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DESIGN GEOTECHNICAL INVESTIGATION
Powder Mountain Resort
Weber County, Utah

IGES Project No. 01628-003

November 9, 2012

Prepared for:

Summit, LLC

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APPENDICES

1.0 EXECUTIVE SUMMARY

This report presents the results of our design geotechnical investigation conducted for the development near Powder Mountain Ski Resort in Weber County, Utah. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the subject site and to provide geotechnical recommendations foundation design, moisture control, and grading. While data collected in our preliminary investigation (IGES, 2012) were utilized in preparation of this report, the recommendations of this report supersede our preliminary recommendations. Our Scope of Work included additional geotechnical investigation, laboratory testing and preparation of this report.

We understand the project consists of developing approximately 200 of 2,000 acres of lightly forested land just south of the existing ski resort. Powder Mountain may undergo a major expansion that could include golf courses, ski lifts, residential, and commercial property development. Site development would include site infrastructure including roads and bridges, retaining structures, and associated underground utilities.

Subsurface soils were sampled in twenty two test pits and one boring excavated at representative locations across the site during the field investigation conducted by IGES. The locations of these explorations were selected based on development plans provided to IGES and the results of preliminary geologic and geotechnical studies. Site soils were predominantly loosely deposited and relatively easy to excavate, although coarse rock to 2 feet in diameter was commonly encountered. Surficial soil consists of mostly clayey/silty gravel, cobble and boulders. Bedrock was encountered 8 feet below existing grade in TP-01 and approximately 6 feet below existing grade in TP-18; however, bedrock was not encountered in any other test pit (maximum depth of the test pits was 15 feet below existing site grade). Bedrock was not encountered in the soil boring, which extended to a depth of 45 feet.

Based on the subsurface conditions encountered at the site, it is our opinion that portions of the subject site outside of mapped landslides are suitable for the proposed development. Areas within mapped landslides areas may be suitable for limited development; however, additional site-specific geotechnical/geologic study will be required on a case-by-case basis to assess the relative risk of future movement potential and to design suitable measures for landslide hazard mitigation, as required. Site development is also subject to Weber County Hillside Development Standards. Western Geologic (2012) has performed recent field work to identify landslides and other geologic hazards at the site.

Map review also indicates that Cambrian Middle Limestone Member (Cbm) may underlie the site. The presence of limestone on-site is problematic because karst structures are formed in limestone formations. Corrosivity tests performed on site soils indicate that soils are acidic. In a previous geologic report by AMEC (2001), a depression potentially indicating a collapsed cavern was identified on-site. For critical structures (emergency facilities, water tanks, critical infrastructure), drilling of site soils and coring of site rock is recommended to ascertain the acid sensitivity of underlying rock and its continuity.

Shallow conventional spread or continuous wall footings constructed on compacted *granular* structural fill may be proportioned utilizing a maximum net allowable bearing pressure of **2,500 pounds per square foot (psf)**. Shallow conventional spread or continuous wall footings constructed on competent, undisturbed native soils may be proportioned utilizing a maximum net allowable bearing pressure of **1,600 psf**. If any portion of a foundation system is underlain by structural fill, then the entire structure must be underlain by a uniform fill blanket (minimum of 2 feet structural fill below all foundations) **–** native-fill transition zones are not allowed. Structural fill should be properly moisture-conditioned and compacted as outlined in this report. The net allowable bearing values presented above are for dead load plus live load conditions.

Based on our observations, soil classifications and variations in several laboratory CBR tests the near surface soils are expected to provide poor to fair pavement support. IGES was not provided with any anticipated traffic data, but have performed pavement analysis based on assumed traffic volume which includes anticipated construction traffic. Those assumptions are stated in Section 6.8 *Pavement Design.* For the primary access road, the recommended pavement section consists of 4 inches of asphalt over 6 inches of roadbase over 10 inches of granular borrow. In residential areas pavement is recommended to contain of 4 inches asphalt, 4 inches roadbase and 6 inches granular borrow. Additional pavement section alternatives are also discussed in Section 6.8.

NOTICE: The scope of services provided within this report is limited to the assessment of the subsurface conditions at the subject site. The executive summary is provided solely for purposes of overview and is not intended to replace the report of which it is part and should not be used separately from the report.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of our final geotechnical investigation conducted for development near Powder Mountain Ski Resort in Weber County, Utah. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the subject site. Our Scope of Work includes additional geotechnical site investigation, laboratory analysis of soil samples, and engineering analysis to supplement our previous work at the site (IGES, 2012).

Our services were performed in accordance with our proposal to Summit LLC (Client), dated October 1, 2012. The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report (Section 7.1).

2.2 PROJECT DESCRIPTION

The site is located southeast of SR-158 Powder Mountain Road, south of previously developed portions of Powder Mountain Resort, in unincorporated Weber County, Utah. The project is accessed by Powder Ridge Road. The investigation area is shown on the *Site Vicinity Map* included in Appendix A at the end of this report (Figure A-1). The completed subsurface explorations are shown on Figures A-2, *Site Geologic Map*, and A-3, *Site Plan*.

Our understanding of the project is based on preliminary drawings provided by Langvaardt Design (September 2, 2012) and subsequent information provided by the Client. We understand the project currently consists of developing approximately 200 of the 2,000 acres contained in the Phase I portion of the development. Based on the preliminary plans reviewed, pedestrian/ski bridges are planned, and we understand that there will be cuts into natural terrain to accommodate the main access roads. We understand that the main lodge (Sky Lodge) is currently under construction.

3.0 METHOD OF STUDY

3.1 SUBSURFACE INVESTIGATION

As a part of this investigation and our preliminary investigation, subsurface soil conditions were explored by excavating twenty two test pits (eleven from our preliminary investigation, eleven from the current investigation) to depths ranging to 15 feet below the existing surface. Figures A-2 & A-3 in Appendix A illustrate the approximate locations of the test pits. Exploration points were placed to provide a representative cross section of the subsurface conditions in areas anticipated for development. Subsurface conditions as encountered in the explorations were logged at the time of our investigation by members of our technical staff and are presented on the enclosed test pit logs, Figures A-4 through A-25 in Appendix A. A *Key to Soil Symbols and Terminology* is presented on Figure A-27.

The test pits were excavated with the aid of a tracked excavator. Both bulk and relatively "undisturbed" soil samples were obtained in the test pit explorations. Relatively "undisturbed" soil samples were obtained with the use of a hand sampler attached to a 6-inch long brass tube driven into the soil with a 2 pound sledge ("undisturbed" samples were usually difficult to obtain due to the coarse nature of the prevailing earth materials encountered).

In addition, a soil boring was advanced at the location of the proposed water tank (see Figure A-26). The boring was accomplished with an ODEX drill rig, which was deemed appropriate considering the coarse, bouldery substrate previously encountered. The boring was advanced to a depth of 45 feet below existing grade. Soil samples were obtained using a drive sampler, alternating between a standard split spoon sampler (SPT) and a Modified California sampler. Due to the coarse character of the soils encountered, relatively undisturbed samples could not be obtained.

All samples were transported to our laboratory for testing to evaluate engineering properties of the various earth materials observed. The soils observed in the explorations were logged and classified in general accordance with the *Unified Soil Classification System* (USCS). Classifications for the individual soil units are shown on the attached test pit and boring logs (Figures A-4 through A-26).

It should be noted that test pit TP-04 was eliminated from the initial geotechnical investigation due to access restrictions (IGES, 2012). As such, TP-04 appears missing; this is not the case.

3.2 LABORATORY INVESTIGATION

Geotechnical laboratory tests were conducted on selected relatively undisturbed and bulk soil samples obtained during our field investigations. The laboratory testing program was designed to evaluate the engineering characteristics of onsite earth materials. Laboratory tests conducted during this investigation include:

- In situ moisture content
- Atterberg Limits
- No. 200 Sieve Wash
- Grain Size Distribution
- Maximum dry density and optimum moisture content
- Direct shear
- CBR for pavement recommendations
- Water-soluble sulfate concentration for cement type recommendations
- Resistivity and pH to evaluate corrosion potential of ferrous metals in contact with site soils

Results of selected laboratory tests are presented on the exploration logs (Appendix A). The laboratory test results are also presented in the *Summary of Laboratory Test Results Table* and on the *Lab Results* summary sheets in Appendix B.

4.0 GEOLOGIC CONDITIONS

4.1 GEOLOGIC SETTING

Ogden Valley in northern Utah is an intermontane valley that trends north-south and is part of a structural transition zone between the uplifted Middle Rocky Mountain Province on the east and the extensional Basin and Range Province on the. Ogden Valley is located near the center of the Intermountain seismic belt (Smith and Sbar, 1974; Smith et al., 1991), and is seismically characterized by three major active faults zones that are in or adjacent to the valley. These fault zones are the Wasatch, Ogden Valley northeastern margin, and Ogden Valley southwestern margin (Hecker, 1993). Structurally, Ogden Valley is a narrow, elongate graben formed by high-angle normal faults, bounded by the horst-block mountain ranges which were formed by the movement of the Ogden Valley margin fault zones.

The subject site is located within the uplilfted Middle Rocky Mountain Province approximately 3 miles east of the Ogden Valley northeastern margin fault zone. The geologic units mapped within or adjacent to the subject site are (from Coogan and King, 2001):

- undifferentiated mass movement deposits (Qm).
- Wasatch Formation (Tw) consisting of conglomerate, sandstone, siltstone, mudstone and minor amounts of limestone.
- St. Charles Formation (Csc) primarily consisting of Dolostone.
- Nounan Formation (Cn) primarily consisting of Dolostone.
- Calls Fort Shale Member of the Bloomington Formation (Cbc) consisting of micaceous shale and limestone.
- Middle Limestone Member of the Bloomington Formation (Cbm) consisting of limestone.

The various geologic units are shown on Figure A-2, *Site Geologic Map.*

4.2 SEISMICITY AND FAULTING

An active fault is defined as a fault that has had activity within the Holocene (<11ka). No active faults are mapped through or immediately adjacent to the site (Sorensen and Crittenden, 1979). Table 4.2.1 lists the closest mapped faults that would likely contribute to the seismicity at the subject site.

Table 4.2.1 – Nearest Mapped Faults to the Subject Site

Fault	Distance (miles)	Estimated M_w*
East Cache Fault Zone**	3.0	7.1
Ogden Valley Northeastern Margin Faults	3.0	7.0
James Peak Fault	3.1	7.5
Ogden Valley North Fork Fault	6.0	7.0
Ogden Valley Southwestern Margin Faults	7.5	7.0
Weber Segment of the Wasatch Fault Zone**	9.0	7.1

*Hecker (1993)

**Considered *Active Faults* within USGS ground motion database

Analyses suggest that the Weber Segment of the Wasatch Fault Zone is the single greatest contributor to the seismic hazard at the subject site. The most recent movement along the Weber Segment of the Wasatch Fault Zone occurred during Holocene Epoch, and there is evidence that as many as 10 to 15 earthquakes have occurred along this segment in the last 15,000 years (Hecker, 1993). A location near Kaysville Utah indicated that the Weber Segment has a measurable offset of 1.4 to 3.4 meters per event (McCalpin, et al., 1994). The Weber Segment is thought to be capable of producing earthquakes as large as magnitude 7.5 (Ms) and is thought to have a recurrence interval of approximately 1,200 years.

The site's seismologic hazard was identified following criteria outlined in the 2012 International Building Code (IBC, 2012). The short (0.2s) and long (1.0s) spectral accelerations were determined based on the location of the site using the *U.S. Seismic "Design Maps" Web Application* (USGS, 2012). Site Class is based on the average shear wave velocity within the upper 100 feet. Based on the field investigation, the soils at the site are representative of a "very dense soil and soft rock" profile (Site Class C) with F_a and F_v values of 1.075 and 1.531, respectively. The Design Response Spectrum corresponding to the Maximum Considered Earthquake (MCE) (the ground motion having a two percent probability of exceedance in 50 years [2PE50]) is presented in Appendix C. Based on the design spectral response accelerations and a Building Risk Category of II, the site's Seismic Design Category is D. The short- and long-period Design Spectral Response Accelerations are presented in Table 4.2.2. The *peak ground acceleration* (PGA) may be taken as $0.4 \cdot S_{MS}$.

The Seismic Design Category may be modified based on a different Building Risk Category and/or the provisions outlined in Section 1613.3.5.1 (IBC, 2009). If proposed structures at the site pertain to a different risk category and/or meet the provisional criteria of Section 1613.3.5.1, IGES should be contacted so that revised recommendations can be provided.

Table 4.2.2 - Short and Long Period Spectral Accelerations for MCE

Parameter	Short Period (0.2 sec)	Long Period (1.0 sec)
MCE Spectral Response Acceleration (g)	$S_S = 0.812$	$S_1 = 0.269$
MCE Spectral Response Acceleration Site Class C (g)	$S_{MS} = S_sF_a = 0.873$	$S_{M1} = S_1F_v = 0.412$
Design Spectral Response Acceleration (g)	$S_{DS} = S_{MS*}{}^2/_3 = 0.582$	$S_{D1} = S_{M1*}{}^2/_3 = 0.275$

IBC, 2012 has not been formally adopted, but it is possible that, depending on the time development and building permits are applied for, regulating agencies will require ground motions be determined according to the latest methods. IGES can modify these parameters as necessary at that time.

4.3 OTHER GEOLOGIC HAZARDS

Geologic hazards can be defined as naturally occurring geologic conditions or processes that could present a danger to human life and property. These hazards must be considered before development of the site. There are several hazards in addition to seismicity and faulting that may be present at the site, and which should be considered in the design of roads and critical facilities such as water tanks and structures designed for human habitation. Other geologic hazards considered significant for this site include debris flow, landslides, shallow bedrock, and karst formation.

4.3.1 Debris Flow

Debris flow is a potential hazard that may exist on areas containing Holocene deposits. This type of flooding typically occurs as a debris flood consisting of a mixture of soil, organic material, and rock debris transported by fast-moving flood water. Similar to stream flooding, debris floods and debris flows can occur as a result of runoff from spring snowmelt and cloudburst rainstorms. Landslides can also mobilize a debris flow.

Debris flows are not known to have been mapped on the site. Subsurface data collected for this site suggest that some portions of the site are covered with a relatively thin veneer of topsoil (½ to 4 feet), overlying colluvium consisting of slope wash and/or decomposed bedrock. Geologic evidence of past debris flow flooding is not readily apparent; as such, we anticipate any fan-style debris flow would be relatively small and consist mainly of a thin sheet-flow of mud and water. While this hazard could cause flooding of basements and damage to landscaping, sheet-flow flooding would not pose a significant hazard to structures or human life. This hazard can be minimized by proper site grading and drainage design.

4.3.2 Landslides

There are several types of landslides that should be considered when evaluating geologic hazards at a site. These include shallow debris slides, deep-seated earth or rock slumps, flows, and creep in colluvium. Several of these landslide types are reported at various locations across the subject site (see Figure A-2 in Appendix A). Evidence of past or current landslides was observed during our field investigation. TP-01 consisted of a chaotic jumbled mass of loose boulders, cobbles, and soil overlying fractured bedrock, suggesting a possible earthflow. Mapped landslides were in evidence above TP-03. Soils in TP-07 showed evidence of landslide deposits, and sag ponds were located upslope of the test pit location. Soils were exceptionally loose in TP-12, which is in an area mapped as undifferentiated landslide. With the exception of TP-09 through TP-11, soils site-wide were generally loose and homogenous with little or no stratification.

Stemming from our preliminary geotechnical investigation, these landslides have been recently studied by Western Geologic (2012); as a consequence of this study, the currently proposed development has been moved outside areas mapped as landslide. However, it is understood that some roadways will necessarily be constructed over areas mapped as landslide, with the understanding that some maintenance may be necessary to account for creep movement. Creep movement, if present, could potentially impact underground utilities. In some cases, where creep movement persists over time, above-ground utilities have been utilized successfully (e.g., Portuguese Bend landslide area in Southern California).

It is our opinion that much of the site is composed of loose incoherent deposits of shallow (e.g. less than 10 feet) colluvium, which is subject to creep. Creep movements typically progress at a rate measured in millimeters per year. The rate of creep usually increases during spring run-off. Due to differential movement of surficial soils colluvium creep can potentially damage underground utilities, roads, and structures on shallow foundations. Structures on deep foundations founded in competent soil or bedrock must be designed and constructed to withstand passive earth pressures from saturated soil in addition to snow loads. However, based on the information available we cannot preclude the possibility of more deep-seated landslide being present at the site.

4.3.3 Shallow Bedrock

Shallow bedrock should be considered when planning improvements that may require excavations in areas where bedrock is relatively shallow or exposed on the surface. Bedrock removal is generally expensive and time consuming. Shallow bedrock may consist of relatively unweathered sandstone, dolostone, or limestone. During our subsurface exploration the excavator met with early refusal on hard rock in TP-01, probably dolomite or limestone. In addition, dolomite was encountered at a depth of 6 feet in TP-18; this bedrock was highly weathered and could be excavated to a depth of 15 feet with an excavator. Based on our observations, excavations extending several feet into moderately weathered bedrock may require special handling and/or blasting.

4.3.4 Karst Formation

Map review indicates that Cambrian Middle Limestone Member (Cbm) may be on site (See Figure A-2). Limestone formations are easily eroded by water (chemical dissolution), which can form underground caverns or crevices. In addition, limestone formations dissolve more readily in the presence of acidic compounds. If caverns become large, overlying soils have the potential to collapse and cause sinkholes. Structures built on karst formations have the potential to catastrophically collapse. In the previous geologic report by AMEC (2001), a depression potentially indicating a collapsed cavern was identified on-site.

The site exploration encountered soils composed of decomposed Wasatch Formation sandstone and conglomerate, decomposed dolostone, and Nounan dolostone bedrock. Although dolostone is not as susceptible to erosion by water as limestone, dolostone or sandstone may be underlain by limestone susceptible to erosion by acidic fluid. pH tests performed previously by AMEC and by IGES for this report indicate on-site soils generally exhibit an acidic pH. Coring where Cambrian Middle Limestone (Cbm) formation is suspected below surficial soils or colluvium is especially recommended, where critical facilities are proposed, to prevent possible sinkholes and associated upslope landslides.

5.0 GENERALIZED SITE CONDITIONS

5.1 SURFACE CONDITIONS

The Powder Mountain Weber County expansion property is an irregular-shaped site of about 2,000 acres. The site topography is moderately rugged and hilly, draining west toward the south fork of Wolf Creek. Maximum topographic relief across the site is estimated to be four hundred feet. Vegetation at the site includes some mature trees (scrub oak, quaking aspens), brush, weeds and native grasses. With the exception of rough dirt roads and radio towers the site is largely undeveloped and is in a relatively natural state. Access to the site is gained from Powder Mountain Road (State Highway 158) and Powder Ridge Road.

5.2 SUBSURFACE CONDITIONS

The subsurface soil conditions were explored at the subject property by excavating twenty two test pits and one soil boring at representative locations across the site. Subsurface soil conditions were logged during our field investigation and are included in the exploration logs in Appendix A at the end of this report (Figures A-4 through A-26). The soil and moisture conditions encountered during our investigation are discussed below.

5.2.1 Soils

Topsoil: Topsoil was encountered throughout the site and generally consisted of Lean CLAY (CL) or silt (ML) with cobbles. The topsoil encountered was characterized by an abundance of organic matter (roots, etc.), a dark, loamy appearance, and was generally dry and 'crumbly'. The thickness of topsoil observed was generally 6 inches or less. Localized areas of deeper topsoil deposits may exist within the creek drainages.

Native Surficial Soils: The majority of the shallow surficial soils encountered in the explorations consisted of Clayey GRAVEL (GC) and Clayey SAND (SC), usually with abundant cobbles and boulders. Soils classifying simply as clay and/or silt were encountered in limited areas. The clays encountered generally consisted of Lean CLAY (CL), although Fat CLAY (CH) was also encountered; where encountered, Fat CLAY was typically associated with the reddish-brown gravelly clay and clayey gravel observed throughout the site. The majority of surficial soils most likely consist of either colluvium or *decomposed* bedrock.

Bedrock: Based on our review of geologic literature, the site is underlain by bedrock consisting of Tertiary-age Wasatch Formation (Tw), which generally consists of unconsolidated conglomerate, and Cambrian-age Nounan (Cn) and St. Charles (Csc) Formations, which consist of medium to dark grey dolostone. It is anticipated that near-surface bedrock encountered will consist primarily of highly weathered to decomposed bedrock. Prominent surface exposures of bedrock were not identified.

Exploration logs of the subsurface soil profiles are presented in Appendix A (Figures A-4 through A-26). The stratification lines shown on the enclosed logs represent the approximate boundary between soil types. The actual in-situ transition may be gradual. Due to the nature and depositional characteristics of the native soils, care should be taken in interpolating subsurface conditions between and beyond the exploration locations.

5.2.2 Groundwater

Groundwater was not encountered in the test pits or soil boring, however springs were active near TP-07 during site reconnaissance and exploration. During construction the groundwater elevation may increase locally due to precipitation, surface runoff, or other sources. We do not anticipate groundwater will adversely affect construction.

5.2.3 Expansive Soil

Expansive soils contain significant amounts of clay particles that change volume as a result of varying moisture conditions. Foundations and hardscape/pavements constructed on these soils may be subject to uplifting forces caused by the swelling. Without proper measures taken, heaving and cracking of building foundations, slabs-on-grade, or pavements could result. Soils that are potentially expansive typically exhibit a high degree of plasticity, i.e. Fat CLAY (CH) and Elastic SILT (ML). Although Fat CLAY and Elastic SILT are potentially expansive, the correlation between Atterberg Limits and expansion potential is approximate; a soil that classifies as Fat CLAY or Elastic SILT is not necessarily expansive.

Based on Atterberg limits testing, the fine-grained soils encountered generally classified as Lean CLAY (CL) or SILT (ML), although five samples did classify as Fat CLAY (CH) (mostly the reddish-brown clays). Based on the results of Atterberg Limits testing, our experience in the area, and review of AMEC’s geologic report, the onsite native soils are expected to have a low to moderate expansion potential. Where reddish-brown, highly plastic clays are identified at foundation subgrade, Expansion Index testing (ASTM D4829) should be performed to assess the expansion potential of subgrade soils.

5.2.4 Strength of Earth Materials

Two direct shear tests (ASTM D3080) were performed to evaluate the inherent strength properties of representative site soils. A relatively undisturbed sample of SILT with sand (ML) from TP-03 was tested; the results indicated the sample tested had an effective friction angle of 32 degrees and an effective cohesion of 36 psf (peak strength). Another sample obtained from TP-16 was tested; this sample consisted of Clayey GRAVEL (GC). This sample was remolded to approximately 95% of the maximum dry density (ASTM D698B) after the coarse fraction was removed. The results indicated the sample tested had an effective friction angle of 26 degrees and a cohesion of 260 psf (the results suggest that the clay fraction may dominate the engineering characteristics of this material when used for structural fill).

A summary of the direct shear test results are presented in Appendix B.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS

Weber County specifically states in the Hillside Development Review Procedures and Standards that certain criteria must be met for development of property for the purpose of human habitation. Structures in areas that are considered steep (greater than 25% grade) and having special soil and/or geologic conditions are considered *restricted lots* (36B-2). The planning division requires that parcels, lots, roads and accesses, exceeding an average of a 25% grade, shall be reviewed by the Hillside Development Review Board as part of the application request. Structures proposed in geologically sensitive areas are required to have a site-specific study performed by an engineering geologist and qualified civil engineer or architect (Weber County: Natural Hazards Overlay Districts – 38-2G). All recommendations herein are subject to change based on future studies, observations and supporting test data.

Supporting data upon which the following 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 soils encountered in the subsurface explorations and the anticipated design data discussed in the PROJECT DESCRIPTION section. 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 deemed necessary.

6.2 EARTHWORK

Prior to the placement of foundations, general site grading is recommended to provide proper support for exterior concrete flatwork, concrete slabs-on-grade, and pavement sections. Site grading is also recommended to provide proper drainage and moisture control on the subject property and to aid in preventing differential movement in foundation soils as a result of variations in moisture conditions.

6.2.1 General Site Preparation and Grading

Below proposed structures, fills, and man-made improvements, all vegetation, topsoil, debris and undocumented fill soils should be removed. Any existing utilities should be re-routed or protected in place. The exposed native soils should then be proof-rolled with heavy rubber-tired equipment such as a scraper or loader. Any soft/loose areas identified during proof-rolling should be removed and replaced with structural fill. All excavation bottoms should be observed by an

IGES representative during proof rolling or otherwise prior to placement of engineered fill to evaluate whether soft, loose, or otherwise deleterious earth materials have been removed and that recommendations contained in this report have been complied with.

6.2.2 Excavations

Soft, loose, or otherwise unsuitable soils beneath structural elements, hardscape or pavements may need to be over-excavated and replaced with structural fill. If over-excavation is required, the excavations should extend one 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 contained in this report.

Prior to placing engineered fill, all excavation bottoms should be scarified to at least 6 inches, moisture conditioned as necessary at or slightly above optimum moisture content (OMC), and compacted to at least 90 percent of the maximum dry density (MDD) as determined by ASTM D-1557 (Modified Proctor).

Below foundations and other structural elements, a minimum over-excavation of 3 feet below existing grade is recommended.

6.2.3 Excavation Stability

The contractor is responsible for site safety, including all temporary trenches excavated at the site and the design of any required temporary shoring. The contractor is responsible for providing the "competent person" required by Occupational Safety and Health (OSHA) standards to evaluate soil conditions. For planning purposes, Soil Type C is expected to predominate at the site (loose sands and gravels). Close coordination between the competent person and IGES should be maintained to facilitate construction while providing safe excavations.

Based on 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 as a protective system to workers in the trench. As an alternative to shoring or shielding, trench walls may be laid back at one and one half horizontal to one vertical (1½H:1V) (34 degrees) in accordance with OSHA Type C soils. Trench walls may need to be laid back at a steeper grade pending evaluation of soil conditions by the geotechnical engineer. Soil conditions should be evaluated in the field on a case-by-case basis. Large rocks exposed on excavation walls should be removed (scaled) to minimize rock fall hazards.

6.2.4 Structural Fill and Compaction

All fill placed for the support of structures, flatwork or pavements should consist of structural fill. Structural fill should consist of granular native soils, which may be defined as soils with less than 25% fines, 10-60% sand, and contain no rock larger than 4 inches in nominal size (6 inches in greatest dimension). Structural fill should also be free of vegetation and debris. All structural fill should be 1 inch minus material when within 1 foot of any base coarse material. 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 4-inch loose lifts if compacted by small hand-operated compaction equipment, maximum 6-inch loose lifts if compacted by light-duty rollers, and maximum 8-inch loose lifts if compacted by heavy duty compaction equipment that is capable of efficiently compacting the entire thickness of the lift. Additional lift thickness may be allowed by IGES provided the Contractor can demonstrate sufficient compaction can be achieved with a given lift thickness with the equipment in use. We recommend that all structural fill be compacted on a horizontal plane, unless otherwise approved by IGES. Structural fill underlying all shallow 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**. Any imported fill materials should be approved prior to importing. Also, prior to placing any fill, the excavations should be observed by IGES to confirm that unsuitable materials have been removed. In addition, proper grading should precede placement of 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.

6.2.5 Oversize Material

Based on our observations at the site, there is a significant potential for the presence of oversize materials (larger than 6 inches in greatest dimension). Large rocks, particularly boulders (>12 inches), may require special handling, such as segregation from structural fill, and disposal. Particularly large boulders may require special equipment and/or blasting for removal.

6.2.5.1 Oversized Particles within Structural Fill

If desired, oversize earth materials may be included in structural fill if they are placed in a manner that will not result in voids, loose soils, uncompacted soils, or point loading (stress concentration) of the project construction. These oversized particles should not be placed within 5 feet of the top of any embankment or berm, or within 5 feet of the outer slope of an embankment or berm. If oversized particles are used in structural fill as discussed above, it is imperative that the contractor place and compact fill around oversized particles in accordance with the recommendations presented in the previous paragraphs. In addition to these recommendations, it is likely that the contractor will be required to use small compaction equipment such as a hand operated jumping jack to compact the structural fill within two feet of the oversized material. We also recommend that a qualified geotechnical engineer or soils technician observe placement and compaction around oversized particles. Alternatively, the oversize material may be crushed onsite and incorporated into the fill.

6.2.6 Utility Trench Backfill

Utility trenches should be backfilled with structural fill in accordance with Section 6.2.4 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 generally does not require densification. Native earth materials can be used as backfill over the pipe bedding zone. All utility trenches backfilled below pavement sections, curb and gutter, 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). However, in all cases the pipe bedding and shading should meet the design criteria of the pipe manufacturer. Specifications from governing authorities having their own precedence for backfill and compaction should be followed where they are more stringent.

6.3 FOUNDATION RECOMMENDATION

Based on our field observations and considering the presence of relatively competent native earth materials outside of mapped landslide areas, proposed conventional structures (habitable and appurtenant structures) may be founded on conventional shallow foundations. Unconventional structures, such as water tanks or towers, may require specialty foundations. The foundations for unconventional structures should be assessed on a case-by-case basis.

6.3.1 Conventional Foundations

Bearing capacity values were calculated using Meyerhof and others' modifications to Terzaghi's original bearing capacity formula. Strength parameters for the bearing strata were assigned based on laboratory shear strength parameters and field observations. A factor of safety of 3 is generally used in developing allowable bearing values; however, additional reduction of allowable bearing is typically warranted to account for static settlement and potentially poor construction practices.

Based on our field observations and considering the presence of relatively competent native earth materials outside of mapped landslide areas, we recommend that the footings for proposed structures be founded either *entirely* on competent native soils or *entirely* on structural fill. Native/fill transition zones are not allowed beneath a single structure footprint. If soft, loose, or otherwise deleterious earth materials are exposed in the footing excavations, then the footings should be deepened such that all footings bear on relatively uniform, competent native earth materials. Alternatively, the foundation excavation may be over-excavated a minimum of 2 feet below the bottom of proposed footings and replaced with structural fill, such that the footings bear entirely on a uniform fill blanket. We recommend that IGES inspect the bottom of the foundation excavation prior to the placement of steel or concrete to identify the competent native earth materials as well as any unsuitable soils. Additional over-excavation may be required based on the actual subsurface conditions observed.

Shallow spread or continuous wall footings constructed on a minimum of 2 feet of *structural fill* may be proportioned utilizing a maximum net allowable bearing pressure of **2,500 pounds per square foot (psf)** for dead load plus live load conditions. Shallow spread or continuous wall footings constructed on *competent native soils* may be proportioned utilizing a maximum net allowable bearing pressure of **1,600 psf.** The net allowable bearing values presented above are for dead load plus live load conditions.

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.

Sizing of Footings: The minimum recommended footing width is 20 inches for continuous wall footings and 30 inches for isolated spread footings. The *maximum* recommended footing width is 5 feet for continuous wall footings and 7 feet for isolated spread footings. Proposed conventional footings that are larger than the maximum recommended dimensions presented herein should be evaluated on a case-by-case basis by IGES.

Foundation drains should be installed around below-ground foundations (e.g., basement walls) to minimize the potential for flooding from shallow groundwater, which may be present at various times during the year.

6.3.2 Water Tank Foundation

We understand that a water tank is proposed at the location of boring B-1; it is anticipated that this tank will be founded upon a mat foundation. Based on our subsurface exploration, we anticipate subgrade soils will consist largely of dense, competent native granular soils. As such, the tank foundation at the currently proposed location may be founded directly upon competent, undisturbed native soils. Tank foundations should be founded a minimum of 4 feet below existing grade. The tank foundation may be designed using an allowable bearing capacity of **2,500 psf** and a Modulus of Subgrade Reaction of **200 psi/inch**. It should be noted that the Modulus of Subgrade Reaction is not a function of soil properties alone but is also influenced by other factors, including the width of the loaded area, the shape of the loaded area, and the specific location under the slab. As such, the structural engineer should exercise care and engineering judgment when using the above stated value for design. The gross allowable bearing value presented above is for dead load plus live load conditions. The recommended bearing value may be increased by 1/3 for transient loading such as for wind or seismic.

Based on our subsurface exploration, we anticipate subgrade soils will consist largely of dense, competent native granular soils. However, if soft, loose, or otherwise deleterious earth materials are exposed in the foundation excavation, the entire footing excavation should be overexcavated a minimum of two feet and replaced with structural fill, such that the mat foundation bears on a uniform fill blanket. Additional overexcavation may be necessary depending on actual soil conditions encountered during construction. The excavation should extend one foot laterally for every foot of depth. Prior to placement of steel/concrete or structural fill (if required), a representative from IGES should observe the excavation subgrade to evaluate whether competent, undisturbed native soils have been exposed in the excavation bottom.

6.4 SETTLEMENT

6.4.1 Static Settlement

Static settlements of properly designed and constructed conventional foundations, founded as described in Section 6.3, are anticipated to be on the order of 1 inch or less. Differential settlement is expected to be half of total settlement over a distance of 30 feet.

6.4.2 Dynamic Settlement

Dynamic settlement (or seismically induced settlement) consists of dry dynamic settlement of unsaturated soils (above groundwater) and liquefaction-induced settlement (below groundwater). During a strong seismic event, seismically induced settlement can occur within loose to moderately dense sandy soil due to reduction in volume during, and shortly after, an earthquake event. Settlement caused by ground shaking is often non-uniformly distributed, which can result in differential settlement.

Based on the subsurface conditions encountered, dynamic settlement arising from a MCE seismic event is expected to be negligible (Pradel, 1998).

6.5 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 0.45 for sandy native soils or structural fill should be used.

Ultimate lateral earth pressures from *granular* backfill acting against retaining walls, temporary shoring, or buried structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in the following table:

Table 6.5 - Lateral Earth Pressure Coefficients

Condition	**Level Backfill**		**2H:1V Backfill**	
	Lateral Pressure Coefficient	**Equivalent Fluid Density (pcf)**	**Lateral Pressure Coefficient**	**Equivalent Fluid Density (pcf)**
Active (Ka)	0.33	40	0.53	64
At-rest (Ko)	0.50	60	0.80	96
Passive (Kp)	3.0	360	—	—

These coefficients and densities assume no buildup of hydrostatic pressures. The force of water should be added to the presented values if hydrostatic pressures are anticipated.

