	10204.5	30.926	Qmc	200	31	637.397	764.653	939.741	0	939.741	1321.61	1321.61
46	7.18971	8791.81	31.5359	Qmc	200	31	565.914	678.899	797.023	0	797.023	1144.3	1144.3
47	6.71974	6671.43	32.1297	Tw	200	40	599.519	719.213	618.774	0	618.774	995.285	995.285
48	6.71974	5120.6	32.7071	Tw	200	40	490.488	588.414	462.894	0	462.894	777.867	777.867
49	6.71974	3425.47	33.2883	Tw	200	40	374.375	449.119	296.889	0	296.889	542.698	542.698
50	6.71974	1187.69	33.8734	Tw	200	40	221.83	266.118	78.7963	0	78.7963	227.71	227.71

Interslice Data

A-A' - Static

Global Minimum Query (spencer) - Safety Factor: 2.53505

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	203.952	8172.11	0	0	0
2	205.915	8171.98	200.514	75.8121	20.711
3	207.878	8171.88	436.737	165.125	20.711
4	209.84	8171.82	706.118	266.975	20.711
5	211.803	8171.79	1024.47	387.34	20.711
6	213.766	8171.8	1383.45	523.065	20.711
7	215.729	8171.84	1772.25	670.067	20.711
8	217.691	8171.91	2180.89	824.568	20.711
9	219.654	8172.02	2600.12	983.075	20.711
10	221.53	8172.16	3161.66	1195.39	20.7111
11	223.406	8172.33	3733.88	1411.74	20.7111
12	225.281	8172.53	4309.94	1629.54	20.711
13	227.157	8172.76	4882.17	1845.89	20.711
14	229.033	8173.02	5443.51	2058.13	20.711
15	230.909	8173.31	5987.43	2263.78	20.711
16	232.785	8173.64	6507.63	2460.46	20.711
17	234.66	8174	6997.74	2645.76	20.711
18	236.536	8174.39	7453.13	2817.94	20.711
19	238.412	8174.82	7869.71	2975.44	20.711
20	240.288	8175.28	8243.87	3116.91	20.711
21	242.164	8175.78	8572.46	3241.14	20.711
22	244.039	8176.31	8852.75	3347.12	20.711
23	245.915	8176.87	9082.48	3433.98	20.711
24	247.791	8177.47	9259.92	3501.06	20.711
25	249.667	8178.11	9383.02	3547.61	20.711
26	251.543	8178.78	9449.71	3572.82	20.711
27	253.418	8179.49	9458.34	3576.09	20.711
28	255.294	8180.24	9407.7	3556.94	20.711
29	257.17	8181.03	9297.05	3515.1	20.711
30	259.046	8181.86	9126.08	3450.46	20.711
31	260.922	8182.73	8894.97	3363.08	20.711
32	262.797	8183.64	8604.37	3253.21	20.711
33	264.673	8184.6	8255.42	3121.28	20.711
34	266.549	8185.6	7849.79	2967.91	20.711
35	268.425	8186.65	7389.67	2793.95	20.711
36	270.301	8187.74	6877.85	2600.43	20.711
37	272.176	8188.89	6317.69	2388.64	20.711
38	274.052	8190.08	5713.23	2160.11	20.7111
39	275.928	8191.33	5072.66	1917.91	20.711
40	277.804	8192.63	4418.34	1670.52	20.711
41	279.68	8193.99	3761.36	1422.12	20.7109
42	281.555	8195.41	3111.93	1176.59	20.7111
43	283.431	8196.9	2481.39	938.183	20.711
44	285.307	8198.45	1882.22	711.644	20.711
45	287.183	8200.07	1328.29	502.212	20.7111
46	289.059	8201.76	835.009	315.707	20.711
47	290.934	8203.53	419.529	158.619	20.711
48	292.81	8205.39	101.053	38.207	20.711
49	294.686	8207.33	-98.845	-37.3721	20.711
50	296.562	8209.37	-155.792	-58.9031	20.711
51	298.438	8211.52	0	0	0

