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Geologic Hazards Assessment
Dauphine-Savory Piedmont Subdivision Lots 1R and 2R and adjacent 2-acre property
Weber County, Utah

GeoStrata Job No. 910-001

December 10, 2013

Prepared for:

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1.0 EXECUTIVE SUMMARY

The purpose of this investigation and report is to assess potential surface fault rupture hazards as well as any other geologic hazards present at the proposed Dauphine-Savory Piedmont residential development as well as a second adjacent property located at approximately 6500 South Bybee Drive in Weber County, Utah. An engineering geologist investigated the geologic conditions within the general site area.

An active fault is reported as passing within 300 feet of the subject property, and as such the subject property is included within a surficial faulting special study zone. This fault is reported to be west dipping and to be one of the main splays of the Weber segment of the Wasatch fault zone. Two exploratory trenches were excavated across residential building lot 1R and adjacent property, and extended to depths ranging from 6½ to 12½ feet below the existing site grade. The soils exposed in the trenches consisted of Holocene-aged alluvial fan and debris flow deposits. The soils consisted of silt, sand, gravel, with occasional cobble and boulders. No evidence of faulting was observed within either of the trenches completed at the subject property. Therefore, no setback recommendations are required nor provided. In addition, two exploratory test pits were excavated on building lot 2R, and extended to a depth of 11 feet. The soils exposed in the test pits consisted of Holocene-aged alluvial fan and debris flow deposits

The site was identified as being at an elevated risk of being impacted by alluvial fan flooding/debris flows. Based on our observations, the site has experienced numerous debris flows as well as alluvial fan floods during the Holocene. It is recommended that site grading and catchment basins/earthen barriers be utilized to minimize the risk of the proposed development being impacted by alluvial fan flooding/debris flows. A debris flow analysis was beyond the scope of this project, but should be considered prior to development.

Due to the potential for alluvial fan flooding and debris flows at the site, strategic grading to create deflection berms and a break in slope away from each residence with slopes great enough and slope heights sufficient to allow alluvial fan flooding/debris flow events from the north and northeast directions to flow around each residence are likely the most feasible forms of mitigation available to the property owner at this time.

NOTICE: The scope of services provided within this report are limited to the assessment of the subsurface conditions for the proposed development. This executive summary is not intended to replace the report of which it is part and should not be used separately from the report. The executive summary is provided solely for purposes of overview. The executive summary omits a number of details, any one of which could be crucial to the proper application of this report.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

The purpose of this investigation and report is to assess the proposed Dauphine Savory Piedmont residential development located at approximately 6500 South Bybee Drive in Weber County, Utah for the presence of geologic hazards that may impact development of the site. This report also covers an adjoining 2-acre property not associated with the proposed Dauphine Savory Piedmont development. Both sites are located within a fault hazard special study area as delineated by the *Surface Fault Rupture Special Study Areas, Wasatch Front and Nearby Areas, Utah* map prepared by the Utah Geological Survey (Christenson and Shaw, 2008). In addition, both sites are located within a debris flow special study area as delineated by the Debris-Flow/Alluvial Fan Special Study Areas, Wasatch Front and Nearby Areas, Utah prepared by the Utah Geological Survey (Christenson and Shaw, 2008). The work performed for this report was performed in accordance with our proposal, dated September 11, 2013. Our scope of services included the following:

- Review of available references and maps of the area;
- Review and evaluation of aerial photographs covering the site area;
- Geologic reconnaissance of the site by an engineering geologist to observe and document pertinent surface features indicative of possible surface rupture fault hazards, debris flow hazards or other geologic hazards.
- Subsurface investigation consisting of trenching across the site from east to west exposing the soil stratigraphy and observing the exposed soil for evidence of surface fault rupture or other geologic hazards.
- Preparation of hand drawn logs to document any fault structures, debris flow deposits or evidence of geologic hazards encountered during our subsurface investigation; and
- Evaluation of our observations combined with existing information and preparation of this written report with conclusions and recommendations regarding possible surface rupture hazards or any other geologic hazards observed to affect the site.

The recommendations contained in this report are subject to the limitations presented in the Limitations section of this report.

2.2 PROJECT DESCRIPTION

The project site is located in the foothills of the Wasatch Mountains at approximately 6500 South Bybee Drive in Weber County (Uintah Heights), Utah. Proposed development, as currently planned, will consist of two to three residential building lots as well as associated roadways and landscape areas. The subject property also includes a 2-acre portion that adjoins the two to three lots to the south. The subject property currently exists as undeveloped hillside property accessed through unpaved trails and roadways. The subject site slopes moderately to the west, and has an estimated topographic change of approximately 70 feet. The project site is shown on the Site Vicinity Map included in the Appendix of this report (Plate 1). The Appendix also includes a Surficial Geology Map (Plate 2) and a Site Exploration Location Map (Plate 3).

3.0 METHODS OF STUDY

3.1 OFFICE INVESTIGATION

To prepare for the investigation, GeoStrata personnel reviewed pertinent literature and maps listed in the references section of this report, which provided background information on the local geologic history of the area and the locations of suspected or known geologic hazards. A detailed knowledge of the stratigraphic units expected in the area provided a useful time-stratigraphic framework for interpreting the units exposed in the trench excavated for the study. In addition, the presence of specific stratigraphic units is also very useful in determining the presence and severity of other geologic hazards that may be present on the subject property.

3.2 GEOLOGIC INVESTIGATION

An engineering geologist investigated the geologic conditions within the general site area. A field geologic reconnaissance was conducted to observe existing geologic conditions and to assess existing surficial evidence of surface fault ruptures, debris flow deposits or evidence other geologic hazards. Based on the geologic reconnaissance, a location was selected for subsurface investigation by means of trenching. While conducting our fieldwork for the surface fault rupture hazard and debris flow hazard assessment we conducted site observations to assess what other geologic hazards might impact the site.

3.3 SUBSURFACE INVESTIGATION

An exploratory trench was excavated across residential building lot 1R and a second trench was excavated across the adjoining property to the south of lot 1R in order to expose and observe the subsurface soils and to assess the subject site for surface fault rupture hazards, debris flow hazards and other geologic hazards. In addition, two exploratory test pits were excavated on residential lot 2R in order to expose and observe the subsurface soils present on that portion of the subject property. The locations of these two trenches and the exploratory test pits are shown on the Site/Exploration Location Map (Plate 3). The geology exposed in these trenches will be described and interpreted in subsequent sections of this report.

4.0 GEOLOGIC CONDITIONS

4.1 GEOLOGIC SETTING

The site is located in Unincorporated Weber County (Uintah Heights), Utah at an elevation ranging from 4900 to 4970 feet above mean sea level within the northern portion of the Salt Lake Basin. The Salt Lake basin is a deep, sediment-filled structural basin of Cenozoic age flanked by the Wasatch Range and Wellsville Mountains to the east and the Promontory Mountains, the Spring Hills, and the West Hills to the west (Hintze, 1980). The southern portion of the Salt Lake Basin is bordered on the west by the east shore of the Great Salt Lake. The Wasatch Range is the easternmost expression of pronounced Basin and Range extension in north-central Utah.