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 native granular soil with an Expansion Index (EI) less than 20.

Walls and structures allowed to rotate slightly should use the active condition. If the element is to be constrained against rotation (i.e., a basement or buried tank wall), the at-rest condition should be used. These values 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.

6.6 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 compacted gravel overlying properly prepared subgrade. The gravel should consist of free-draining gravel or road base with a 3/4-inch maximum particle size and no more than 5 percent passing the No. 200 mesh sieve. The layer should be compacted to at least 95 percent of the MDD as determined by ASTM D-1557.

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 fibermesh. Slab reinforcement should be designed by the structural engineer; however, as a minimum, slab reinforcement should consist of #4 bars placed 24 inches on-center within the middle third of the slab. We recommend a **minimum slab thickness of 5 inches**; a thicker slab section may be required if the slab-on-grade is designed to bear a significant structural load (i.e., a structural slab or mat foundation, which is different than slab-on-grade flooring). We recommend that concrete be tested to assess that 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 **200 psi/inch** may be used for design.

A moisture barrier (vapor retarder) consisting of **10-mil thick Visqueen** (or equivalent) plastic sheeting should be placed below slabs-on-grade where moisture-sensitive floor coverings or equipment is planned. Prior to placing this moisture barrier, any objects that could puncture it, such as protruding gravel or rocks, should be removed from the building pad. Alternatively, the subgrade may be covered with 2 inches of clean sand.

6.7 MOISTURE PROTECTION AND SURFACE DRAINAGE

During Construction: Over-wetting the soils prior to, during, or after construction may result in softening and ‘pumping’, causing equipment mobility problems and difficulty in achieving compaction. Every effort should be taken to ensure positive drainage away from roadway areas to reduce the potential for water to migrate below pavements and concrete flatwork. The recommended minimum slope is two percent (2%) in pavement areas. Moisture should not be allowed to infiltrate the soils in the vicinity of, or upslope from, the roadways.

Slope Protection: To aid in maintaining surficial slope stability, we recommend that a water interceptor swale be constructed at the top of engineered slopes (cut slopes exposing surficial soil, fill slopes). This swale should be designed to intercept all uphill slope drainage and divert the drainage around the slopes. The drainage should be controlled as it travels around the slopes and should be tied into the curb and gutter or other drainage system associated with the road. This recommendation does not apply to cut slopes that are comprised solely of hard, competent bedrock.

Residential Structures: Moisture should not be allowed to infiltrate into the soils in the vicinity of the foundations. As such, design strategies to minimize ponding and infiltration near the home should be implemented. Structures that are located near the toe of ascending slopes may be subject to sheet flow during periods of heavy rain or snow melt. Therefore, the Civil Engineer may also wish to consider construction of additional surface drainage to intercept surface runoff, or a curtain drain to intercept seasonal groundwater flow, if any.

We recommend that hand watering, desert landscaping or Xeriscape be considered within 5 feet of the foundations. We further recommend roof runoff devices be installed to direct all runoff a minimum of 10 feet away from structures. The home builder should be responsible for compacting the exterior backfill soils around the foundation. Additionally, the ground surface within 10 feet of the house should be constructed so as to slope a minimum of **five** percent away from the home. Pavement sections should be constructed to divert surface water off of the pavement into storm drains. Parking strips and roadway shoulder areas should be constructed to prevent infiltration of water into the areas surrounding pavement. Landscape plans must conform to Weber County development codes.

6.8 PRELIMINARY PAVEMENT SECTION DESIGN

Based on soil classifications and laboratory obtained CBR values of 1.8 -31.2 for the native soils tested, the near-surface soils are expected to provide poor to fair pavement support. Anticipated traffic volumes were not available at the time this report was prepared. However, based on our understanding of the project development we have estimated pavement loading based on the number and type of structures as well as anticipated construction traffic. We also understand that future development of the property may include other areas (Mary's Bowl, Geertsen Meadow and Geertsen Canyon) that would require use of access roads developed in this Phase. For passenger traffic we have assumed that half of the residential structure will be occupied at any one time during the year. Construction traffic will be seasonal, with peak truck traffic only being experience for 5-6 months per year (averaged over the pavement's design life). Based on our assumptions, the main access road will be subjected to approximately 727,000 ESAL's over its 20-year design life (assuming 2 percent annual growth rate). Residential side streets and cul-de sacs will be subjected to approximately 195,000 ESAL's. Given our observations and the results of laboratory testing, soils across the site are highly variable in their ability to support the anticipated pavement loading. We present the following pavement section alternatives for consideration:

Table 6.8.1 - Pavement Section Alternatives

Roadway/Area	Main Access		Residential	
	Recommended	Alternate	Recommended	Alternate
Asphalt Concrete Pavement (inches)	4	5	4	5
Untreated Road Base (inches)	6	12	4	6
Granular Borrow (inches)	10	0	6	0

We understand that Weber County standards call for a minimum pavement section consisting of 3 inches of asphalt, 6 inches of road base and 8 inches of "pit-run" gravel. Given anticipated weather, maintenance (plowing, salt) and the potential for construction traffic throughout the life of the road, we do not recommend that this section be utilized for the main access road. This section may be utilized on residential side streets; however, based on our experience we recommend that a minimum of 4 inches of asphalt be used in all public roads throughout the development.

The selected pavement section should be constructed on properly prepared subgrade. Material cost will likely play a factor in selecting the preferred pavement section. Additional variation in pavement layer thickness may also be acceptable if they can provide equal or greater structural capacity to the sections presented in table 6.8.1. The coarse fraction of the native soils will likely be suitable for generating gravel (i.e., ¾-minus) and/or a coarse pit-run material. Site materials would have to be processed to segregate coarse (cobbles and boulders) for crushing. However, for road base the majority of native site soils probably contain too much silt and clay for generation of a "state spec" road base; separating the fines from the coarse fraction may not be practical. You may wish to consult a materials expert (e.g., a person at a local pit) to see if a portable batch plant could effectively and economically generate road base from native site soils. Consideration should also be given to using a geotextile as part of the pavement construction. Given the remote location of the site, using geotextiles will allow for a reduction in the required thickness of imported roadbase; decreasing construction time, related materials handling and hauling/placement costs.

We have attempted to account for construction traffic in our estimation of anticipated pavement loading. However, an accurate assessment of the volume and type of vehicles that will be used for construction is not feasible at this time. During construction, a significant amount of heavy construction traffic is typical. Some distress may occur on the pavement during construction.

Over the life of the main access we anticipate that pavement distress from construction traffic will occur and need to be addressed.

Asphalt has been assumed to be a high stability plant mix and base course material composed of crushed stone with a minimum CBR of 70, granular borrow should have a minimum CBR of 30. Road base and granular borrow should be compacted to 95% of MDD 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. Subgrade should be scarified to a depth of 8 inches and compacted to 95% of MDD as determined by ASTM D-1557. Positive drainage away from roadways must be provided to minimize the potential for saturation of subgrade soils beneath constructed pavements.

Where Portland Cement Concrete (PCC) pavements are planned, such as near trash enclosures or other areas expected to support heavy truck traffic, we recommend a minimum of 6 inches PCC underlain by a minimum 6 inches of aggregate base course.

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

6.9 GEOLOGIC HAZARDS

A landslide study has recently been completed at the site (Western Geologic, 2012). We understand that the development has been moved outside of mapped landslide areas (with the exception of some roadways that must necessarily cross mapped landslides).

Areas within mapped landslides may be suitable for limited development; however, additional site-specific geotechnical/geologic study will be required on a site- and project-specific basis to design suitable measures for landslide hazard mitigation.

6.10 SOIL CORROSION POTENTIAL

To evaluate the corrosion potential of concrete in contact with onsite native soil, several representative soil samples were tested in our soils laboratory for soluble sulfate content. Laboratory test results indicate that the samples tested had sulfate contents ranging from ~5 to 127 ppm. Based on these results, the onsite native soils are expected to exhibit a low potential for sulfate attack to concrete.

To evaluate the corrosion potential of ferrous metal in contact with onsite native soil, several representative soil samples were tested in our soils laboratory for resistivity (AASHTO T288), chloride content, and pH. The tests indicated that the onsite soil tested has minimum soil resistivities ranging from 980 to 14,000 OHM-cm, chloride contents less than 57.5 ppm, and pH values ranging from 4.0 to 6.5. In all cases except one, the minimum resistivity was measured above 2,000 OHM-cm. Based on these results, the onsite native soil is considered moderately corrosive to ferrous metal; however, soils classifying as Fat CLAY (CH), which were encountered intermittently throughout the site, may be severely corrosive to ferrous metals.

Consideration should be given to retaining the services of a qualified corrosion engineer to provide an assessment of any metal or concrete that may be associated with planned construction, including buried utilities, reinforcing steel, valves, and similar improvements in contact with native soils. Due to low soil pH (acidic soil chemistry), the corrosion engineer should also provide an assessment of any concrete that may in contact with native soils.

7.0 CLOSURE

7.1 LIMITATIONS

The recommendations contained in this report are based on limited field exploration, laboratory testing, review of existing hazard studies and other geotechnical data, and our understanding of the proposed construction. The subsurface data used in the preparation of this report were obtained from the explorations made for this investigation. It is possible that variations in the soil and groundwater conditions could exist between and beyond the points explored. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, IGES should also be notified.

This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, expressed or implied, is made.

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.

7.2 ADDITIONAL SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during the construction. IGES staff or other qualified personnel should be on site to verify compliance with these recommendations. These tests and observations should include at a minimum the following:

- Observations and testing during site preparation, earthwork and structural fill placement.
- Consultation as may be required during construction.
- Quality control on concrete placement to verify slump, air content, and strength.
- Quality control and testing during placement and compaction of asphalt.

We also recommend that project plans and specifications be reviewed by us to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding the report or wish to discuss additional services, please do not hesitate to contact us at your convenience (801) 270-9400.

8.0 REFERENCES

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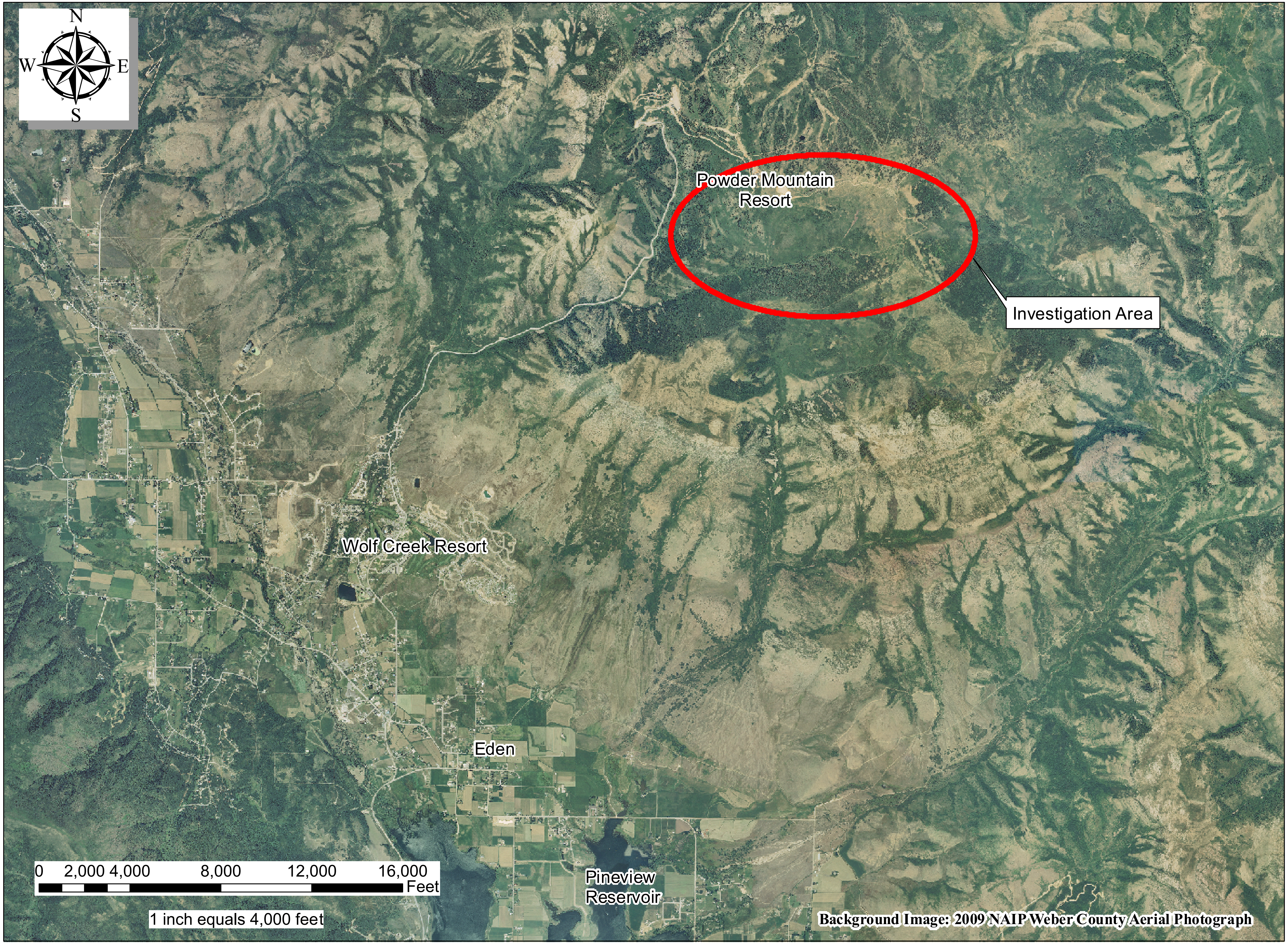
APPENDIX A



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ISSUE: DRAFT

PROJECT#:	01628-001
FILE LOCATION:	01628\001\Maps\GIS\Site_map.mxd
DRAWN BY:	JH
DESIGNED BY:	BM
CHECKED BY:	BM
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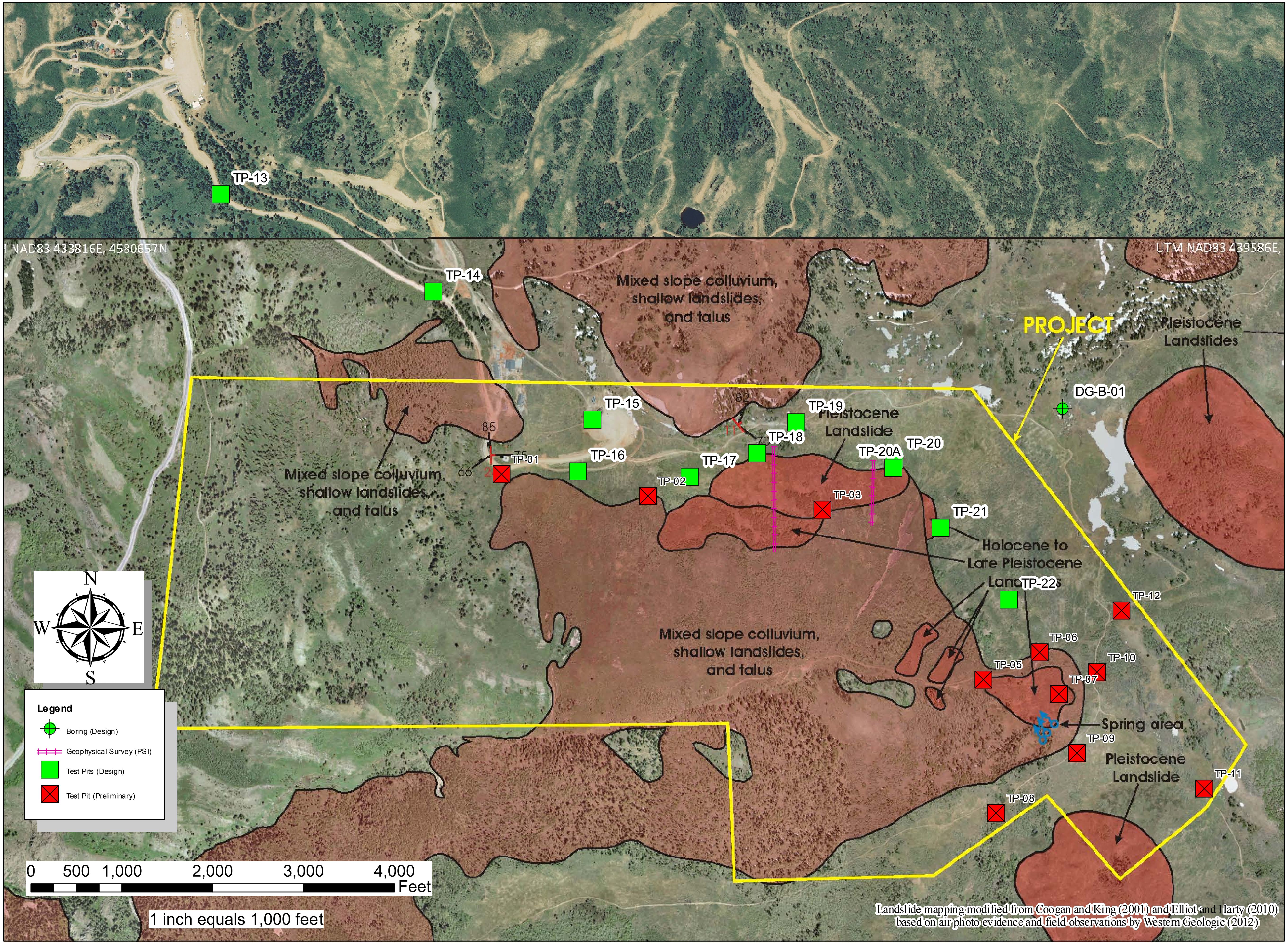
SHEET TITLE

Powder Mountain

SITE VICINITY MAP

FIGURE

A-1



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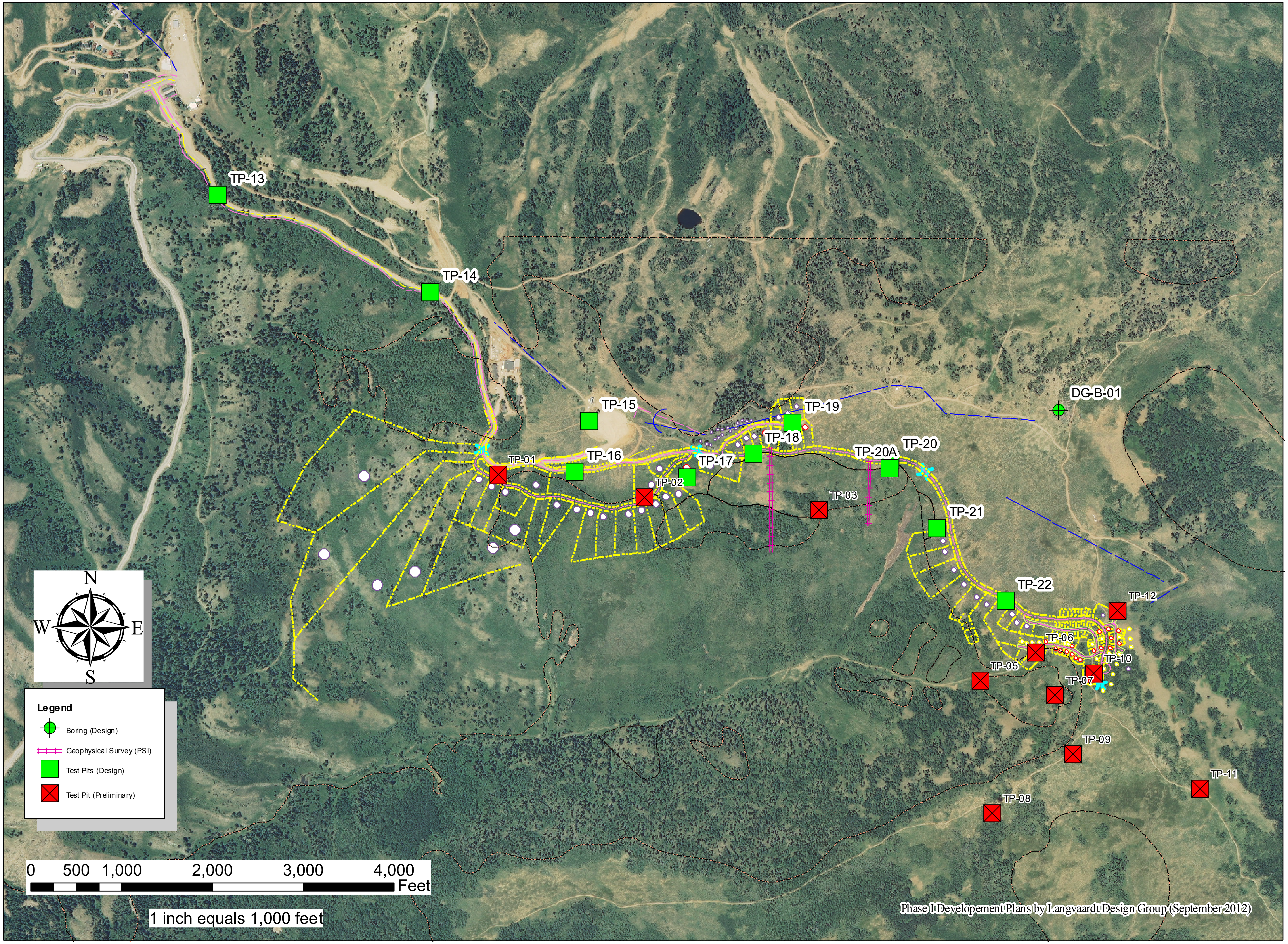
SHEET TITLE

Powder Mountain - Geotechnical Investigation

Geologic Map

FIGURE

A-2



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SHEET TITLE

Powder Mountain - Geotechnical Investigation

Site Plan

FIGURE

A-3

DATE		
STARTED:	7/2/12	
COMPLETED:	7/2/12	
BACKFILLED:	7/2/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: JMG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-01**
Sheet 1 of 1

LOCATION
LATITUDE 41.36785 LONGITUDE 111.76844 ELEVATION (ft) 8,723

Moisture Content and Atterberg Limits (Plastic Limit — Moisture Content — Liquid Limit; scale 10 20 30 40 50 60 70 80 90)

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0				Clayey GRAVEL - 30 to 40% cobbles and boulders - medium dense, slightly moist, brown, some organics, boulders bedded various directions (stratigraphy not evident) loose gravel in 3-ft by 2-ft pockets, boulders encountered primarily limestone up to 3-ft at smallest dimension, some rounded rock in upper 12-in					
		Grab		GC						
		Grab		GC						
1					- excavation raveling					
		Grab		GC			4.4	21.6	34	13
	5									
					- excavation raveling					
2										
		Grab			**Nounan Formation (Cn)** dark grey dolostone with thin veins of quartzite stringers, no reaction to HCl					
					Bottom of test pit @ 8.5 Feet					
3	10									

IGES

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
▼- MEASURED
▽- ESTIMATED

NOTES:
No ground water encountered

Figure A - 4

DATE	
STARTED:	7/2/12
COMPLETED:	7/2/12
BACKFILLED:	7/2/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: JMG

Rig Type: Kubota KX080-3

TEST PIT NO:

TP-02

Sheet 1 of 1

LOCATION

LATITUDE 41.36699 LONGITUDE 111.76498 ELEVATION (ft) 8,673

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit / Moisture Content / Liquid Limit) 10 20 30 40 50 60 70 80 90
0	0				GM	Silty GRAVEL - 30% cobbles and boulders - dense, slightly moist, brown, cobbles and boulders rounded, up to 30 inches - excavation standing vertical						
1					SM	Silty SAND with gravel - 30% cobbles and boulders - dense, slightly moist, reddish-brown, boulders up to 18 inches						
	5				SM							
2					SC	Clayey SAND with gravel - 20% cobbles - dense, moist, reddish-brown						
3	10				SC	- excavation held vertical walls to 10 feet						
						Bottom of test pit @ 10.5 Feet						

LOG OF TEST PITS (A) - (4 LINE HEADER) 01628-001 TEST PITS.GPJ IGES.GDT 11/7/12

IGES

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure

A - 5

DATE	
STARTED:	7/2/12
COMPLETED:	7/2/12
BACKFILLED:	7/2/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: JMG
Rig Type: Kubota KX080-3

TEST PIT NO:
TP-03
Sheet 1 of 1

LOCATION
LATITUDE 41.36720 LONGITUDE 111.75757 ELEVATION (ft) 8,603

Depth (Feet)	Samples	Unified Soil Classification	Material Description	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0			SILT with sand - medium stiff, slightly moist, brown					
	Grab sample	ML			10.5	73.5	41	14
	3" O.D. thin-walled hand sampler	ML	- top 4 feet of excavation raveling					
	3" O.D. thin-walled hand sampler	GC	Clayey GRAVEL - dense, moist, reddish-brown	102.1	21.2			
5								
	Grab sample	CL	Lean CLAY with gravel - medium stiff, moist, red mottled with yellow		32.4	80.3	48	27
	Grab sample	CL	Sandy Lean CLAY with gravel - medium stiff, moist, grey mottled with reddish-brown, angular gravel up to 3/4"		32.5	58.9	43	22
			Bottom of test pit @ 8.5 Feet					
10								

Depth scale: METERS 0, 1, 2, 3; FEET 0, 5, 10. Columns also include WATER LEVEL and GRAPHICAL LOG.

Moisture Content and Atterberg Limits (Plastic Limit – Moisture Content – Liquid Limit; scale 10 20 30 40 50 60 70 80 90)

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure A - 6

IGES

DATE		
STARTED:	7/2/12	
COMPLETED:	7/2/12	
BACKFILLED:	7/2/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: JMG

Rig Type: Kubota KX080-3

TEST PIT NO: **TP-05**

Sheet 1 of 1

LOCATION

LATITUDE 41.36248 LONGITUDE 111.74710 ELEVATION (ft) 8,488

Depth (feet)	Unified Soil Classification	Material Description	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	ML	Gravelly SILT - stiff, dry, light brown, some cobbles					
	SM	Silty SAND with gravel - 20% cobbles - dense, slightly moist, light reddish brown, some boulders up to 30 inches throughout					
5	GC	Clayey GRAVEL with sand - 20% cobbles - dense, moist, reddish brown		10.6		27	10
	GC-GM	Silty Clayey GRAVEL with sand - 20% cobbles - dense, moist, reddish brown					
		Bottom of test pit @ 9 Feet					

Depth scale: METERS 0–3; FEET 0–10

Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (scale 10 20 30 40 50 60 70 80 90)

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure A - 7

DATE	
STARTED:	7/3/12
COMPLETED:	7/3/12
BACKFILLED:	7/3/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: DAG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-06**
Sheet 1 of 1

LOCATION
LATITUDE 41.36262 LONGITUDE 111.74601 ELEVATION (ft) 8,506

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit) 10 20 30 40 50 60 70 80 90
0	0				GM	Silty GRAVEL with sand - 50% gravel, cobbles, and boulders - medium dense, moist, reddish brown, subrounded gravel, cobbles and boulders up to 3 feet in silty sand matrix, easy to excavate, homogenous appearance - uniform from top to bottom						
	5	Grab				- matrix classifies as SM		9.7	35.7			● (~10)
	8					Bottom of test pit @ 8 Feet						
1, 2, 3	10											

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure

A - 8

DATE		
STARTED:	7/3/12	
COMPLETED:	7/3/12	
BACKFILLED:	7/3/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: DAG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-07**
Sheet 1 of 1

LOCATION
LATITUDE 41.36080 LONGITUDE 111.74625 ELEVATION (ft) 8,482

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0				CL	Gravelly Lean CLAY - medium stiff, slightly moist, yellowish brown, subrounded gravel and cobble in a lean clay matrix, low plasticity clay, roots; homogenous appearance, possible debris flow or landslide deposits)					
1		Grab sample						15.5	55.9	36	18
	5										
2					GC	Clayey GRAVEL with sand - moist, reddish brown, with coarse, clayey sand matrix, subrounded gravel and cobble					
		Grab sample						9.2	15.8		
3	10					- possible landslide deposits					
						Bottom of test pit @ 11 Feet					

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure
A - 9

DATE		
STARTED:	7/2/12	
COMPLETED:	7/3/12	
BACKFILLED:	7/3/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: DAG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-08**
Sheet 1 of 1

LOCATION: LATITUDE 41.35741 LONGITUDE 111.75136 ELEVATION (ft) 8,505

Depth (feet)	USCS	MATERIAL DESCRIPTION	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	CL	Lean CLAY with sand and gravel - medium stiff, dry, medium brown, low plasticity, abundant sand and rounded gravel and cobbles, thin topsoil ~4 to 6"					
	SC	Clayey SAND with gravel - dense, moist, reddish brown, well-rounded gravel and cobble in very stiff to hard clayey matrix			21.6	32	12
	SC	Clayey SAND with gravel - medium dense to loose, moist, reddish brown, medium grained, well-rounded gravel and some cobbles, moderately difficult to excavate		12.0		34	13
9		Bottom of test pit @ 9 Feet					

Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; scale 10 20 30 40 50 60 70 80 90

Depth scale: METERS 0, 1, 2, 3; FEET 0, 5, 10

IGES®

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure A - 10

DATE	
STARTED:	7/3/12
COMPLETED:	7/3/12
BACKFILLED:	7/3/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: DAG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-09**
Sheet 1 of 1

LOCATION: LATITUDE 41.35930 LONGITUDE 111.74558 ELEVATION (ft) 8,533

Depth (ft)	Samples	USCS	MATERIAL DESCRIPTION	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0		CL	Lean CLAY with sand and gravel - soft, slightly moist, medium brown, low plasticity clay, easy to excavate,abundant roots, well-rounded gravel and cobble					
	Grab sample (~3–3.5 ft)	SC	Clayey SAND with gravel - medium dense, moist, reddish brown, medium grained, subangular to subrounded gravel to 3 in., well-bedded, stratified, some roots					
	Grab sample (~5–5.5 ft)	GC	Clayey GRAVEL with sand - dense, moist, reddish brown, well-rounded gravel and cobble to 8 in., some boulders to 36 in., very stiff clayey sand matrix, difficult excavation, homogenous		13.9	39.2		
8			Bottom of test pit @ 8 Feet					

Moisture Content and Atterberg Limits (Plastic Limit — Moisture Content — Liquid Limit; scale 10 20 30 40 50 60 70 80 90)

Depth scale: METERS 0, 1, 2, 3; FEET 0, 5, 10

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure A - 11

DATE		
STARTED:	7/3/12	
COMPLETED:	7/3/12	
BACKFILLED:	7/3/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: DAG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-10**

Sheet 1 of 1

LOCATION

LATITUDE 41.36067 LONGITUDE 111.74360 ELEVATION (ft) 8,573

Depth (Meters)	Depth (Feet)	Samples	Water Level	Unified Soil Classification	Material Description	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0			CL	Lean CLAY with sand and gravel - loose, dry, yellowish brown, ~15% subrounded gravel to 3 in., about 2 in. topsoil, well-rooted, krotovina					
				SC	Clayey SAND with gravel - dense, moist reddish brown, subrounded gravel and cobble, occasional boulders to 3.5 ft., moderately cemented, homogenous, mottled appearence					
1		Grab sample						21.8	36	15
	5									
2		Grab sample		SM	Silty SAND with gravel to cobbles, some boulders					
					Bottom of test pit @ 8.5 Feet					
3	10									

Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; scale 10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure

A - 12

DATE	
STARTED:	7/3/12
COMPLETED:	7/3/12
BACKFILLED:	7/3/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: DAG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-11**

Sheet 1 of 1

LOCATION

LATITUDE 41.35827 LONGITUDE 111.73973 ELEVATION (ft) 8,534

MATERIAL DESCRIPTION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0				CL	Topsoil - Lean CLAY with sand and gravel - medium yellowish brown, roots					
					CL	Lean CLAY with sand - stiff, very moist, reddish brown, low plasticity, ~ 25% fine sand, roots through abundant fissures, homogenous, porous					
1		Grab sample						13.7	75.3		
	5										
					SM	- 12-in. lens of Silty SAND - medium grained, low to non-plastic fines					
2					CL	Lean CLAY - stiff, moist, reddish brown, low plasticity, ~15% sand					
		Grab sample			GC	Clayey GRAVEL with sand - dense, moist, grayish brown, coarse gravel and subrounded cobble in a clayey sand matrix		15.8	41.1	25	9
3	10					Bottom of test pit @ 9.5 Feet					

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure A - 13

DATE	
STARTED:	7/2/12
COMPLETED:	7/2/12
BACKFILLED:	7/2/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-001

IGES Rep: JMG
Rig Type: Kubota KX080-3

TEST PIT NO: **TP-12**
Sheet 1 of 1

LOCATION
LATITUDE 41.36307 LONGITUDE 111.74305 ELEVATION (ft) 8,566

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0				SM	Silty SAND with gravel - 50% cobble and boulders - medium dense, slightly moist, medium dense, brown, cobble and gravel rounded to subrounded, boulders up to 30 inches - test pit easy to excavate, excavation fairly homogenous and loose to to 7½ feet, excavation raveling throughout						
1					ML	Sandy SILT - 60-80% cobbles - soft, slightly moist, cobbles 2 to 4 inches, predominant voids						
	5				SM	Silty SAND with gravel - 40 to 50% cobbles - medium dense, moist, brown, boulders up to 18 inches						
2												
					GC	Clayey GRAVEL with sand - 30% cobbles - dense, moist, brown, gravel up to 18 inches						
						Bottom of test pit @ 8.5 Feet						
3	10											

LOG OF TEST PITS (A) - (4 LINE HEADER) 01628-001 TEST PITS.GPJ IGES.GDT 11/7/12

IGES®

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
No ground water encountered