A-A' - Seismic

Global Minimum Query (spencer) - Safety Factor: 1.58329

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	661.948	8312.94	0	0	0
2	675.99	8313.9	2952.09	1230.67	22.6303
3	690.032	8314.99	7417.18	3092.09	22.6304
4	704.073	8316.22	13161.6	5486.82	22.6303
5	718.115	8317.58	20013.9	8343.44	22.6304
6	732.157	8319.07	27817.8	11596.8	22.6305
7	746.198	8320.7	36371.4	15162.6	22.6304
8	760.24	8322.46	45486.1	18962.4	22.6304
9	774.282	8324.36	54987	22923.1	22.6304
10	788.323	8326.4	64758.4	26996.6	22.6304
11	802.365	8328.58	74699.4	31140.9	22.6304
12	816.407	8330.89	84656.6	35291.8	22.6304
13	830.448	8333.34	94488.3	39390.5	22.6304
14	844.49	8335.93	104064	43382.6	22.6305
15	858.532	8338.66	113266	47218.8	22.6305
16	872.573	8341.53	121987	50854	22.6303
17	886.615	8344.55	130128	54248.1	22.6304
18	900.657	8347.7	137573	57351.7	22.6304
19	914.698	8351	144224	60124.4	22.6304
20	928.74	8354.45	150037	62547.8	22.6304
21	942.782	8358.03	154978	64607.6	22.6304
22	956.823	8361.77	159022	66293.3	22.6303
23	970.865	8365.65	162152	67598.2	22.6304
24	984.907	8369.69	164362	68519.4	22.6303
25	998.948	8373.87	165649	69056.1	22.6304
26	1012.99	8378.2	165998	69201.8	22.6304
27	1027.03	8382.69	165401	68952.8	22.6304
28	1041.07	8387.33	163858	68309.4	22.6304
29	1055.11	8392.13	161378	67275.5	22.6304
30	1069.16	8397.08	157979	65858.8	22.6304
31	1083.2	8402.2	153680	64066.6	22.6304
32	1097.24	8407.47	148403	61866.8	22.6305
33	1111.28	8412.91	142131	59252.1	22.6305
34	1125.32	8418.51	134881	56229.5	22.6304
35	1139.36	8424.28	126700	52819	22.6304
36	1153.41	8430.22	117880	49142.2	22.6304
37	1167.45	8436.33	108586	45267.4	22.6303
38	1181.49	8442.61	98936.4	41244.8	22.6304
39	1195.53	8449.07	89091.5	37140.7	22.6304
40	1209.57	8455.71	79190.2	33013	22.6304
41	1223.61	8462.52	69378.5	28922.7	22.6304
42	1237.66	8469.53	59767.3	24915.9	22.6304
43	1251.7	8476.71	50156.7	20909.4	22.6304
44	1265.74	8484.09	40602.4	16926.4	22.6304
45	1279.78	8491.66	31242	13024.3	22.6305
46	1293.82	8499.43	22224.5	9265.02	22.6304
47	1307.86	8507.4	14164.2	5904.8	22.6304
48	1321.91	8515.57	7766.84	3237.86	22.6304
49	1335.95	8523.95	3322.39	1385.05	22.6305
50	1349.99	8532.54	1186.82	494.764	22.6304
51	1364.03	8541.35	0	0	0