The near-surface geology of the Salt Lake Valley is dominated by sediments, which were deposited within the last 30,000 years by Lake Bonneville (Scott and others, 1983; Hintze, 1993). As the lake receded, streams began to incise large deltas that had formed at the mouths of major canyons along the Wasatch Range, and the eroded material was deposited in shallow lakes and marshes in the basin and in a series of recessional deltas and alluvial fans. Sediments toward the center of the valley are predominately deep-water deposits of clay, silt and fine sand. However, these deep-water deposits are in places covered by a thin post-Bonneville alluvial cover. Surface sediments within the vicinity of Trench 1 are mapped as Pleistocene-aged lacustrine gravel-bearing deposits associated with the regressive (Provo) phase of the Bonneville lake cycle (Yonkee and Lowe, 2004). This unit is described as clast-supported, moderately to well-sorted, pebble to cobble gravel and gravelly sand, interlayered with some silt and sand; deposited and reworked in higher energy environments along the regressive shorelines near the mountain front. The thickness of this unit is generally less than 20 feet. Based on our observations, the sediment exposed in Trench 1 is more likely associated with alluvial fan processes that have reworked Bonneville-aged sediment. The surface sediments within the vicinity of Trench 2 are mapped as Holocene-aged alluvial fan deposits (Yonkee and Lowe, 2004). This unit is described as a mixture of gravel and sand deposited by streams, and diamicton deposited by debris flows; forms fans having distinct levees and channels at mouths of mountain-fronts canyons. The thickness of this unit is generally less than 20 feet. GeoStrata's observations of the subsurface sediment concur with the preceding description. The surface sediments within the vicinity of the two test pits, TP-1 and TP-2, excavated on the eastern portion of the property are mapped as Bonneville lacustrine gravel-bearing deposits as described above. Based on our observations, the sediment

exposed in both of the test pits are more likely associated with alluvial fan processes that comprise reworked Bonneville-aged sediment.

4.2 TECTONIC SETTING

The site is located west of the mouth of Broad Hollow within the foothills of the Wasatch Mountain Range. The Weber segment of the Wasatch fault zone is mapped approximately 400 feet west of the subject lots along the toe of the steeply west dipping range front. The Weber segment of the Wasatch fault is thought to have most recently experienced a seismic event during the Quaternary Period, and there is evidence that as many as 10 to 15 events 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 measureable offset of 1.4 to 3.4 meters per event (McCalpin and others, 1994). The Weber Segment may be capable of producing earthquakes as large as magnitude 7.5 (Ms) and has a recurrence interval of approximately 1,200 years. The southern terminus of the Weber Segment occurs at the Salt Lake Salient, a ridge of Paleozoic and Tertiary bedrock that extends west of the Wasatch Front at the northern end of the Salt Lake rupture segment. The geometry of linkage between the main rupture zones in the Weber segment and faults in the interior of the Salt Lake salient is not clear. Surface scarps at the southern margin of the salient are discontinuous but apparently extend into the large normal fault along the eastern boundary of the segment. There is no reported evidence for Quaternary movement on this fault in the interior of the salient, so presumably the Quaternary ruptures have not reactivated most of this fault. The Pleasant View Salient marks the boundary between the Weber Segment and the Brigham City Segment to the north (Personius, 1986, Zoback, 1983).

The site is also located approximately 23 miles east of the East Great Salt Lake fault zone (Hecker, 1993). Evidence suggests that this fault zone has been active during Holocene times (0 to 10,000 years) and has segment lengths comparable to that of the Wasatch fault zone, indicating that it is capable of producing earthquakes of a comparable magnitude (7.5 Ms).

Analysis of the ground shaking hazard along the Wasatch Front suggests that the Wasatch Fault Zone is the single greatest contributor to the seismic hazard in the Salt Lake City region. Each of the faults listed above show evidence of Holocene-aged movement, and is therefore considered active.

5.0 GENERALIZED SITE CONDITIONS

5.1 SURFACE CONDITIONS

As stated previously, the project site is located in the foothills of the Wasatch Mountains at approximately 6500 South Bybee Drive in Weber County (Uintah Heights), Utah, and is underlain by alluvial fan and debris flow deposits originating from drainages to the east of the subject site. The site is in a relatively natural state, and is heavily vegetated with scrub oak, sage brush and native weeds and grasses. A small shed and associated unpaved roadway was observed on building lot 2R. No structures were observed on the other portions of the subject property. The properties to the north, east, and south of the subject site are undeveloped hillside properties, while the properties to the west are occupied by established residential developments.

5.2 SUBSURFACE CONDITIONS

The subsurface soil conditions were explored for the purpose of evaluating the presence or absence of active faults as well as any other geologic hazards at the subject property by excavating two trenches across the subject site oriented generally east to west approximately perpendicular to the mapped splays of the Weber segment of the Wasatch fault. Subsurface soil conditions and soil stratigraphy were logged at the time of trenching (Plates 4 through 11). The following is a description of the trench excavation as observed during our field investigation.

5.2.1 Trench 1 Description

The trench was approximately 90 feet long, oriented approximately S80°W, and extended along the southern portion of lot 1R. The trench was excavated with a trackhoe to depths ranging from 6½ to 10 feet below the existing site grade. Trench 1 was located to intersect any faults that trend through the proposed buildable portion of the subject lot. A hand log of the trench can be found on Plates 4 through 11.

Sediments exposed in the trench were observed to be comprised of massively to weakly bedded silt and sand deposits with occasional units of gravel and cobble in a matrix of silt and sand, and were observed to comprise alluvial fan deposits with occasional debris flow deposits. The soils exposed in Trench 1 have been separated into five stratigraphic units and labeled Unit 1 through Unit 5. The oldest sediment observed at the bottom of Trench 1 was designated as Unit 1, and was only observed within the eastern-most 7½ feet of the trench. Unit 1 was observed to consist

of a silt and sand and contained crude laminations approximately every 3 to 4 inches. Iron staining was prevalent throughout, while the sand content increased with depth. Unit 1 is believed to represent lacustrine silt and sand deposits of Pleistocene-age (mapped unit Qlf_4). Considering the presence of thin laminations as well as the lack of gravel, it is likely that these soils were deposited in deeper water environments and as delta bottom set beds during transgression or regression of Lake Bonneville.

Unit 2 was observed to span the full length of the trench with the exception of the easternmost 7-feet, which were occupied by Unit 1. Unit 2 was observed to consist of sand and silt. The sediment comprising Unit 2 was observed to be massively bedded, moderately sorted, and was weakly cemented. Unit 2 is believed to represent Holocene alluvial fan deposits. Considering the general lack of gravel-cobble- sediment, it is believed that these deposits represent alluvial sediments located in the more distal portion of the fan. These alluvial sediments were dominated by fluvial processes and likely alluvial fan flooding as well.