Figure A - 14

DATE		Project	IGES Rep / Rig Type	TEST PIT NO:
STARTED:	10/9/12	Geotechnical Investigation	IGES Rep: BMJ	TP-13
COMPLETED:	10/9/12	Summit LLC Powder Mountain Development	Rig Type: Komatsu Tracked Hoe	
BACKFILLED:	10/9/12	Weber County, Utah Project Number 01628-003		Sheet 1 of 1

LOCATION

LATITUDE 41.37660 LONGITUDE -111.78010 ELEVATION (ft) ~8265

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit) 10 20 30 40 50 60 70 80 90
0	0	Grab sample (approx. 1–2 ft)		GM	GM	Silty GRAVEL with sand, medium dense to dense, slightly moist, medium brown, clasts range in diameter from approximately ¼ to 24 inches in diameter, clasts are sub-rounded						
	5					No Groundwater Encountered Bottom of test pit @ 5 Feet						

Depth scale: Meters 0, 1, 2, 3, 4, 5, 6; Feet 0, 5, 10, 15

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Figure

A - 15

DATE		
STARTED:	10/9/12	
COMPLETED:	10/9/12	
BACKFILLED:	10/9/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO:
TP-14
Sheet 1 of 1

LOCATION
LATITUDE 41.37330 LONGITUDE -111.77120 ELEVATION (ft) ~8583

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit) 10 20 30 40 50 60 70 80 90
0	0				GM	Silty GRAVEL with sand, medium dense, slightly moist, medium dense, fill						
		▯			GC	Clayey GRAVEL, medium dense, slightly moist to moist, reddish brown, clasts range in diameter from approximately ¼ to 24 inches, lenses of Lean CLAY with gravel, some plasticity in fines						
1												
	5					No Groundwater Encountered Bottom of test pit @ 5 Feet						
2												
3	10											
4												
	15											
5												
6												

SAMPLE TYPE
▯ - GRAB SAMPLE
⊠ - 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
▼ - MEASURED
▽ - ESTIMATED

NOTES:

Figure

A - 16

DATE		
STARTED:	10/9/12	
COMPLETED:	10/9/12	
BACKFILLED:	10/9/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah
Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO: **TP-15**
Sheet 1 of 1

LOCATION
LATITUDE 41.36930 LONGITUDE -111.76490 ELEVATION (ft) ~8902

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit / Moisture Content / Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0				ML	Sandy SILT with gravel, medium stiff, slightly moist, medium brown, clasts ranges from approximately ¼ to 24 inches in diameter, clasts are sub-angular to sub-rounded, roots in upper 6 to 8 inches, minor pinholes in matrix						
		Grab sample			GM	Silty GRAVEL with sand, medium dense to dense, slightly moist, tan, clasts range from approximately ¼-inches to 5 feet in diameter			20.5			
1	5											
2												
						Color reddish brown						
3	10											
						No Groundwater Encountered						
						Bottom of test pit @ 12 Feet						
4												
	15											
5												
6												

LOG OF TEST PITS (A) - (4 LINE HEADER) 01628-003 TEST PIT LOGS.GPJ IGES.GDT 11/7/12

IGES®

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Figure A - 17

DATE	
STARTED:	10/9/12
COMPLETED:	10/9/12
BACKFILLED:	10/9/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO: **TP-16**
Sheet 1 of 1

LOCATION
LATITUDE 41.36790 LONGITUDE -111.76590 ELEVATION (ft) ~8823

DEPTH (METERS)	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0	CL	Sandy Lean CLAY with gravel, medium stiff, slightly moist, medium brown, pinholes in matrix, clasts range in diameter from approximately ¼ to 12 inches, low plasticity, grades to SILT					
					4.3		40	15
1		GC	Clayey GRAVEL with sand, medium dense, slightly moist, tan, clasts range from approximately ¼-inches to 4 feet in diameter, clasts are sub-angular to sub-rounded					
3	10	GC	Clayey GRAVEL, medium dense, slightly moist to moist, reddish gray, fabric appears to be weathered bedrock that is completely friable					
		CH	Fat CLAY with gravel, medium stiff, moist, red, high plasticity in fines, clasts range from approximately ¼ to 6 inches in diameter				54	33
			Lenses of Clayey GRAVEL					
	15		No Groundwater Encountered					
			Bottom of test pit @ 15 Feet					

Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; scale 10 20 30 40 50 60 70 80 90)

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Figure A - 18

IGES

DATE		
STARTED:	10/9/12	
COMPLETED:	10/9/12	
BACKFILLED:	10/9/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah
Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO:
TP-17
Sheet 1 of 1

LOCATION
LATITUDE 41.36770 LONGITUDE -111.76090 ELEVATION (ft) ~8750

MATERIAL DESCRIPTION

DEPTH METERS	DEPTH FEET	SAMPLES	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0		ML	Sandy SILT with gravel, medium stiff, slightly moist, brown, pinholes in matrix, clasts range from approximately ¼-inches to 2 feet in diameter, roots in upper 2 to 4 inches					
		Grab	CL	Lean CLAY, stiff, slightly moist to moist, reddish brown to tan brown, pinholes throughout matrix		12.3		43	17
1		Thin-walled		- Grades to Fat CLAY (CH)				54	32
	5		GC	Clayey GRAVEL, medium dense, slightly moist, reddish gray, lenses of red clay (CH)					
3	10	Grab	CH	Fat CLAY, medium stiff, moist, red		38.9			
		Thin-walled						66	44
				No Groundwater Encountered					
	15			Bottom of test pit @ 14 Feet					

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

LOG OF TEST PITS (A) - (4 LINE HEADER) 01628-003 TEST PIT LOGS.GPJ IGES.GDT 11/7/12

IGES®

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Figure
A - 19

DATE		
STARTED:	10/8/12	
COMPLETED:	10/8/12	
BACKFILLED:	10/8/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO: **TP-18**

Sheet 1 of 1

LOCATION

LATITUDE 41.36860 LONGITUDE -111.75800 ELEVATION (ft) ~8768

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit – Moisture Content – Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0				SM	Silty SAND with gravel, medium dense, slightly moist, medium brown, clasts range from approximately ¼-inches to 8 inches in diameter, clasts angular to sub-angular consisting of dolomite						
		Grab						6.5	41.8			●
1		Grab			SP-SM	Poorly Graded SAND with silt, loose, slightly moist, gray, reddish brown Fat CLAY (CH) lenses running along bedrock interface and throughout sand layer, some gravel consisting of dolomite			5.7			
		Grab								55	37	├──┤
	5											
2						**St. Charles Limestone (Csd) - Dolomite Member** Dolomite bedrock, highly weathered, highly fractured, fractures generally filled with calcium carbonate at shallow depths or open, near interface with soil units above the fractures are filled with reddish brown Fat CLAY (CH) observed above						
3	10											
4												
	15					No Groundwater Encountered Bottom of test pit @ 15 Feet						
5												
6												

IGES®

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Figure A - 20

DATE	
STARTED:	10/8/12
COMPLETED:	10/8/12
BACKFILLED:	10/8/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO: **TP-19**

Sheet 1 of 1

LOCATION: LATITUDE 41.36930 LONGITUDE -111.75620 ELEVATION (ft) ~8828

Depth (ft)	USCS	MATERIAL DESCRIPTION	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	ML	Sandy SILT with gravel, medium stiff, slightly moist, brown, clasts range from approximately ¼-inches to 2 feet in diameter, clasts are sub-angular to sub-rounded		8.2			
	GM	Silty GRAVEL with sand, medium dense, slightly moist, tan-grown, clasts range from approximately ¼-inches to 3 feet in diameter					
5	CL	Lean CLAY with gravel, stiff, moist, reddish brown, black organic traces throughout, clasts range from approximately ¼-inches to 5 feet in diameter				36	17
	GC	Clayey GRAVEL, medium dense, slightly moist to moist, reddish brown matrix, clasts range from approximately ¼-inches to 5 feet in diameter, clasts sub-angular to sub-rounded, small lenses of Lean CLAY (CL) with gravel, grades to gravelly lean clay			65.5		
		No Groundwater Encountered					
		Bottom of test pit @ 13.5 Feet					

Depth scale: METERS 0–6; FEET 0, 5, 10, 15

Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit): 10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

IGES

Figure A - 21

DATE		
STARTED:	10/8/12	
COMPLETED:	10/8/12	
BACKFILLED:	10/8/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-003

IGES Rep: BMJ

Rig Type: Komatsu Tracked Hoe

TEST PIT NO:

TP-20

Sheet 1 of 1

LOCATION

LATITUDE 41.36810 LONGITUDE -111.75320 ELEVATION (ft) ~8732

MATERIAL DESCRIPTION

DEPTH (METERS)	DEPTH (FEET)	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0				ML	TOPSOIL - Sandy SILT with gravel, medium stiff, slightly moist, brown, roots in upper 2 feet					
		Grab sample						5.6			
					GM	Silty GRAVEL with sand, medium dense, slightly moist, tan, clasts range from approximately ¼-inches to 3 feet in diameter, clasts sub-angular to sub-rounded					
1											
	5	Grab sample							20.7		
2											
					GC	Clayey GRAVEL with sand, dense, slightly moist to moist, reddish brown matrix, clasts up to 5 feet in diameter, clasts are sub-angular to angular, minor pinholes in matrix					
3	10										
4		Grab sample									
						No Groundwater Encountered					
	15					Bottom of test pit @ 14 Feet					
5											
6											

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Figure

A - 22

DATE	
STARTED:	10/8/12
COMPLETED:	10/8/12
BACKFILLED:	10/8/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO: **TP-20A**
Sheet 1 of 1

LOCATION
LATITUDE 41.36800 LONGITUDE -111.75300 ELEVATION (ft) ~8710

MATERIAL DESCRIPTION

Depth (ft)	Samples	USCS	Material Description	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0 – ~2.5		ML	Sandy SILT with gravel, medium stiff, slightly moist, brown, roots in upper 2 feet					
~2.5 – ~6		GM	Silty GRAVEL with sand, medium dense, slightly moist, tan, clasts range from approximately ¼-inches to 3 feet in diameter, clasts sub-angular to sub-rounded					
~6 – 12	Grab sample (~8 ft)	CH	Fat CLAY with gravel, medium stiff, high plasticity, moist, reddish brown		27.4		76	53

No Groundwater Encountered

Bottom of test pit @ 12 Feet

Moisture Content and Atterberg Limits (Plastic Limit — Moisture Content — Liquid Limit; scale 10 20 30 40 50 60 70 80 90)

Depth scale: METERS 0–6; FEET 0, 5, 10, 15

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

IGES

Figure A - 23

DATE	
STARTED:	10/8/12
COMPLETED:	10/8/12
BACKFILLED:	10/8/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah
Project Number 01628-003

IGES Rep: BMJ
Rig Type: Komatsu Tracked Hoe

TEST PIT NO: **TP-21**
Sheet 1 of 1

LOCATION
LATITUDE 41.36670 LONGITUDE -111.75050 ELEVATION (ft) ~8683

Depth (ft)	USCS	MATERIAL DESCRIPTION	Liquid Limit	Plasticity Index
0	SM	Silty SAND with gravel, medium dense, slightly moist, medium brown, clasts range from approximately ¼-inches to 2 feet in diameter, roots in upper 2 to 4 inches		
~3	GM	Silty GRAVEL with sand, medium dense, slightly moist, tan, clasts range from approximately ¼-inches to 3 feet in diameter, sub-angular clasts		
		Small lenses of Lean CLAY (CL) with gravel, reddish brown, lenses do not appear continuous		
~9	CL	Lean CLAY with gravel, stiff, moist, reddish-brown, clasts range from approximately ¼-inches to 6 feet in diameter, clasts are sub-angular to sub-rounded		
		Moisture increases with depth	34	16
14.5		No Groundwater Encountered		
		Bottom of test pit @ 14.5 Feet		

Columns: DEPTH (METERS, FEET), SAMPLES, WATER LEVEL, GRAPHICAL LOG, UNIFIED SOIL CLASSIFICATION, Dry Density(pcf), Moisture Content %, Percent minus 200, Liquid Limit, Plasticity Index, Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 10 20 30 40 50 60 70 80 90)

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Figure A - 24

DATE		
STARTED:	10/8/12	
COMPLETED:	10/8/12	
BACKFILLED:	10/8/12	

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County, Utah

Project Number 01628-003

IGES Rep: BMJ

Rig Type: Komatsu Tracked Hoe

TEST PIT NO:

TP-22

Sheet 1 of 1

LOCATION

LATITUDE 41.36380 LONGITUDE -111.74820 ELEVATION (ft) ~8632

MATERIAL DESCRIPTION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit) 10 20 30 40 50 60 70 80 90
0	0				GM	Silty GRAVEL with sand, medium dense, slightly moist, tan-brown, roots in upper 2 to 4 inches, clasts range from approximately ¼-inches to 3 feet in diameter, clasts sub-angular to sub-rounded						
						Color orange-brown, gravel up to 5 feet in diameter						
3	10								24.9			
4						No Groundwater Encountered						
						Bottom of test pit @ 13 Feet						
5	15											
6												

SAMPLE TYPE

- ▯ - GRAB SAMPLE
- ⊠ - 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL

- ▼ - MEASURED
- ▽ - ESTIMATED

NOTES:

Figure A - 25

DATE	
STARTED:	10/8/12
COMPLETED:	10/8/12
BACKFILLED:	10/8/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County Utah
IGES Project Number: 01628-003

IGES Rep: DAG
Rig Type: Odex
Boring Type:

BORING NO: **B-1**

LOCATION
LATITUDE 41.36000 LONGITUDE 111.74640 ELEVATION 8,902 feet (above m.s.l)
Water Tank Site

ELEVATION	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	Water Level	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index
	0		@ 0' Silty SAND with gravel and boulders, light brown, dry, abundant boulders on surface, non-plastic fines							
8900		CL	@ 2½' Gravelly CLAY, hard, low plasticity, grayish brown w/ iron staining, abundant gravel-size subrounded rocks, some pulverized rocks, ~15-20% fine sand	15 33 32						
	5		@ 5' no recovery	50/5"						
			@ 6' Odex becomes stalled in clay							
8895		SC	@ 7½'Clayey SAND, dense, fine-grained, low plasticity fines, moist, reddish brown, several pulverized rocks, homogenous appearance, uniform	8 13 20				33	24	10
	10	GC	@ 10' Clayey GRAVEL, dense, coarse-grained, abundant angular/pulverized rock in a sandy lean clay matrix, low plasticity, reddish brown with orange mottling, moist, rocks are quartzite	28 49 50						
8890										
	15	SC	@ 15' Clayey SAND with gravel, dense, fine- to coarse-grained, abundant pulverized angular rocks, low plasticity clay, reddish brown with orange and white mottling, no reaction to HCl	27 36 28				33		
8885										
	20	CL	@ 20' Lean CLAY with gravel, first 6 inches is clay, medium stiff, low plasticity, reddish brown, most, ~25% coarse fraction, below is pulverized quartzite in a sandy/clayey matrix, reddish brown	46 50/3"					30	15
8880										

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

N - OBSERVED BLOW COUNT PER 6 INCHES

SAMPLE TYPE
- 2" O.D./1.38" I.D. Split Spoon Sampler
- 3.25" O.D./2.42" I.D. 'U' Sampler
- 3" O.D. Thin-Walled Shelby Sampler
- Grab Sample
- Modified California Sampler
- Sample from Auger Cuttings

BORING LOG

NOTES:

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A - 26a

DATE	
STARTED:	10/8/12
COMPLETED:	10/8/12
BACKFILLED:	10/8/12

Geotechnical Investigation
Summit LLC
Powder Mountain Development
Weber County Utah
IGES Project Number: 01628-003

IGES Rep: DAG
Rig Type: Odex
Boring Type:

BORING NO: **B-1**

LOCATION
LATITUDE 41.36000 LONGITUDE 111.74640 ELEVATION 8,902 feet (above m.s.l.)
Water Tank Site

Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (10 20 30 40 50 60 70 80 90)

ELEVATION	DEPTH (FEET)	SAMPLES	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	N	Water Level	Dry Density(pcf)	Moisture Content (%)	Percent minus 200	Liquid Limit	Plasticity Index
				@ 25' SPT refusal on hard rock - no recovery	n/a						
8875											
	30	Split Spoon		@ 30' No recovery	50/3"						
8870											
	35	Split Spoon	GM	@ 35' Silty GRAVEL with sand, coarse sand and gravel, dense, 4" recovery, bent shoe on hard rock	50/4"						
8865											
	40	Modified California	GM	@ 40' Silty GRAVEL, dense, coarse gravel in a silty sand matrix, fine- to medium-grained sand, reddish brown, moist, several angular rocks, refusal on rock	50/3"						
8860											
			GM	@ 45' Silty GRAVEL, dense, coarse gravel in a silty sand matrix, fine- to medium-grained sand, reddish brown, moist, several angular rocks	50/3"						
	45	Modified California									
8855											
				Total depth 45 feet No groundwater Bottom of Boring @ 45.2 Feet							

N - OBSERVED BLOW COUNT PER 6 INCHES

IGES

SAMPLE TYPE
- 2" O.D./1.38" I.D. Split Spoon Sampler
- 3.25" O.D./2.42" I.D. 'U' Sampler
- 3" O.D. Thin-Walled Shelby Sampler
- Grab Sample
- Modified California Sampler
- Sample from Auger Cuttings

BORING LOG

NOTES:

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Figure A - 26b

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
WEAKELY	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	ATTERBERG 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

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.

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

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

FIGURE A-27

IGES, Inc. Project No.:01628-003

APPENDIX B

SUMMARY OF LABORATORY TEST RESULTS TABLE

Preliminary Geotechnical Investigation | **Summit LLC/Powder Mountain Weber County Development** | **Project No: 01628-003**

SAMPLE LOCATION		Natural Dry Density (pcf)	Natural Moisture Content (%)	GRADATION			ATTERBERG LIMITS							CHEMICAL TESTS			
Point No.	Depth (ft)			Gravel >#4 (%)	Sand (%)	Silt and Clay <#200 (%)	Liquid Limit	Plasticity Index	Direct Shear c' (psf)	Direct Shear phi' (degrees)	Proctor (Standard) MDD (pcf)	Proctor (Standard) OMC (%)	CBR (%)	Soluable Sulfate (ppm)	Chloride Content (ppm)	Resistivity (Minimum ohm-cm)	pH
TP-01	4		4.4	70.7	7.7	21.6	34	13									
TP-02	1													<5.44	<54.4	5600	5.2
TP-03	0.5		10.5			73.5	41	14			98.2	19.9	5.5				
	2								36	32							
	4	102.1	21.2														
	6		32.4			80.3	48	27									
	8		32.5	17.0	24.1	58.9	43	22									
TP-05	6		10.6				27	10						32.1	<55.4	14000	4.0
TP-06	5		9.7			35.7											
TP-07	4		15.5			55.9	36	18									
	7		9.2			15.8											
TP-08	3			29.9	44.3	21.6	32	12			133.4	8.0					
	7.5		12.0				34	13									
TP-09	3													24.6	<53.0	13000	4.1
	5		13.9			39.2											
TP-10	4			29.4	44.0	21.8	36	15									
TP-11	2		13.7			75.3					107.3	16.7	1.8				
	7		15.8			41.1	25	9						47.9	<57.7	5800	4.7
TP-13	1										134.1	9.9	23.6				
TP-14	1										133.2	7.7	4.1				
TP-15	2			41.4	25.9	20.5											
TP-16	2		4.3				40	15									
	6								258	26	134.2	6.4					
	11						54	33									
TP-17	1.5		12.3				43	17									
	2.5													85.6	<12	2200	6.5
	3						54	32									
	10		38.9														
	12						66	44									
TP-18	1		6.5	21.6	27.1	41.8											
	3					5.7											
	4						55	37						34.4	<11.4	980	6.3
TP-19	1		8.2								115.9	14.2	6.4				
	5						36	17									
	9					65.5											
TP-20	1.5		5.6														
	6			45.1	34.2	20.7											
TP-20A	8		27.4				76	53									
TP-21	9													59.9	<10.9	10600	5.3
	14						34	16									
TP-22	10			43.8	31.3	24.9											

SUMMARY OF LABORATORY TEST RESULTS TABLE

Preliminary Geotechnical Investigation | **Summit LLC/Powder Mountain Weber County Development** | **Project No: 01628-003**

SAMPLE LOCATION		Natural Dry Density (pcf)	Natural Moisture Content (%)	GRADATION			ATTERBERG LIMITS							CHEMICAL TESTS			
Point No.	Depth (ft)			Gravel >#4 (%)	Sand (%)	Silt and Clay <#200 (%)	Liquid Limit	Plasticity Index	Direct Shear c' (psf)	Direct Shear phi' (degrees)	Proctor (Standard) MDD (pcf)	Proctor (Standard) OMC (%)	CBR (%)	Soluable Sulfate (ppm)	Chloride Content (ppm)	Resistivity (Minimum ohm-cm)	pH
B-1	7.5					32.9	24	10									
	15			30.9	36.5	32.6	30	15									
	20													127	<11.5	3800	5.2

LABORATORY TEST RESULTS

CURRENT STUDY

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: TP-16
Sample:
Depth: 2'
Description: Brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

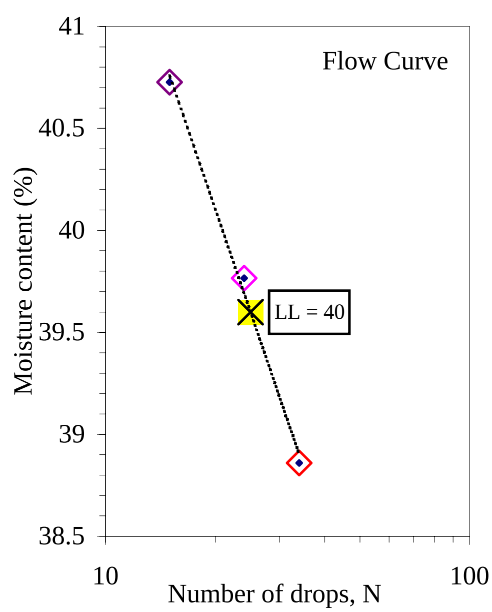
Plastic Limit

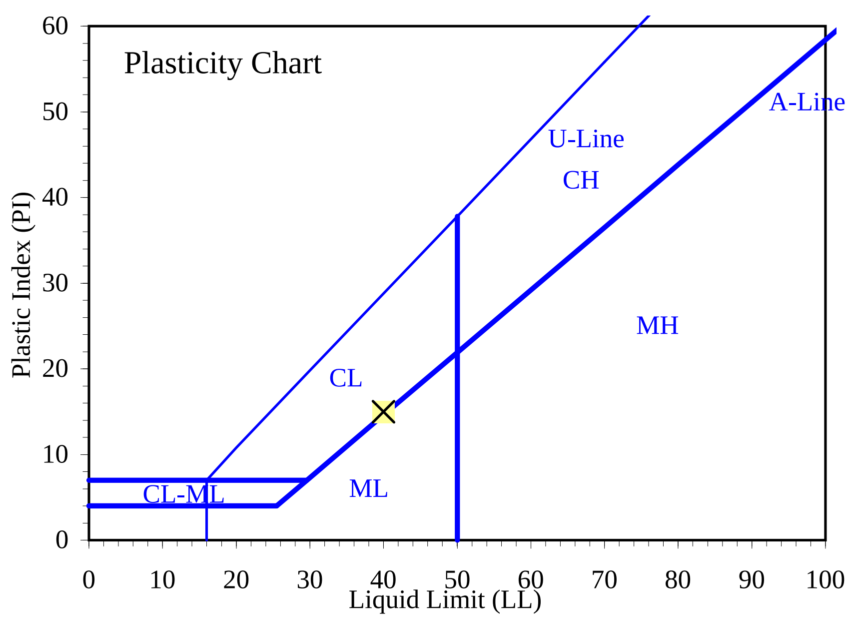
Determination No	1	2				
Wet Soil + Tare (g)	30.29	30.15				
Dry Soil + Tare (g)	28.48	28.47				
Moisture Loss (g)	1.81	1.68				
Tare (g)	21.32	21.76				
Dry Soil (g)	7.16	6.71				
Moisture Content, w (%)	25.28	25.04				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	24	15			
Wet Soil + Tare (g)	32.32	32.45	32.56			
Dry Soil + Tare (g)	29.32	29.40	29.31			
Moisture Loss (g)	3.00	3.05	3.25			
Tare (g)	21.60	21.73	21.33			
Dry Soil (g)	7.72	7.67	7.98			
Moisture Content, w (%)	38.86	39.77	40.73			
One-Point LL (%)		40				

Liquid Limit, LL (%)	**40**
Plastic Limit, PL (%)	**25**
Plasticity Index, PI (%)	**15**





Entered by:____________
Reviewed:____________

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: TP-16
Sample:
Depth: 11'
Description: Dark reddish brown fat clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

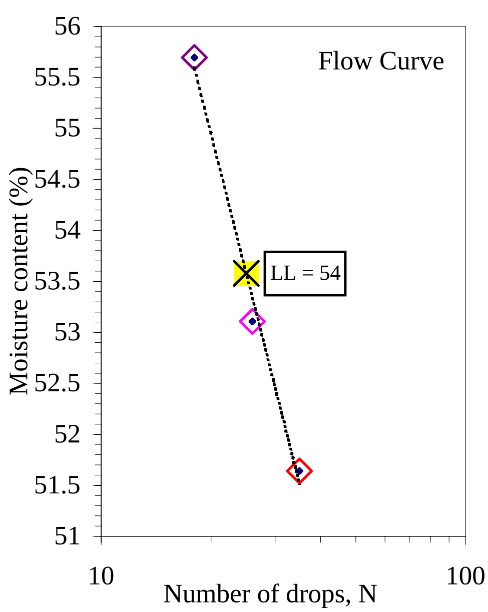
Plastic Limit

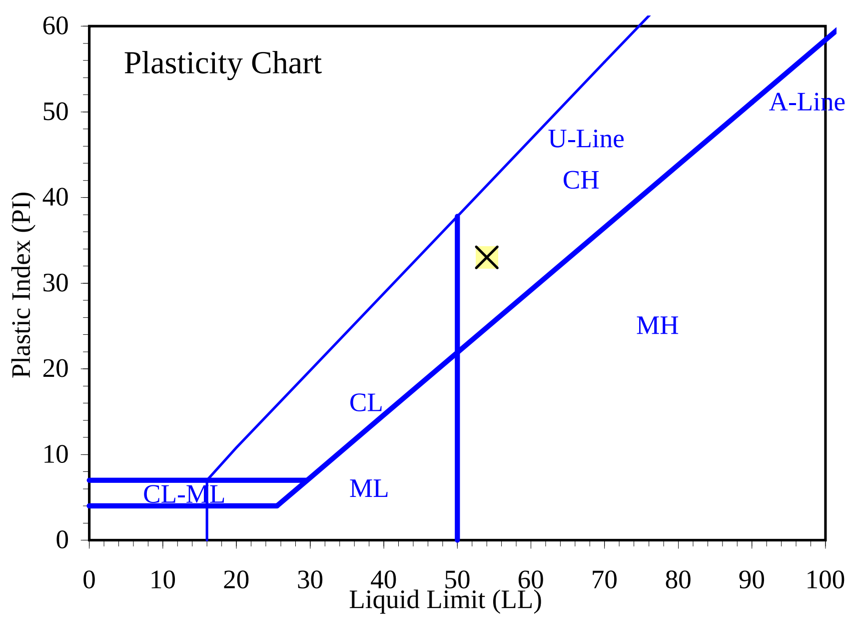
Determination No	1	2				
Wet Soil + Tare (g)	29.23	29.16				
Dry Soil + Tare (g)	27.85	27.85				
Moisture Loss (g)	1.38	1.31				
Tare (g)	21.31	21.56				
Dry Soil (g)	6.54	6.29				
Moisture Content, w (%)	21.10	20.83				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	26	18			
Wet Soil + Tare (g)	31.81	30.09	31.49			
Dry Soil + Tare (g)	28.35	27.10	27.97			
Moisture Loss (g)	3.46	2.99	3.52			
Tare (g)	21.65	21.47	21.65			
Dry Soil (g)	6.70	5.63	6.32			
Moisture Content, w (%)	51.64	53.11	55.70			
One-Point LL (%)		53				

Liquid Limit, LL (%)	**54**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**33**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/31/2012
By: BRR

Boring No.: TP-17
Sample:
Depth: 1.5'
Description: Brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

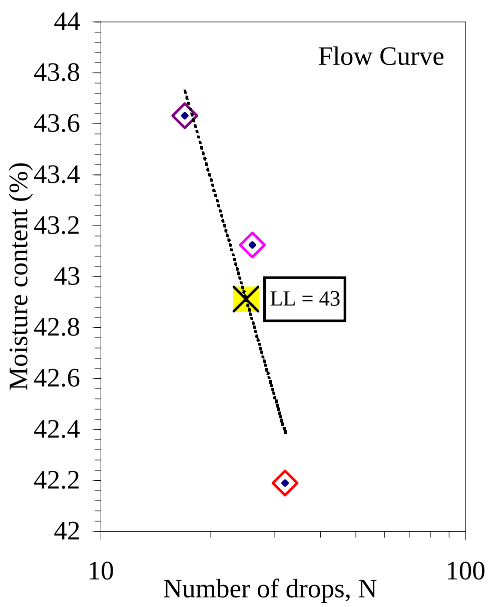
Plastic Limit

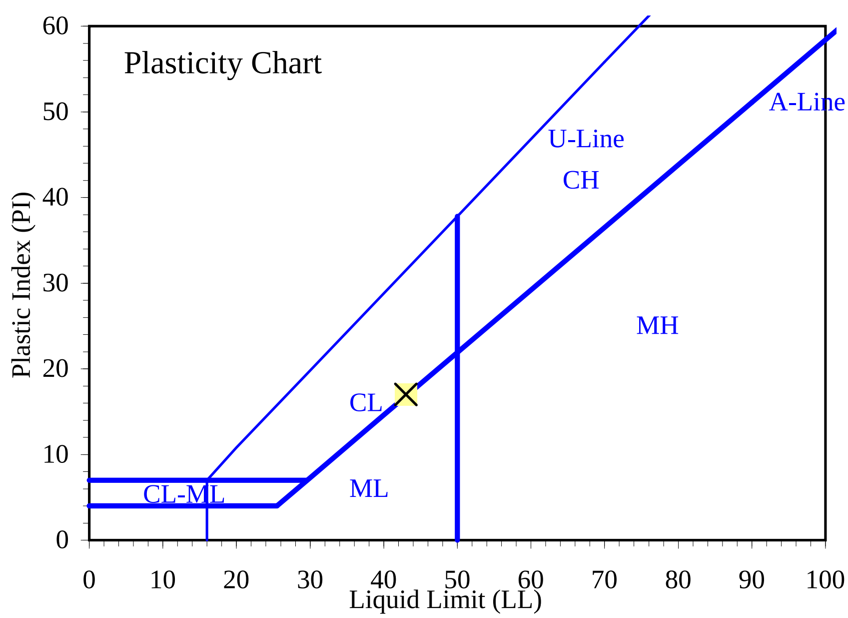
Determination No	1	2			
Wet Soil + Tare (g)	29.75	28.86			
Dry Soil + Tare (g)	28.07	27.41			
Moisture Loss (g)	1.68	1.45			
Tare (g)	21.48	21.78			
Dry Soil (g)	6.59	5.63			
Moisture Content, w (%)	25.49	25.75			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	26	17			
Wet Soil + Tare (g)	33.12	30.95	32.18			
Dry Soil + Tare (g)	29.69	28.19	28.96			
Moisture Loss (g)	3.43	2.76	3.22			
Tare (g)	21.56	21.79	21.58			
Dry Soil (g)	8.13	6.40	7.38			
Moisture Content, w (%)	42.19	43.13	43.63			
One-Point LL (%)		43				

Liquid Limit, LL (%)	**43**
Plastic Limit, PL (%)	**26**
Plasticity Index, PI (%)	**17**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: **Powder Mountain Development**
No: **01628-002**
Location: Powder Mountain Resort
Date: 10/31/2012
By: BRR

Boring No.: **TP-17**
Sample:
Depth: **3'**
Description: Reddish brown fat clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

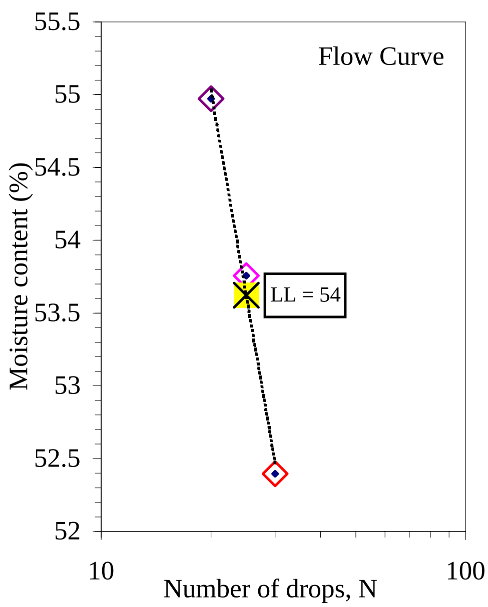
Plastic Limit

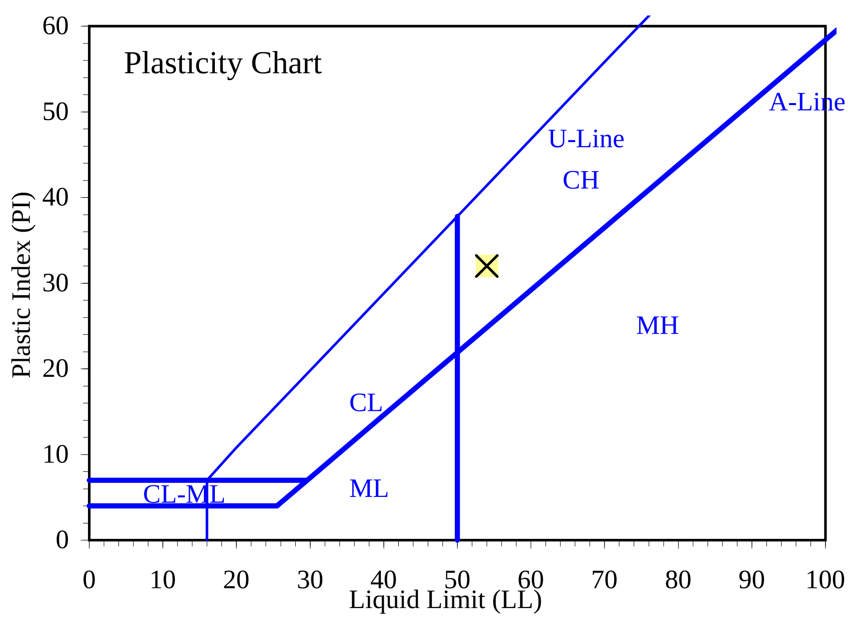
Determination No	1	2			
Wet Soil + Tare (g)	27.60	29.13			
Dry Soil + Tare (g)	26.52	27.76			
Moisture Loss (g)	1.08	1.37			
Tare (g)	21.60	21.59			
Dry Soil (g)	4.92	6.17			
Moisture Content, w (%)	21.95	22.20			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	25	20			
Wet Soil + Tare (g)	31.74	30.65	30.05			
Dry Soil + Tare (g)	28.24	27.43	27.12			
Moisture Loss (g)	3.50	3.22	2.93			
Tare (g)	21.56	21.44	21.79			
Dry Soil (g)	6.68	5.99	5.33			
Moisture Content, w (%)	52.40	53.76	54.97			
One-Point LL (%)	54	54	54			