B-B' - Static

Global Minimum Query (spencer) - Safety Factor: 1.93414

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	1550.49	8439.08	0	0	0
2	1554.88	8439.17	639.732	231.351	19.8819
3	1559.27	8439.33	1521.83	550.351	19.8819
4	1563.66	8439.54	2608.7	943.405	19.8819
5	1568.05	8439.8	3865.07	1397.75	19.8818
6	1572.44	8440.13	5257.84	1901.43	19.8819
7	1576.83	8440.51	6756.06	2443.24	19.8819
8	1581.22	8440.96	8330.79	3012.73	19.8819
9	1585.61	8441.46	9955.05	3600.12	19.8819
10	1589.99	8442.02	11603.7	4196.34	19.8819
11	1594.38	8442.64	13253.5	4792.96	19.8819
12	1598.77	8443.32	14882.8	5382.19	19.8819
13	1603.16	8444.06	16471.9	5956.86	19.8819
14	1607.55	8444.86	18002.5	6510.37	19.8819
15	1611.94	8445.72	19458	7036.74	19.8819
16	1616.33	8446.64	20823.4	7530.53	19.8819
17	1620.72	8447.63	22085.3	7986.88	19.8819
18	1625.11	8448.67	23231.7	8401.44	19.8819
19	1629.49	8449.78	24252	8770.44	19.8819
20	1633.88	8450.96	25137.4	9090.62	19.8819
21	1638.27	8452.19	25880.2	9359.24	19.8819
22	1642.66	8453.5	26474.3	9574.11	19.8819
23	1647.05	8454.87	26915.2	9733.53	19.8819
24	1651.44	8456.3	27198.5	9836	19.8819
25	1655.83	8457.8	27320.2	9880.01	19.8819
26	1660.22	8459.38	27277.6	9864.6	19.8819
27	1664.6	8461.02	27069.5	9789.35	19.8819
28	1668.99	8462.73	26696.3	9654.38	19.8819
29	1673.38	8464.52	26159.8	9460.37	19.8819
30	1677.77	8466.37	25463.4	9208.53	19.8819
31	1682.16	8468.3	24612.2	8900.68	19.8819
32	1684.76	8469.49	24036.5	8692.49	19.8819
33	1689.19	8471.56	22943.9	8297.36	19.8819
34	1693.61	8473.71	21714.9	7852.94	19.8819
35	1698.03	8475.94	20361	7363.32	19.8819
36	1702.45	8478.25	18895.4	6833.27	19.8818
37	1706.88	8480.65	17333.1	6268.3	19.8819
38	1711.3	8483.14	15691.5	5674.62	19.8818
39	1715.72	8485.72	13989.9	5059.26	19.8818
40	1720.14	8488.39	12250	4430.05	19.8819
41	1724.57	8491.15	10495.9	3795.72	19.8819
42	1728.99	8494.01	8754.35	3165.9	19.8819
43	1733.41	8496.97	7054.69	2551.24	19.8819
44	1737.84	8500.04	5429.31	1963.44	19.8819
45	1742.26	8503.21	3913.73	1415.35	19.8819
46	1746.68	8506.5	2546.92	921.062	19.8819
47	1751.1	8509.9	1371.54	496.002	19.882
48	1755.53	8513.42	451.942	163.439	19.8819
49	1759.95	8517.06	-124.466	-45.0115	19.8819
50	1764.37	8520.84	-296.156	-107.101	19.8819
51	1768.79	8524.75	0	0	0

B-B' - Seismic

Global Minimum Query (spencer) - Safety Factor: 1.19965

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	1427.63	8398.07	0	0	0
2	1434.82	8398.89	1495.06	665.899	24.0082
3	1442.01	8399.78	3203.09	1426.66	24.0082
4	1449.19	8400.73	5080.47	2262.84	24.0082
5	1456.38	8401.75	7086.61	3156.38	24.0082
6	1463.57	8402.84	9183.88	4090.5	24.0082
7	1470.76	8404	11337.5	5049.72	24.0082
8	1477.95	8405.23	13515.5	6019.79	24.0081
9	1485.14	8406.52	15688.5	6987.65	24.0082
10	1492.33	8407.88	17829.9	7941.43	24.0082
11	1499.52	8409.32	19915.6	8870.39	24.0081
12	1506.71	8410.82	21923.9	9764.89	24.0082
13	1513.9	8412.39	23835.7	10616.4	24.0081
14	1521.09	8414.03	25634.1	11417.4	24.0081
15	1528.28	8415.74	27306.1	12162.1	24.0081
16	1535.47	8417.53	28843.8	12847.1	24.0083
17	1542.66	8419.38	30231.2	13465	24.0082
18	1549.85	8421.31	31452.9	14009.1	24.0082
19	1557.04	8423.31	32495.9	14473.7	24.0082
20	1564.23	8425.39	33349.5	14853.9	24.0082
21	1571.42	8427.54	34005	15145.8	24.0082
22	1578.61	8429.76	34456.3	15346.8	24.0081
23	1585.8	8432.06	34699.2	15455	24.0082
24	1592.99	8434.44	34731.7	15469.5	24.0082
25	1600.18	8436.89	34554.2	15390.5	24.0083
26	1607.37	8439.42	34169	15218.9	24.0082
27	1614.56	8442.02	33580.6	14956.8	24.0082
28	1621.75	8444.71	32795.5	14607.1	24.0082
29	1628.94	8447.48	31822.6	14173.8	24.0082
30	1636.13	8450.33	30672.8	13661.7	24.0082
31	1643.32	8453.26	29359.1	13076.6	24.0083
32	1650.51	8456.27	27889.9	12422.2	24.0083
33	1657.7	8459.37	26255.8	11694.3	24.0081
34	1664.89	8462.55	24469.8	10898.9	24.0083
35	1672.08	8465.82	22549.6	10043.6	24.0082
36	1679.27	8469.17	20514.6	9137.18	24.0081
37	1686.46	8472.62	18386.8	8189.48	24.0082
38	1693.64	8476.15	16190.6	7211.3	24.0082
39	1700.83	8479.77	13952.7	6214.51	24.0081
40	1708.02	8483.49	11702	5212.08	24.0082
41	1715.21	8487.3	9470.27	4218.06	24.0082
42	1722.4	8491.21	7291.47	3247.62	24.0082
43	1729.59	8495.22	5202.28	2317.1	24.0082
44	1736.78	8499.32	3242.03	1444	24.0082
45	1743.97	8503.53	1452.76	647.058	24.0081
46	1751.16	8507.83	-120.674	-53.7483	24.0082
47	1758.35	8512.24	-1384.75	-616.768	24.0082
48	1765.07	8516.47	-1344.89	-599.015	24.0082
49	1771.79	8520.78	-1103.47	-491.486	24.0082
50	1778.51	8525.19	-604.522	-269.254	24.0082
51	1785.23	8529.7	0	0	0