Unit 3 was contained within Unit 2, and was not present in all portions of the trench. Unit 3 was observed to consist of massively bedded sand, silt, gravel, and cobbles. The gravel and cobbles were observed to be subangluar to subrounded, and had a maximum observed diameter of 12 inches. No visible imbrication was observed in the gravel and cobble material, which were supported in a matrix of sand and silt. This unit was first observed approximately 34 feet west of the eastern end of the trench, and persisted for the remaining length of the trench. This unit obtained a maximum thickness of approximately 3 feet. Based on the massive bedding and the presence of oversized material, Unit 3 is believed to represent debris flow deposits of Holocene age comprised of sediment that was deposited during periodic debris flow events with enough energy to reach the distal portions of the fan.

Unit 4 was observed to immediately overlie Unit 2. Unit 4 was observed to consist of massively bedded silt and sand. This unit was observed to contain significant root traces, carbonate stringers, and had a dark brown color. Occasional seams of sand and gravel in a matrix of silt were present, and ranged from 3 to 10 feet in length and 6 to 12 inches in thickness. No imbrication of the gravel and cobbles was apparent, and their maximum observed diameter was approximately 3 inches. The presence of occasional gravel layers is believed to represent small scale debris flow or hyper-concentrated flow events. Based on the overall lack of oversized material, it is likely that the sediment located outside of the gravel layers was deposited by alluvial fan processes located near distal portions of the fan.

Unit 5 was observed to be contained within Unit 2. Unit 5 was observed to consist of massively bedded silt and sand with gravel. The gravel was observed to be subangular, and had a maximum observed diameter of 1½ inches. No imbrication of the gravel was apparent. Unit 5 is believed to represent a small scale debris flow or hyper-concentrated flow event with enough energy to reach the distal portion of the fan.

Unit 6 was observed to immediately overlie Unit 2. Unit 5 was observed to consist of silt, sand, and gravel with occasional cobble. The gravel and cobble were angular, had a maximum diameter of approximately 12 inches, and did not appear to be imbricated. It is our opinion that Unit 6 represents the active soil profile. The presence of well-developed O, B, and C topsoil horizons suggests that the current site geomorphology has been established for a relatively long time.

It is our opinion that the oldest continuous material, Unit 2 was deposited at some point in the Holocene, and considering the depth of the trench it is believed that the sediments are of an age to preserve evidence of Holocene-aged movement along the Weber segment of the Wasatch Fault. No fault-related deformation was observed within any of the deposits observed in Trench 1. It is our opinion that no active surface rupture faults are located within the limits of the area exposed in Trench 1.

5.2.2 Trench 2 Description

The trench was excavated approximately 95 feet long, oriented approximately N80°W, and extended through the 2-acre property located adjacent to building lots 1R and 2R. The trench was excavated with a trackhoe to a depth of approximately 7½ to 12½ feet. Trench 1 was located to intersect any faults that trend through the proposed buildable portion of the subject lot. A hand log of the trench can be found on Plate B-2.

Sediments exposed in the trench were observed to be comprised of massively bedded gravel and cobble in a matrix of silt and sand, and are thought to represent a series of alluvial deposits as well as possible debris flow deposits. The soils exposed in Trench 2 have been separated into seven stratigraphic units, and labeled Unit 1 through Unit 7. The oldest sediment observed at the bottom of Trench 2 was designated as Unit 1, and consisted of sand, silt and gravel. Unit 1 was first observed approximately 55 feet from the eastern end of Trench 2, and persisted to the western end. The gravel was subangular to subrounded and had an average diameter of 1 to 1½ inches. This soil unit was moderately-sorted, moderately- to weakly-cemented, and largely matrix

supported. Based on the lack of bedding and imbrication, Unit 1 is believed to represent an older Holocene debris flow deposit.

Unit 2 was observed to overlie Unit 1, and was first observed approximately 43 feet from the eastern end of Trench 2, and persisted to the western end. Unit 2 consisted of massively bedded sand, gravel, and cobble in a silty matrix. The gravel and cobble are subrounded, and have an average diameter of 2-inches, although cobbles up to 8-inches in diameter were observed. No imbrication of the gravel and cobbles was apparent. This soil unit was lightly cemented, and contained significant iron staining throughout. Based on the lack of bedding and imbrication, it is our opinion that Unit 2 represents predominately debris flow sediments of Holocene-age deposited on the medial portion of the alluvial fan.

Unit 3 was observed to immediately overlie Unit 2, and was first observed approximately 28 feet from the eastern end of Trench 2 and persisted for a length of approximately 30 feet. Unit 3 was observed to consist of massively bedded gravel and cobbles in a matrix of sand and silt. The gravel and cobbles were angular to subangular, and had an average diameter of 1 inch, although material up to 5 inches in diameter was observed. Smaller (2 to 3 feet in length) channels of moderately sorted gravel and sand with minor silt were observed throughout. The gravel in these channels appeared to be weakly imbricated towards the west. Based on the overall lack of bedding as well as the lack of imbrication, it is our opinion that Unit 3 represents Holocene-aged debris flow events. In small places it appears that the debris flow deposits were reworked by smaller fluvial processes.

Unit 4 was observed to immediately overlie Unit 3, and was first observed at the eastern end of the trench and persisted approximately 50 feet to the west. Unit 4 was observed to consist of massively bedded sand and gravel in a silty matrix. The gravels were subangular, and had an average diameter of 1½ inch. Much like Unit 3, smaller (2 to 3 feet in length) channels of moderately sorted gravel and sand with minor silt were observed throughout. The gravel in these channels appeared to be weakly imbricated towards the west. Based on the overall lack of bedding as well as the lack of imbrication, it is our opinion that Unit 3 represents Holocene-aged debris flow events. In small places it appears that the debris flow deposits were reworked by smaller fluvial processes.

Unit 5 was observed to immediately overlie Unit 4, and was first observed at the eastern end of the trench and persisted approximately 42 feet to the west. Unit 5 was observed to consist of massively bedded sand and gravel in a silty matrix. The gravels were subangluar to subrounded,

and had an average diameter of 1½ to 2 inches. Much like Units 3 and 4, Unit 5 contained smaller (2 to 3 foot in length) channels of moderately sorted gravel and sand with minor silt were observed throughout. The gravel in these channels appeared to be weakly imbricated towards the west. This unit also contained possible paleosol layers. Based on the overall lack of bedding as well as the lack of imbrication, it is our opinion that Unit 3 represents Holocene-aged debris flow events. In small places it appears that the debris flow deposits were reworked by smaller fluvial processes.

Unit 6 was observed to immediately overlie all the previous discussed units, and was observed to consist of gravel and cobbles in a matrix of silt and sand. The gravel and cobble were angular to subangular, had a maximum diameter of approximately 8 inches, and did not appear to be imbricated. It is our opinion that Unit 3 represents the active soil profile. The presence of well-developed O, B, and C topsoil horizons suggests that the current site geomorphology has been established for a relatively long time.

It is our opinion that the oldest material, Unit 1, was deposited at some point in the Holocene, and considering the depth of the trench it is believed that the sediments are of an age to preserve evidence of Holocene-aged movement along the Weber segment of the Wasatch Fault. No fault-related deformation was observed within any of the deposits observed in Trench 2. It is our opinion that no active surface rupture faults are located within the limits of the area exposed in Trench 2.

5.2.3 Test Pit 1 Description

Test pit TP-1 was excavated on the western portion of the easternmost residential lot, and was approximately 11 feet in depth. Test pit TP-1 was located to investigate the subsurface soils for the presence of debris flow deposits. A test pit log of TP-1 can be found on Plate 12.