Liquid Limit, LL (%)	**54**
Plastic Limit, PL (%)	**22**
Plasticity Index, PI (%)	**32**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: TP-17
Sample:
Depth: 12'
Description: Reddish brown fat clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

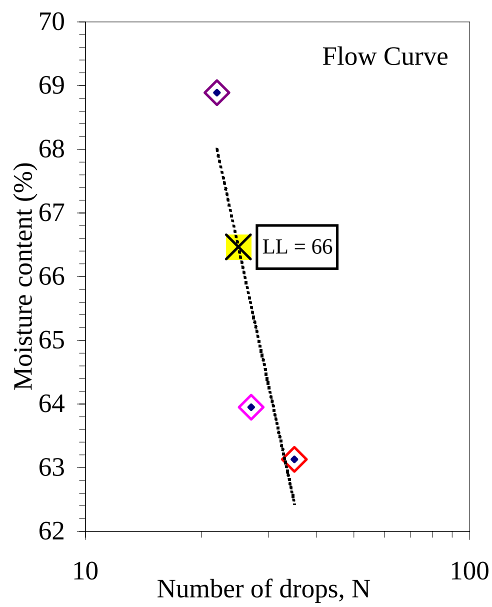
Plastic Limit

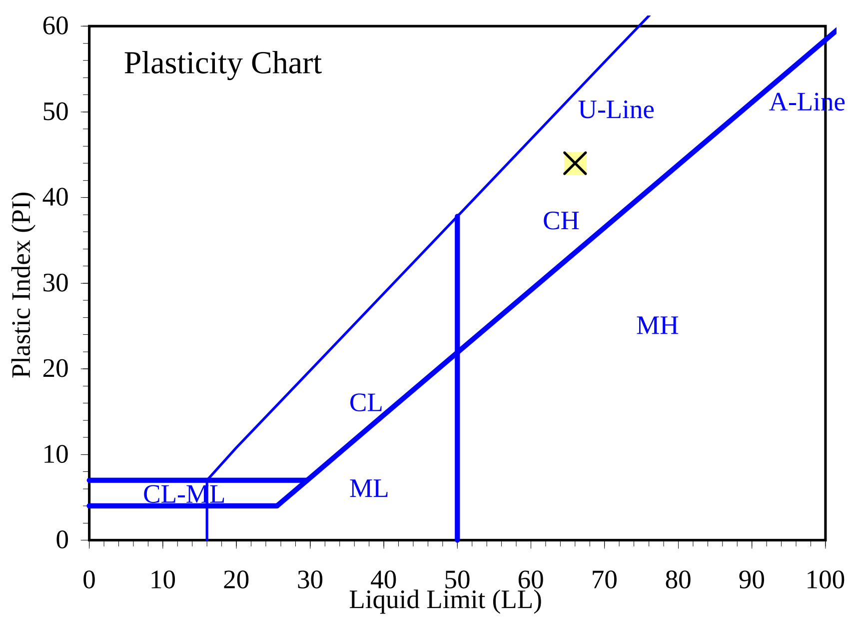
Determination No	1	2			
Wet Soil + Tare (g)	31.79	32.75			
Dry Soil + Tare (g)	29.90	30.73			
Moisture Loss (g)	1.89	2.02			
Tare (g)	21.31	21.56			
Dry Soil (g)	8.59	9.17			
Moisture Content, w (%)	22.00	22.03			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	27	22			
Wet Soil + Tare (g)	31.79	32.23	27.60			
Dry Soil + Tare (g)	27.92	28.15	25.12			
Moisture Loss (g)	3.87	4.08	2.48			
Tare (g)	21.79	21.77	21.52			
Dry Soil (g)	6.13	6.38	3.60			
Moisture Content, w (%)	63.13	63.95	68.89			
One-Point LL (%)		65	68			

Liquid Limit, LL (%)	**66**
Plastic Limit, PL (%)	**22**
Plasticity Index, PI (%)	**44**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/31/2012
By: BRR

Boring No.: TP-18
Sample:
Depth: 4'
Description: Reddish brown fat clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

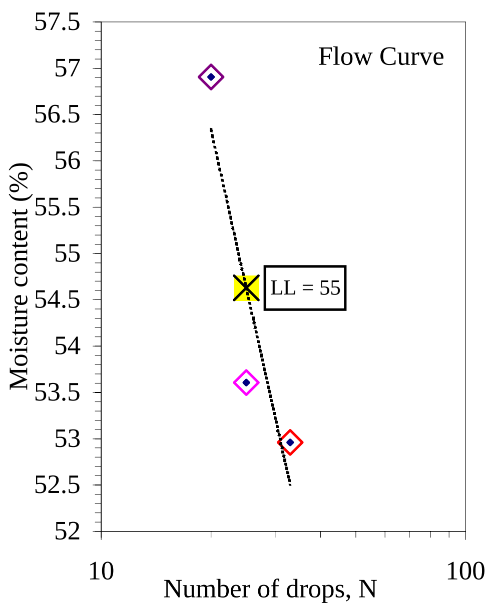
Plastic Limit

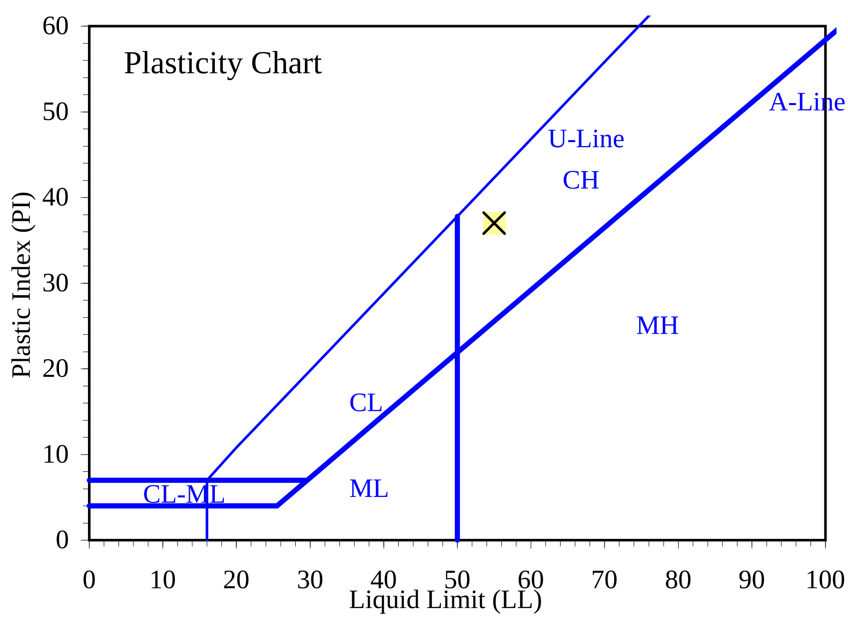
Determination No	1	2				
Wet Soil + Tare (g)	29.25	31.25				
Dry Soil + Tare (g)	28.13	29.76				
Moisture Loss (g)	1.12	1.49				
Tare (g)	21.83	21.41				
Dry Soil (g)	6.30	8.35				
Moisture Content, w (%)	17.78	17.84				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	25	20			
Wet Soil + Tare (g)	30.85	32.38	33.68			
Dry Soil + Tare (g)	27.63	28.59	29.23			
Moisture Loss (g)	3.22	3.79	4.45			
Tare (g)	21.55	21.52	21.41			
Dry Soil (g)	6.08	7.07	7.82			
Moisture Content, w (%)	52.96	53.61	56.91			
One-Point LL (%)		54	55			

Liquid Limit, LL (%)	**55**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**37**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: **Powder Mountain Development**
No: **01628-002**
Location: Powder Mountain Resort
Date: 10/31/2012
By: BRR

Boring No.: **TP-19**
Sample:
Depth: **5'**
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

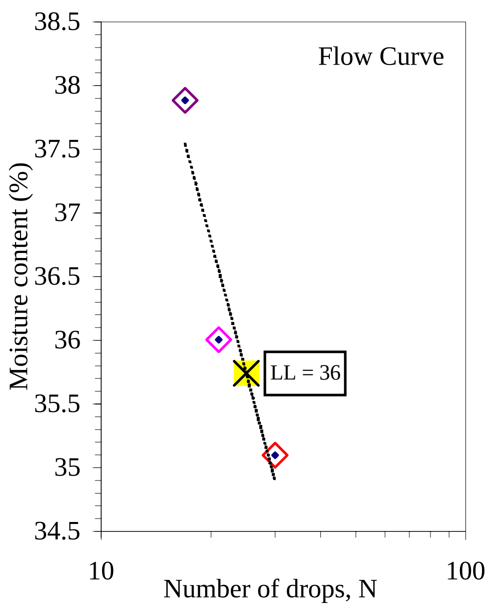
Plastic Limit

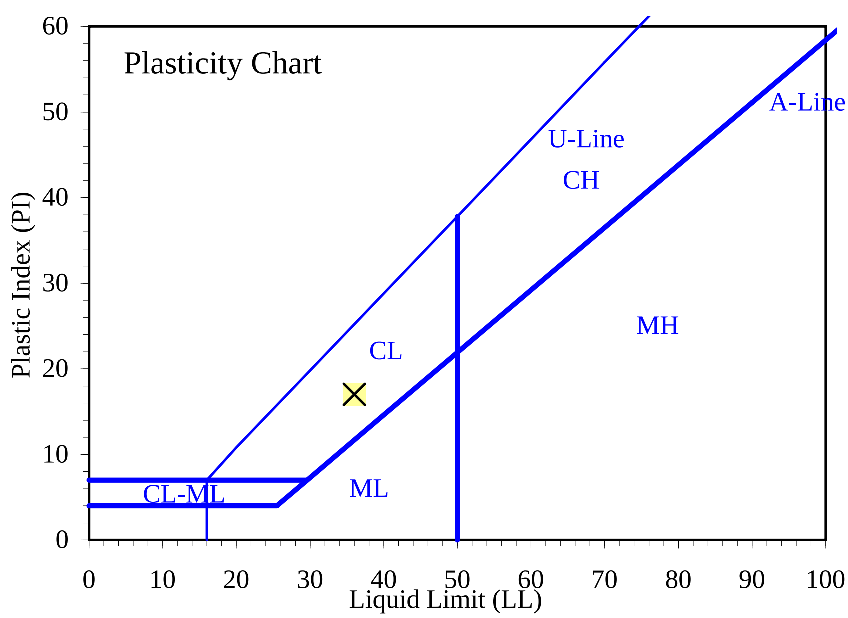
Determination No	1	2			
Wet Soil + Tare (g)	31.39	33.70			
Dry Soil + Tare (g)	29.82	31.78			
Moisture Loss (g)	1.57	1.92			
Tare (g)	21.84	21.77			
Dry Soil (g)	7.98	10.01			
Moisture Content, w (%)	19.67	19.18			

Liquid Limit

Determination No	1	2	3		
Number of Drops, N	30	21	17		
Wet Soil + Tare (g)	31.61	32.52	31.02		
Dry Soil + Tare (g)	28.89	29.51	28.44		
Moisture Loss (g)	2.72	3.01	2.58		
Tare (g)	21.14	21.15	21.63		
Dry Soil (g)	7.75	8.36	6.81		
Moisture Content, w (%)	35.10	36.00	37.89		
One-Point LL (%)	36	35			

Liquid Limit, LL (%)	**36**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**17**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: TP-20A
Sample: SB
Depth: 8'
Description: Dark reddish brown fat clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

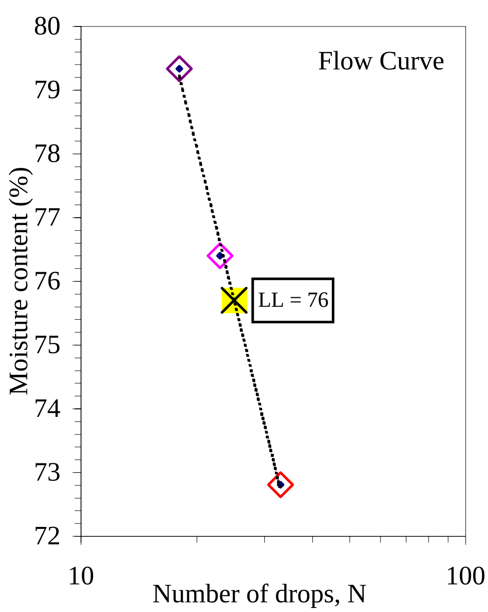
Plastic Limit

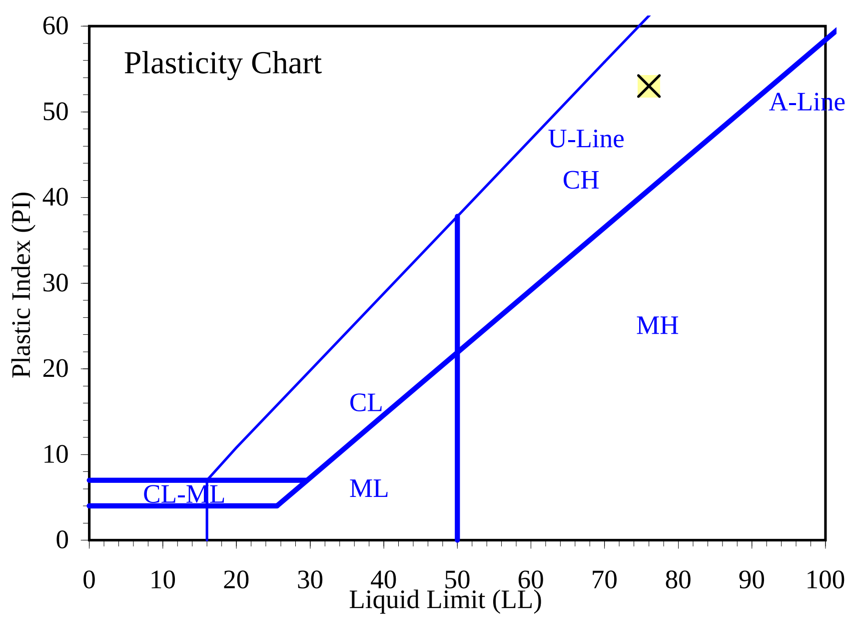
Determination No	1	2				
Wet Soil + Tare (g)	29.01	29.46				
Dry Soil + Tare (g)	27.60	28.00				
Moisture Loss (g)	1.41	1.46				
Tare (g)	21.49	21.64				
Dry Soil (g)	6.11	6.36				
Moisture Content, w (%)	23.08	22.96				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	23	18			
Wet Soil + Tare (g)	29.10	30.63	30.81			
Dry Soil + Tare (g)	25.94	26.68	26.74			
Moisture Loss (g)	3.16	3.95	4.07			
Tare (g)	21.60	21.51	21.61			
Dry Soil (g)	4.34	5.17	5.13			
Moisture Content, w (%)	72.81	76.40	79.34			
One-Point LL (%)		76				

Liquid Limit, LL (%)	**76**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**53**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/31/2012
By: BRR

Boring No.: TP-21
Sample:
Depth: 14'
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

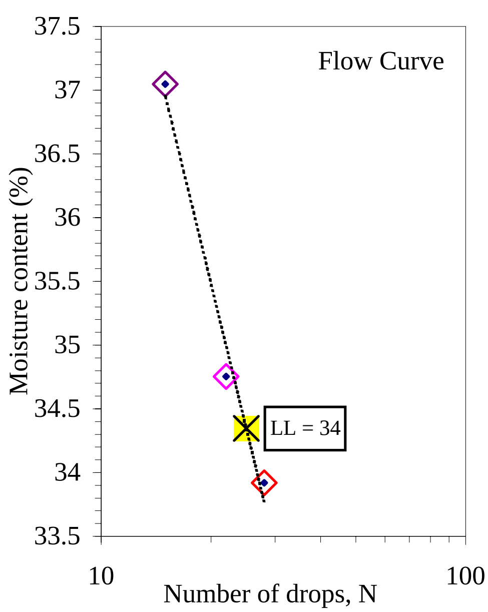
Plastic Limit

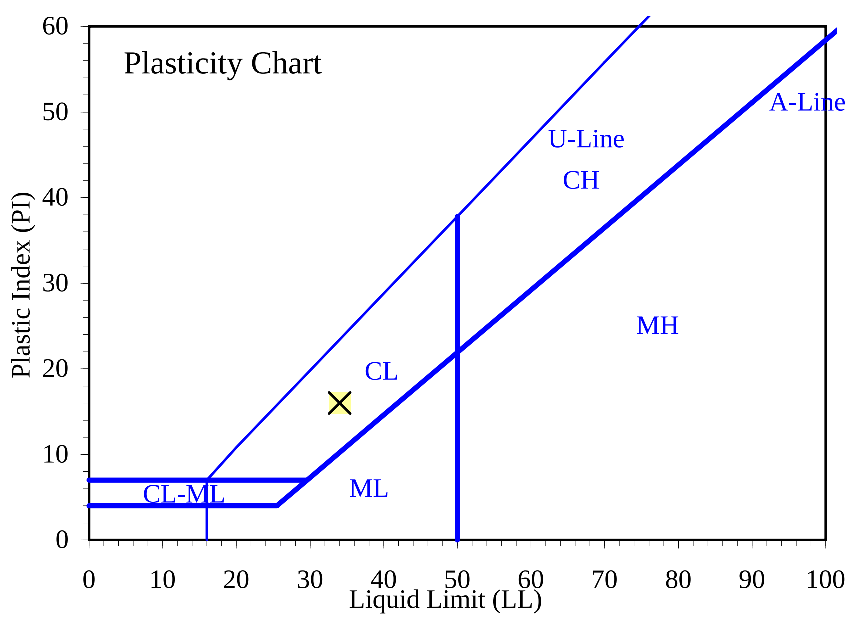
Determination No	1	2			
Wet Soil + Tare (g)	31.06	31.11			
Dry Soil + Tare (g)	29.55	29.59			
Moisture Loss (g)	1.51	1.52			
Tare (g)	21.37	21.33			
Dry Soil (g)	8.18	8.26			
Moisture Content, w (%)	18.46	18.40			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	22	15			
Wet Soil + Tare (g)	31.62	31.73	31.70			
Dry Soil + Tare (g)	29.11	29.12	28.84			
Moisture Loss (g)	2.51	2.61	2.86			
Tare (g)	21.71	21.61	21.12			
Dry Soil (g)	7.40	7.51	7.72			
Moisture Content, w (%)	33.92	34.75	37.05			
One-Point LL (%)	34	34				

Liquid Limit, LL (%)	**34**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**16**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: B-01
Sample:
Depth: 7.5'
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

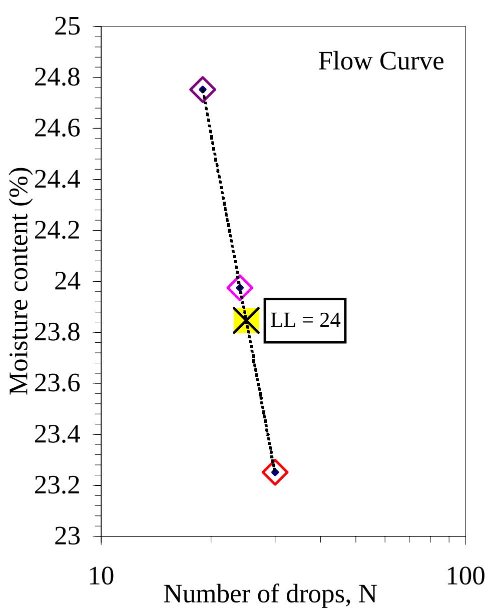
Plastic Limit

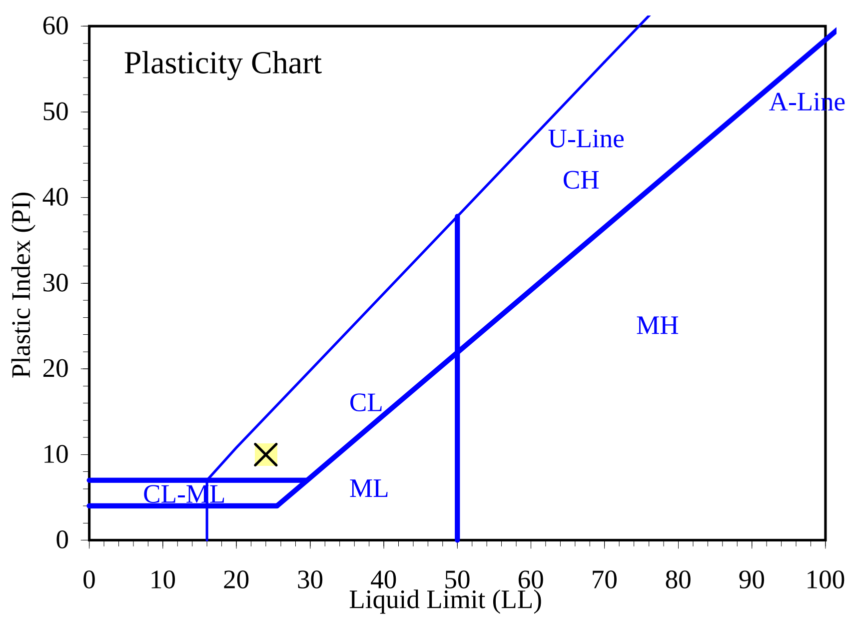
Determination No	1	2				
Wet Soil + Tare (g)	30.99	32.98				
Dry Soil + Tare (g)	29.84	31.59				
Moisture Loss (g)	1.15	1.39				
Tare (g)	21.66	21.63				
Dry Soil (g)	8.18	9.96				
Moisture Content, w (%)	14.06	13.96				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	24	19			
Wet Soil + Tare (g)	33.82	33.77	32.91			
Dry Soil + Tare (g)	31.56	31.43	30.66			
Moisture Loss (g)	2.26	2.34	2.25			
Tare (g)	21.84	21.67	21.57			
Dry Soil (g)	9.72	9.76	9.09			
Moisture Content, w (%)	23.25	23.98	24.75			
One-Point LL (%)	24	24				

Liquid Limit, LL (%)	**24**
Plastic Limit, PL (%)	**14**
Plasticity Index, PI (%)	**10**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: **Powder Mountain Development**
No: **01628-002**
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: **B-01**
Sample:
Depth: **20'**
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

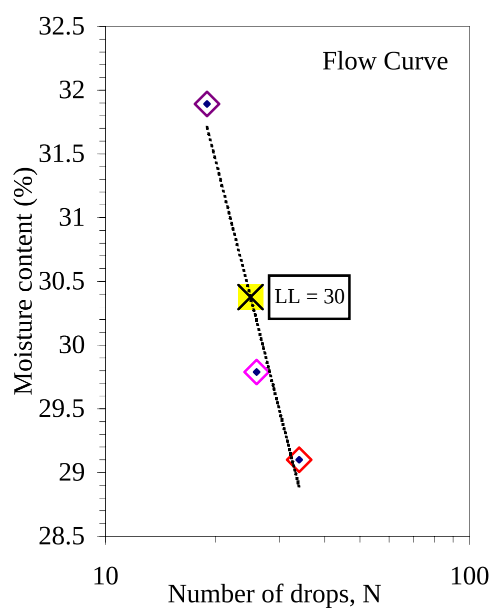
Plastic Limit

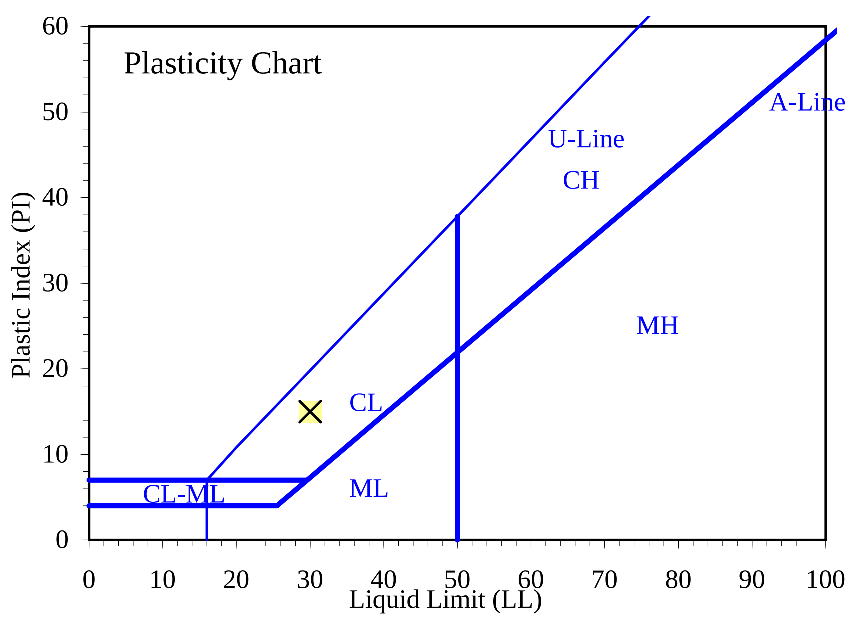
Determination No	1	2				
Wet Soil + Tare (g)	31.31	30.14				
Dry Soil + Tare (g)	30.09	29.00				
Moisture Loss (g)	1.22	1.14				
Tare (g)	21.80	21.13				
Dry Soil (g)	8.29	7.87				
Moisture Content, w (%)	14.72	14.49				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	26	19			
Wet Soil + Tare (g)	32.59	32.65	31.08			
Dry Soil + Tare (g)	30.07	30.10	28.72			
Moisture Loss (g)	2.52	2.55	2.36			
Tare (g)	21.41	21.54	21.32			
Dry Soil (g)	8.66	8.56	7.40			
Moisture Content, w (%)	29.10	29.79	31.89			
One-Point LL (%)		30				

Liquid Limit, LL (%)	**30**
Plastic Limit, PL (%)	**15**
Plasticity Index, PI (%)	**15**





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Particle-Size Analysis of Soils

(ASTM D422)

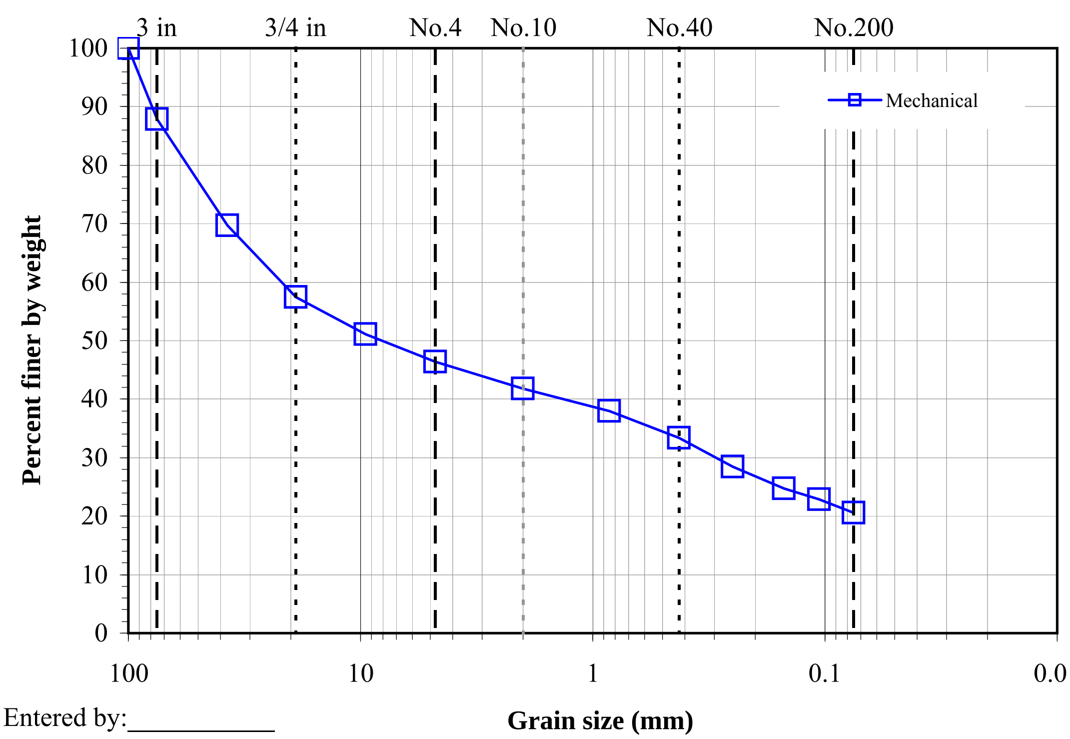
Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/26/2012
By: BRR

Boring No.: TP-15
Sample:
Depth: 2'
Description: Reddish brown silty gravel with sand

Split:	Yes	
Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	25511.10	24968.0
+3/4" Coarse fraction (g):	10666.3	10614.4
-3/4" Split fraction (g):	1711.2	1654.53
Split fraction:	0.575	

Moisture data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	874.57	2119.18
Dry soil + tare (g):	870.92	2062.56
Tare (g):	124.42	408.03
Moisture content (%):	0.5	3.4

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	100.0	
3"	3042.13	75	87.8	
1.5"	7574.66	37.5	69.7	
3/4"	10614.40	19	57.5	←Split
3/8"	183.12	9.5	51.1	
No.4	319.96	4.75	46.4	
No.10	452.32	2	41.8	
No.20	562.06	0.85	38.0	
No.40	694.54	0.425	33.4	
No.60	835.72	0.25	28.5	
No.100	941.70	0.15	24.8	
No.140	997.93	0.106	22.8	
No.200	1063.17	0.075	20.5	



Gravel (%): 53.6
Sand (%): 25.8
Fines (%): 20.5

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils

(ASTM D422)

IGES

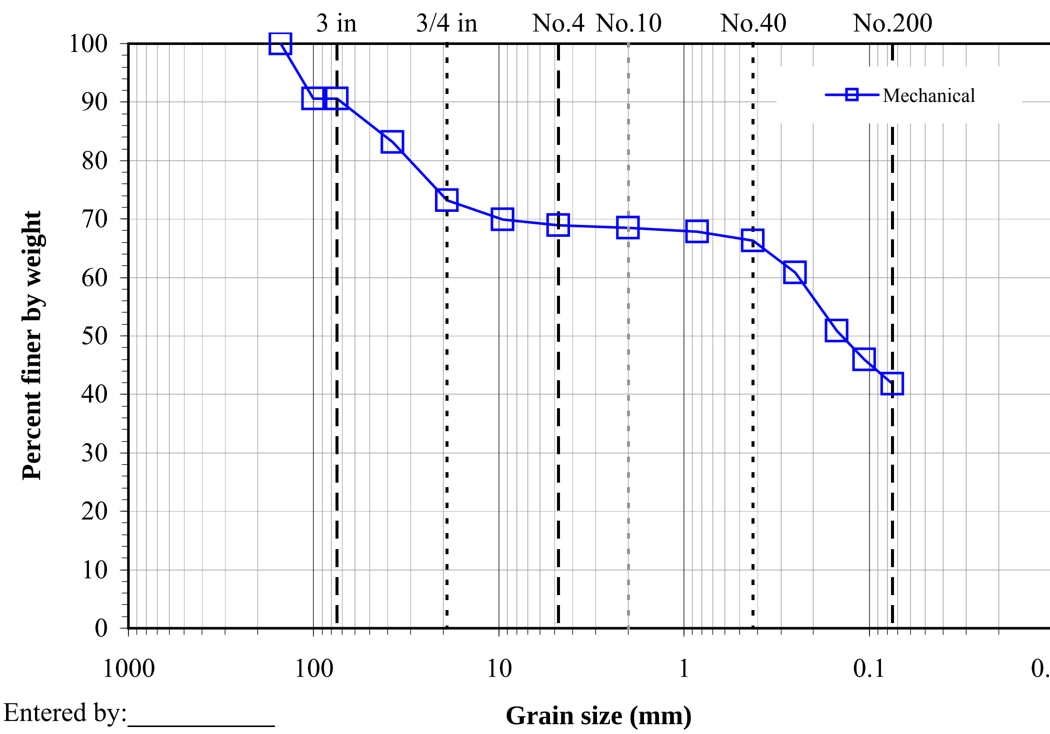
Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/26/2012
By: BRR

Boring No.: TP-18
Sample:
Depth: 1'
Description: Reddish brown clayey gravel with sand

Split:	Yes	
Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	19008.40	17971.2
+3/4" Coarse fraction (g):	4827.7	4818.9
-3/4" Split fraction (g):	1225.4	1136.49
Split fraction:	0.732	