Discharge Sections

Entity Information

◆ A-A'

Shared Entities

Type	Coordinates (x,y)
External Boundary	1949.34, 8538.53
	1901.78, 8543
	1874.17, 8545.75
	1839.28, 8550.76
	1767.23, 8558.37
	1679.86, 8567.21
	1627.09, 8570.18
	1566.71, 8571.52
	1522.59, 8571.38
	1488.31, 8569.32
	1446.53, 8563.56
	1433.35, 8560.81
	1361.48, 8540.63
	1325.84, 8532.64
	1293.99, 8524.95
	1231.45, 8500.09
	1172.61, 8482.43
	1134.15, 8470.4
	1077.77, 8446.65
	984.636, 8414.09
	887.144, 8384.96
	775.249, 8347.5
	704.727, 8325.55
	611.91, 8298.2
	528.214, 8272.38
	451.391, 8253.13
	381.567, 8234.73
	328.179, 8221.17
	274.838, 8203.87
	246.015, 8189.3
	231.518, 8182.98
	224.806, 8180.06
	208.736, 8173.05
	175.636, 8166.54
	144.004, 8163.47
	94.2447, 8162.82
	64.4264, 8161.82
	30.1398, 8158.49
	0, 8157.28
	0, 8136.69
	0, 8120
	1984.36, 8120
	1984.36, 8534.29
Material Boundary	0, 8136.69
	40.3972, 8141.52
	88.9317, 8145.23
	102.19, 8147.89
	134.328, 8153.01
	171.223, 8158.21
	190.434, 8161.31
	205.558, 8165.23
	221.663, 8172.99
	231.518, 8182.98

B-B'

Shared Entities

Type	Coordinates (x,y)
External Boundary	2428.44, 8543.84
	2403.84, 8547.3
	2353.05, 8550.68
	2278.26, 8552.74
	2230.37, 8555.86
	2122.49, 8562.24
	2023.22, 8564.36
	1963.17, 8565.03
	1918.03, 8562.38
	1877.96, 8555.85
	1827.13, 8540.87
	1775.52, 8527.12
	1751.87, 8518.81
	1645.88, 8475.05
	1524.86, 8429.41
	1427.69, 8398.09
	1312.47, 8366.01
	1228.31, 8342.81
	1179.16, 8332.31
	1109.6, 8316.87
	1057.46, 8306.86
	1036.4, 8303.51
	982.147, 8292.52
	908.093, 8276.38
	841.528, 8262.46
	782.059, 8244.43
	731.685, 8225.62
	681.039, 8211.64
	644.669, 8198.47
	573.727, 8170.64
	554.226, 8162.99
	488.28, 8140.27
	435.9, 8122.22
	388.843, 8108.69
	340.083, 8093.38
	297.186, 8079.92
	266.035, 8071.87
	209.714, 8060.8
	145.359, 8049.32
	111.031, 8043.19
	99.3238, 8041.1
	59.0323, 8033.77
	0, 8023.34
	0, 8012.33
	0, 8010
	2452.32, 8010
	2452.32, 8542.54

Material Boundary	573.727, 8170.64 626.577, 8178.1 651.034, 8185.36 719.725, 8203.52 750.32, 8209.16 807.499, 8225.41 874.238, 8241.7 931.082, 8260.73 965.439, 8267.47 1030.29, 8279.82 1062.45, 8288.4 1215.97, 8328.57 1323.5, 8353.08 1417.38, 8375.58 1482.3, 8391.12 1517.69, 8402.79 1581.37, 8423.22 1621.54, 8441.16 1676.86, 8465.9 1711.14, 8481.46 1730.75, 8492.8 1757.21, 8511.25 1775.52, 8527.12
Material Boundary	0, 8012.33 29.3486, 8017.72 70.9517, 8025.36 102.428, 8034.45 111.031, 8043.19