Sediments exposed in the test pit were observed to be comprised of massively bedded gravel, cobble and locally boulders in a matrix of silt and sand, and were observed to represent a series of alluvial deposits and debris flow deposits. The soils exposed in TP-1 have been separated into six stratigraphic units, and labeled Unit 1 through Unit 6. The oldest sediment observed at the bottom of TP-1 was designated as Unit 1, and was observed to consist of sand, silt and gravel with occasional cobble. The sediment comprising Unit 1 was observed to be moderately sorted. The gravel and cobble within Unit 1 were observed to be subangular to subrounded with an average diameter of ½ to 1 inches. Some material up to 4-inches in diameter was observed. The

gravels and cobble showed weak imbrication oriented towards the northwest. Unit 1 is believed to represent an older (lower Holocene) alluvial fan deposit. Considering that the clast size within this Unit 1 was observed to be generally below 3 inches and that the majority of these clasts were observed to be horizontally bedded and show weak imbrication to the northwest, it is believed that these deposits represent alluvial sediments located in the more distal portion of the alluvial fan. These alluvial sediments where dominated by fluvial processes and likely alluvial fan flooding as well.

Unit 2 was observed to immediately overlie Unit 1. Unit 2 was observed to consist of massively bedded sand, silt, gravel, and cobbles. The gravel and cobbles were observed to be subrounded, and had a maximum observable diameter of 6 inches. No imbrication was apparent in the gravel and cobbles. It was observed that Unit 2 became increasingly dominated by coarse-grained material with depth. Based on the fact that no imbrication was observed in this unit, it is our opinion that Unit 2 represents inter-layered alluvial and debris flow sediments of Holocene age comprised of sediment that was deposited on the medial portion of the alluvial fan.

Unit 3 was observed to immediately overlie Unit 2. Unit 3 was observed to consist of weakly bedded gravel in a sand and silt matrix. The sediment comprising Unit 3 was observed to be moderately sorted. The gravel and cobble within Unit 1 were observed to be subrounded with an average diameter of ½ to 1 inches. Some material up to 10-inches in diameter was observed. The gravels and cobble showed weak imbrication oriented towards the northwest. Unit 1 is believed to represent a Holocene alluvial fan deposit. Considering that the clast size within this Unit 1 was observed to be generally below 3 inches and that the majority of these clasts were observed to be horizontally bedded and show weak imbrication to the northwest, it is believed that these deposits represent alluvial sediments located in the more distal portion of the alluvial fan. These alluvial sediments where dominated by fluvial processes and likely alluvial fan flooding as well.

Unit 4 was observed to immediately overlie Unit 3. Unit 4 was observed to consist of massively bedded sand, silt, gravel, cobbles and boulders. The gravel and cobbles were observed to be subrounded to subangular, and had a maximum observable diameter of 14 inches. No imbrication was apparent in the gravel and cobbles. Based on the fact that no imbrication was observed in this unit, it is our opinion that Unit 4 represents inter-layered alluvial and debris flow sediments of Holocene age comprised of sediment that was deposited on the medial portion of the alluvial fan.

Unit 5 was observed to immediately overlie Unit 4. Unit 5 was observed to consist of massively bedded sand, silt, gravel, cobbles and boulders. The gravel and cobbles were observed to be subrounded to subangular, and had a maximum observable diameter of 24 inches. No imbrication was apparent in the gravel and cobbles. Based on the fact that no imbrication was observed in this unit, it is our opinion that Unit 5 represents inter-layered alluvial and debris flow sediments of Holocene age comprised of sediment that was deposited on the medial portion of the alluvial fan.

Unit 6 was observed to consist of silt, sand, gravel, cobble and boulders. The gravel, cobble and boulders were angular, had a maximum diameter of approximately 18 inches, and did not appear to be imbricated. Unit 6 was poorly-sorted, and contained within a matrix of silt and sand. It is our opinion that Unit 6 represents the active soil profile. The presence of well-developed O, B, and C topsoil horizons suggests that the current site geomorphology has been established for a relatively long time.

5.2.4 Test Pit 2 Description

Test pit TP-2 was excavated on the eastern portion of the easternmost residential lot, and was approximately 11 feet in depth. Test pit TP-2 was located to investigate the subsurface soils for the presence of debris flow deposits. A test pit log of TP-2 can be found on Plate 13.

Sediments exposed in the test pit were observed to be comprised of massively bedded gravel, cobble and locally boulders in a matrix of silt and sand, and were observed to represent a series of alluvial deposits and debris flow deposits. The soils exposed in TP-2 have been separated into six stratigraphic units, and labeled Unit 1 through Unit 6. The oldest sediment observed at the bottom of TP-1 was designated as Unit 1, and was observed to consist of sand, silt and gravel with occasional cobble. The sediment comprising Unit 1 was observed to be massively bedded. The gravel and cobble within Unit 1 were observed to be subangular to subrounded with an average diameter of 2 inches. Some material up to 12-inches in diameter was observed. No imbrication was apparent in the gravel and cobbles. It was observed that Unit 1 became increasingly dominated by coarse-grained material with depth. Based on the fact that no imbrication was observed in this unit, it is our opinion that Unit 1 represents inter-layered alluvial and debris flow sediments of Holocene age comprised of sediment that was deposited on the medial portion of the alluvial fan.

Unit 2 was observed to immediately overlie Unit 1. Unit 2 was observed to consist of weakly bedded gravel and cobbles in a matrix of silt and sand. The gravel and cobbles were observed to be subrounded to subangular, and had an average diameter of 1 inch, although material up to 8 inches was observed. The gravels and cobbles showed weak imbrication oriented to the west-northwest. Unit 2 is believed to represent a Holocene alluvial fan deposit. Considering that the clast size within this Unit 1 was observed to be generally below 3 inches and that the majority of these clasts were observed to be horizontally bedded and show weak imbrication to the west-northwest, it is believed that these deposits represent alluvial sediments located in the more distal portion of the alluvial fan. These alluvial sediments where dominated by fluvial processes and likely alluvial fan flooding as well.

Unit 3 was observed to immediately overlie Unit 2. Unit 3 was observed to consist of massively bedded sand, silt and gravel. The gravel was observed to be subrounded and had a maximum observable diameter of 2 inches. Smaller (2 to 3 inches in length) channels of moderately sorted gravel and sand with minor silt were observed throughout this deposit. The gravel in these channels appeared to be weakly imbricated towards the west. Based on the overall lack of bedding as well as the lack of imbrication, it is our opinion that Unit 3 represents Holocene-aged debris flow events. In small places it appears that the debris flow deposits were reworked by smaller fluvial processes.

Unit 4 was observed to immediately overlie Unit 3. Unit 4 was observed to consist of weakly bedded gravel and cobbles in a matrix of silt and sand. The gravel and cobbles were observed to be subrounded to subangular, and had an average diameter of ¾ inch, although material up to 3 inches was observed. Unit 4 is believed to represent a Holocene alluvial fan deposit. Considering that the clast size within this Unit 4 was observed to be generally below 3 inches and that the majority of these clasts were observed to be horizontally bedded and show weak imbrication to the west-northwest, it is believed that these deposits represent alluvial sediments located in the more distal portion of the alluvial fan. These alluvial sediments where dominated by fluvial processes and likely alluvial fan flooding as well.