Moisture data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	689.71	1634.20
Dry soil + tare (g):	688.68	1545.33
Tare (g):	122.40	408.84
Moisture content (%):	0.2	7.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	100.0	
4"	1698.71	100	90.5	
3"	1698.71	75	90.5	
1.5"	3025.00	37.5	83.2	
3/4"	4818.93	19	73.2	←Split
3/8"	51.62	9.5	69.9	
No.4	66.02	4.75	68.9	
No.10	73.63	2	68.4	
No.20	82.47	0.85	67.9	
No.40	106.74	0.425	66.3	
No.60	191.13	0.25	60.9	
No.100	345.71	0.15	50.9	
No.140	422.38	0.106	46.0	
No.200	487.52	0.075	41.8	



Gravel (%): 31.1
Sand (%): 27.1
Fines (%): 41.8

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils

(ASTM D422)

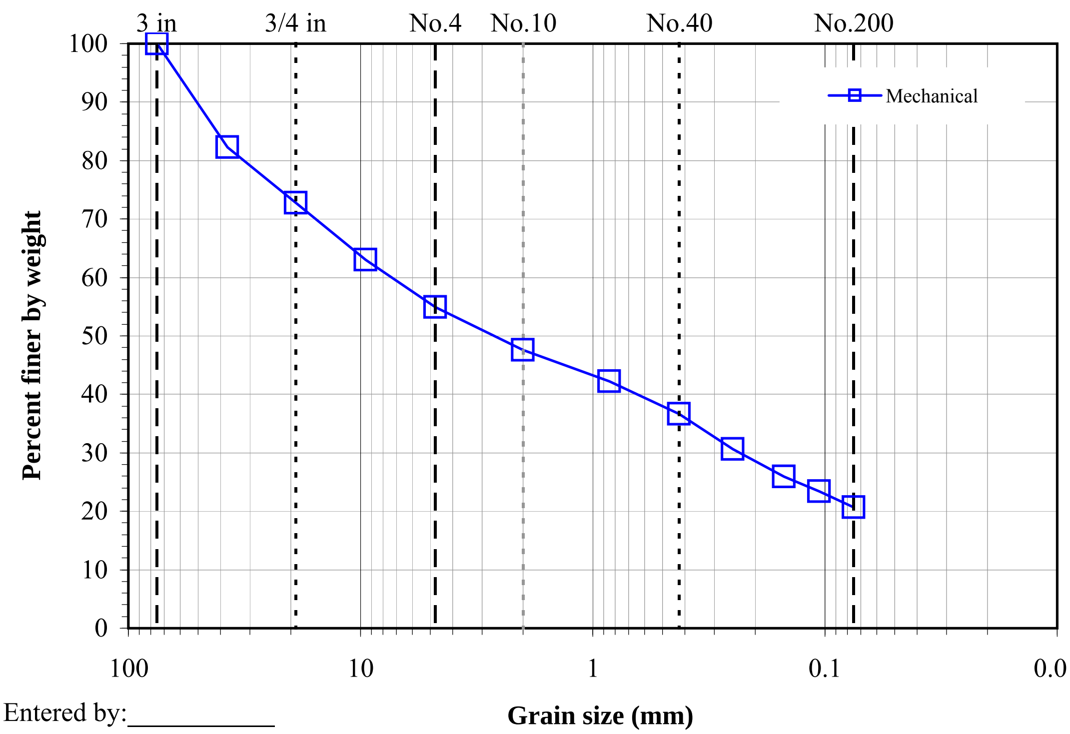
Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/26/2012
By: BRR

Boring No.: TP-20
Sample:
Depth: 6'
Description: Reddish brown clayey gravel with sand

Split:	Yes	
Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	2510.56	2472.2
+3/4" Coarse fraction (g):	675.99	674.6
-3/4" Split fraction (g):	1834.1	1797.03
Split fraction:	0.727	

Moisture data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	802.73	2243.01
Dry soil + tare (g):	801.39	2205.95
Tare (g):	126.87	408.92
Moisture content (%):	0.2	2.1

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
8"	-	200	-
6"	-	150	-
4"	-	100	-
3"	-	75	100.0
1.5"	438.53	37.5	82.3
3/4"	674.65	19	72.7 ←Split
3/8"	240.70	9.5	63.0
No.4	440.30	4.75	54.9
No.10	620.30	2	47.6
No.20	752.00	0.85	42.3
No.40	890.10	0.425	36.7
No.60	1038.90	0.25	30.7
No.100	1156.70	0.15	25.9
No.140	1217.50	0.106	23.4
No.200	1286.10	0.075	20.7



Gravel (%): 45.1
Sand (%): 34.2
Fines (%): 20.7

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils

(ASTM D422)

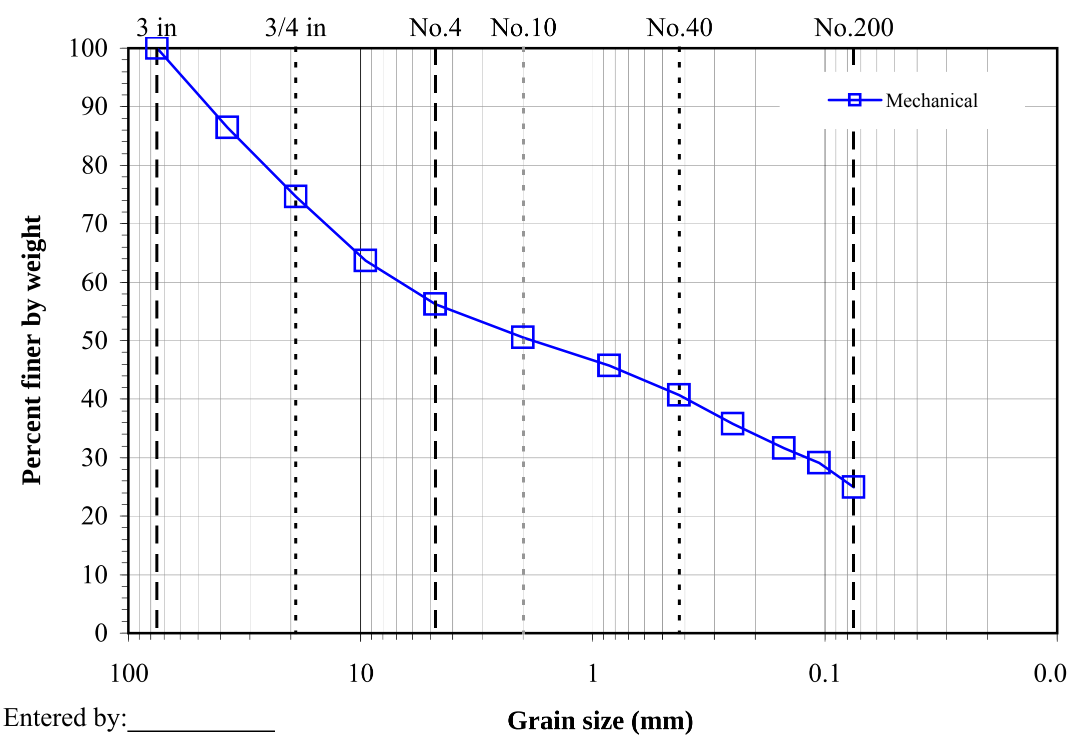
Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/26/2012
By: BRR

Boring No.: TP-22
Sample:
Depth: 10'
Description: Reddish brown silty gravel with sand

Split:	Yes	
Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	4988.70	4813.3
+3/4" Coarse fraction (g):	1244	1221.1
-3/4" Split fraction (g):	1234.5	1184.25
Split fraction:	0.746	

Moisture data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	701.05	1551.22
Dry soil + tare (g):	690.50	1500.94
Tare (g):	127.68	316.69
Moisture content (%):	1.9	4.2

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	653.35	37.5	86.4	
3/4"	1221.11	19	74.6	←Split
3/8"	173.78	9.5	63.7	
No.4	291.94	4.75	56.2	
No.10	382.64	2	50.5	
No.20	458.72	0.85	45.7	
No.40	538.98	0.425	40.7	
No.60	616.00	0.25	35.8	
No.100	681.97	0.15	31.7	
No.140	722.78	0.106	29.1	
No.200	789.00	0.075	24.9	



Gravel (%): 43.8
Sand (%): 31.3
Fines (%): 24.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils

(ASTM D422)

IGES

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/26/2012
By: BRR

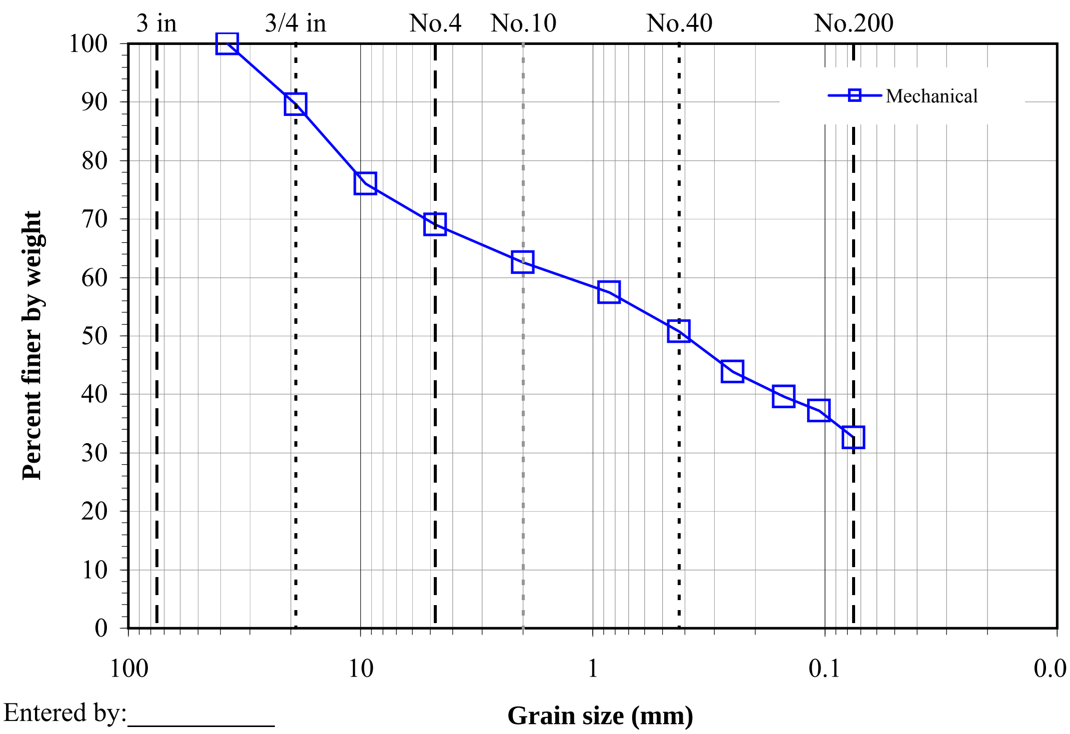
Boring No.: B-01
Sample:
Depth: 15'
Description: Reddish brown clayey sand with gravel

Split:	No	
	-	
	Moist	Dry
Total sample wt. (g):	927.86	863.3
Split fraction:	1.000	

Moisture data

Moist soil + tare (g):	-	1394.86
Dry soil + tare (g):	-	1330.30
Tare (g):	-	467.00
Moisture content (%):	0.0	7.5

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
8"	-	200	-
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	100.0
3/4"	89.80	19	89.6
3/8"	206.90	9.5	76.0
No.4	267.00	4.75	69.1
No.10	322.90	2	62.6
No.20	367.30	0.85	57.5
No.40	424.60	0.425	50.8
No.60	484.10	0.25	43.9
No.100	521.60	0.15	39.6
No.140	542.20	0.106	37.2
No.200	581.70	0.075	32.6



Gravel (%): 30.9
Sand (%): 36.5
Fines (%): 32.6

Entered by:___________
Reviewed:___________

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

(ASTM D1140)

IGES

Project: **Powder Mountain Development**
No: **01628-002**
Location: Powder Mountain Resort
Date: 10/24/2012
By: BRR

Sample Info.	Boring No.	TP-18	TP-19	B-01						
	Sample									
	Depth	3'	9'	7.5'						
	Split	No	No	No						
	Split Sieve*									
	Moist total sample wt. (g)	744.71	645.12	456.01						
	Moist coarse fraction (g)									
	Moist split fraction + tare (g)									
	Split fraction tare (g)									
	Dry split fraction (g)									
	Dry retained No. 200 + tare (g)	910.04	607.74	505.53						
	Wash tare (g)	220.91	409.82	225.60						
	No. 200 Dry wt. retained (g)	689.13	197.92	279.93						
	Split sieve* Dry wt. retained (g)									
	Dry total sample wt. (g)	730.44	573.38	417.40						
Coarse Fraction	Moist soil + tare (g)									
	Dry soil + tare (g)									
	Tare (g)									
	Moisture content (%)									
Split Fraction	Moist soil + tare (g)	965.62	1054.94	681.61						
	Dry soil + tare (g)	951.35	983.20	643.00						
	Tare (g)	220.91	409.82	225.60						
	Moisture content (%)	1.95	12.51	9.25						
	Percent passing split sieve* (%)									
	Percent passing No. 200 sieve (%)	**5.7**	**65.5**	**32.9**						

Entered by:___________

Reviewed:___________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/24/2012
By: BRR

Boring No.: TP-13
Sample:
Depth: 1-2'
Sample Description: Brown silty gravel with sand
Engineering Classification: Not requested
As-received moisture content (%): Not requested

Method: ASTM D698 C
Mold Id. Inc 4
Mold volume (ft^3): 0.0751

Preparation method: Moist
Rammer: Mechanical-sector face
Rock Correction: Yes * See results below

Optimum moisture content (%): 12
Maximum dry unit weight (pcf): 126.4

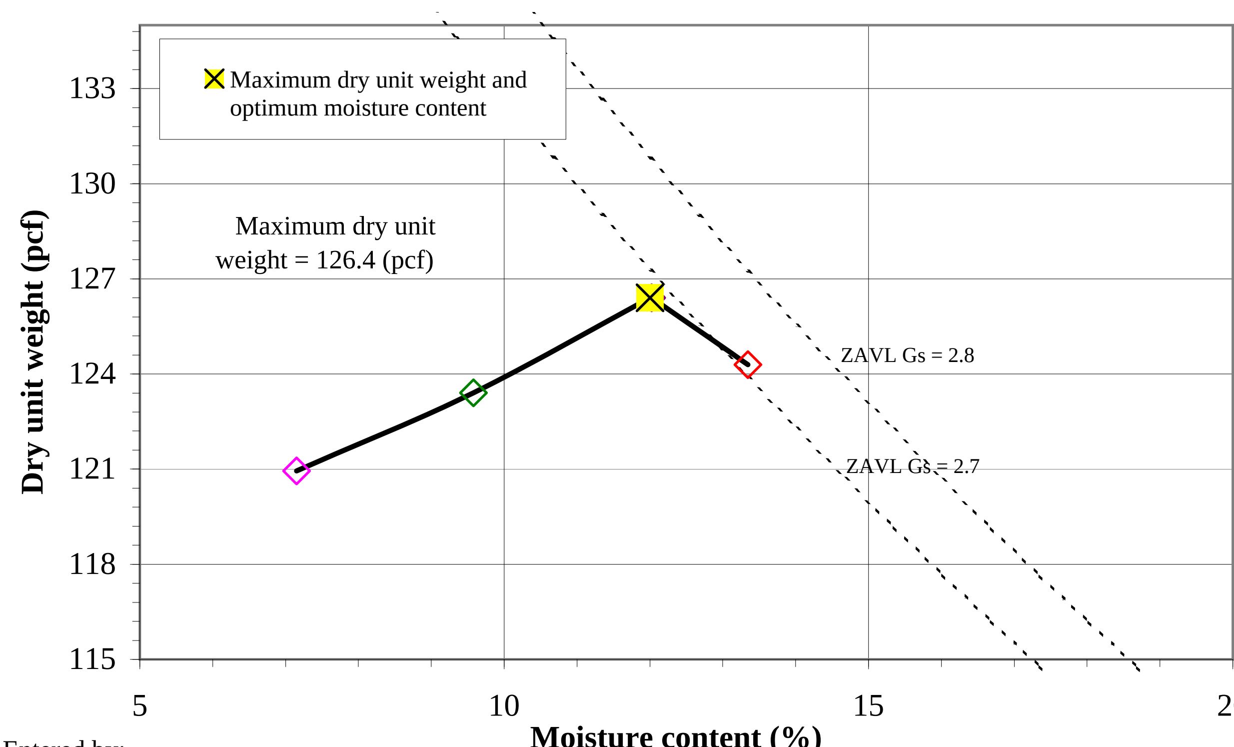
Point Number	+4	+6	+2	As Is				
Wt. Sample + Mold (g)	10428.2	10403.6	10211.3	10019.2				
Wt. of Mold (g)	5604	5604	5604	5604				
Wet Unit Wt., γ_m (pcf)	141.6	140.9	135.2	129.6				
Wet Soil + Tare (g)	867.02	1089.4	856.53	936.7				
Dry Soil + Tare (g)	787.2	976.18	792.46	882.66				
Tare (g)	123.35	127.76	123.71	126.83				
Moisture Content, w (%)	**12.0**	**13.3**	**9.6**	**7.1**				
Dry Unit Wt., γ_d (pcf)	**126.4**	**124.3**	**123.4**	**120.9**				

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

(ASTM D4718)

Corrected moisture content (%): 9.9
Corrected dry unit weight (pcf): 134.1

Oversized fraction, +3/4-in. (%): 24.3
Moisture content, +3/4-in. (%): 3.2
Sieve for oversized fraction: 3/4-in.
Bulk specific gravity, Gs: 2.65 Assumed



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Reviewed:___________

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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

IGES

Project: **Powder Mountain Development**
No: **01628-002**
Location: Powder Mountain Resort
Date: 10/25/2012
By: BRR

Boring No.: **TP-14**
Sample:
Depth: **1'**
Sample Description: Reddish brown clayey gravel with sand
Engineering Classification: Not requested
As-received moisture content (%): Not requested

Method: ASTM D698 C
Mold Id. Inc 4
Mold volume (ft^3): 0.0751

Preparation method: Moist
Rammer: Mechanical-sector face
Rock Correction: Yes * See results below

Optimum moisture content (%): 10.4
Maximum dry unit weight (pcf): 123.9

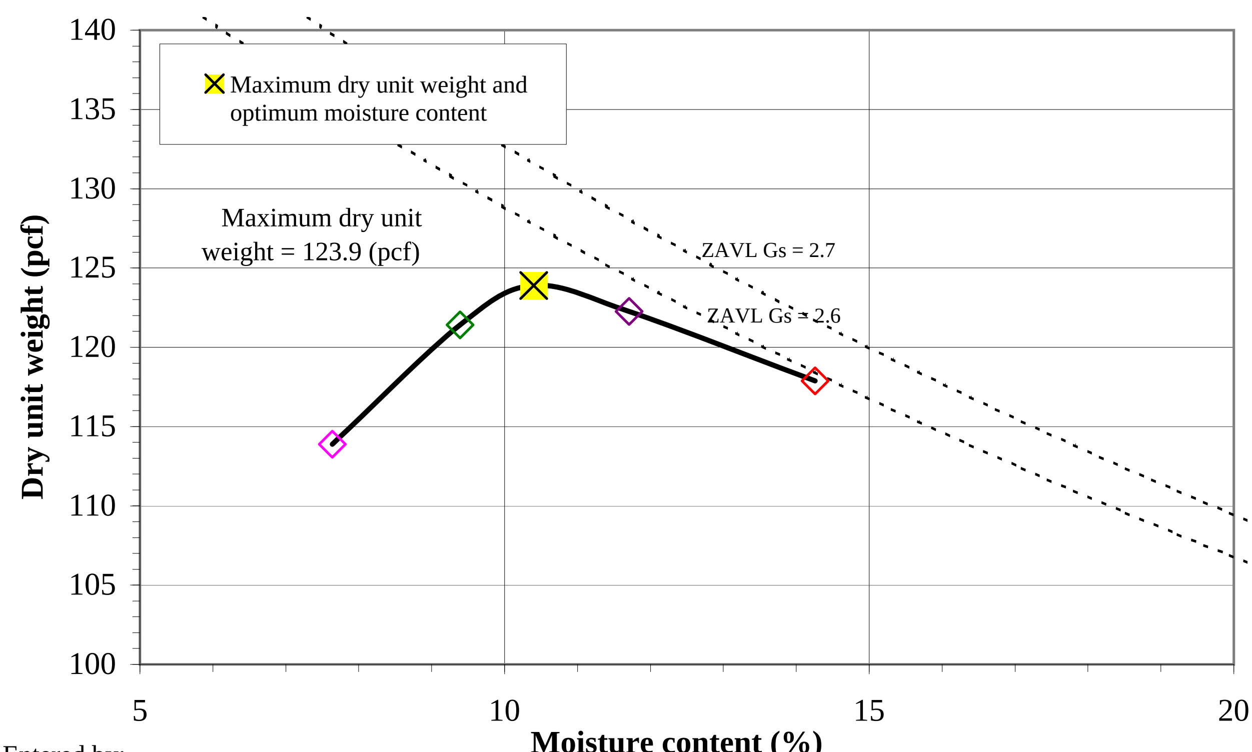
Point Number	+4	+6	+2	As Is				
Wt. Sample + Mold (g)	10257.2	10192.7	10128.9	9780.0				
Wt. of Mold (g)	5604	5604	5604	5604				
Wet Unit Wt., γ_m (pcf)	136.6	134.7	132.8	122.6				
Wet Soil + Tare (g)	981.31	1058.6	896.97	928.81				
Dry Soil + Tare (g)	891.04	941.84	830.85	872.01				
Tare (g)	120.09	123.14	126.65	128.39				
Moisture Content, w (%)	**11.7**	**14.3**	**9.4**	**7.6**				
Dry Unit Wt., γ_d (pcf)	**122.3**	**117.9**	**121.4**	**113.9**				

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

(ASTM D4718)

Corrected moisture content (%): 7.7
Corrected dry unit weight (pcf): 133.2

Oversized fraction, +3/4-in. (%): 27.8
Moisture content, +3/4-in. (%): 0.7
Sieve for oversized fraction: 3/4-in.
Bulk specific gravity, Gs: 2.65 Assumed



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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/29/2012
By: JDF

Boring No.: TP-16
Sample:
Depth: 6'
Sample Description: Brown clayey gravel
Engineering Classification: Not requested
As-received moisture content (%): Not requested

Method: ASTM D698 C
Mold Id. Inc 7
Mold volume (ft^3): 0.0752

Preparation method: Moist
Rammer: Mechanical-sector face
Rock Correction: Yes * See results below

Optimum moisture content (%): 8.9
Maximum dry unit weight (pcf): 124.2

Point Number	+4%	+6%	+8%	+10%	+2%			
Wt. Sample + Mold (g)	10936.2	11151.2	11118.5	11077.0	10814.5			
Wt. of Mold (g)	6538.3	6538.3	6538.3	6538.3	6538.3			
Wet Unit Wt., γ_m (pcf)	129.0	135.3	134.3	133.1	125.4			
Wet Soil + Tare (g)	1271.5	1141.8	1430.3	1196.5	1131.6			
Dry Soil + Tare (g)	1208.5	1066.5	1304	1076.2	1088			
Tare (g)	273.26	223.5	219.19	223.35	214.13			
Moisture Content, w (%)	**6.7**	**8.9**	**11.6**	**14.1**	**5.0**			
Dry Unit Wt., γ_d (pcf)	**120.9**	**124.2**	**120.3**	**116.7**	**119.5**			

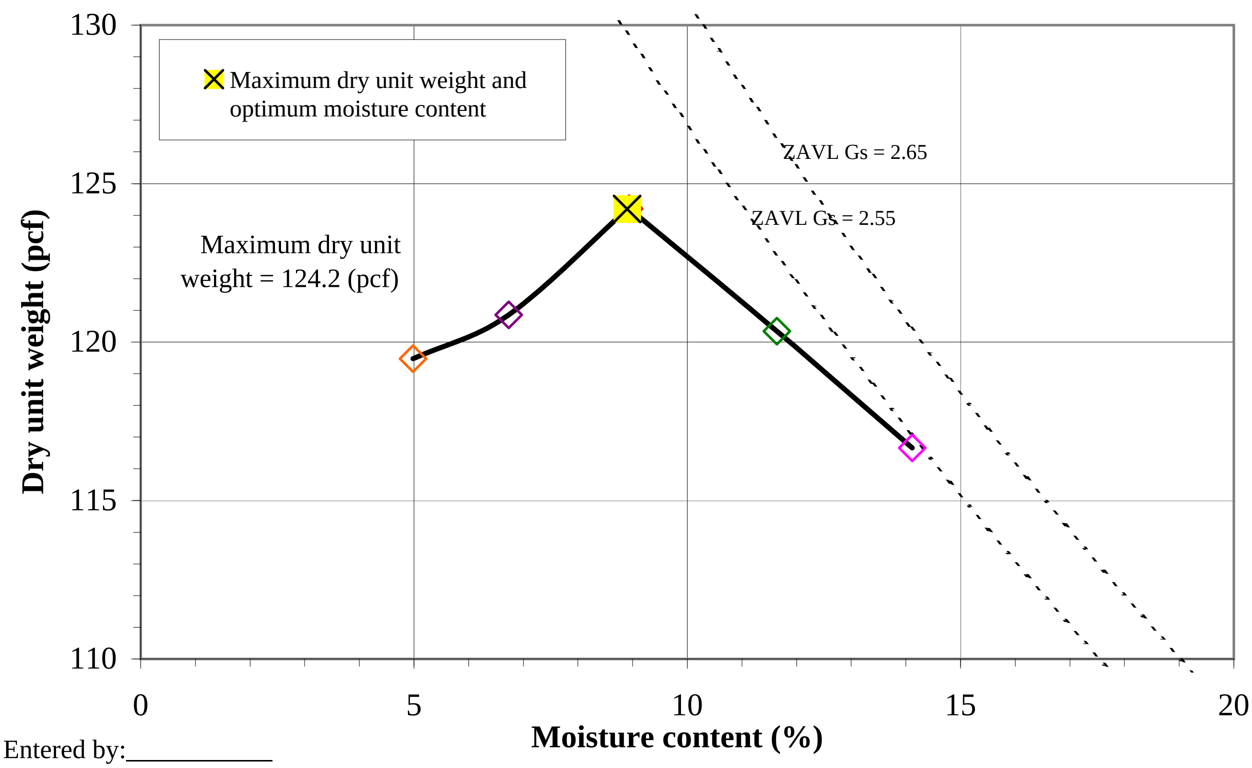
*Correction of Unit Weight and Water Content for Soils Containing Oversize Particles

(ASTM D4718)

Corrected moisture content (%): 6.4
Corrected dry unit weight (pcf): 134.2

Oversized fraction, +3/4-in. (%): 30.0
Moisture content, +3/4-in. (%): 0.6
Sieve for oversized fraction: 3/4-in.
Bulk specific gravity, Gs: 2.65 Assumed

Comments:
According to ASTM D4718 the allowable 3/4" oversized fraction is 30% for correction, the actual oversized fraction is 45.8%.



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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/24/2012
By: BRR

Boring No.: TP-19
Sample:
Depth: 1'
Sample Description: Reddish brown clayey sand with gravel
Engineering Classification: Not requested
As-received moisture content (%): 8.2

Method: ASTM D698 B
Mold Id. Inc 2
Mold volume (ft^3): 0.0332

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: Yes * See results below

Optimum moisture content (%): 16.7
Maximum dry unit weight (pcf): 109.9

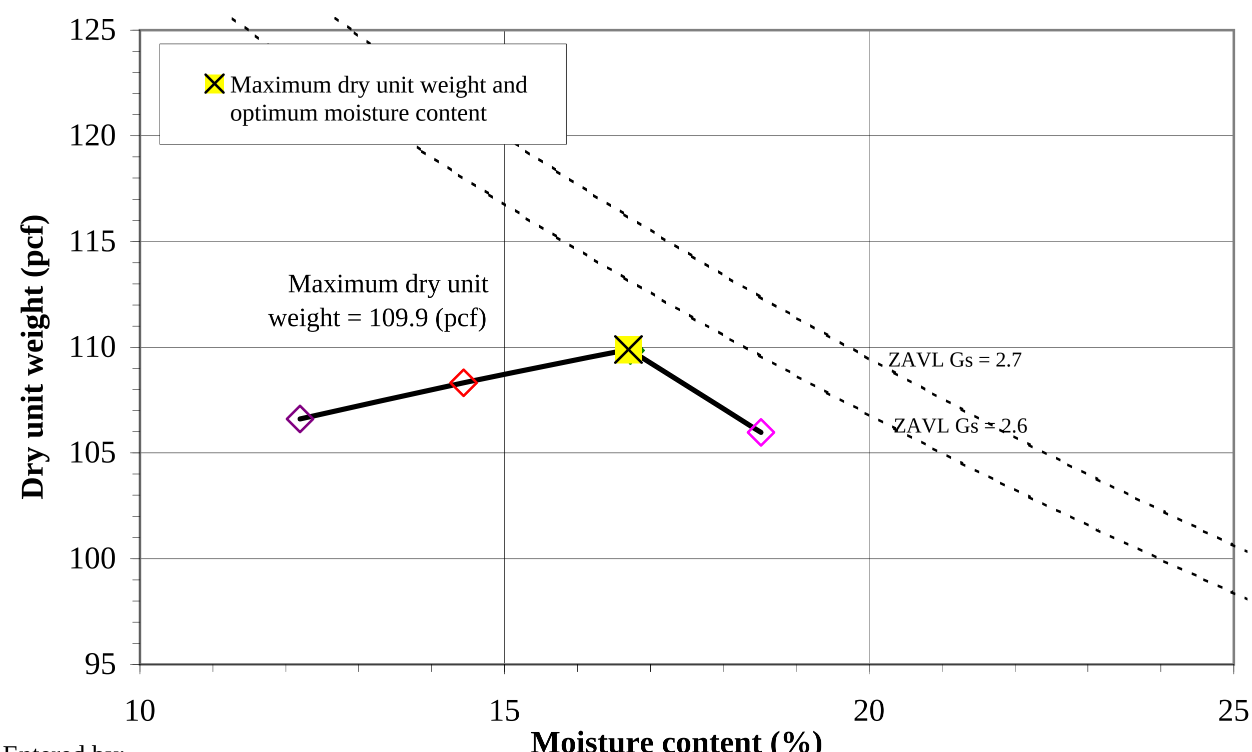
Point Number	+4	+6	+8	+10				
Wt. Sample + Mold (g)	5966.5	6031.9	6096.2	6056.6				
Wt. of Mold (g)	4164.1	4164.1	4164.1	4164.1				
Wet Unit Wt., γ_m (pcf)	119.6	124.0	128.2	125.6				
Wet Soil + Tare (g)	706.91	602.48	702.45	655.8				
Dry Soil + Tare (g)	643.52	542.68	619.39	570.87				
Tare (g)	123.77	128.56	122.71	112.2				
Moisture Content, w (%)	**12.2**	**14.4**	**16.7**	**18.5**				
Dry Unit Wt., γ_d (pcf)	**106.6**	**108.3**	**109.9**	**106.0**				

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

(ASTM D4718)

Corrected moisture content (%): 14.2
Corrected dry unit weight (pcf): 115.9

Oversized fraction, +3/8-in. (%): 15.5
Moisture content, +3/8-in. (%): 0.5
Sieve for oversized fraction: 3/8-in.
Bulk specific gravity, Gs: 2.65 Assumed



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California Bearing Ratio

(ASTM D 1883)

IGES

Project: Powder Mountain Development
Number: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: TP-13
Sample:
Depth: 1-2'
Original Method: ASTM D698 C
Engineering Classification: Not requested
Condition of Sample: Soaked
Scalp and Replace: No

Maximum Dry Unit Weight (pcf): 126.4
Optimum Moisture Content (%): 12
Relative Compaction (%): 101.0
0.1 in. Corrected CBR (%): 23.6
0.2 in. Corrected CBR (%): 31.2

As Compacted Data

Mold Id.	4	Wet Soil + Tare (g)	1193.4
Wt. of Mold + Sample (g)	12036.1	Dry Soil + Tare (g)	1098.07
Wt. of Mold (g)	7190.5	Tare (g)	294.51
Dry Unit Weight (pcf)	127.6	Moisture Content (%)	11.9

After Soaking Data

			Average	Top 1 in.
Wt. of Mold + Sample (g)	12065.1	Wet Soil + Tare (g)	982.53	1031.41
Dry Unit Weight (pcf)	128.0	Dry Soil + Tare (g)	907.79	941.65
		Tare (g)	221.66	179.19
		Moisture Content (%)	10.9	11.8

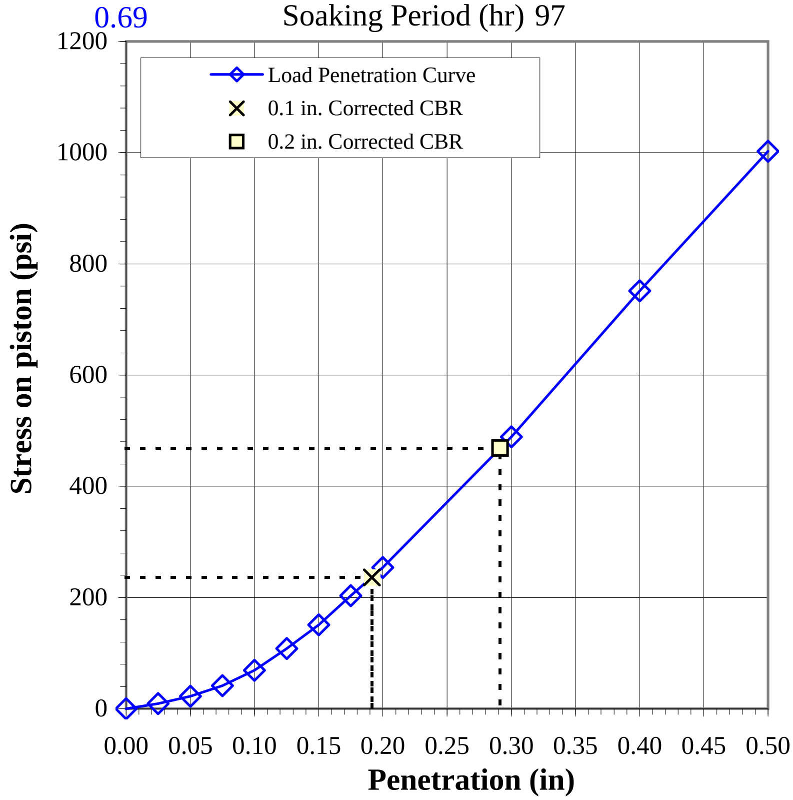
Swell Data

Date	Time	Dial		
			Surcharge (psf)	50
10/25/2012	11:35	0.702	Swell (%)	-0.26
10/29/2012	12:36	0.69	Soaking Period (hr)	97

Penetration Data

Zero load (lb) = 0
Area of Piston (in^2) = 3

Penetration (in.)	Raw Load (lb)	Piston Stress (psi)	Std. Stress (psi)
0.000	0	0	
0.025	28	9	
0.050	68	23	
0.075	124	41	
0.100	208	69	1000
0.125	324	108	1125
0.150	452	151	1250
0.175	609	203	1375
0.200	761	254	1500
0.300	1466	489	1900
0.400	2255	752	2300
0.500	3008	1003	2600



Entered By:___________
Reviewed:___________

California Bearing Ratio
(ASTM D 1883)

IGES

Project: Powder Mountain Development
Number: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: BRR

Boring No.: TP-14
Sample:
Depth: 1'
Original Method: ASTM D698 C
Engineering Classification: Not requested
Condition of Sample: Soaked
Scalp and Replace: No

Maximum Dry Unit Weight (pcf): 123.9
Optimum Moisture Content (%): 10.4
Relative Compaction (%): 100.1
0.1 in. CBR (%): 4.1
0.2 in. CBR (%): 4.5

As Compacted Data

Mold Id.	B	Wet Soil + Tare (g)	1300.81
Wt. of Mold + Sample (g)	11871.4	Dry Soil + Tare (g)	1209.92
Wt. of Mold (g)	7228.1	Tare (g)	310.48
Dry Unit Weight (pcf)	124.0	Moisture Content (%)	10.1

After Soaking Data

			Average	Top 1 in.
Wt. of Mold + Sample (g)	11975.9	Wet Soil + Tare (g)	930.72	855.82
Dry Unit Weight (pcf)	122.2	Dry Soil + Tare (g)	857.54	765.54
		Tare (g)	225.63	160.18
		Moisture Content (%)	11.6	14.9

Swell Data

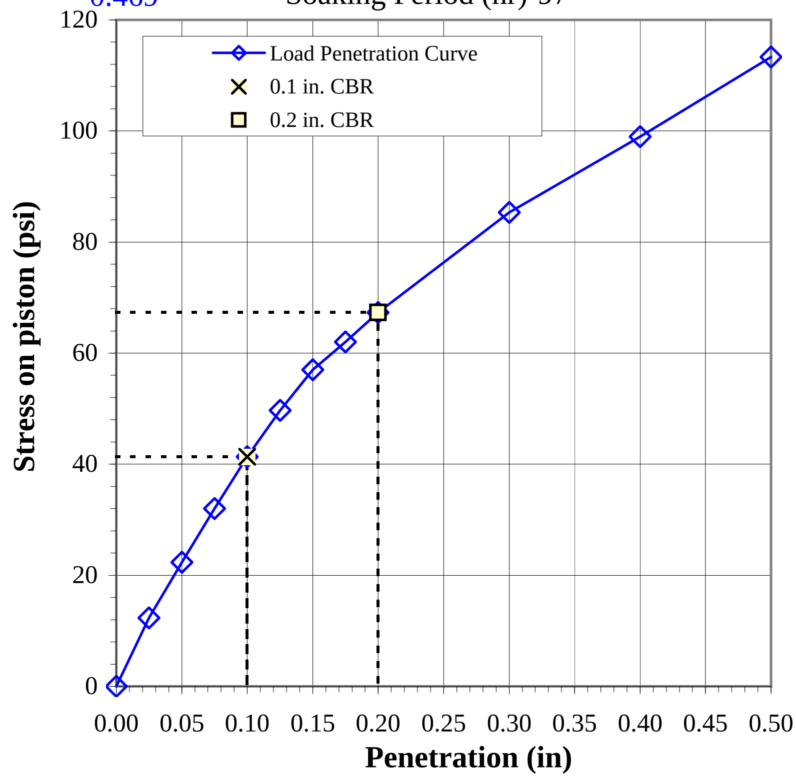
Date	Time	Dial
10/25/2012	11:55	0.399
10/29/2012	12:35	0.469

Surcharge (psf) 50
Swell (%) 1.53
Soaking Period (hr) 97

Penetration Data

Zero load (lb) = 0
Area of Piston (in^2) = 3

Penetration (in.)	Raw Load (lb)	Piston Stress (psi)	Std. Stress (psi)
0.000	0	0	
0.025	37	12	
0.050	67	22	
0.075	96	32	
0.100	124	41	1000
0.125	149	50	1125
0.150	171	57	1250
0.175	186	62	1375
0.200	202	67	1500
0.300	256	85	1900
0.400	297	99	2300
0.500	340	113	2600



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Reviewed:___________

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California Bearing Ratio
(ASTM D 1883)

Project:	**Powder Mountain Development**	**Boring No.:**	TP-19
Number:	**01628-002**	**Sample:**	
Location:	Powder Mountain Resort	**Depth:**	1'
Date:	10/30/2012	Original Method:	ASTM D698 B
By:	BRR	Engineering Classification:	Not requested
Maximum Dry Unit Weight (pcf):	109.9	Condition of Sample:	Soaked
Optimum Moisture Content (%):	16.7	Scalp and Replace:	No
Relative Compaction (%):	100.3		
0.1 in. Corrected CBR (%):	**6.4**		
0.2 in. Corrected CBR (%):	**7.1**		

As Compacted Data

Mold Id.	3	Wet Soil + Tare (g)	1303.07
Wt. of Mold + Sample (g)	11496.3	Dry Soil + Tare (g)	1164.19
Wt. of Mold (g)	7145.3	Tare (g)	309.75
Dry Unit Weight (pcf)	110.2	Moisture Content (%)	16.3

After Soaking Data

			Average	Top 1 in.
Wt. of Mold + Sample (g) 11560.8		Wet Soil + Tare (g)	818.63	988.27
Dry Unit Weight (pcf) 109.7		Dry Soil + Tare (g)	724.02	862.32
		Tare (g)	177.3	181.19
		Moisture Content (%)	17.3	18.5

Swell Data

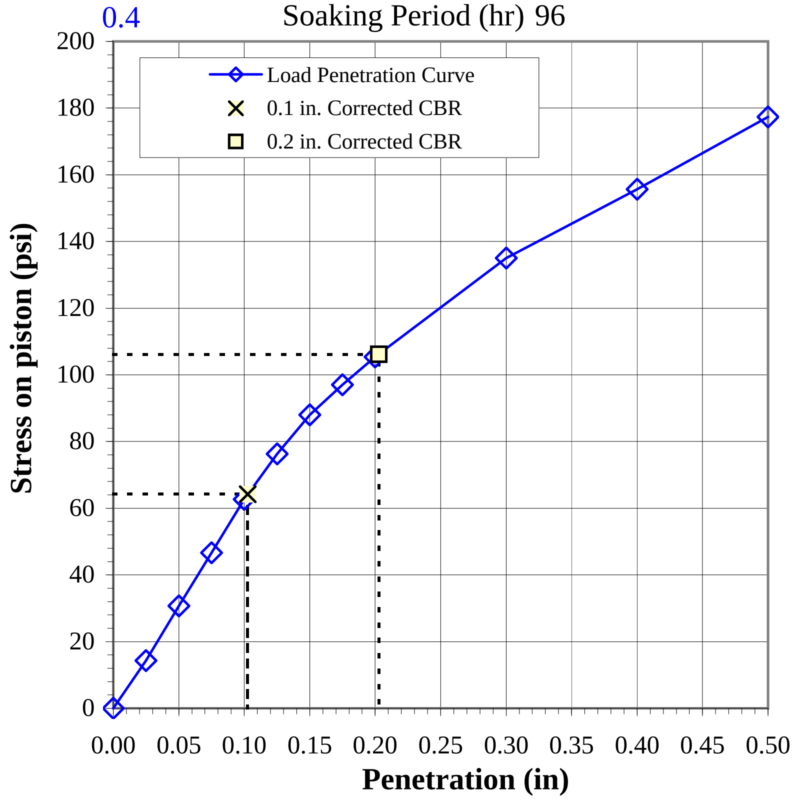
Date	Time	Dial		
			Surcharge (psf)	50
10/25/2012	12:15	0.38	Swell (%)	0.44
10/29/2012	12:34	0.4	Soaking Period (hr)	96

Penetration Data

Zero load (lb) = 0

Area of Piston (in^2) = 3

Penetration (in.)	Raw Load (lb)	Piston Stress (psi)	Std. Stress (psi)
0.000	0	0	
0.025	43	14	
0.050	92	31	
0.075	140	47	
0.100	188	63	1000
0.125	229	76	1125
0.150	264	88	1250
0.175	291	97	1375
0.200	316	105	1500
0.300	405	135	1900
0.400	467	156	2300
0.500	532	177	2600



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Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 11/1/2012
By: JDF

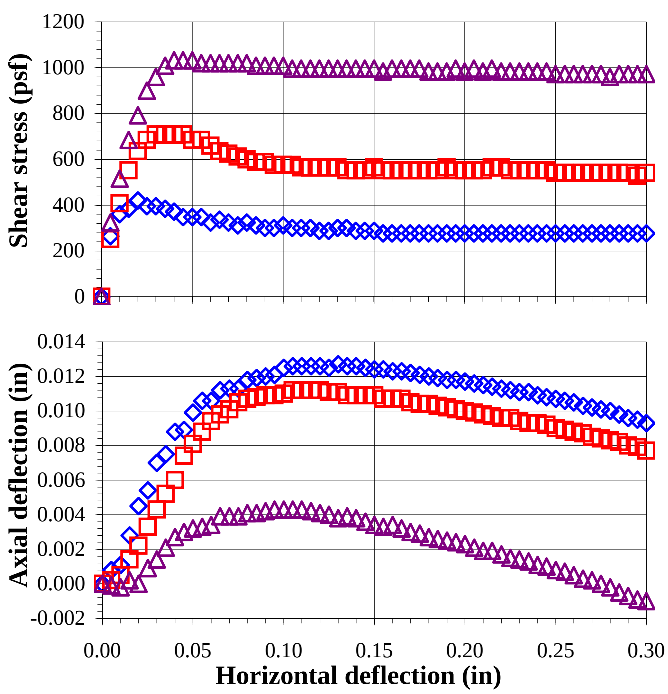
Boring No.: TP-16
Sample:
Depth: 6'
Sample Description: Brown clayey gravel
Sample type: Laboratory compacted
Dry unit weight 118 pcf
at 8.9 (%) w
Compaction specifications: 95% of ASTM D698B

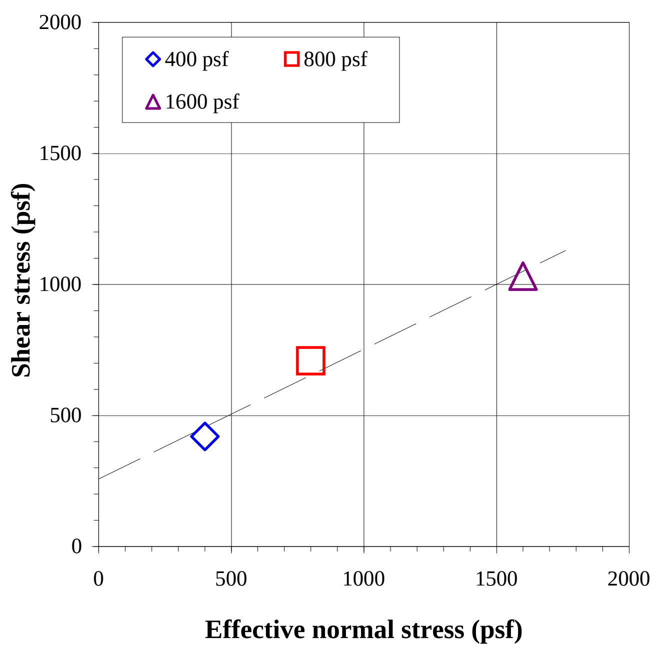
Test type: Inundated
Horizontal deformation (in.): 0.3
Shear rate (in./min): 0.0043

	Sample 1		Sample 2		Sample 3	
Effective normal stress (psf)	400		800		1600	
Peak shear stress (psf)	420		708		1032	
Horizontal deformation at peak(in)	0.020		0.030		0.040	
	Initial	Final	Initial	Final	Initial	Final
Sample height (in)	1.0000	1.0166	1.0000	1.0058	1.0000	0.9930
Sample diameter (in)	2.416	2.416	2.416	2.416	2.416	2.416
Wt. rings + wet soil (g)	197.22	208.08	197.94	208.57	199.78	209.78
Wt. rings (g)	42.46	42.46	43.18	43.18	45.02	45.02
Wet soil + tare (g)	336.40	184.29	336.40	183.56	336.40	184.35
Dry soil + tare (g)	319.10	161.35	319.10	160.86	319.10	162.23
Tare (g)	120.73	21.05	120.73	20.67	120.73	21.78
Water content (%)	8.7	16.4	8.7	16.2	8.7	15.7
Dry unit weight (pcf)	118.3	116.4	118.3	117.6	118.3	119.1

ϕ' (deg)	26
c' (psf)	258

Average of 3 samples	Initial	Final
Water content (%)	8.7	16.1
Dry unit weight (pcf)	118.3	117.7





Comments:
Specimens swelled upon inundation.

Entered by:___________
Reviewed:___________

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

IGES

Project: Powder Mountain Development
No: 01628-002
Location: Powder Mountain Resort
Date: 10/30/2012
By: JDF

Section	Field	TP-17		TP-18		TP-21		B-01	
Sample info.	Boring No.	TP-17		TP-18		TP-21		B-01	
	Sample								
	Depth	2.5'		4'		9'		20'	
Moisture data	Wet soil + tare (g)	84.23		69.18		68.82		67.12	
	Dry soil + tare (g)	79.19		65.75		65.95		64.26	
	Tare (g)	37.52		37.45		37.75		37.71	
	Moisture content (%)	12.1		12.1		10.2		10.8	
Chem. data	pH	6.5		6.3		5.3		5.2	
	Soluble chloride* (ppm)	<12		<11.4		<10.9		<11.5	
	Soluble sulfate** (ppm)	85.6		34.4		59.9		127	
Resistivity data		Soil condition (%)	Resistivity (Ω-cm)	Soil condition (%)	Resistivity (Ω-cm)	Soil condition (%)	Resistivity (Ω-cm)	Soil condition (%)	Resistivity (Ω-cm)
		As is	45000	As is	12000	As is	59000	As is	7900
		+3	17000	+3	3500	+3	20100	+3	5300
		+6	55000	+6	2100	+6	13000	+6	3800
		+9	2800	+9	1200	+9	10600	+9	3900
		+12	2200	+12	980	+12	12000		
		+15	2200	+15	1100				
	Minimum resistivity (Ω-cm)	**2200**		**980**		**10600**		**3800**	

* Performed by AWAL using EPA 300.0

** Performed by AWAL using ASTM C1580

Entered by:___________

Reviewed:___________

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LABORATORY TEST RESULTS

IGES, 2012

Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-01
Sample:
Depth: 4'
Description: Brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

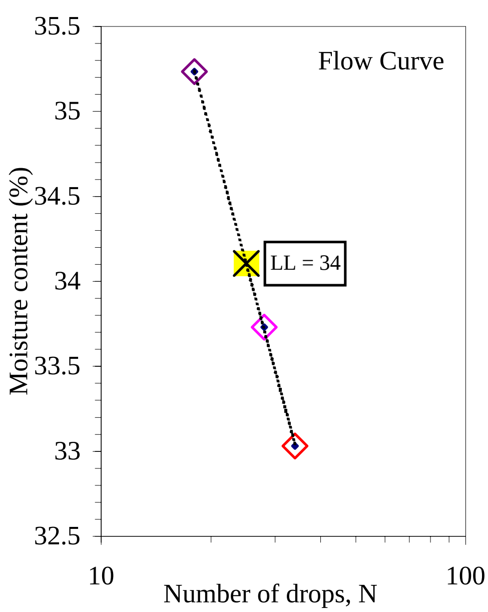
Plastic Limit

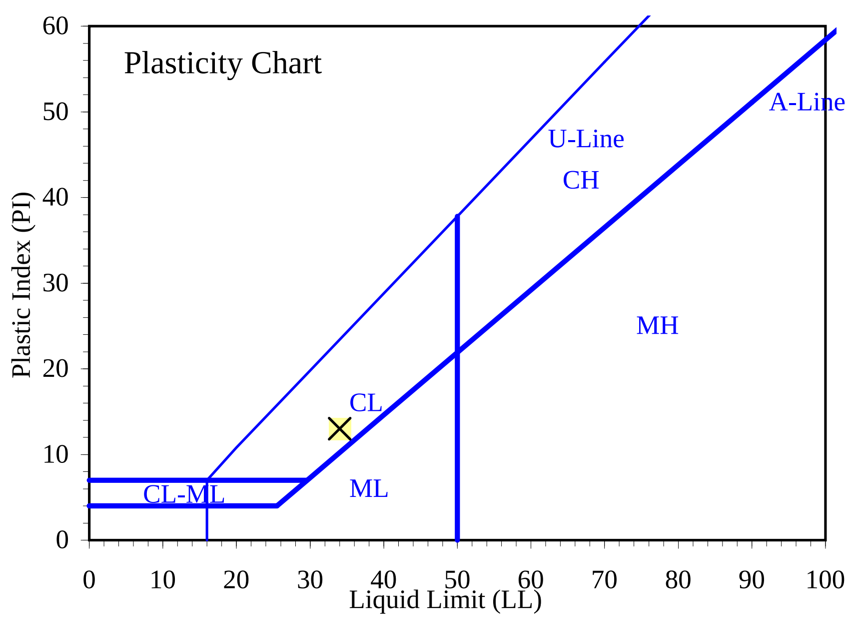
Determination No	1	2			
Wet Soil + Tare (g)	30.17	32.22			
Dry Soil + Tare (g)	28.62	30.38			
Moisture Loss (g)	1.55	1.84			
Tare (g)	21.32	21.80			
Dry Soil (g)	7.30	8.58			
Moisture Content, w (%)	21.23	21.45			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	28	18			
Wet Soil + Tare (g)	31.59	32.64	33.18			
Dry Soil + Tare (g)	29.04	29.81	30.09			
Moisture Loss (g)	2.55	2.83	3.09			
Tare (g)	21.32	21.42	21.32			
Dry Soil (g)	7.72	8.39	8.77			
Moisture Content, w (%)	33.03	33.73	35.23			
One-Point LL (%)		34				

Liquid Limit, LL (%)	**34**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**13**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-03
Sample:
Depth: 0.5'
Description: Dark brown silt

Preparation method: Air Dry
Liquid limit test method: Multipoint

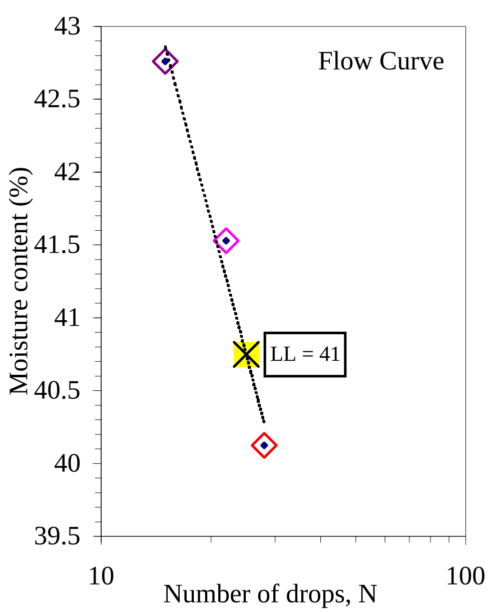
Plastic Limit

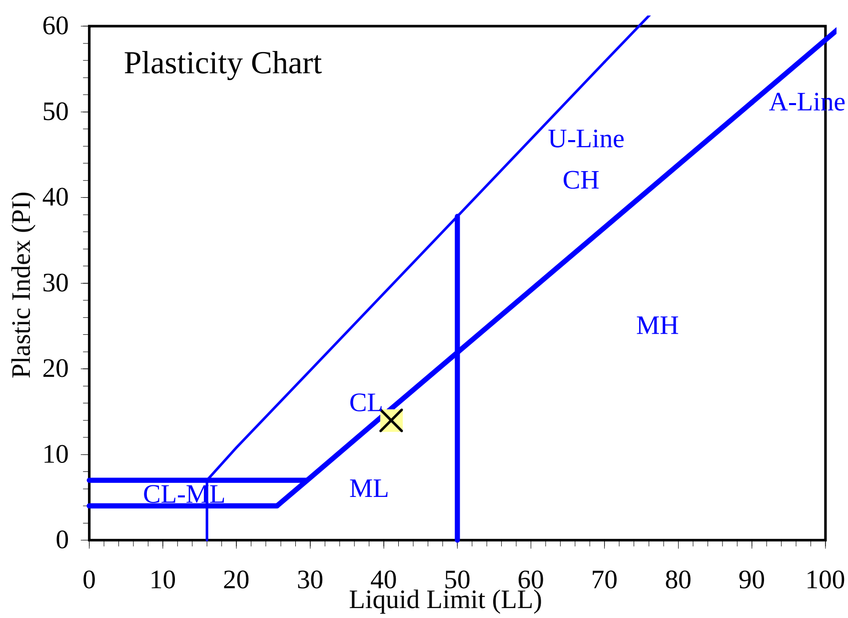
Determination No	1	2				
Wet Soil + Tare (g)	32.50	31.29				
Dry Soil + Tare (g)	30.19	29.13				
Moisture Loss (g)	2.31	2.16				
Tare (g)	21.52	21.05				
Dry Soil (g)	8.67	8.08				
Moisture Content, w (%)	26.64	26.73				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	22	15			
Wet Soil + Tare (g)	32.84	31.90	31.83			
Dry Soil + Tare (g)	29.59	28.86	28.67			
Moisture Loss (g)	3.25	3.04	3.16			
Tare (g)	21.49	21.54	21.28			
Dry Soil (g)	8.10	7.32	7.39			
Moisture Content, w (%)	40.12	41.53	42.76			
One-Point LL (%)	41	41				

Liquid Limit, LL (%)	**41**
Plastic Limit, PL (%)	**27**
Plasticity Index, PI (%)	**14**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-03
Sample:
Depth: 6'
Description: Red/brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

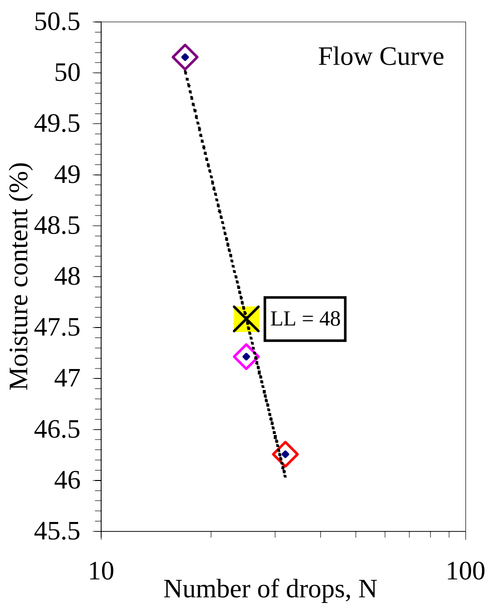
Plastic Limit

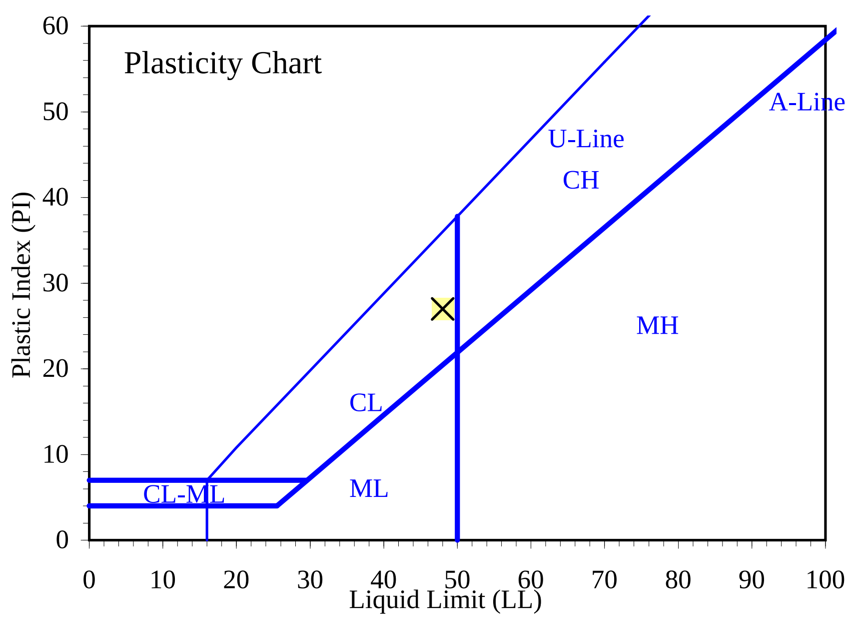
Determination No	1	2			
Wet Soil + Tare (g)	29.90	32.78			
Dry Soil + Tare (g)	28.43	30.80			
Moisture Loss (g)	1.47	1.98			
Tare (g)	21.56	21.49			
Dry Soil (g)	6.87	9.31			
Moisture Content, w (%)	21.40	21.27			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	25	17			
Wet Soil + Tare (g)	30.99	31.46	31.08			
Dry Soil + Tare (g)	27.90	28.24	27.86			
Moisture Loss (g)	3.09	3.22	3.22			
Tare (g)	21.22	21.42	21.44			
Dry Soil (g)	6.68	6.82	6.42			
Moisture Content, w (%)	46.26	47.21	50.16			
One-Point LL (%)		47				

Liquid Limit, LL (%)	**48**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**27**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-03
Sample:
Depth: 8'
Description: Brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

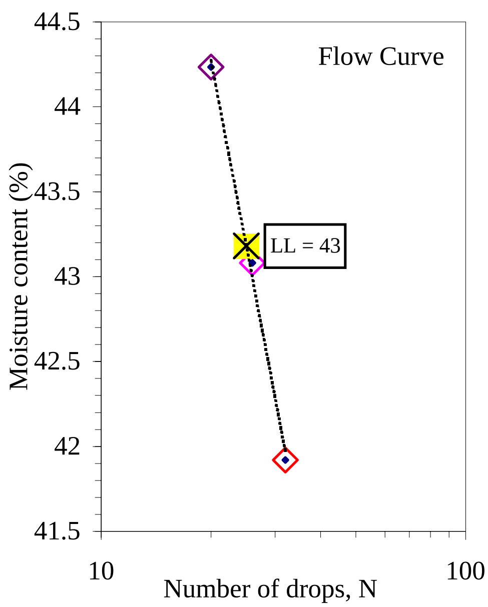
Plastic Limit

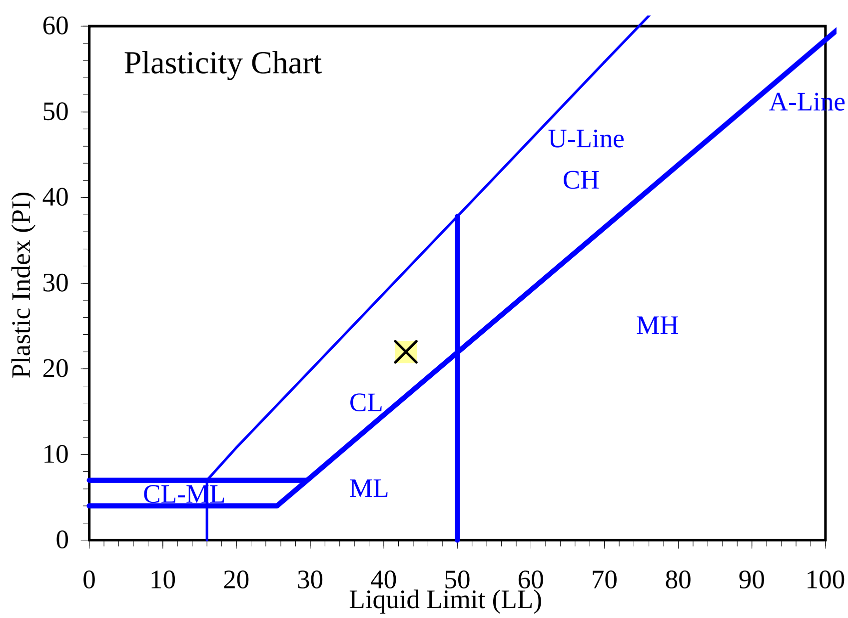
Determination No	1	2			
Wet Soil + Tare (g)	30.16	32.27			
Dry Soil + Tare (g)	28.68	30.37			
Moisture Loss (g)	1.48	1.90			
Tare (g)	21.59	21.21			
Dry Soil (g)	7.09	9.16			
Moisture Content, w (%)	20.87	20.74			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	32	26	20			
Wet Soil + Tare (g)	33.12	31.76	32.32			
Dry Soil + Tare (g)	29.67	28.74	29.06			
Moisture Loss (g)	3.45	3.02	3.26			
Tare (g)	21.44	21.73	21.69			
Dry Soil (g)	8.23	7.01	7.37			
Moisture Content, w (%)	41.92	43.08	44.23			
One-Point LL (%)		43	43			

Liquid Limit, LL (%)	**43**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**22**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-05
Sample:
Depth: 6'
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

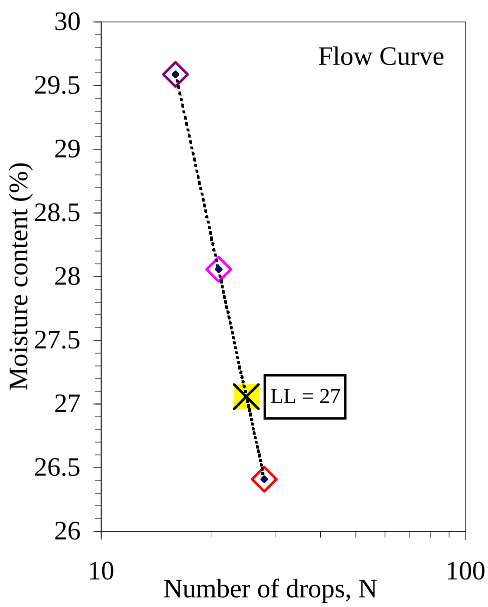
Plastic Limit

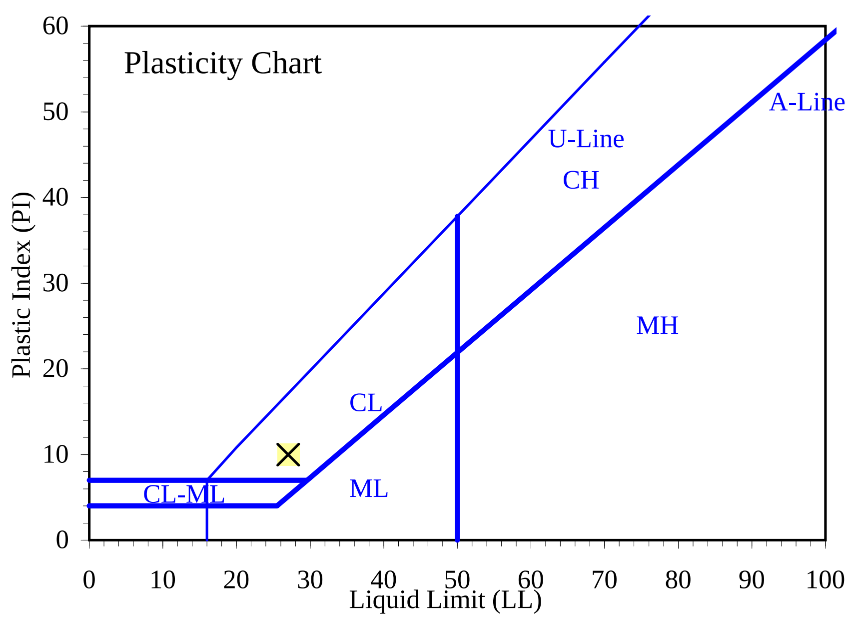
Determination No	1	2			
Wet Soil + Tare (g)	31.84	32.51			
Dry Soil + Tare (g)	30.33	30.94			
Moisture Loss (g)	1.51	1.57			
Tare (g)	21.25	21.43			
Dry Soil (g)	9.08	9.51			
Moisture Content, w (%)	16.63	16.51			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	21	16			
Wet Soil + Tare (g)	33.46	31.90	30.64			
Dry Soil + Tare (g)	30.93	29.56	28.56			
Moisture Loss (g)	2.53	2.34	2.08			
Tare (g)	21.35	21.22	21.53			
Dry Soil (g)	9.58	8.34	7.03			
Moisture Content, w (%)	26.41	28.06	29.59			
One-Point LL (%)	27	27				

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





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-07
Sample:
Depth: 4'
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