Unit 5 was observed to immediately overlie Unit 4. Unit 5 was observed to consist of massively bedded sand, silt, gravel and cobble. The gravel and cobbles were observed to be subrounded to subangular, and had a maximum observable diameter of 6 inches. No imbrication was apparent in the gravel and cobbles. Based on the fact that no imbrication was observed in this unit, it is our opinion that Unit 5 represents inter-layered alluvial and debris flow sediments of Holocene age comprised of sediment that was deposited on the medial portion of the alluvial fan.

Unit 6 was observed to consist of silt, sand, gravel, cobble and boulders. The gravel, cobble and boulders were angular, had a maximum diameter of approximately 18 inches, and did not appear to be imbricated. Unit 3 was poorly-sorted, and contained within a matrix of silt and sand. It is our opinion that Unit 3 represents the active soil profile. The presence of well-developed O, B, and C topsoil horizons suggests that the current site geomorphology has been established for a relatively long time.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 SURFACE RUPTURE HAZARD

GeoStrata conducted a surface fault rupture hazard assessment across building lot 1R as well as on the adjacent 2-acre parcel to assess these residential lots for surface fault rupture hazards. Trenching was not completed on building lot 2R as it is located outside of the surficial faulting special study zone. The western lots were selected for surface fault rupture hazard assessment because these two lots are located closest to the mapped location of the Weber segment of the Wasatch fault zone. Plate A-2 show the mapped locations of the Weber segment of the Wasatch fault zone as reported by Yonkee and Lowe (2004) and by Nelson and Personius (1993). Plate A-2 also shows the surface fault rupture hazard special study area as determined by GeoStrata utilizing a distance of 500 feet from the reported location of the Weber segment. This distance of 250 feet is recommended by Christiansen and others (2003) for the upthrown side of the fault. Since the location of the fault was reported by Nelson and Personius (1993) on a larger and less accurate scale, GeoStrata used the location as reported by Yonkee and Lowe (2004) to assess the special study area in an attempt to be more conservative.

The fault mapped by Yonkee and Lowe (2004) was not observed in the trenches excavated by GeoStrata. It is the opinion of GeoStrata that the fault mapped by Yonkee and Lowe (2004) is located to the west of our exploration trenches. Based on the lack of any observed faulting in the Holocene-aged alluvial fan deposits observed at the bottom of both our exploratory trenches, it is our opinion that no active surface fault rupture-related deformation underlies the areas of the western two residential lots where the two trenches were excavated and observed.

It should be noted that while it is our opinion that the sediments observed within the trenches are of proper age to preserve evidence of recent seismic event, no age testing was completed as part of this investigation. As such, there remains the possibility that the sediments are upper Holocene-aged, and not of proper age to preserve fault movement. The trenches excavated as part of this investigation were advanced to the maximum practical depth.

6.2 ALLUVIAL FAN FLOODING/DEBRIS FLOW

Alluvial fan flooding is a potential hazard that may exist in areas containing Holocene alluvial fan 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. Debris floods and

debris flows can be a hazard on or below alluvial fans or in stream channels above alluvial fans. Precipitation (rainfall and snowmelt) is generally viewed as a debris-flow "trigger", but this represents only one of the many factors that contribute to debris-flow hazard. Vegetation, root depth, soil gradation, antecedent moisture conditions and long term climatic cycles all contribute to the generation of debris and initiation of debris-flows. Events of relatively short duration, such as a fire, can significantly alter a basin's natural resistance to debris-flow mobilization for an extended period of time. These factors are difficult to quantify or predict and vary not only between different watersheds, but also within each sub-area of a drainage basin. In general, there are two methods by which a debris-flow can be mobilized: 1) when shallow landslides from channel side-slopes are conveyed in existing channels when mixed with water and 2) channel scour where debris is initially mobilized by moving water in a channel and then the mobilized debris continues to assemble and transport downstream sediments.

Based on our field observations, residential building lot 1R is underlain by Holocene-aged alluvial fan deposits and is likely located near the distal or lateral portions of the fan. The finer-grained nature of the sediments observed in Trench 1 suggests that the area surrounding Trench 1 does not experience as many high energy events, with only one to two packets of debris flow sediment being observed. Our observations suggest that the adjacent 2-acre property containing Trench 2 experiences higher energy events, with 5 to 6 stacked debris flow packets being observed within our excavation. The debris flows likely originated from Broad Hollow drainage located to the east of the subject lots. Based on these observations, it is likely that Trench 2 is located in a more active channel, whereas Trench 1 is located in a distal edge of the fan, and experiences fewer debris flow events. Both of the test pits located on building lot 2R contained 5 stacked debris flow/fluvial flooding events, indicating that they are located in a relatively high-energy portion of the channel.

Based on the presence of mapped and observed past alluvial fan deposits on the subject site, the site does have the potential to be impacted by future alluvial fan flooding and debris flows. It is our recommendation that mitigation of alluvial fan flooding and debris flow hazards be designed prior to development of the site and implemented as part of construction. Given the location of Broad Hollow, alluvial fan flooding and debris flows affecting the site would come from the east to northeast.

Study of the Broad Hollow drainage basin and the entire alluvial fan deposit were outside the scope of this investigation. Proper site grading and drainage planning will greatly reduce the potential for future alluvial fan flooding/debris flow events from impacting the proposed

development, however, it is likely that further remediation for this property and adjoining properties, such as a catchment basin at the canyon mouth or redirecting berm will be required to properly minimize the potential for future impacts from alluvial fan flooding/debris flow events. Based on observations made at the time of our investigation, the property owner has constructed a catchment upgradient from the proposed development. While this basin will aid in reducing the potential for debris flow events from impacting the property, it remains a possibility that large events will surpass the volume of the basin, and as such it is recommended that strategic grading be implemented to create deflection berms and a break in slope away from each residence with slopes great enough and slope heights sufficient to allow alluvial fan flooding/debris flow events from the east and northeast directions to flow around each residence. These are likely the most feasible forms of mitigation available to the property owner at this time. Based on our observations the average debris flow event appears to deposit 5 to 6 feet of sediment. This value should be verified through the completion of a formal debris flow analysis.

7.0 CLOSURE

7.1 LIMITATIONS

The conclusions and recommendations contained in this report which include professional opinions and judgments, are based on the information available to us at the time of our evaluation, the results of our field observations, our limited subsurface exploration and our understanding of the proposed site development. 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 subsurface conditions could exist between 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, our firm 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 development changes from that described in this report, our firm 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. Development of property in the immediate vicinity of active faults or other geologic hazards involves a certain level of inherent risk. It is impossible to predict where ground rupture will occur during a seismic event. New faults may develop, existing faults may propagate beyond their current lengths, and displacement and ground shaking may be greater or less than that currently anticipated.

This report was written for the exclusive use of Matt Rasmussen and only for the proposed project described herein. 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. We are not responsible for the technical interpretations by others of the information described or documented in this report. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk.

8.0 REFERENCES CITED

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0 500 1,000 2,000 3,000 4,000 Feet

1:24,000

Base Map: 2012 HRO 6 inch Orthophotography obtained from the State of Utah AGRC.

All Locations are Approximate

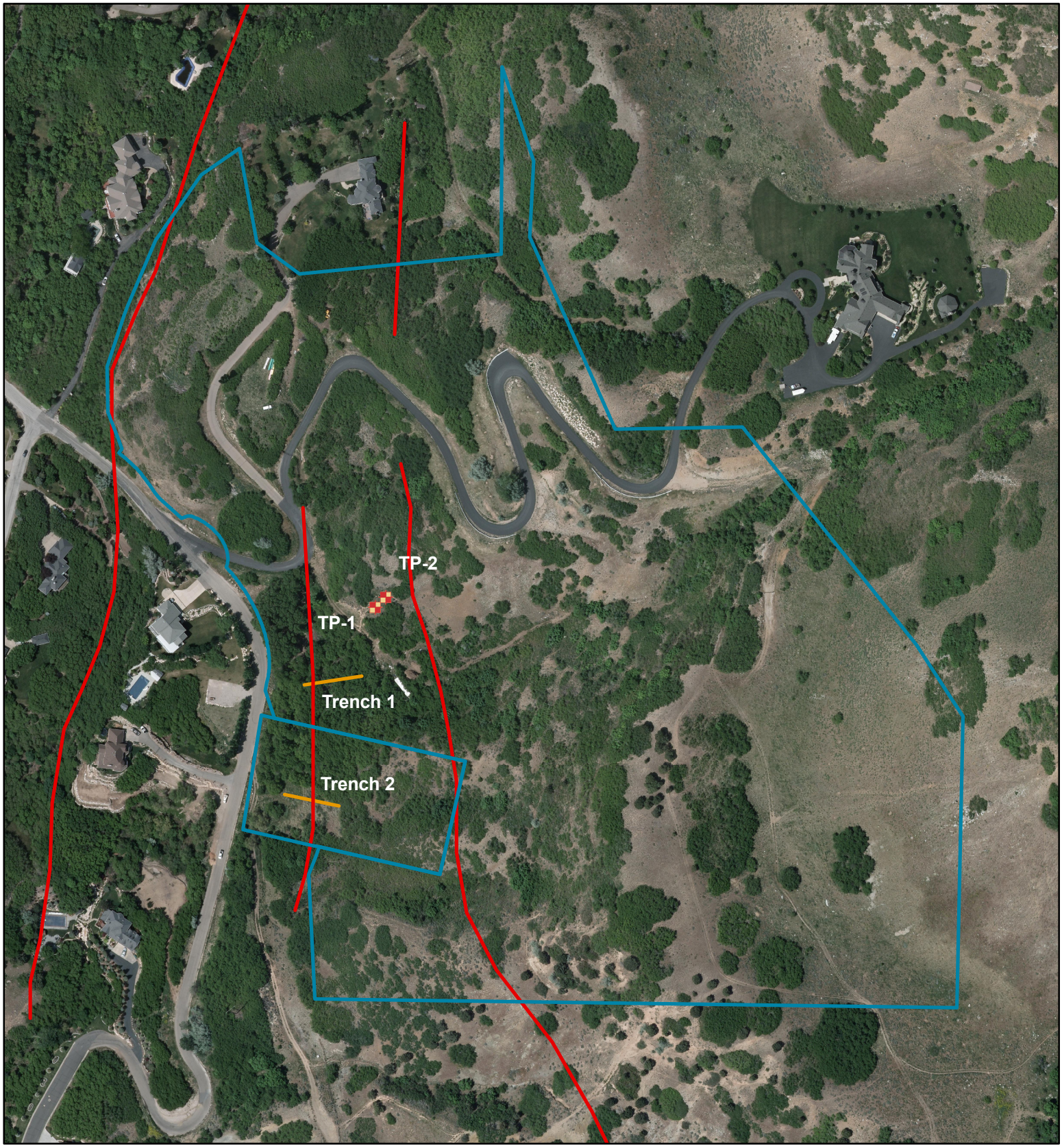
N

GeoStrata
Engineering & Geosciences

Matt Rassmusen
Dauphine-Savory Piedmont Subdivision
South Weber, Utah
Project Number: 910-001

Exploration Location Map

Plate A-1



0 75 150 300 450 600 Feet

1:3,000

Base Map: 2012 HRO 6 inch Orthophotography obtained from the State of Utah AGRC.

All Locations are Approximate

N

Legend

- Site Boundary
- Fault
- Trench
- Test Pit

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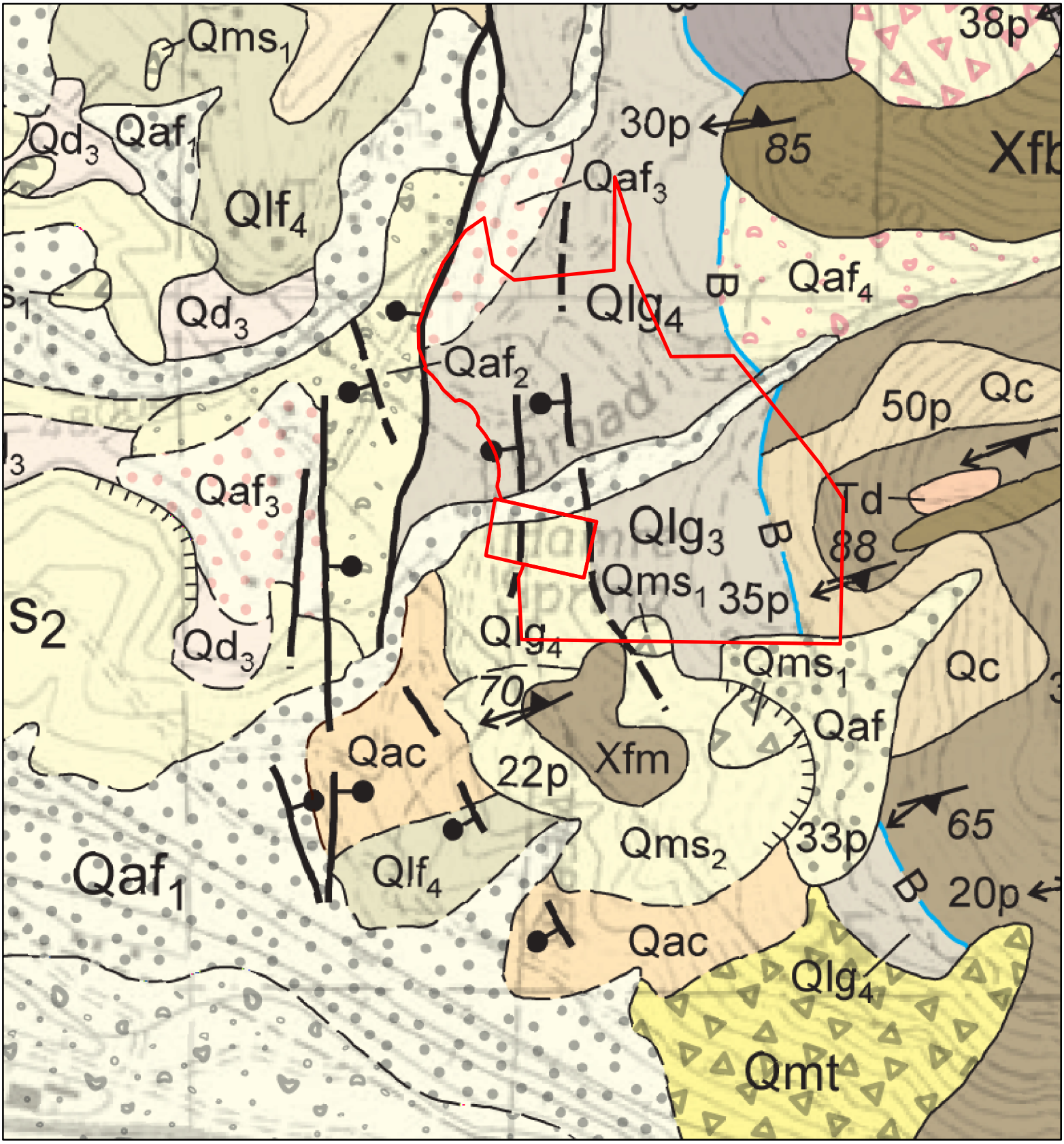
Engineering & Geosciences

Matt Rassmusen
Dauphine-Savory Piedmont Subdivision
South Weber, Utah
Project Number: 910-001

Exploration Location Map

Plate A-2



Legend

Site Boundary

Qac – Colluvium and Alluvium undivided

Qaf – Alluvial fan deposits

Qlg – Lacustrine gravel-bearing deposits

Qlf – lacustrine fine-grained deposits

Qms – Landslide deposits

Xfm – Migmatic gneiss

0 100 200 400 600 800 Feet

1:6,000

Base Map: USGS 7.5 Minute Topographic Map obtained from the State of Utah AGRC.

All Locations are Approximate

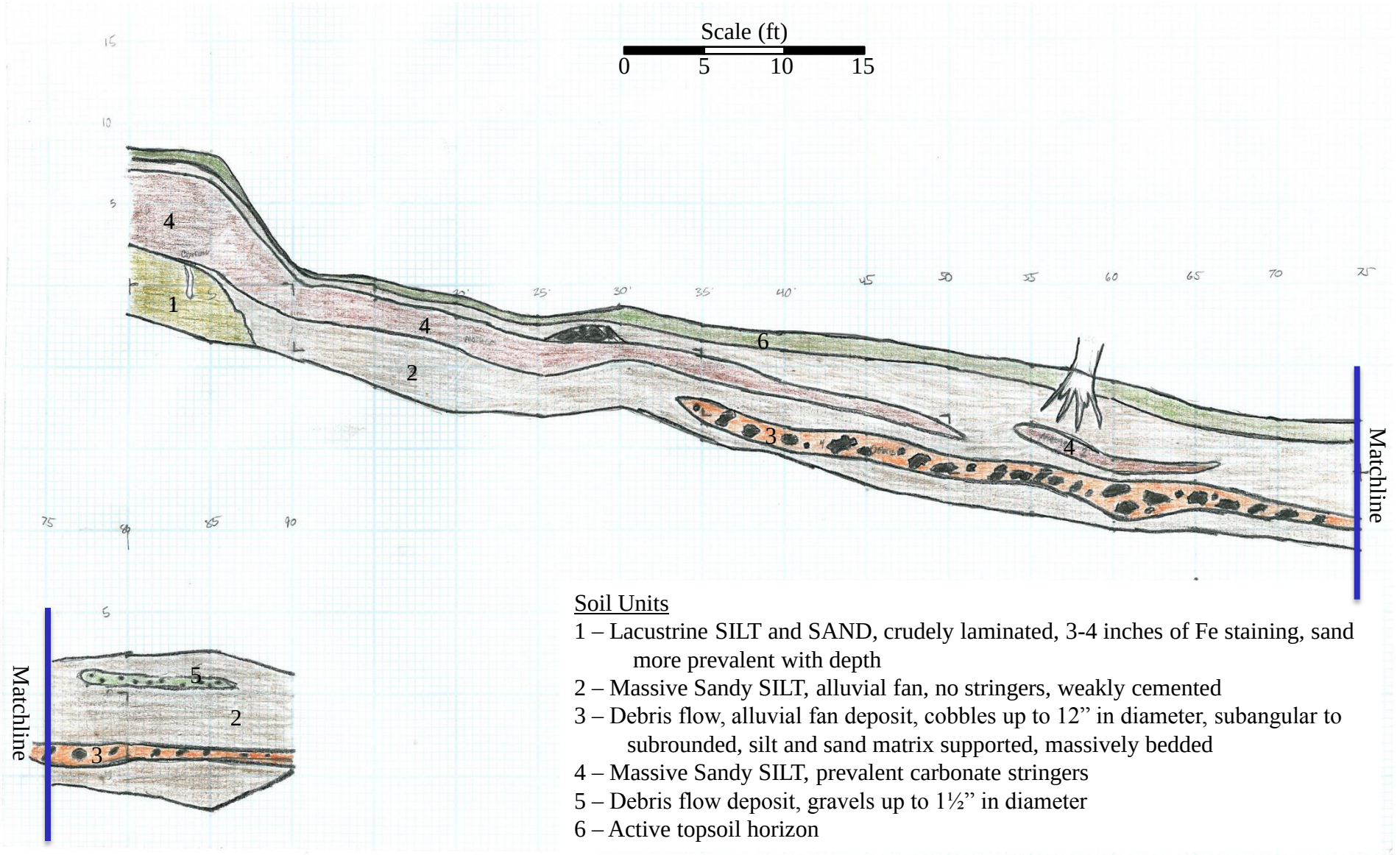
N

GeoStrata
Engineering & Geosciences

Matt Rassmusen
Dauphine-Savory Piedmont Subdivision
South Weber, Utah
Project Number: 910-001

Geologic Map

Plate A-3



Soil Units

1 – Lacustrine SILT and SAND, crudely laminated, 3-4 inches of Fe staining, sand more prevalent with depth

2 – Massive Sandy SILT, alluvial fan, no stringers, weakly cemented

3 – Debris flow, alluvial fan deposit, cobbles up to 12” in diameter, subangular to subrounded, silt and sand matrix supported, massively bedded

4 – Massive Sandy SILT, prevalent carbonate stringers

5 – Debris flow deposit, gravels up to 1½” in diameter

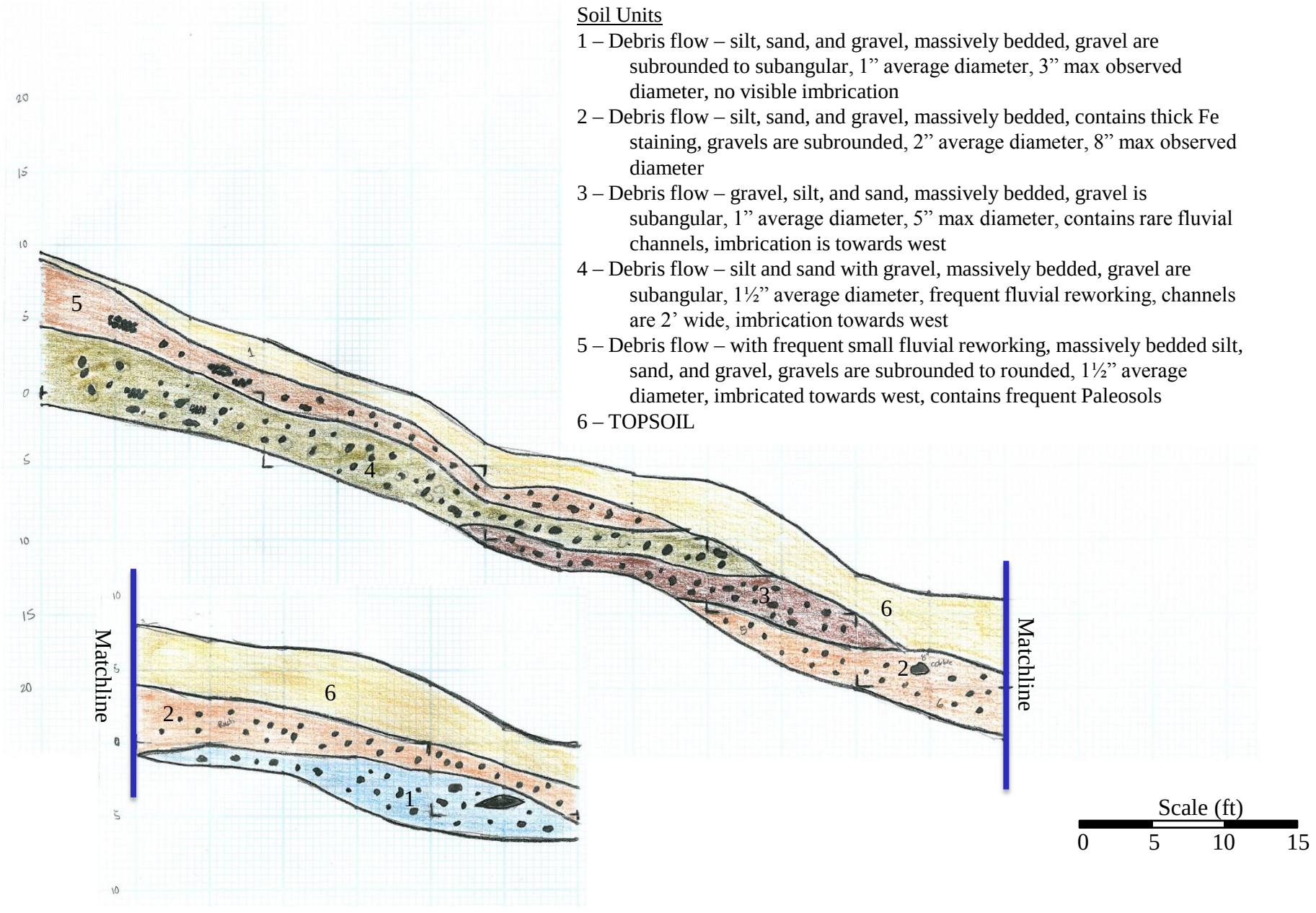
6 – Active topsoil horizon

GeoStrata

Lab Summary Report

Matt Rassmusen
Dauphine-Savory Piedmont Subdivision
Weber County, UT
Project Number: 910-001

Plate B - 1



GeoStrata

Lab Summary Report

Matt Rassmusen
Dauphine-Savory Piedmont Subdivision
Weber County, UT
Project Number: 910-001

Plate B - 2

DATE	
STARTED:	10/22/13
COMPLETED:	10/22/13
BACKFILLED:	10/22/13

Matt Rassmusen
Dauphine-Savory Piedmont Subdivision
Weber County, UT
Project Number 910-001

GeoStrata Rep: S. Seal
Rig Type: Trackhoe

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

LOCATION
NORTHING EASTING ELEVATION

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					TOPSOIL; Clayey SAND with gravel, cobbles, and boulders - with roots and pinholes throughout					
1						Debris Flow - massively bedded, sand, gravel, cobbles and boulders in silty matrix, clasts are subangular to subrounded, boulders observed up to 24" in diameter, novisible imbrication					
	5					Debris Flow - massively bedded, sand, gravel, cobbles and boulders in silty/clayey matrix, clasts are subrounded to subangular, dark brown color, possible paleosol, cobbles observed up to 10" in diameter					
2						Hyper-Concentrated Flow - gravel in a silt and sand matrix, weakly bedded, gravel is subrounded, cobbles observed up to 10" in diameter, weak imbrication to the NW		3.2	12.3	NP	NP
						Debris Flow - massively bedded, sand and gravel in silt matrix, gravels are subrounded, gravel observed up to 3" in diameter		0.8	7.9	NP	NP
3	10					@ 9.5 ft - material is angular, gravel observed up to 6" in diameter					
						Hyper-Concentrated Flow - gravel in a silt and sand matrix, weakly bedded, gravel is subrounded to subangular, gravel observed up to 4" in diameter, weak imbrication to the NW					
4						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

LOG OF TEST PITS (B) TEST PIT LOGS.GPJ GEOSTRATA.GDT 12/5/13

GeoStrata

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate B-3

DATE	
STARTED:	10/22/13
COMPLETED:	10/22/13
BACKFILLED:	10/22/13

Matt Rassmusen
Dauphine-Savory Piedmont Subdivision
Weber County, UT
Project Number 910-001

GeoStrata Rep: S. Seal
Rig Type: Trackhoe

TEST PIT NO:
TP-2
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION

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					TOPSOIL; Silty SAND with gravel, cobble, and boulders - with roots and pinholes throughout					
						Debris Flow - massively bedded, sand, gravel, and cobbles in silt matrix, gravel is subrounded to subangular, cobbles observed up to 6" in diameter					
1						Fluvial Deposit - gravel in a sand and silt matrix, weakly bedded, gravel is subrounded to subangular, gravel observed up to 3" in diameter					
	5					Huper-Concentrated Flow - sand with gravel and silt, massively bedded, contains frequent 2-3" long channel deposits, weakly cemented, gravel is subrounded, gravel observed up to 2" in diameter		2.0	10.9	NP	NP
2						Fluvial Deposit - gravel in a matrix of silt and sand, weakly bedded, gravel is subangular, gravel observed up to 6" in diameter, no imbrication		0.8	3.8	NP	NP
3	10					Debris Flow - massively bedded, sand, gravel and cobbles in a silt matrix, gravel is subrounded, cobbles observed up to 12" in diameter					
						Bottom of Test Pit @ 11 Feet					
4											

Moisture Content and Atterberg Limits

Plastic Limit | Moisture Content | Liquid Limit

10 20 30 40 50 60 70 80 90

LOG OF TEST PITS (B) TEST PIT LOGS.GPJ GEOSTRATA.GDT 12/5/13

GeoStrata

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B-4