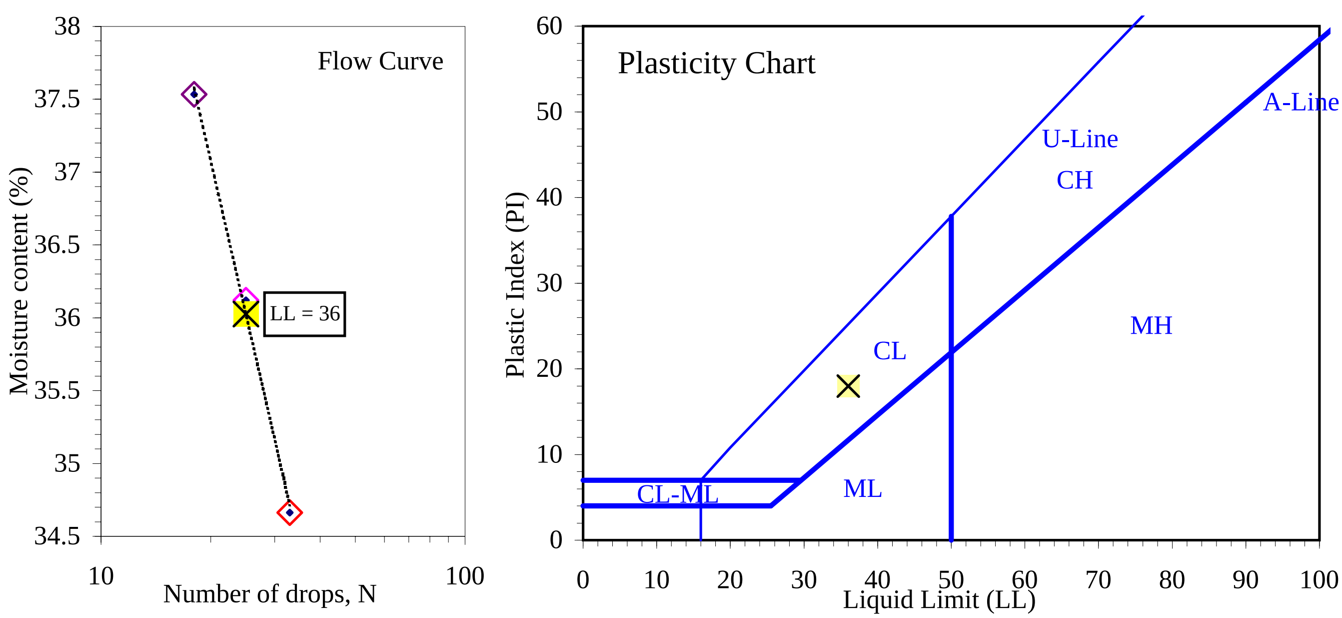
Plastic Limit

Determination No	1	2				
Wet Soil + Tare (g)	29.82	30.70				
Dry Soil + Tare (g)	28.51	29.20				
Moisture Loss (g)	1.31	1.50				
Tare (g)	21.39	21.10				
Dry Soil (g)	7.12	8.10				
Moisture Content, w (%)	18.40	18.52				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	25	18			
Wet Soil + Tare (g)	32.32	30.26	31.43			
Dry Soil + Tare (g)	29.54	27.84	28.72			
Moisture Loss (g)	2.78	2.42	2.71			
Tare (g)	21.52	21.14	21.50			
Dry Soil (g)	8.02	6.70	7.22			
Moisture Content, w (%)	34.66	36.12	37.53			
One-Point LL (%)		36				

Liquid Limit, LL (%)	**36**
Plastic Limit, PL (%)	**18**
Plasticity Index, PI (%)	**18**



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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/18/2012
By: BRR

Boring No.: TP-08
Sample:
Depth: 3'
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

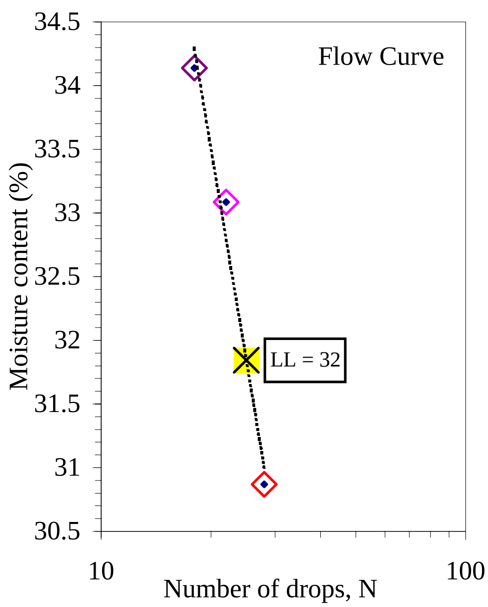
Plastic Limit

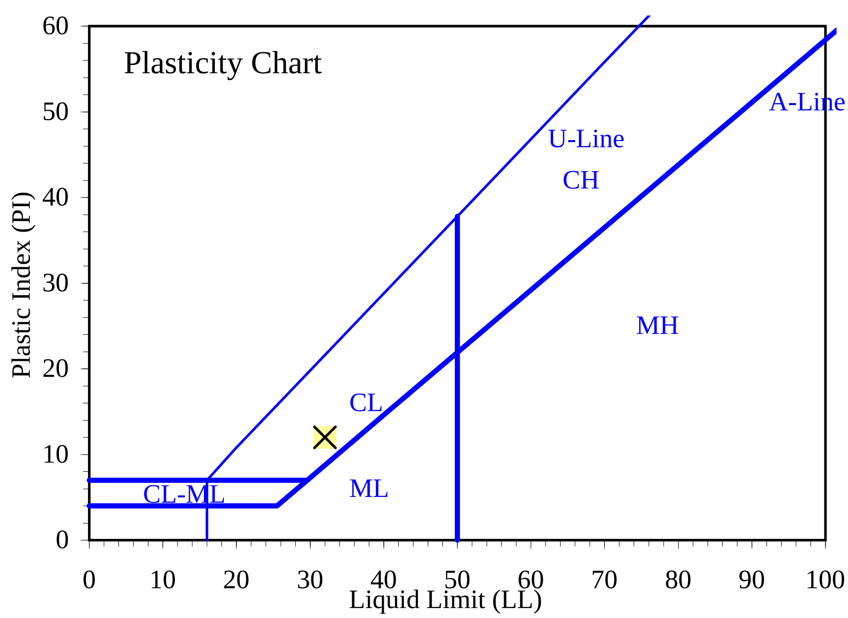
Determination No	1	2			
Wet Soil + Tare (g)	29.93	30.37			
Dry Soil + Tare (g)	28.51	28.90			
Moisture Loss (g)	1.42	1.47			
Tare (g)	21.63	21.66			
Dry Soil (g)	6.88	7.24			
Moisture Content, w (%)	20.64	20.30			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	22	18			
Wet Soil + Tare (g)	33.71	30.50	31.77			
Dry Soil + Tare (g)	30.87	28.28	29.08			
Moisture Loss (g)	2.84	2.22	2.69			
Tare (g)	21.67	21.57	21.20			
Dry Soil (g)	9.20	6.71	7.88			
Moisture Content, w (%)	30.87	33.08	34.14			
One-Point LL (%)	31	33				

Liquid Limit, LL (%)	**32**
Plastic Limit, PL (%)	**20**
Plasticity Index, PI (%)	**12**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-08
Sample:
Depth: 7.5'
Description: Red/orange lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

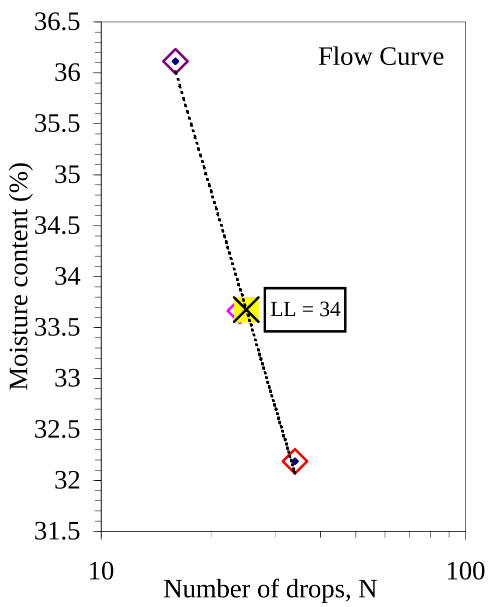
Plastic Limit

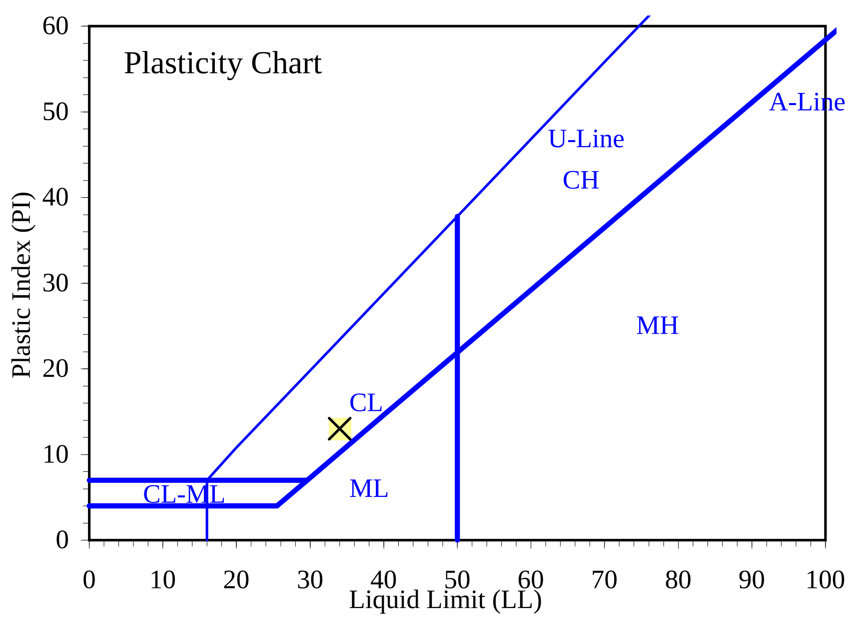
Determination No	1	2				
Wet Soil + Tare (g)	30.78	33.19				
Dry Soil + Tare (g)	29.13	31.13				
Moisture Loss (g)	1.65	2.06				
Tare (g)	21.26	21.18				
Dry Soil (g)	7.87	9.95				
Moisture Content, w (%)	20.97	20.70				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	24	16			
Wet Soil + Tare (g)	32.93	32.32	31.94			
Dry Soil + Tare (g)	30.21	29.61	29.17			
Moisture Loss (g)	2.72	2.71	2.77			
Tare (g)	21.76	21.56	21.50			
Dry Soil (g)	8.45	8.05	7.67			
Moisture Content, w (%)	32.19	33.66	36.11			
One-Point LL (%)		33				

Liquid Limit, LL (%)	**34**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**13**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/18/2012
By: BRR

Boring No.: TP-10
Sample:
Depth: 4'
Description: Reddish brown lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

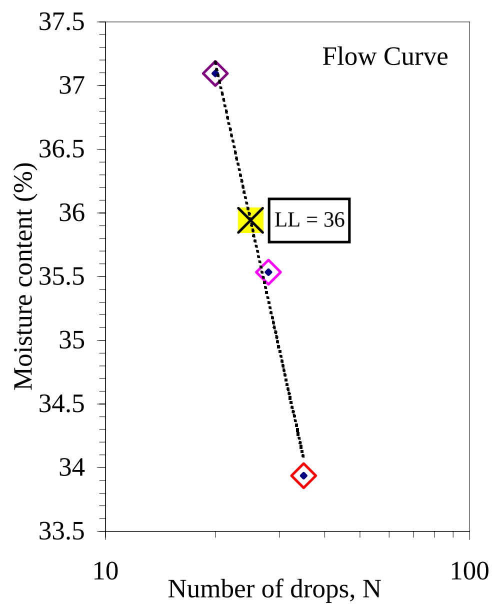
Plastic Limit

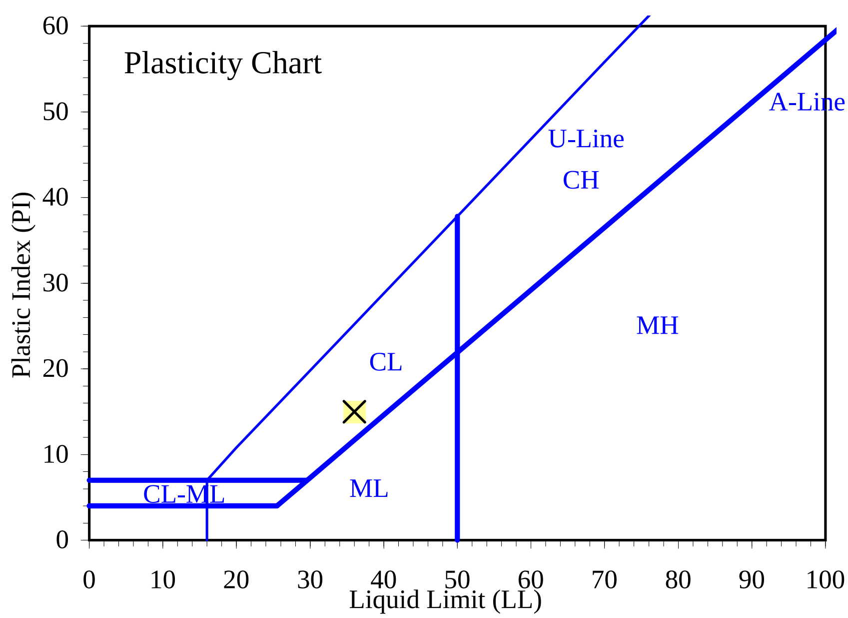
Determination No	1	2				
Wet Soil + Tare (g)	31.44	29.70				
Dry Soil + Tare (g)	29.74	28.29				
Moisture Loss (g)	1.70	1.41				
Tare (g)	21.73	21.52				
Dry Soil (g)	8.01	6.77				
Moisture Content, w (%)	21.22	20.83				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	28	20			
Wet Soil + Tare (g)	31.83	30.56	31.30			
Dry Soil + Tare (g)	29.21	28.14	28.67			
Moisture Loss (g)	2.62	2.42	2.63			
Tare (g)	21.49	21.33	21.58			
Dry Soil (g)	7.72	6.81	7.09			
Moisture Content, w (%)	33.94	35.54	37.09			
One-Point LL (%)		36	36			

Liquid Limit, LL (%)	**36**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**15**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: BRR

Boring No.: TP-11
Sample:
Depth: 7'
Description: Red/orange lean clay

Preparation method: Air Dry
Liquid limit test method: Multipoint

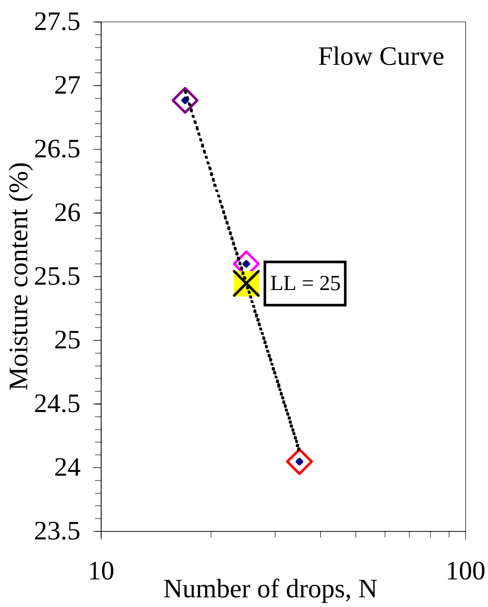
Plastic Limit

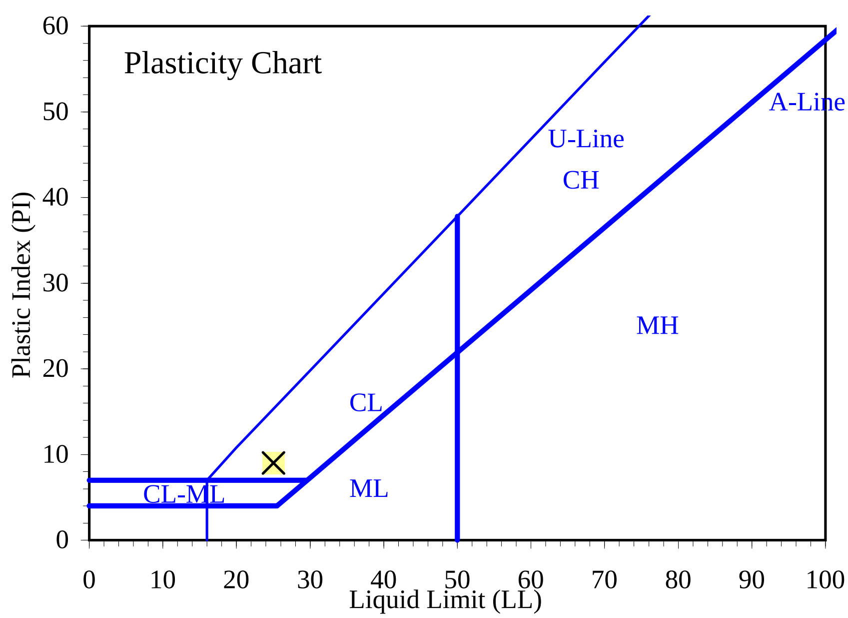
Determination No	1	2				
Wet Soil + Tare (g)	31.47	30.47				
Dry Soil + Tare (g)	30.04	29.20				
Moisture Loss (g)	1.43	1.27				
Tare (g)	21.38	21.42				
Dry Soil (g)	8.66	7.78				
Moisture Content, w (%)	16.51	16.32				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	25	17			
Wet Soil + Tare (g)	33.01	34.36	33.06			
Dry Soil + Tare (g)	30.80	31.70	30.60			
Moisture Loss (g)	2.21	2.66	2.46			
Tare (g)	21.61	21.31	21.45			
Dry Soil (g)	9.19	10.39	9.15			
Moisture Content, w (%)	24.05	25.60	26.89			
One-Point LL (%)		26				

Liquid Limit, LL (%)	**25**
Plastic Limit, PL (%)	**16**
Plasticity Index, PI (%)	**9**





Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils

(ASTM D422)

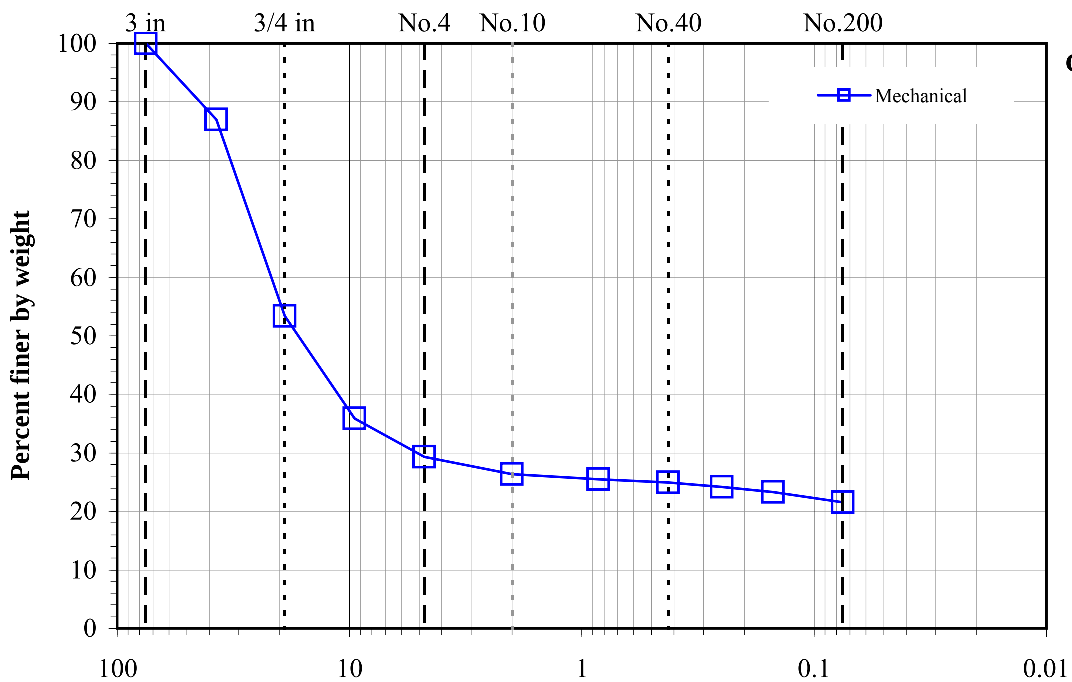
Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/12/2012
By: JDF

Boring No.: TP-01
Sample:
Depth: 4'
Description: Brown clayey gravel

Split:	Yes	
Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	4344.48	4160.6
+3/4" Coarse fraction (g):	1965.2	1938.1
-3/4" Split fraction (g):	1745.64	1630.61
Split fraction:	0.534	

Moisture data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	2373.22	2056.10
Dry soil + tare (g):	2346.14	1941.07
Tare (g):	408.43	310.46
Moisture content (%):	1.4	7.1

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
12"	-	300	-	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	542.32	37.5	87.0	
3/4"	1938.11	19	53.4	←Split
3/8"	534.40	9.5	35.9	
No.4	737.10	4.75	29.3	
No.10	826.60	2	26.3	
No.20	850.90	0.85	25.5	
No.40	869.90	0.425	24.9	
No.60	893.70	0.25	24.1	
No.100	918.40	0.15	23.3	
No.200	972.40	0.075	21.6	



Gravel (%): 70.7
Sand (%): 7.7
Fines (%): 21.6

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils

(ASTM D422)

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/12/2012
By: JDF

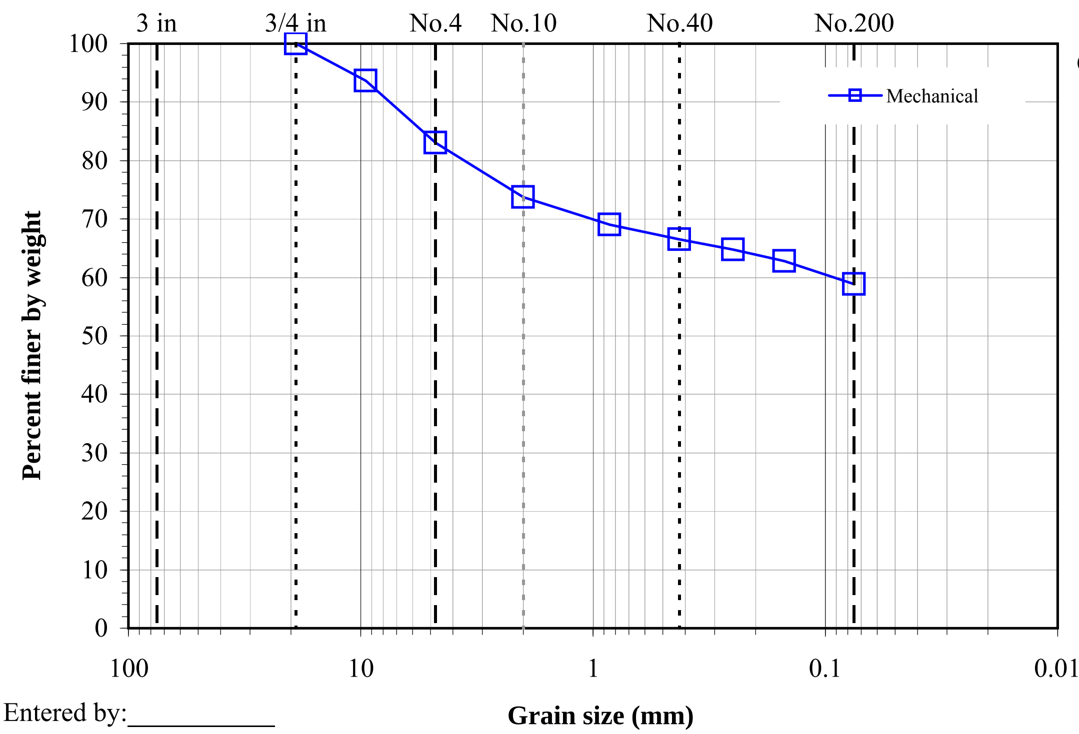
Boring No.: TP-03
Sample:
Depth: 8'
Description: Brown sandy clay with gravel

Split:	No		
	-		
	Moist	Dry	
Total sample wt. (g):	779.93	588.8	
Split fraction:	1.000		

Moisture data

Moist soil + tare (g):	-	995.00
Dry soil + tare (g):	-	803.84
Tare (g):	-	215.07
Moisture content (%):	0.0	32.5

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
12"	-	300	-
8"	-	200	-
6"	-	150	-
4"	-	100	-
3"	-	75	-
1.5"	-	37.5	-
3/4"	-	19	100.0
3/8"	37.31	9.5	93.7
No.4	99.89	4.75	83.0
No.10	154.37	2	73.8
No.20	182.27	0.85	69.0
No.40	197.06	0.425	66.5
No.60	207.16	0.25	64.8
No.100	219.19	0.15	62.8
No.200	242.02	0.075	58.9



Gravel (%): 17.0
Sand (%): 24.1
Fines (%): 58.9

Entered by:___________
Reviewed:___________

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Particle-Size Analysis of Soils

(ASTM D422)

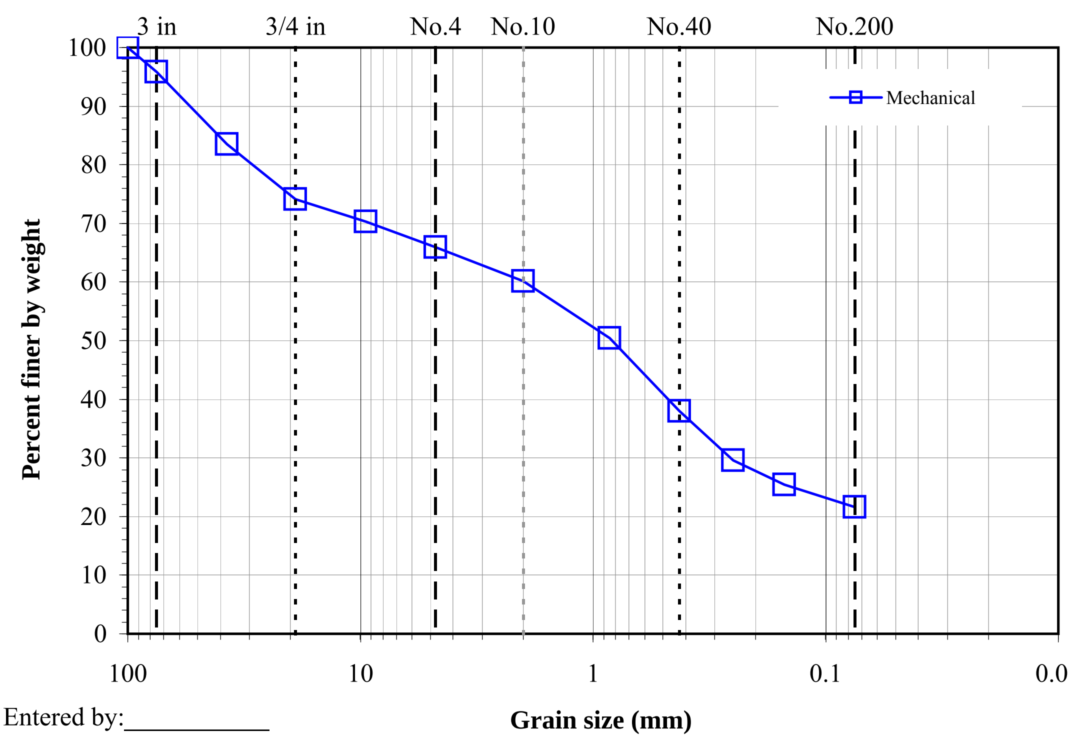
Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/18/2012
By: DKS

Boring No.: TP-08
Sample:
Depth: 3.0'
Description: Reddish brown clayey sand with gravel

Split:	Yes	
Split sieve:	3/4"	
	Moist	Dry
Total sample wt. (g):	24740.30	23549.0
+3/4" Coarse fraction (g):	6196.6	6087.3
-3/4" Split fraction (g):	665.33	626.51
Split fraction:	0.742	

Moisture data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	2629.40	1058.38
Dry soil + tare (g):	2591.24	1019.56
Tare (g):	465.90	393.05
Moisture content (%):	1.8	6.2

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
12"	-	300	-
8"	-	200	-
6"	-	150	-
4"	-	100	100.0
3"	979.81	75	95.8
1.5"	3889.76	37.5	83.5
3/4"	6087.30	19	74.2 ←Split
3/8"	32.20	9.5	70.3
No.4	69.40	4.75	65.9
No.10	118.50	2	60.1
No.20	200.50	0.85	50.4
No.40	305.90	0.425	37.9
No.60	376.10	0.25	29.6
No.100	411.60	0.15	25.4
No.200	444.30	0.075	21.6



Gravel (%): 34.1
Sand (%): 44.4
Fines (%): 21.6

Entered by:___________
Reviewed:___________

Particle-Size Analysis of Soils

(ASTM D422)

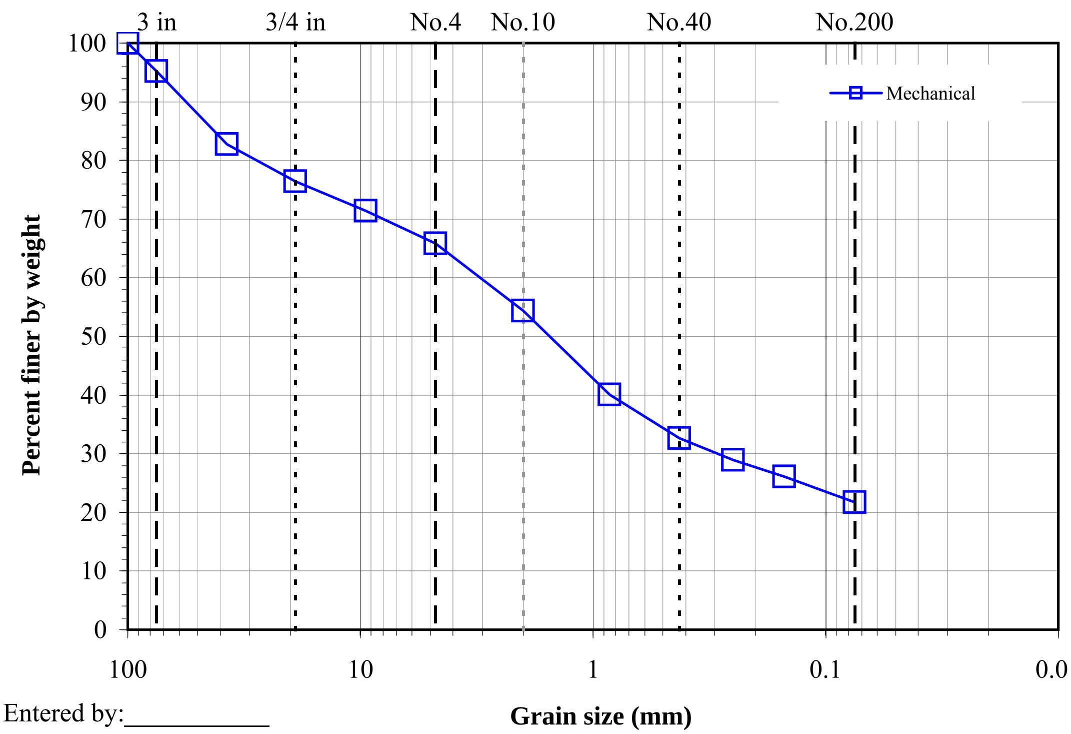
Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/18/2012
By: DKS

Boring No.: TP-10
Sample:
Depth: 4.0'
Description: Reddish brown clayey sand with gravel

	Moist	Dry
Split:	Yes	
Split sieve:	3/4"	
Total sample wt. (g):	20088.70	19007.3
+3/4" Coarse fraction (g):	4541	4488.5
-3/4" Split fraction (g):	1265.32	1181.59
Split fraction:	0.764	

Moisture data	C.F.(+3/4")	S.F.(-3/4")
Moist soil + tare (g):	1923.73	1581.10
Dry soil + tare (g):	1906.20	1497.37
Tare (g):	407.99	315.78
Moisture content (%):	1.2	7.1

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer
12"	-	300	-
8"	-	200	-
6"	-	150	-
4"	-	100	100.0
3"	910.64	75	95.2
1.5"	3282.39	37.5	82.7
3/4"	4488.48	19	76.4 ←Split
3/8"	76.80	9.5	71.4
No.4	164.10	4.75	65.8
No.10	340.10	2	54.4
No.20	561.70	0.85	40.1
No.40	677.10	0.425	32.6
No.60	734.90	0.25	28.9
No.100	777.50	0.15	26.1
No.200	845.10	0.075	21.8



Gravel (%): 34.2
Sand (%): 44.0
Fines (%): 21.8

Entered by:___________
Reviewed:___________

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

(ASTM D1140)

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/13/2012
By: JDF

Sample Info.	Boring No.	TP-03	TP-03	TP-06	TP-07	TP-07	TP-09	TP-11	TP-11
	Sample								
	Depth	0.5'	6'	5'	4'	7'	5'	2'	7'
	Split	Yes	No	No	No	No	No	No	No
	Split Sieve*	3/8"							
	Moist total sample wt. (g)	14739.90	595.33	1585.35	398.75	1076.26	1119.76	301.64	516.19
	Moist coarse fraction (g)	790.00							
	Moist split fraction + tare (g)	781.78							
	Split fraction tare (g)	288.34							
	Dry split fraction (g)	444.14							
	Dry retained No. 200 + tare (g)	385.61	210.94	1145.49	371.56	1051.48	812.23	354.29	486.11
	Wash tare (g)	288.34	122.18	215.39	219.21	221.76	214.17	288.71	223.55
	No. 200 Dry wt. retained (g)	97.27	88.76	930.10	152.35	829.72	598.06	65.58	262.56
	Split sieve* Dry wt. retained (g)	785.51							
	Dry total sample wt. (g)	13341.66	449.66	1445.89	345.14	985.35	983.43	265.40	445.75
Coarse Fraction	Moist soil + tare (g)	909.88							
	Dry soil + tare (g)	905.39							
	Tare (g)	119.97							
	Moisture content (%)	0.57							
Split Fraction	Moist soil + tare (g)	781.78	717.51	1800.74	617.96	1298.02	1333.93	590.35	739.74
	Dry soil + tare (g)	732.48	571.84	1661.28	564.35	1207.11	1197.60	554.11	669.30
	Tare (g)	288.34	122.18	215.39	219.21	221.76	214.17	288.71	223.55
	Moisture content (%)	11.10	32.40	9.65	15.53	9.23	13.86	13.65	15.80
	Percent passing split sieve* (%)	**94.1**							
	Percent passing No. 200 sieve (%)	**73.5**	**80.3**	**35.7**	**55.9**	**15.8**	**39.2**	**75.3**	**41.1**

Entered by:___________

Reviewed:___________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/17/2012
By: DKS

Boring No.: TP-03
Sample:
Depth: 0.5'
Sample Description: Dark brown silt
Engineering Classification: Not requested
As-received moisture content (%): 10.5

Method: ASTM D698 B
Mold Id. Inc 2
Mold volume (ft^3): 0.0332

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: Yes * See results below

Optimum moisture content (%): 21.1
Maximum dry unit weight (pcf): 95.8

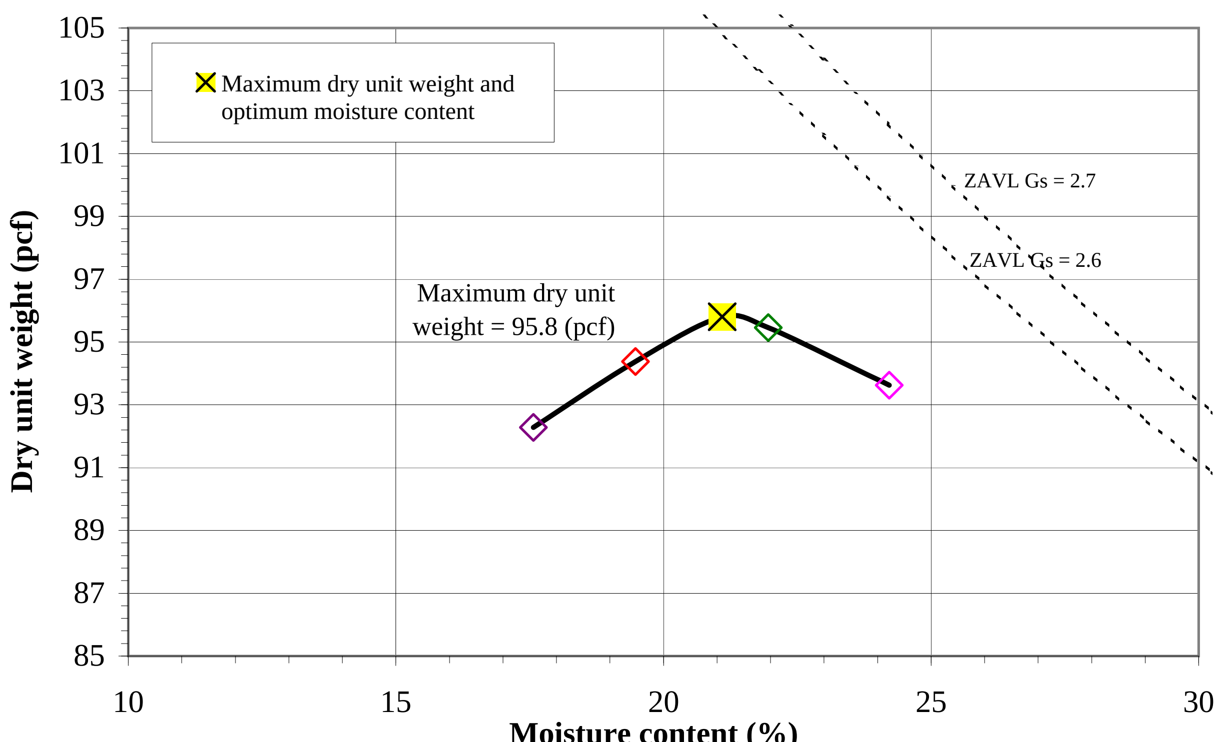
Point Number	+6%	+8%	+10%	+12%				
Wt. Sample + Mold (g)	5799.2	5863.5	5918.7	5916.8				
Wt. of Mold (g)	4164.4	4164.4	4164.4	4164.4				
Wet Unit Wt., γ_m (pcf)	108.5	112.8	116.4	116.3				
Wet Soil + Tare (g)	621.58	694.63	796.43	742.18				
Dry Soil + Tare (g)	547.9	601.57	692.37	622.39				
Tare (g)	128.53	123.74	218.43	127.72				
Moisture Content, w (%)	**17.6**	**19.5**	**22.0**	**24.2**				
Dry Unit Wt., γ_d (pcf)	**92.3**	**94.4**	**95.5**	**93.6**				

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

(ASTM D4718)

Corrected moisture content (%): 19.9
Corrected dry unit weight (pcf): 98.2

Oversized fraction, +3/8-in. (%): 5.9
Moisture content, +3/8-in. (%): 0.6
Sieve for oversized fraction: 3/8-in.
Bulk specific gravity, Gs: 2.65



Entered by:___________

Reviewed:___________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/18/2012
By: DKS

Boring No.: TP-08
Sample:
Depth: 3.0'
Sample Description: Reddish brown clayey sand with gravel
Engineering Classification: Not requested
As-received moisture content (%): 10.5

Method: ASTM D698 C
Mold Id. Inc 6
Mold volume (ft^3): 0.0750

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: Yes * See results below

Optimum moisture content (%): 10.2
Maximum dry unit weight (pcf): 125

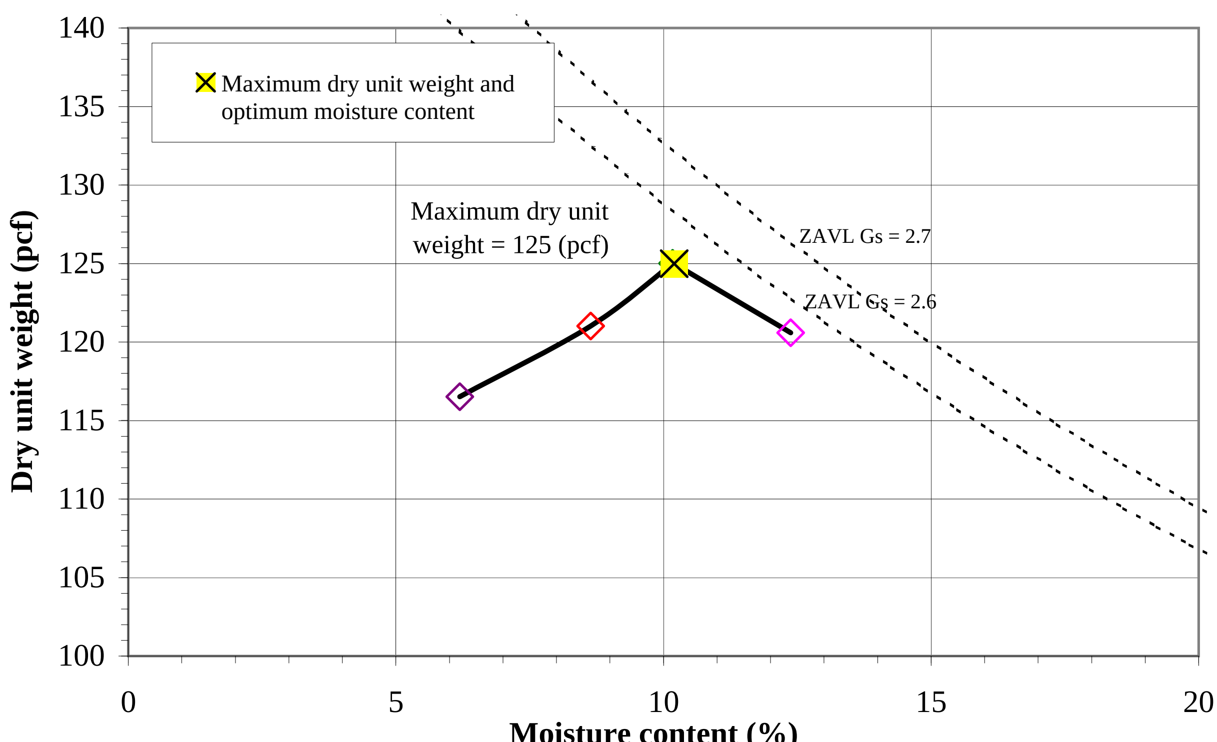
Point Number	As Is	+2%	+4%	+12%				
Wt. Sample + Mold (g)	10766.4	11029.6	11242.5	11167.6				
Wt. of Mold (g)	6554.1	6554.1	6554.1	6554.1				
Wet Unit Wt., γ_m (pcf)	123.7	131.5	137.7	135.5				
Wet Soil + Tare (g)	960.65	1080.6	1150.1	1028.7				
Dry Soil + Tare (g)	912.05	1004.8	1055.7	929				
Tare (g)	127.68	127.35	126.62	123.69				
Moisture Content, w (%)	**6.2**	**8.6**	**10.2**	**12.4**				
Dry Unit Wt., γ_d (pcf)	**116.5**	**121.0**	**125.0**	**120.6**				

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

(ASTM D4718)

Corrected moisture content (%): 8.0
Corrected dry unit weight (pcf): 133.4

Oversized fraction, +3/4-in. (%): 25.8
Moisture content, +3/4-in. (%): 1.8
Sieve for oversized fraction: 3/4-in.
Bulk specific gravity, Gs: 2.65



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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/13/2012
By: DKS

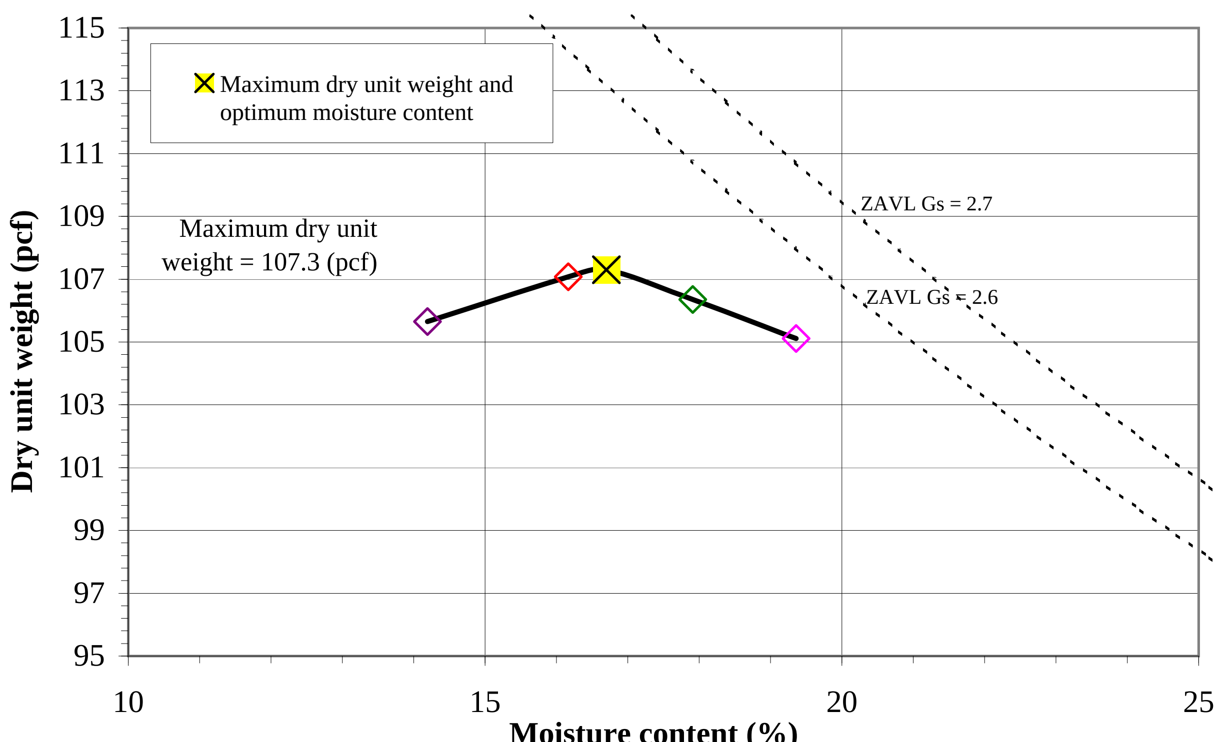
Boring No.: TP-11
Sample:
Depth: 2.0'
Sample Description: Red clay
Engineering Classification: Not requested
As-received moisture content (%): Not requested

Method: ASTM D698 B
Mold Id. Inc 2
Mold volume (ft^3): 0.0332

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No * See results below

Optimum moisture content (%): 16.7
Maximum dry unit weight (pcf): 107.3

Point Number	+2%	+4%	+6%	+8%				
Wt. Sample + Mold (g)	5982.4	6038.7	6054.0	6054.8				
Wt. of Mold (g)	4164.4	4164.4	4164.4	4164.4				
Wet Unit Wt., γ_m (pcf)	120.6	124.4	125.4	125.5				
Wet Soil + Tare (g)	740.18	760.64	741.66	678.06				
Dry Soil + Tare (g)	663.89	672.6	648.34	588.02				
Tare (g)	126.38	128.06	127.31	122.86				
Moisture Content, w (%)	**14.2**	**16.2**	**17.9**	**19.4**				
Dry Unit Wt., γ_d (pcf)	**105.7**	**107.1**	**106.4**	**105.1**				



Entered by:___________

Reviewed:___________

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California Bearing Ratio
(ASTM D 1883)

Project: Powder Mountain
Number: 01628-001
Location: Weber County
Date: 7/19/2012
By: DKS

Boring No.: TP-03
Sample:
Depth: 0.5'
Original Method: ASTM D698 B
Engineering Classification: Not requested
Condition of Sample: Soaked
Scalp and Replace: No

Maximum Dry Unit Weight (pcf): 95.8
Optimum Moisture Content (%): 21.1
Relative Compaction (%): 100.4
0.1 in. Corrected CBR (%): 5.5
0.2 in. Corrected CBR (%): 6.1

As Compacted Data

Wt. of Mold + Sample (g) 11284.9
Wt. of Mold (g) 7307.1
Dry Unit Weight (pcf) 96.2

Wet Soil + Tare (g) 626.98
Dry Soil + Tare (g) 540.62
Tare (g) 139.84
Moisture Content (%) 21.5

After Soaking Data

Wt. of Mold + Sample (g) 11365.8
Dry Unit Weight (pcf) 95.5

	Average	Top 1 in.
Wet Soil + Tare (g)	813.06	479.03
Dry Soil + Tare (g)	681.34	405.42
Tare (g)	126.89	127.67
Moisture Content (%)	23.8	26.5

Swell Data

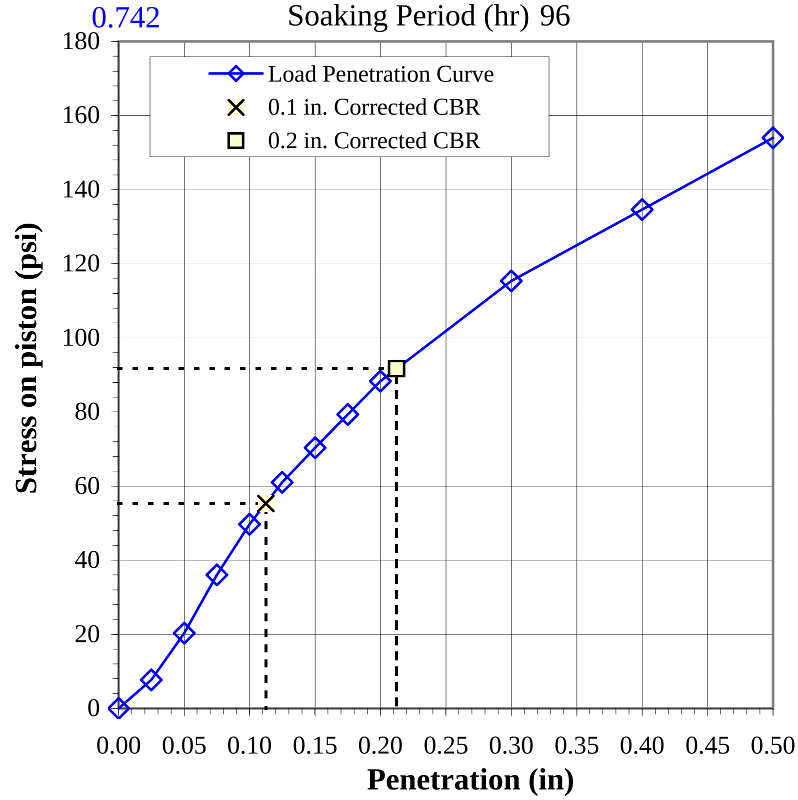
Date	Time	Dial
7/14/2012	12:22	0.699
7/18/2012	12:18	0.742

Surcharge (psf) 50
Swell (%) 0.94
Soaking Period (hr) 96

Penetration Data

Zero load (lb) = 0
Area of Piston (in^2) = 3

Penetration (in.)	Raw Load (lb)	Piston Stress (psi)	Std. Stress (psi)
0.000	0	0	
0.025	23	8	
0.050	61	20	
0.075	108	36	
0.100	149	50	1000
0.125	183	61	1125
0.150	211	70	1250
0.175	238	79	1375
0.200	265	88	1500
0.300	346	115	1900
0.400	404	135	2300
0.500	462	154	2600



Entered By:___________
Reviewed:___________

California Bearing Ratio

(ASTM D 1883)

Project: Powder Mountain
Number: 01628-001
Location: Weber County
Date: 7/19/2012
By: DKS

Boring No.: TP-11
Sample:
Depth: 2.0'
Original Method: ASTM D698 B
Engineering Classification: Not requested
Condition of Sample: Soaked
Scalp and Replace: No

Maximum Dry Unit Weight (pcf): 107.3
Optimum Moisture Content (%): 16.7
Relative Compaction (%): 102.1
0.1 in. CBR (%): 1.8
0.2 in. CBR (%): 1.8

As Compacted Data

Wt. of Mold + Sample (g) 11357.3
Wt. of Mold (g) 7147.5
Dry Unit Weight (pcf) 109.6

Wet Soil + Tare (g) 644.63
Dry Soil + Tare (g) 584.94
Tare (g) 122.65
Moisture Content (%) 12.9

After Soaking Data

Wt. of Mold + Sample (g) 11583.6
Dry Unit Weight (pcf) 105.3

	Average	Top 1 in.
Wet Soil + Tare (g)	799.73	395.69
Dry Soil + Tare (g)	697.18	341.17
Tare (g)	126.37	127.67
Moisture Content (%)	18.0	25.5

Swell Data

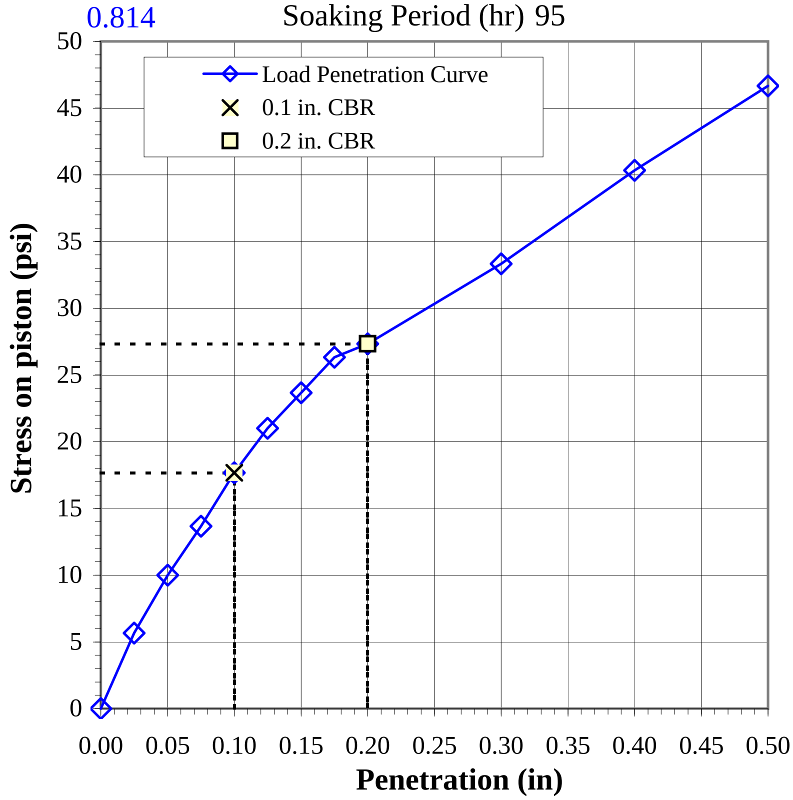
Date	Time	Dial
7/14/2012	12:55	0.586
7/18/2012	12:20	0.814

Surcharge (psf) 50
Swell (%) 4.97
Soaking Period (hr) 95

Penetration Data

Zero load (lb) = 0
Area of Piston (in^2) = 3

Penetration (in.)	Raw Load (lb)	Piston Stress (psi)	Std. Stress (psi)
0.000	0	0	
0.025	17	6	
0.050	30	10	
0.075	41	14	
0.100	53	18	1000
0.125	63	21	1125
0.150	71	24	1250
0.175	79	26	1375
0.200	82	27	1500
0.300	100	33	1900
0.400	121	40	2300
0.500	140	47	2600



Entered By:___________
Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/12/2012
By: JDF

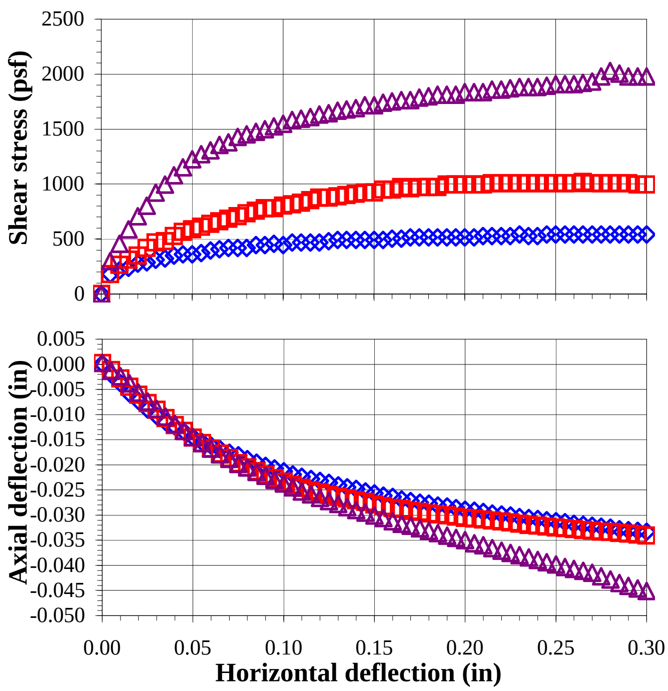
Boring No.: TP-03
Sample:
Depth: 2'
Sample Description: Brown clay with sand and gravel
Sample type: Undisturbed-trimmed from thin-wall

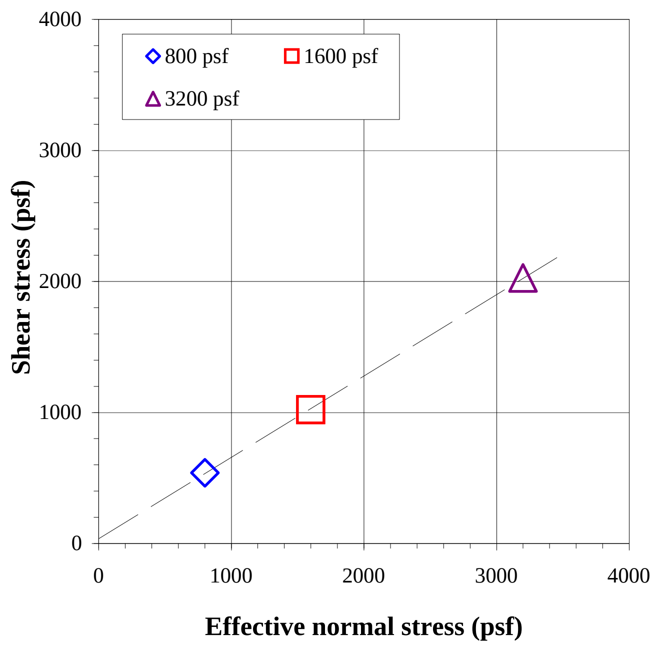
Test type: Inundated
Horizontal deformation (in.): 0.3
Shear rate (in./min): 0.0042

	Sample 1		Sample 2		Sample 3	
Effective normal stress (psf)	800		1600		3200	
Peak shear stress (psf)	540		1020		2028	
Horizontal deformation at peak(in)	0.230		0.265		0.280	
	Initial	Final	Initial	Final	Initial	Final
Sample height (in)	1.0000	0.9448	1.0000	0.8496	1.0000	0.8214
Sample diameter (in)	2.416	2.416	2.416	2.416	2.416	2.416
Wt. rings + wet soil (g)	165.19	170.32	151.32	154.25	155.36	157.23
Wt. rings (g)	43.28	43.28	43.18	43.18	42.03	42.03
Wet soil + tare (g)	325.73	145.41	325.73	132.97	325.73	136.26
Dry soil + tare (g)	285.92	116.52	285.92	108.27	285.92	112.02
Tare (g)	126.75	21.07	126.75	21.30	126.75	22.49
Water content (%)	25.0	30.3	25.0	28.4	25.0	27.1
Dry unit weight (pcf)	81.0	85.8	71.9	84.6	75.3	91.7

φ' (deg)	32
c' (psf)	36

Average of 3 samples	Initial	Final
Water content (%)	25.0	28.6
Dry unit weight (pcf)	76.1	87.4





Entered by:___________
Reviewed:___________

Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and Ions in Water by Chemically Suppressed Ion Chromatography *(AASHTO T 288, ASTM D4972, D4327, and C1580)*

IGES

Project: Powder Mountain
No: 01628-001
Location: Weber County
Date: 7/18/2012
By: MP

Section	Parameter	TP-02		TP-05		TP-09		TP-11	
Sample info.	Boring No.	TP-02		TP-05		TP-09		TP-11	
	Sample								
	Depth	1.0'		6.0'		3.0'		7.0'	
Moisture data	Wet soil + tare (g)	116.27		68.53		109.88		83.75	
	Dry soil + tare (g)	92.19		64.66		102.22		78.76	
	Tare (g)	30.03		29.42		30.37		30.32	
	Moisture content (%)	38.7		11.0		10.7		10.3	
Chemical data	pH distilled water	5.2		4.0		4.1		4.7	
	pH, $CaCl_2$ solution	4.8		3.3		3.8		3.9	
	Soluble chloride* (ppm)	< 54.4		< 55.4		< 53.0		< 57.7	
	Soluble sulfate** (ppm)	< 5.44		32.1		24.6		47.9	
Resistivity data		Soil condition (%)	Resistivity (Ω-cm)	Soil condition (%)	Resistivity (Ω-cm)	Soil condition (%)	Resistivity (Ω-cm)	Soil condition (%)	Resistivity (Ω-cm)
		As Is	52000	As Is	41000	As Is	23000	As Is	11000
		+3	24000	+3	17000	+3	13000	+3	6300
		+6	19000	+6	14000	+6	13000	+6	5800
		+9	11000	+9	14000	+9	14000	+9	6100
		+12	6700						
		+15	5900						
		+18	5800						
		+21	5600						
		+24	5600						
	Minimum resistivity (Ω-cm)	**5600**		**14000**		**13000**		**5800**	

* Performed by AWAL using EPA 300.0

** Performed by AWAL using ASTM C1580

Comments: Moisture content was performed upon completion of test.

Entered by:___________

Reviewed:___________

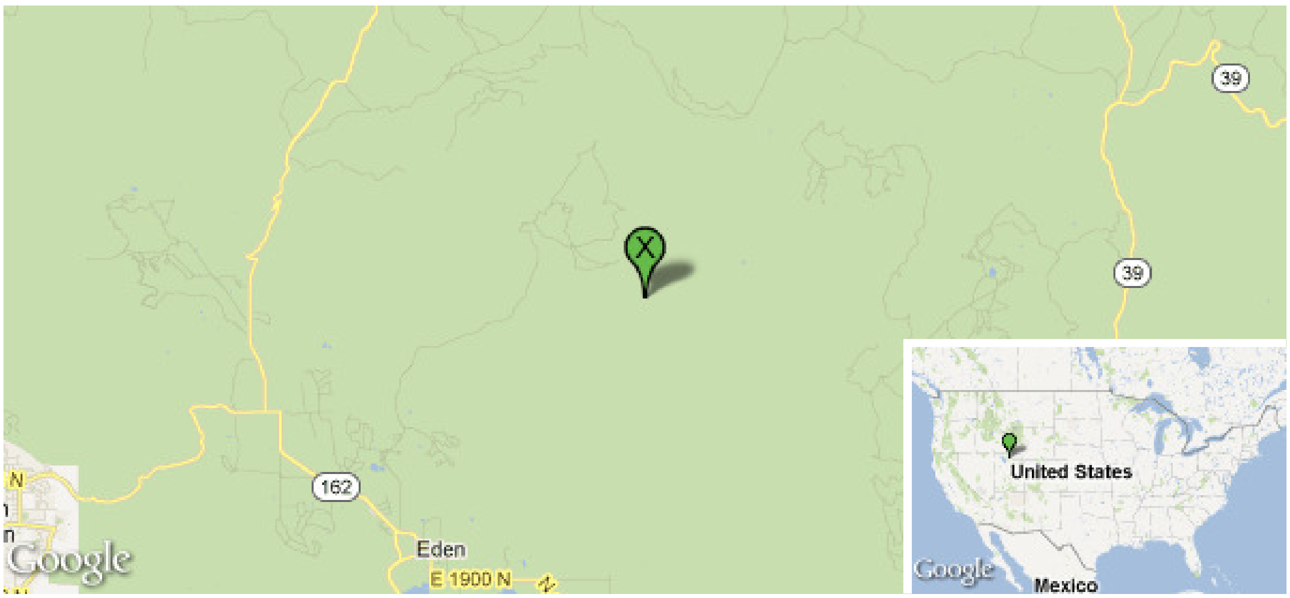
APPENDIX C

USGS

Design Maps Summary Report

User–Specified Input

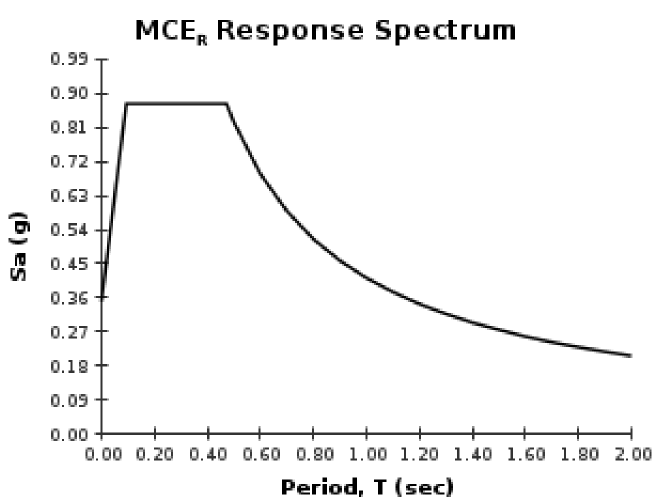
Report Title	Powder Mountain Resort - Addition Fri July 20, 2012 15:40:55 UTC
Building Code Reference Document	2012 International Building Code (which makes use of 2008 USGS hazard data)
Site Coordinates	41.36101°N, 111.74651°W
Site Soil Classification	Site Class C – "Very Dense Soil and Soft Rock"
Risk Category	I/II/III

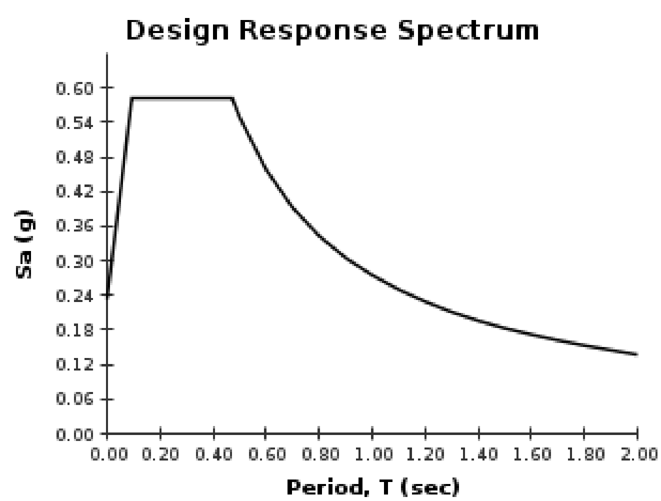


USGS–Provided Output

S_S =	0.812 g	S_{MS} =	0.873 g	S_{DS} =	0.582 g
S_1 =	0.269 g	S_{M1} =	0.412 g	S_{D1} =	0.275 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





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Design Maps Detailed Report

2012 International Building Code (41.36101°N, 111.74651°W)

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1] S_S = 0.812 g

From Figure 1613.3.1(2) [2] S_1 = 0.269 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class C, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \leq 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = C and S_s = 0.812 g, F_a = 1.075

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = C and S_1 = 0.269 g, F_v = 1.531

Equation (16-37):	$S_{MS} = F_a S_S = 1.075 \times 0.812 = 0.873$ g
Equation (16-38):	$S_{M1} = F_v S_1 = 1.531 \times 0.269 = 0.412$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39):	$S_{DS} = ⅔ S_{MS} = ⅔ \times 0.873 = 0.582$ g
Equation (16-40):	$S_{D1} = ⅔ S_{M1} = ⅔ \times 0.412 = 0.275$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.582 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.275 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = D

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf