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LANDSLIDE INVESTIGATION
THREE FALLS RANCH
ALPINE, UTAH

IGES Job No. 00608-005

July 20, 2005

Prepared for:

Mr. Will Jones
Pine Valley Realty

IGES

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APPENDIX

Aerial Photographs Reviewed for this Project:

Date	Photo ID	Reference
Apr. 8, (?)	WF-S 130	Copy from Robert Biek, UGS
Apr. 8, (?)	WF-S 131	Copy from Robert Biek, UGS
Apr. 8, (?)	WF-S 132	Copy from Robert Biek, UGS
Apr. 8, (?)	WF-S 133	Copy from Robert Biek, UGS

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1.0 EXECUTIVE SUMMARY

This report presents the results of a geologic investigation conducted on landslide deposits previously mapped by the Utah Geological Survey in the eastern portion of the Three Falls Ranch Development located in northern Alpine, Utah (Plate A-1). The scope of work completed for this study included a site reconnaissance, subsurface exploration, laboratory testing, geologic interpretation, and preparation of this report. The purposes of this investigation were to assess the geologic and geotechnical conditions in the area of this mapped landslide.

The area was explored by field observations, and combinations of open trenches, test pits and core drilling. An engineering geologist hand logged the test pits, rock core, and the entire length of each trench to illustrate our interpretations of soil features exposed in the trenches.

The trenches revealed that the small basin is caused by graben formation associated faulting on both ends of each trench. Core drilling and test pits indicate that up slope previously mapped landslide material does not exist, and consequently does not pose a threat for future landslide activity.

Previously mapped landslide material constitutes possibly old landslide deposits that are overlain by lacustrine deposits located in the graben dated to 19,400 to 21,360 years before present.

We recommend that lot specific investigations and testing be performed in order to establish localized soil conditions, and structural features that will impact the design of future homes and other facilities.

NOTICE: The scope of services provided within this report are limited to the assessment of the subsurface conditions for the subject site. 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.

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2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geologic investigation conducted on deposits mapped as landslides in the eastern portion of the Three Falls Ranch Development located in northern Alpine, Utah (Plate A-1). The deposit was mapped and identified as a landslide by Robert Biek with the Utah Geological Survey as part of the geologic map of the Lehi Quadrangle and part of the Timpanogos Cave Quadrangle, Salt Lake and Utah Counties, Utah (2005). The site is east of Fort Canyon, near the junction of the Traverse Mountains and the Wasatch Range, south of Lone Peak, in Section 12, Township 4 South, Range 1 East; and Section 7, Township 4 South, Range 2 East (Salt Lake Base Line and Meridian). The purposes of this investigation were to assess the geologic and geotechnical conditions in the area of the subject site and assess the condition of the mapped landslide. In particular a field investigation was performed to assess the nature, age, and stability of the mapped landslide mass, and the potential for future movement of the mass.

The scope of work completed for this study included a site reconnaissance, subsurface exploration, stereographic aerial photograph interpretation, geologic interpretation, and preparation of this report. Our services were performed in accordance with our proposals and signed authorizations, dated January 25, 2005. The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report.

2.2 PROJECT DESCRIPTION

The mapped landslide is shown on the Geologic Map included in Appendix A at the end of this report (Plate A-4a). A Site/Exploration Location Map is located in Appendix A as well (Plate A-3).

Proposed development of the site consists of the construction of 2-lane residential roadways providing access to large sized residential lots. The proposed roadway alignment contains both cut and fill sections as it runs along the surface of the mapped landslide mass.

3.0 METHOD OF STUDY

3.1 OFFICE INVESTIGATION

As a part of this investigation we reviewed pertinent available 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 faults. Western GeoLogic, LLC., completed a geological hazards evaluations and supplemental report on the Three Falls Ranch development, which focused on faulting hazards associated with the area. Our office previously completed two geotechnical reports for the project addressing roadways and the proposed water tank. A detailed knowledge of the stratigraphic units expected in the area provided a useful time-stratigraphic framework for interpreting the units exposed in the trenches excavated for the study.

Stereographic aerial photograph interpretation was performed for the site using photographs provided to IGES by Robert Biek of the Utah Geological Survey. A set of four 9 x 9 inch photographs were provided for this study.

3.2 GEOLOGIC INVESTIGATION

An engineering geologist investigated the geologic conditions, within and around the area of the mapped landslide. Geologic research consisted of reviewing existing aerial photographs, previous geologic reports of the area, and other available geologic literature pertinent to the site as indicated in the references cited. A field geologic reconnaissance was conducted, as well as subsurface explorations, to observe existing geologic conditions and site geomorphology. The findings of the geologic investigation are presented in Sections 4.0 and 5.0 of this report. Based on the geologic maps, the aerial photograph review, and site field observations, locations were chosen in portions of the mapped landslide mass for subsurface investigation. Excavation of two trenches, three test pits and core drilling were completed in these areas to observe the landslide deposit, if possible, and to observe indications of the nature and timing of previous slide activity.

3.3 SUBSURFACE INVESTIGATION

IGES conducted a subsurface investigation of the site from April 2005 to July 2005. This investigation was conducted by excavating two trenches through the small valley along the southern flank and scarp of the mapped landslide. In addition three test pits and a boring were performed up slope also in the mapped landslide mass, to assess the soil material present and potential for sliding. The approximate trench locations, test pits and boring are shown on Plate A-3. The trenches generally extended to depths of up to 17 feet below existing site grade. An engineering geologist hand logged the entire length of each trench to illustrate our interpretations of soil and structural features exposed in the trenches. The rock core and test pits were logged by an engineering geologist and are included in Appendix A (Plates A-5a-5d, and A-6 through A-8). A key to Soil Symbols and Terms is located on Plate A-9. The hand drawn logs are included on (Plates A-10a-c).

4.0 GEOLOGIC CONDITIONS

4.1 GEOLOGIC SETTING

The site is located in the northern end of Utah Valley at the eastern end of Traverse Mountain, and south of Lone Peak in the Wasatch Range. The site is at an elevation between approximately 5800 to 6700 feet mean sea level. The northern end of Utah Valley is bounded by the Lake Mountains on the west, Traverse Mountain and Lone Peak (part of the Wasatch Range) on the north, and the Wasatch Range on the east and northeast. The area is part of the eastern portion of the Basin and Range physiographic province (Hintze, 1993). The Basin and Range province is comprised of north-south trending fault-block mountain ranges and intervening sediment filled structural basins formed by extensional faulting. These structural basins represent deep, sediment-filled valleys of Cenozoic age (Machette, 1992; Hintze, 1980; Hintze, 1993). The Wasatch Range is located along the eastern edge of Utah Valley and marks the easternmost expression of pronounced Basin and Range extension in north-central Utah. The boundary between the Basin and Range province and the Middle Rocky Mountain physiographic province, to the east, is the Wasatch fault zone.

The Fort Canyon fault trends approximately east-west through the central portion of the mapped landslide mass. The Fort Canyon fault is a west-northwestward projection of the Deer Creek fault, which is a transverse structure (northern tear fault of the east-vergent Charleston-Nebo thrust fault, Machette, 1992). The Fort Canyon fault transfers motion along the Wasatch fault zone from the northern portion of the Provo segment in Utah Valley to the southern portion (Cottonwood section) of the Salt Lake Valley segment (Machette, 1992). The Provo segment is 70 km long and is one of the longest segments of the Wasatch fault zone. The Traverse Mountains (a bedrock salient, located west of the site) mark the northern extent of the Provo segment and forms a structural boundary between the Salt Lake City and Provo segments of the Wasatch fault zone. Dry Mountain, Tithing Mountain, and Little Mountain are located south of Payson, Utah and mark the southern extent of the Provo segment. Analyses of ground shaking hazard along the Wasatch Front suggests that the Wasatch fault zone is the single greatest contributor to the seismic hazard in the Utah Valley region.

The study area lies in a region were both extensional and strike-slip structural characteristics are reported. The Fort Canyon fault is accommodating both the valley basins (Utah and Salt Lake) dropping downward to the south and west, associated with normal faulting, and transform (strike-slip) motion between the two Wasatch fault segments (Provo and Salt Lake) causing potential voids (pull apart basins), overlapping (pressure ridges), and secondary splay faults. The Dear Creek Detachment fault is approximated through the study area roughly paralleling the Fort Canyon fault along the south flank of the trace, trending west-northwest. Three splay faults are mapped (Biek, 2005) south of the mapped landslides with approximate trends of North 38, 45, and 47 degrees East from east to west. The three splay faults exhibit unique repetitive trends with similar spacing intervals.

The landslide is mapped as being younger (Qmsy) materials deposited in the study area. This division is based on the degree to which the characteristic features of a landslide are preserved. Historic landslides are characterized by hummocky topography, numerous internal scarps, chaotic bedding, as well as more recent evidence such as tilted trees, fresh scarps, and damaged roads, utilities, or other structures. The characteristics of younger landslides are similar to those of historic landslides but do not appear to be as recent. Features of younger landslides, such as scarps, appear more weathered and less morphologically distinct. The characteristic features of the older landslides are morphologically subtle or indistinguishable. Some older landslides have such subtle characteristics that there can be some question as to whether they are landslides. The mapped landslide that underlies the subject site is considered to be a younger landslide (Biek, 2005).

The landslide deposits mapped at the subject site are characterized by hummocky topography, thin extensive fluid flow deposits and debris flows (Western GeoLogic). The characteristic features of the landslide(s) are morphologically subtle at best with the only surface expression being hummocky surface topography. A landslide scarp feature is mapped along the northern flank of a small ridge south of the study area. This scarp is reported by Biek (2005) to be the head scarp of the landslide mass (Qmsy) north of the feature. In the central portion of the southern study area a mixed environment deposit is mapped as Qac (Biek, 2005). Qac is described as alluvial and colluvial deposits in swales. West of the southern study area Qaco is mapped as a potential sag pond deposit.

5.0 GENERALIZED SITE CONDITIONS

5.1 SURFACE CONDITIONS

Our study area consists of two areas mapped as a landslide mass by Biek (2003, 2005). The southern area consists of some low hummocky hills with pond depressions setting between the southern flank of Lone Peak, south of the Fort Canyon Fault, and north of some small ridges north of Alpine, Utah. The northern area north of the Fort Canyon Fault, consists of a moderate southwest facing slope, sloping at approximately 27 degrees on average. The area is generally vegetated with various weeds, grasses, brush and trees in meadow and wooded/brush areas.

5.2 SUBSURFACE CONDITIONS

As previously mentioned, the subsurface soil conditions were explored on the mapped landslide areas with open trench excavations through a small basin and through the approximate boundaries of lower mapped landslide mass. Test pit excavations and core drilling were also performed in the northern upslope portion of the mapped landslide mass. These explorations were hand logged and are also shown in Appendix A (Plates A-10). The soil, bedrock and moisture conditions encountered, during our investigation, are discussed below.

5.2.1 Soils

The soils encountered in these exploration locations consisted of Lean and Silty CLAY (CL), Fat CLAY (CH), Clayey and Sandy SILT (ML), Silty SAND (SM), and GRAVEL (GM, GP-GM, GC). These soils were accumulated by processes including, but not limited to, disintegration of parent rock (both mechanically and chemically), lacustrine, colluvial and alluvial.

The subsurface soil profiles observed in the trenches are presented in Appendix A (Plate A-10). 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 soils, care should be taken in interpolating subsurface conditions between and beyond the exploration locations.

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5.2.1.1 Boring 1

Core drilling was performed in the potential landslide and landslide source area mapped by Biek (2005), located upslope and north of the Fort Canyon fault trace. The area is north and northeast of the small basin located in the study area. The boring location is west of the proposed water tank site located in the south central area of the mapped unit, and northeast of the small basin area. The boring was advanced to 99.7 ft below the ground surface.

Bedrock was encountered at between approximately 3 to 11 feet, based on our test pit observations. The near surface material is disintegrating parent bedrock material. The entire rock core consisted of monzo-granite (Biek, 2005) with zones of alteration. In the upper 26 feet of the boring the rock quality was generally highly weathered and appeared moderately strong to weak, and consisted of altered monzo-granite. Below 26 feet the rock became less weathered to fresh and increase in competency to very and extremely strong. The rock appeared to be generally unaltered with a few zones of alteration usually associated with higher fracturing. Rock quality designation (RQD) values for the rock core is presented in the boring log Plate A-5a through A-5d.

5.2.1.2 Test Pits 1, 2, and 3

The test pits west of the proposed water tank site were excavated at approximately the same elevation through the mapped landslide deposit (Biek, 2005). The soil profiles exposed in the test pits exhibited a general C horizon type of development with partial disintegration of parent material consisting exclusively of monzo-granitic rocks mapped above the test pit area and mapped landslide mass. The rock clasts were generally highly to moderately weathered, and weak to moderately strong, with an apparent decrease in weathering and increase in competency and rock appearance with depth until refusal was met between 13 and 14 feet below ground surface. Gravel and cobble sized clasts were typically angular with some being very angular, having lenticular shape concaved downward with closely to very closely spaced fracturing (small scale exfoliation development). Soil formation above the bedrock consisted of Silty Gravels with some clay with various degrees of decomposition occurring to the rocks. The test pits excavated during the previous water tank study were identical to our current test pits, with the exception that we met refusal at shallower depths do to the type of excavator used (rubber tired backhoe).

5.2.1.3 Trench 1

Trench 1 was excavated approximately 247 feet long, and is generally up to approximately 17 vertical feet in depth. The trench is oriented approximately 20 degrees northeasterly with a short northwestward zigzag along the northern end. The trench was excavated through a small gap between two ridges and cut into each ridge. The trench cuts through a mapped scarp feature (Biek, 2005) in the southern end of the trench along the north flank of the southern ridge. The southern ridge, from west to east, trends approximately South 55 degrees East southwest of the trench, and prior to crossing the trench, changes orientation to approximately North 80 degrees East along with the mapped scarp. The northern small ridge is oriented approximately North The soils and structural features exposed in Trench 1 were observed and logged by an engineering geologist. The trench was logged from the south end to the north end.

Two larger faulting features were apparent in the southern potion of Trench 1 coinciding with the mapped landslide scarp feature. The faults were oriented at approximately South 70 and 88 degrees East, and dipped towards the North at 63 and 67 degrees respectively. The apparent offset of the faults appeared to be greater than 8 and 14 feet respectively measured vertically.

Soils exposed in the fault blocks in the southern end of Trench 1 consisted of a pebbly, grusified appearing Silty Sand soil with fine and medium gravels of granitic rock fragments and trace amounts of limestone and quartzite, with a decomposing granite cobble, overlain by a Silty Clay/Clayey Silt soil with increasing clayey content towards the surface, with decreasing gravel content downslope. The Silty Sand soil resembles mapped (Biek, 2005) finer grained portions of glacial outwash or till deposits of the Dry Creek glacial advance (Qgod and Qgtd). The other soil exposed in the lower fault block in the southern end of the trench consisted of a jumbled mix of poorly sorted Silty and Clayey Gravels with cobbles and small boulders consisting of sub-angular and some subrounded clasts of carbonate coated limestones and some quartzite/sandstones, and a small block (small boulder) of pulverized decomposing marbleized limestone. The clasts were generally fractured and disintegrating. Soils exposed in the south side of the block (opposite the lower southern fault trace) dip southward towards the upper south side fault, with apparent parallel stratifications features throughout the block oriented approximately North 78 degrees East dipping southward approximately 36 degrees. Soils above the gravel soils of the lower exposed fault block and fill in between the lower block and blocks consists of brown highly plastic Clay with some subangular gravel sized clasts of orthoquartzite with lesser amounts of limestone. The silt and sand content in the clay increases and then decreases to various degrees up to the ground surface above the lower block. Some of the soils constituents of the upper block have been incorporated into the clay and silty clay along the upper south fault contact. The granular soil surface and the lower south fault of the lower southern block forms a small horst feature.

Less apparent were faults in the northern end of Trench 1. Soil materials exposed in the lower portion of the trench side wall resembling fault structures were comprised of angular to subangular carbonate coated gravel, cobble and small boulder sized clasts of limestone (marbleized limestone). The apparent upper and lower faults have orientations of South 80 and 73 degrees, dipping south 66 to 68 degrees respectively, and form a graben feature between the two small ridges. Overlying the coated limestone clasts was angular clasts of brecciated orthoquartzite, which grade upward into a Clayey Gravel consisting of red-brown highly plastic clay containing clasts of the quartzite. The clay content appeared to increase upward towards the surface. The highly plastic clayey gravel soil appeared to grade subtlety to brown Clay with gravel, with lesser and lesser amounts of gravel grading down slope to Silty Clay into the small basin. The clay soils appear to consist of fluidized flow landslides. The overlying fine grained soils, in our opinion do not exhibit landslide features, but appear to have been deposited into the graben depression formed through valley fill processes, slope creep, and possible weathering of fault scarp surface ruptures. No apparent discreet contact or slide plane was observed between the fine grained soils exposed in the trench. Faulting appeared to offset the older units consisting of the marbleized limestone, brecciated orthoquartzite and overlying red-brown and brown fat Clay, and was overlain by weathering products of the clay consisting of less plastic brown clayey and silty clay, and clayey and sandy silt.

5.2.1.4 Trench 2

Trench 2 was excavated 417 feet long, up to 16 feet deep, and oriented approximately northwest at approximately North 24 degrees West. The soils exposed in the trench were observed and logged by an engineering geologist. The trench was logged from the northern end to the southern end. The trench was excavated through a small basin, east of Trench 1. The north end of the Trench 2 was cut from nearly the crest of the same small ridge north of Trench 1, crossing a mapped fault by Western Geologic (2004). The southern end was cut into a hill along the southern flank of the small basin. Several faults were observed in the northern end of the trench, and one in the southern end of the trench.

Faults in the northern end of the trench were oriented between North 32 to 54 degrees East, and dipping between 57 to 87 degrees. The faulted structure exposed in the trench exhibited normal faulting and wedge development, and has strong shearing textures in areas within the fault zone. Bedrock was exposed in upper fault blocks and wedge blocks along the fault zones in the north end of Trench 2. The bedrock exposed in the trench consisted of light-gray marbleized limestone overlain by marble/limestone breccia (that appeared to be intact relic limestone, deformed and shattered. The marbleized limestone was overlain, at the crest of the small northern ridge, by a thin zone of disintegrating parent material (C horizon) forming subangular cobbles and small boulders, with heavy carbonate coatings. The outer portion of the limestone bedrock exposed was highly fractured, crushed to pulverized at its surface and was less fractured (close to very closely spaced fractures) with depth. Orientation of a bedding surface was approximately North 72 degrees West, dipping 21 degrees southwest. The carbonate coated subangular limestone cobbles and boulders were also observed in the bottom of Trench 2 south of the bedrock exposed along the trench. Between faults were areas of infilling of colluvial wedges over the faults.

Overlying the limestone materials was a very angular brecciated orthoquartzite material typically orange to orange-yellow in color, which has an associated overlying unit consisting of a red-brown to brown highly plastic clay containing various amounts of the orthoquartzite clasts decreasing upward content. A small portion of the brecciated orthoquartzite is exposed along the up-thrown portion of a fault in the southern end of Trench 2 and appears to have been offset by faulting. The fault in the southern end has an orientation of North 69 degrees East, dipping approximately 48 degrees northwest. Overlying the brown clay was a silty clay which appeared to be a well established E soil horizon with a white-ish appearance, carbonate stringers, and small fractures coated with carbonate. Overlying the fault in the southern end of the trench were numerous large fractures with heavy carbonate coatings and a radial aspect located in a small zone over the fault. Orientations of the large fractures were between North 5 degrees East and South 70 degrees East. Overlying the silty clay (E-horizon) unit in the southern end was red-brown to brown plastic clay with subangular gravels consisting of orthoquartzite with lesser amounts of limestone.

Faulting on both ends have created a graben structure which forms the small basin like meadow Trench 2 was excavated across. The plastic brown clay material appears to be weathering from the red-brown clay on the footwall side of the fault down into the graben forming a colluvial wedge. Overlying the plastic clay is silty clay with a very subtle contact at best, and later lacustrine (silt, sandy silt, and silty sand) deposits filling in the lower area of the small basin. The silty clay appears to inter finger with the lacustrine deposits and eventually covers the lacustrine material. Generally, the contacts between the material units are gradational, or just hard to see due to similar soil types on either side of the contact. The lower portion of the lacustrine deposits were radiocarbon dated to be between 19,400 to 21,360 years old (before present, BP) 2 sigma calibrated age.

5.2.2 Bedrock

5.2.2.1 Small Basin Meadow

Bedrock was not observed to outcrop in the small basin area. The area is mapped as young landslide (Qmsy, Biek (2005)), however, bedrock was observed in the north end of Trench 2. The bedrock exposed in Trench 2 consisted of light-gray marbleized limestone, and marble/limestone breccia overlain in areas by a thin zone of disintegrating parent material (C horizon) forming subangular cobbles and small boulders, with heavy carbonate coatings, exposed at the north end of the trench at the small ridge crest. Rocks resembling this description, are mapped by Biek (2005) approximately 1700 feet east of the trench exposure, and are named the Doughnut Formation (Mdo) Upper Mississippian in age. The outer portion of the exposed limestone bedrock was highly fractured, crushed to pulverized at its surface; the rock was less fractured (close to very closely spaced fractures) with depth. The carbonate coated subangular limestone cobbles and boulders were also observed in the bottom of Trench 2 south of the bedrock exposed portion, and in the bottom of Trench 1 in the north end.

Overlying the limestone and carbonate coated cobbles was a very angular brecciated orthoquartzite material typically orange to orange-yellow in color. This brecciated orthoquartzite has an associated overlying unit consisting of a red-brown to brown highly plastic clay containing various amounts of the orthoquartzite clasts. These orthoquartzite clasts decrease in frequency upward in the soil profile. The brecciated orthoquartzite material is also described by Biek (2005) as overlying the marbleized limestone material and is part of the Doughnut Formation. A small portion of the brecciated orthoquartzite is exposed along the up-thrown portion of a fault in the southern end of Trench 2.

5.2.2.2 Potential Landslide Source Area

The potential landslide and landslide source area mapped by Biek (2005), is located upslope and north of the Fort Canyon fault trace. This area was originally mapped as Qrc (Biek, 2003). The area is north and northeast of the small basin area. A previous limited subsurface study was performed on the proposed water tank site located in the south central area of the mapped unit, and northeast of the graben. The area was explored by field observations, stereoscopic aerial photograph interpretation, by excavating test pits, and core drilling 99.7 ft vertically below the ground surface. During the current study all the subsurface explorations were performed west of the proposed water tank site.

The previous study indicated shallow bedrock with high P-wave velocities (approximately 12,000 ft/sec on average), and refusal during excavations with a rubber tired backhoe at 3 to 6 ft. During the current study an excavator (Caterpillar Model 320) encountered refusal on igneous intrusive bedrock in all three test pits at between 13 and 14 feet depending on the side of the trench measured. The observed soil horizons overlying the bedrock, in all three test pits, appeared as partially disintegrating parent material (C horizon, consisting of monzo-granite), with a thin A horizon (approximately 1 to 2 feet). During core drilling moderately to highly weathered, moderately strong monzo-granite/ bedrock was encountered to a depth of approximately 26 feet, after which weathering decreased and competency of the rock increased. The rock core quality increased to slightly weathered to fresh, and very strong to extremely strong with depth. Upslope, north and northeast of the proposed water tank site, bedrock is exposed at the surface for several hundred feet upslope, and disappears under a veneer of concentrated grusified soils observed up the slope to nearly the top of a ridge northeast of the mapped landslide deposit. Materials resembling the mapped landslide mass in the hummocky portion of the site were not observed to overlay any of the granitic bedrock, on the surface nor in subsurface explorations.

5.2.3 Groundwater/Moisture Content Conditions

Groundwater was not observed in either Trenches performed as part of this study, however groundwater was observed in the test pits performed upslope of the small basin area. Groundwater in the test pits ranged between approximately 10 and 12 feet below the ground surface at the location explored. Groundwater was also encountered during core drilling. During excavation of the test pit, groundwater was observed to be following through fractures and jointing in the rock mass prior to stabilizing

6.0 FINAL DISCUSSION

Biek (2005) has mapped the area of study as a younger landslide, Western Geologic has also described units in the area as a landslide mass. The purpose of our investigation was to assess the condition and extent of the mapped landslide deposits and assess their nature and origin.

It is our opinion, based on our observations and exploration information, that the mapped landslide deposit representing the hummocky topography and associated small basins are the result of complex structural features related to both transform and extensional faulting along the Fort Canyon fault. The small basin meadow trenched for this study is a graben feature associated with normal faulting and possible strike slip components of faulting along the north side of the graben. The small basin could be a pull-apart basin structure associated with strike-slip faulting. Units identified as landslide in origin may represent old landslide deposits, but have been weathered into adjacent low-lying areas by slope wash, creep, and possibly localized small slides into grabens derived from fault scarp ruptures and seismic events. Source areas for the landslide mass were not observed during the fieldwork conducted for this investigation.

The upslope mapped landslide mass (Biek, 2005), does not contain any landslide associated materials or materials similar to those found in the trenches excavated in the small graben. The materials encountered in the up slope area consisted of shallow igneous bedrock with a thin overlying regolithic soil development. It is our opinion that the up slope regolith and shallow bedrock do not pose a source location for the described landslide materials below. It is possible that the soils identified by Western Geologic may be landslide deposits, but the source areas for these deposits are no longer located upslope of the landslide deposit. Future sliding of the current upslope material seems highly unlikely.

Mr. Robert Biek previous mapped the up slope area in question (Qmsy) as Qrc (Biek, 2003) representing regolithic development over rock and not a landslide mass. We believe this original interpretation to be accurate. We believe that the lower landslide mass in the small basin where Trench 2 is located should be interpreted as Qaco, representing locally derived sediments deposited in swales, by slope-wash, creep, and fluvial processes, that have as a parent source possibly old landslide mass located farther up-slope near the Fort Canyon fault.

Given the observed variability of soils and the limited exploration of the site conducted for this investigation it is not possible to accurately predict all geomechanical behavior to be expected at the site. We recommend that specific investigations and testing be performed in order to establish localized soil conditions and structural features that will impact the design of future homes on a lot by lot basis and otherwise for the various infrastructure and facilities associated with the development.

7.0 CLOSURE

7.1 LIMITATIONS

The recommendations contained in this report are based on limited field observations and explorations, laboratory testing, 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 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 construction 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.

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

We 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.

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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 CITED

Biek, R.F., (2003) in review, Interim Geologic Map of the Lehi Quadrangle and part of the Timpanogos Cave Quadrangle, Salt Lake and Utah Counties, Utah: Utah Geological Survey Open-File Report 416, scale 1:24,000.

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Hintze, L. F., 1980, Geologic Map of Utah: Utah Geological and Mineral Survey Map-A-1, scale 1:500,000.

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IGES, Inc., 2004, Geotechnical Investigation of the Proposed Culinary Water Tank Site, Three Falls Ranch, Alpine, Utah

Machette, M.N., 1992, Surficial geologic map of Wasatch fault zone, eastern part of the Utah Valley, Utah County and parts of Salt Lake and Juab Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2095, scale 1:50,000.

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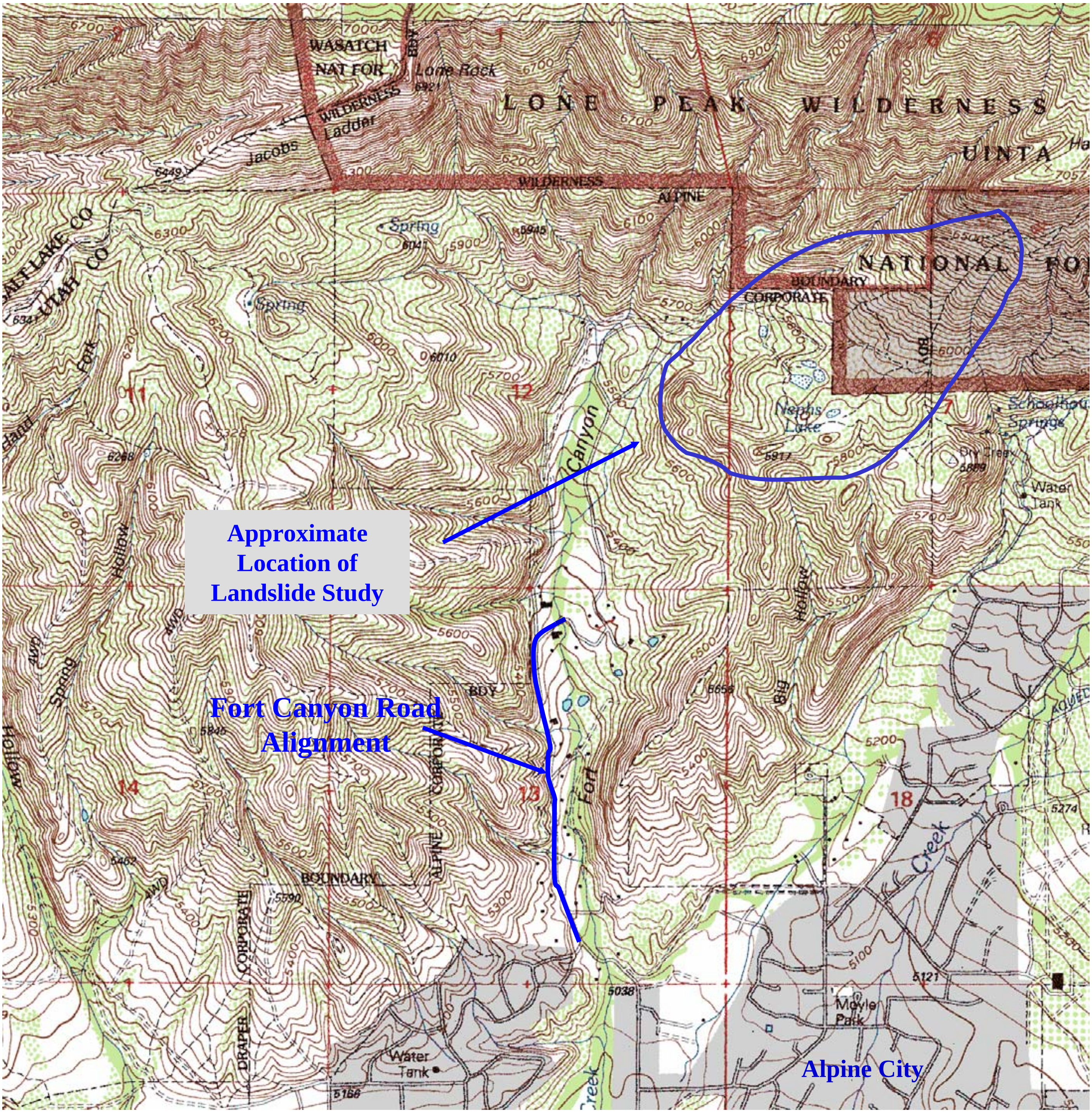
APPENDIX A

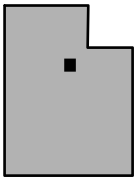


BASE MAP:
LEHI, UTAH
U.S.G.S. 7.5 MINUTE QUADRANGLE
1983

0' 1000' 2000'

SCALE 1:24,000

CONTOUR INTERVAL 20 feet



MAP LOCATION

N

IGES

Project Number – 00608-005

Landslide Investigation
Three Falls Ranch
Alpine, Utah

SITE VICINITY MAP

PLATE

A-1

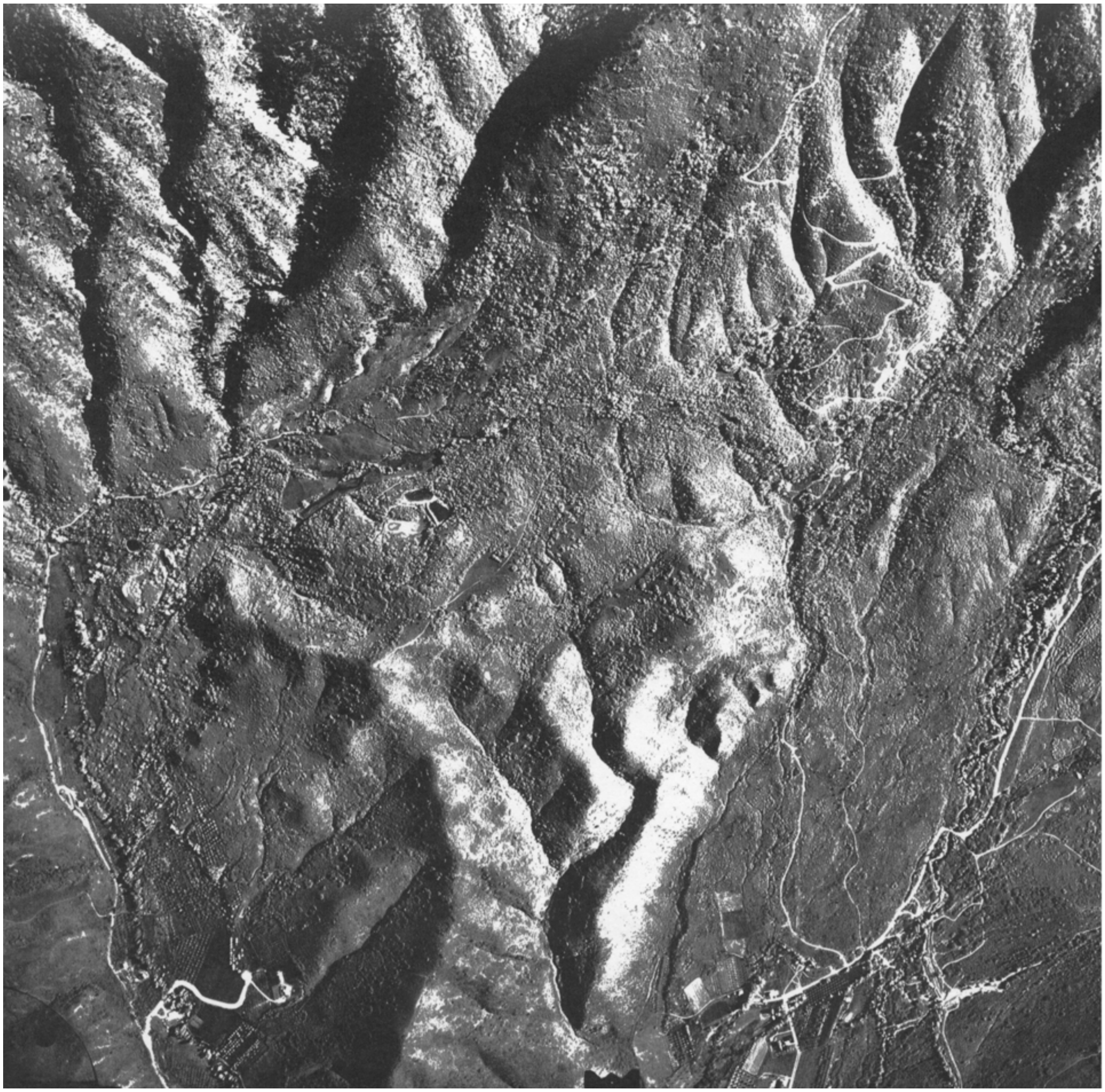
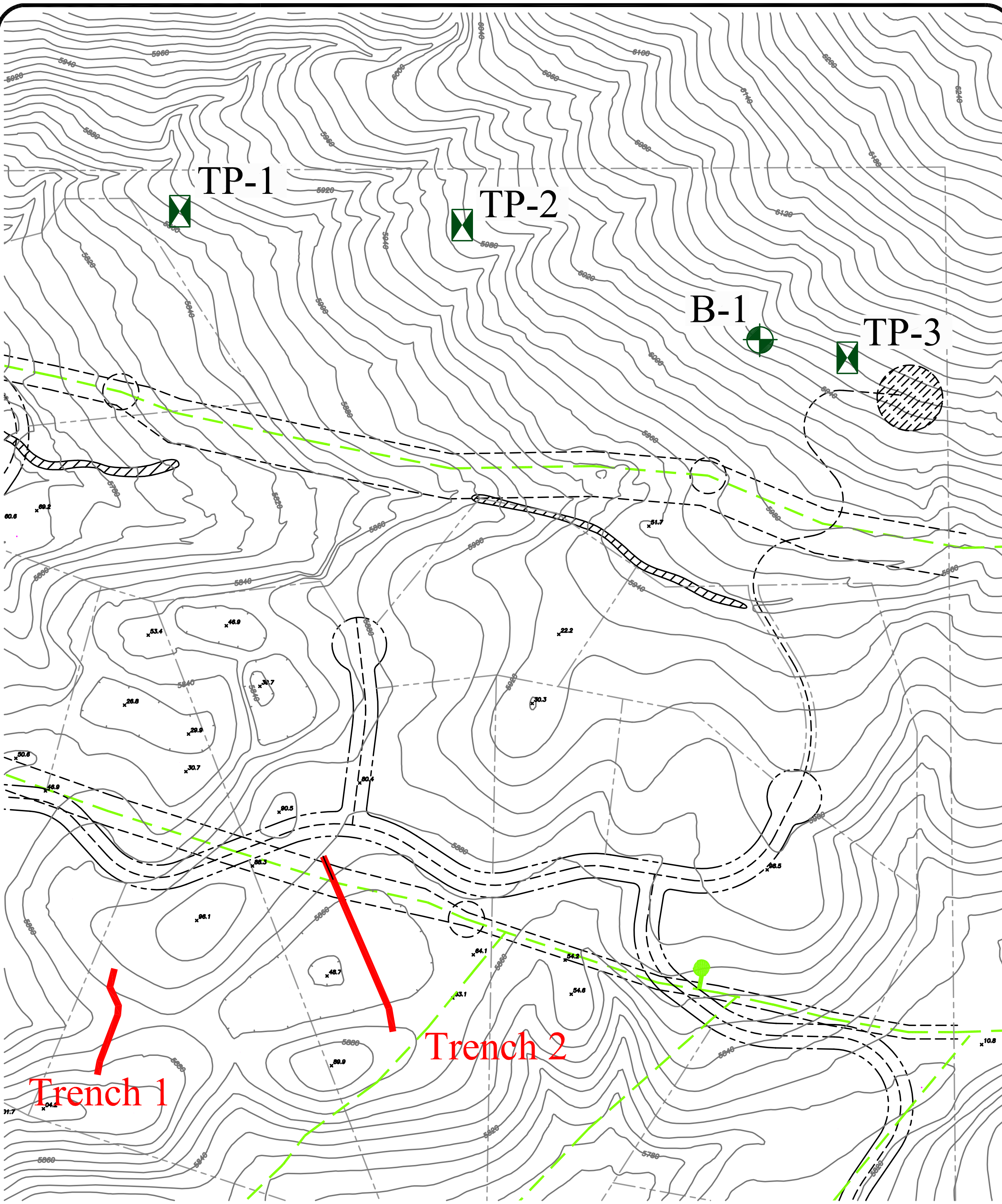


Plate	Landslide Investigation	Aerial Photo	IGES
A-2	Three Falls Ranch Alpine, Utah		Project Number – 00608-005



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7/12/05

dfn

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No.	Revision/Issue	Date

Landslide Investigation
Three Falls Ranch
Alpine, Utah

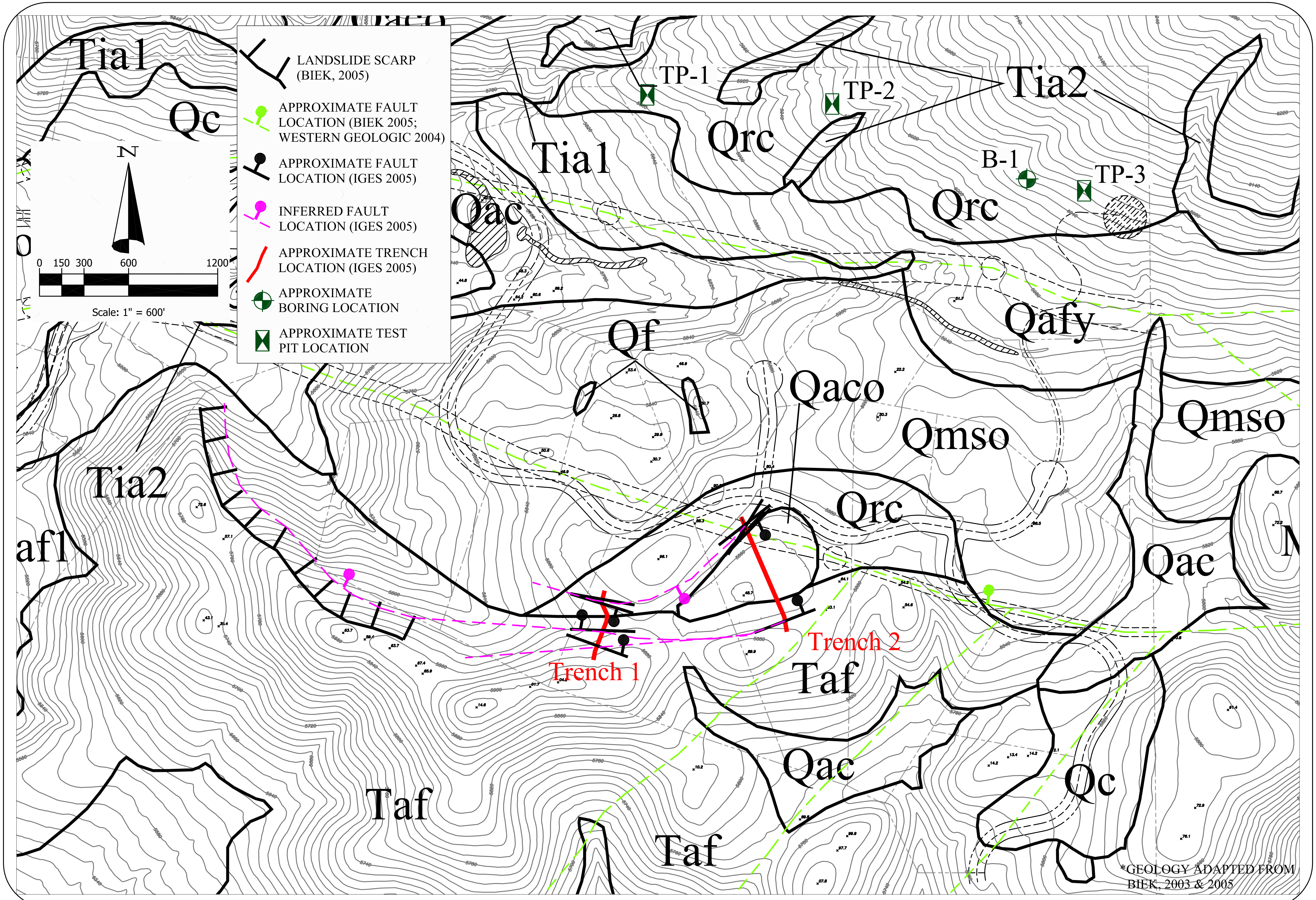
Project Number 00608-005

Exploration Locations

Drawing Notes

PLATE

A-3



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Drawing Notes

Site/Geologic Map

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Project Number 00608-005

No.	Revision/Issue	Date

PLATE
A-4

jah 7/18/05 I:\Projects\ 00608\005\ESP-LOC 005.dwg

DATE	
STARTED:	4/13/05
COMPLETED:	4/15/05
BACKFILLED:	

Three Falls Ranch

Alpine, Uah

Project Number 00608-005

IGES Rep: dfn
Rig Type: Core Rig
Boring Type: Borehole

BORING NO: **B-1**

LOCATION

NORTHING | EASTING | ELEVATION

DEPTH (METERS)	DEPTH (FEET)	SAMPLE TYPE	WATER LEVEL	RECOVERY PERCENT	RQD	DESCRIPTION OF ROCK QUALITY**	GRAPHICAL LOG	MATERIAL CLASSIFICATION	MATERIAL DESCRIPTION	N*	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0	0							GP GM	Gravelly SILT - brown, some clay, sand, and some cobbles, moist, soft to medium dense						
					0										
1									Highly weathered bedrock 2.3 to 26 feet monzo-granite/granodiorite - orange-brown, highly to completely weathered, very closely spaced to decomposed, very poor RQD, moderately strong to weak, recovered rock is very closely spaced to shattered and healed w						
	5														
2					0										
3	10		▽												
					12										
4									Closely spaced 13.5 to 14.5						
	15														
5					0										
					16										
									4 inch zone of moderately weathered, strong to moderately strong, green colored mass						
6	20								Closely spaced from 16.5 to 28 feet, fracture trends are near horizontal, with some orientations at approximately 30 degrees from horizontal						
7					0										
					18										

* N - UNCORRECTED, EQUIVALENT SPT BLOW COUNT

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
- ROCK CORE SAMPLE

****RQD KEY**

0-25%	**Very Poor (VP)**
25-50%	**Poor (P)**
50-75%	**Fair (F)**
75-90%	**Good (G)**
90-100%	**Excellent (E)**

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Plate

A - 5a

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ROCK LOG 608-005.GPJ IGES.GDT 7/12/05

DATE	STARTED: 4/13/05	Three Falls Ranch	BORING NO:
	COMPLETED: 4/15/05	Alpine, Uah	B-1
	BACKFILLED:	Project Number 00608-005	Sheet 2 of 4

IGES Rep: dfn
Rig Type: Core Rig
Boring Type: Borehole

LOCATION

NORTHING | EASTING | ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLE TYPE	WATER LEVEL	RECOVERY PERCENT	RQD	DESCRIPTION OF ROCK QUALITY**	GRAPHICAL LOG	MATERIAL CLASSIFICATION	MATERIAL DESCRIPTION	N*	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	25														
8									Closely spaced fractures						
									One inch bands of green colored rock from 26 to 37.5 feet, mineral grains appear foliated with orange-brown altered zones, healed fractures, fresh to moderately weathered						
					56										
9	30				75				Closely spaced fractures						
10									Closely to very closely spaced fractures						
									Minor clay along fracture, oriented approximately 40 degrees from horizontal						
	35				87										
11									37.5 to 99.7 generally gray to light gray monzogranite with large crystals of K-spar, some zones of alteration and healed fractures, iron oxide staining, orange brown						
12	40								Moderately to closely spaced fractures						
					23										
13															
	45								Closely to very closely spaced fractures						
14					75				Moderately spaced fractures						
15									Very closely spaced fractures						
					77										

* N - UNCORRECTED, EQUIVALENT SPT BLOW COUNT

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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
- ROCK CORE SAMPLE

RQD KEY
- **0-25% Very Poor (VP)**
- **25-50% Poor (P)**
- **50-75% Fair (F)**
- **75-90% Good (G)**
- **90-100% Excellent (E)**

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Plate
A - 5b

DATE	STARTED: 4/13/05	Three Falls Ranch	IGES Rep: dfn	BORING NO:
	COMPLETED: 4/15/05	Alpine, Uah	Rig Type: Core Rig	B-1
	BACKFILLED:	Project Number 00608-005	Boring Type: Borehole	Sheet 3 of 4

LOCATION: NORTHING | EASTING | ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLE TYPE	WATER LEVEL	RECOVERY PERCENT	RQD	DESCRIPTION OF ROCK QUALITY**	GRAPHICAL LOG	MATERIAL CLASSIFICATION	MATERIAL DESCRIPTION	N*	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	50								Moderately to closely spaced fractures						
16															
									Very closely spaced fractures						
	55				94				Closely spaced fractures						
17															
									Large inclusion 57 to 58 feet						
									Moderately to closely spaced fractures						
18															
	60				61										
19															
									Multiple fracture intersections, closely spaced fractures						
	65				42				Very closely spaced fractures						
20									Closely spaced fractures						
					54										
21															
	70														
22					100				Moderately to closely spaced fractures						

* N - UNCORRECTED, EQUIVALENT SPT BLOW COUNT

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
- ROCK CORE SAMPLE

**RQD KEY
- 0-25% **Very Poor (VP)**
- 25-50% **Poor (P)**
- 50-75% **Fair (F)**
- 75-90% **Good (G)**
- 90-100% **Excellent (E)**

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Plate
A - 5c

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DATE		Three Falls Ranch	BORING NO:
STARTED: 4/13/05		IGES Rep: dfn	B-1
COMPLETED: 4/15/05		Alpine, Uah	Sheet 4 of 4
BACKFILLED:		Rig Type: Core Rig	
		Boring Type:Borehole	
		Project Number 00608-005	

LOCATION

NORTHING EASTING ELEVATION

DEPTH (METERS)	DEPTH (FEET)	SAMPLE TYPE	WATER LEVEL	RECOVERY PERCENT	RQD	DESCRIPTION OF ROCK QUALITY**	GRAPHICAL LOG	MATERIAL CLASSIFICATION	MATERIAL DESCRIPTION	N*	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
23	75														
					89				Closely spaced fracture, discolor orange-red						
									2 inch zone multiple fracture intersection (very closely spaced)						
24					76				Moderately to closely spaced fractures						
	80														
25					0										
					67										
26	85				24				Closely ro very closely spaced fractures						
27															
	90				63				Closely spaced fractures						
28									Closely to very closely spaced fractures						
									Moderately to closely spaced fractures						
29	95				78				Closely to very closely spaced fractures, 2 inches alteration along fractures, slightly to moderately weathered, very strong						
									Moderately to closely spaced fractures						
30															

Bottom of Boring @ 99.7 Feet

N* UNCORRECTED, EQUIVALENT SPT BLOW COUNT

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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
- ROCK CORE SAMPLE

RQD KEY

0-25%	Very Poor (VP)
25-50%	Poor (P)
50-75%	Fair (F)
75-90%	Good (G)
90-100%	Excellent (E)

WATER LEVEL
▼ - MEASURED ▽ - ESTIMATED

Plate

A - 5d

DATE					
STARTED: 4/12/05	Three Falls Ranch	IGES Rep: dfn	TEST PIT NO:
COMPLETED: 4/12/05	Alpine, Uah	Rig Type: CAT 320	TP-1
BACKFILLED:	Project Number 00608-005		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	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 - brown, moist, loose to medium dense, some organics 0-12 inches, increasing gravel content with depth, with sand and cobbles, angular clasts, matrix consists of grussified material, all clasts consist of grainitic rocks						
1					Tia2	Weathered Bedrock (monzogranite) - orange-brown with green and some gray, closely to very spaced fractues, moderately to highly weathered in places, moderately strong to strong, moist, clasts have an exfoliated appearance, increasing competency with depth						
2	5											
3	10		▼									
4						Bottom of Test Pit @ 13 Feet						
5	15											
6												

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

WATER LEVEL
▼- MEASURED
▽- ESTIMATED

NOTES:

Plate

A - 6

DATE		
STARTED:	4/12/05	
COMPLETED:	4/12/05	
BACKFILLED:		

Three Falls Ranch

Alpine, Uah

Project Number 00608-005

IGES Rep: dfn

Rig Type: CAT 320

TEST PIT NO: **TP-2**

Sheet 1 of 1

LOCATION

NORTHING | EASTING | ELEVATION

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				ML	Gravelly SILT - brown, moist, soft to medium stiff, increasing gravel content, grussified						
					Tia2	Weathered Bedrock (monzogranite) - orange-brown with green and some gray, closely to very spaced fractues, moderately to highly weathered in places, moderately strong to strong, moist, clasts have an exfoliated appearance, increasing competency with depth						
1												
	5											
2												
3	10											
			▼ (measured)									
4						Bottom of Test Pit @ 13 Feet						
	15											
5												
6												

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

WATER LEVEL
- ▼ - MEASURED
- ▽ - ESTIMATED

NOTES:

Plate

A - 7

DATE		Project	IGES Rep. / Rig Type	TEST PIT NO:
STARTED: 4/12/05		Three Falls Ranch	IGES Rep: dfn	TP-3
COMPLETED: 4/12/05		Alpine, Uah	Rig Type: CAT 320	Sheet 1 of 1
BACKFILLED:		Project Number 00608-005		

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	Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 10 20 30 40 50 60 70 80 90)
0	0				GM	Siltly GRAVEL - brown green-brown, some orgaincs 0-12 inches, moist, loose to medium dense, increasinggravel content, grussified						
					Tia2	Weathered Bedrock (monzogranite) - orange-brown with green and some gray, closely to very spaced fractues, moderately to highly weathered in places, moderately strong to strong, moist, clasts have an exfoliated appearance, increasing competency with depth						
1	5											
2												
3	10											
4						Bottom of Test Pit @ 14 Feet						
5	15											
6												

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

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate

A - 8

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

MOISTURE CONTENT

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

GENERAL NOTES

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

STRATIFICATION

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

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

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

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

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNTRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
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.

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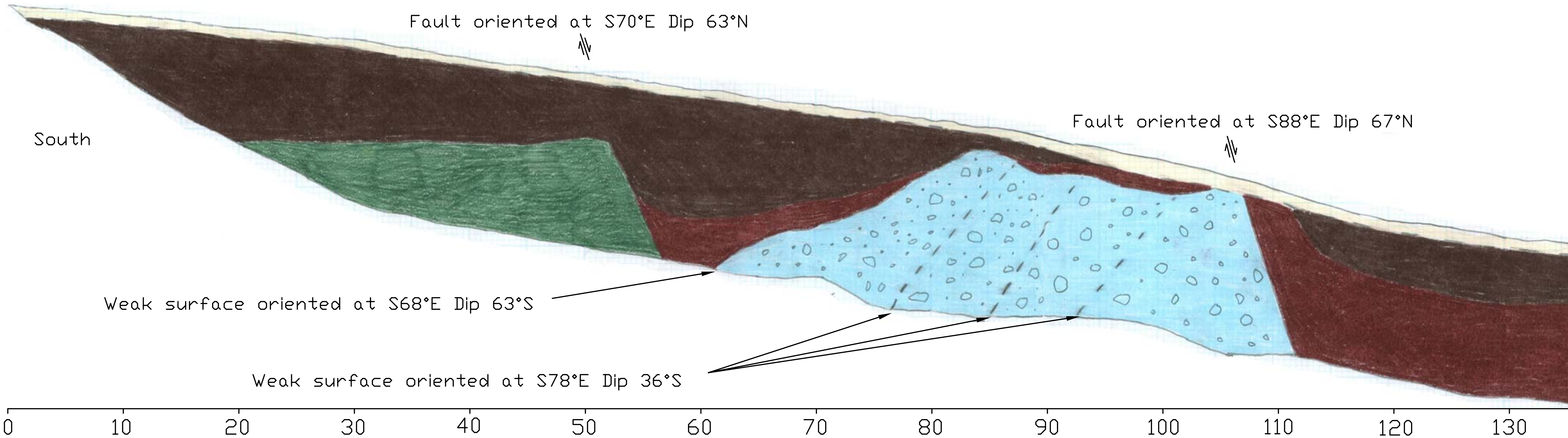
KEYLOGG H:\office\forms\USCS

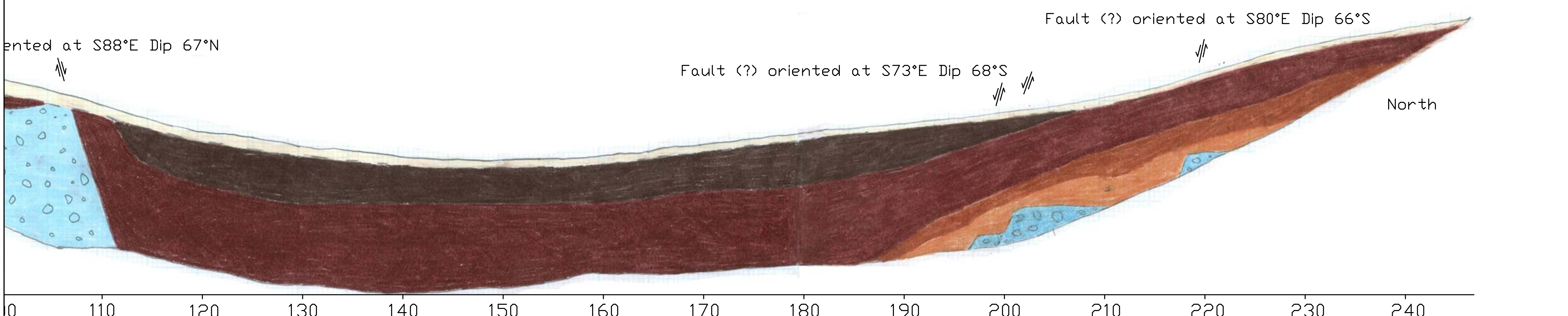
Project Number 00608-005

PLATE

A-9



Trench 1



MARK	REVISIONS	DATE	BY	CHK	MARK	REVISIONS	DATE	BY	CHK

CONSULTANTS:

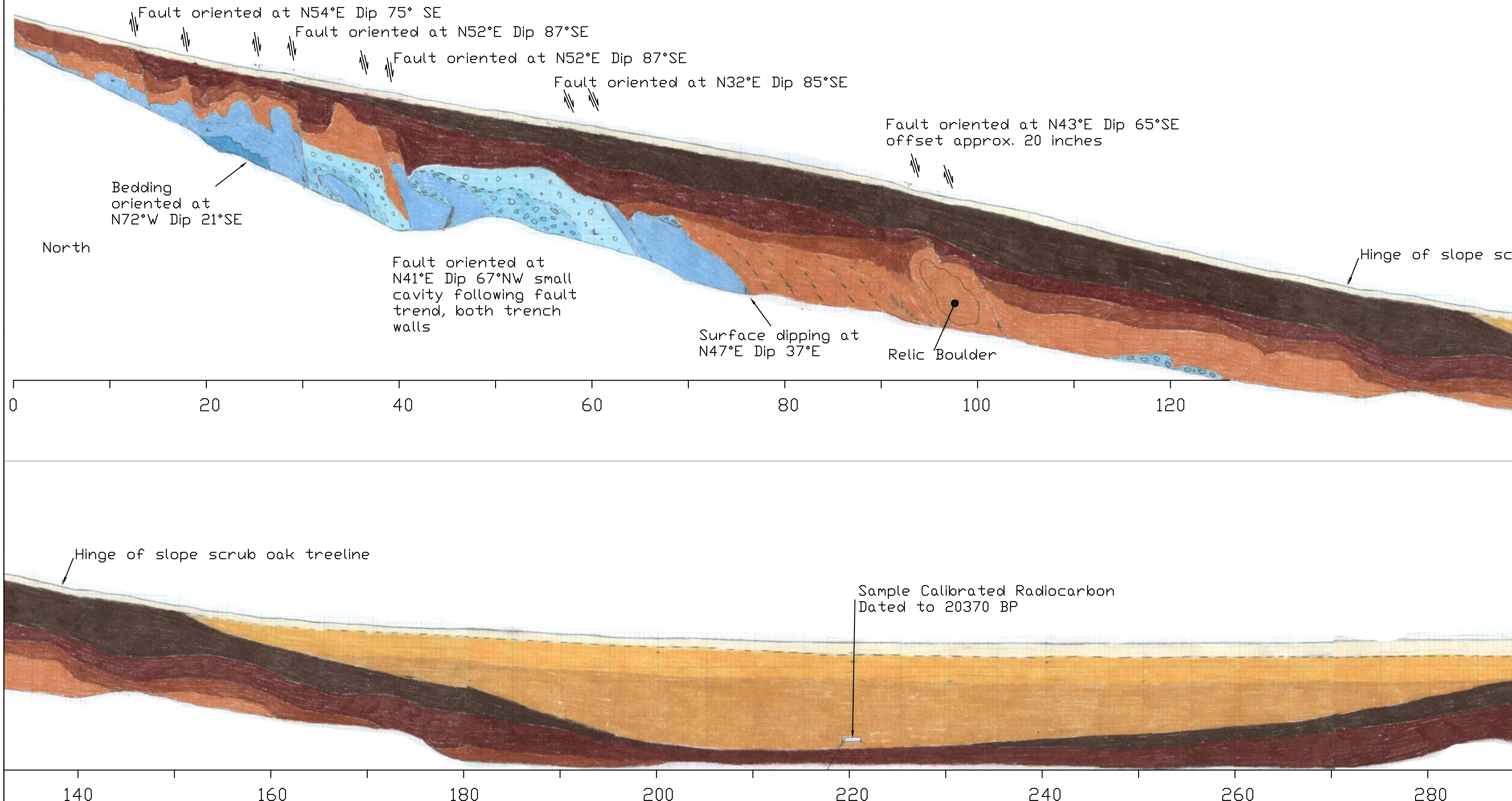
IGES
ideas for a changing world

4153 Commerce Drive
Salt Lake City, Utah
(801) 270-9400
(801) 270-9401 Fax

LANDSLIDE INVESTIGATION
THREE FALLS RANCH
ALPINE, UTAH
TRENCH 1 LOG

PLOT DATE: 7/20/05

DESIGNED BY: DATE:	-	APPROVED BY: DATE:	-
DRAWN BY: DATE:	DLB 7/20/05	PLOT SCALE	1=1
CHECKED BY: DATE:	DFN 7/20/05	DWG SCALE	1"=10'
PROJECT:	00608-005	REVISION NO:	1
DRAWING NO.	-	Plate	A-10a



MARK	REVISIONS	DATE	BY	CHK	MARK	REVISIONS	DATE	BY	CHK

CONSULTANTS:

IGES
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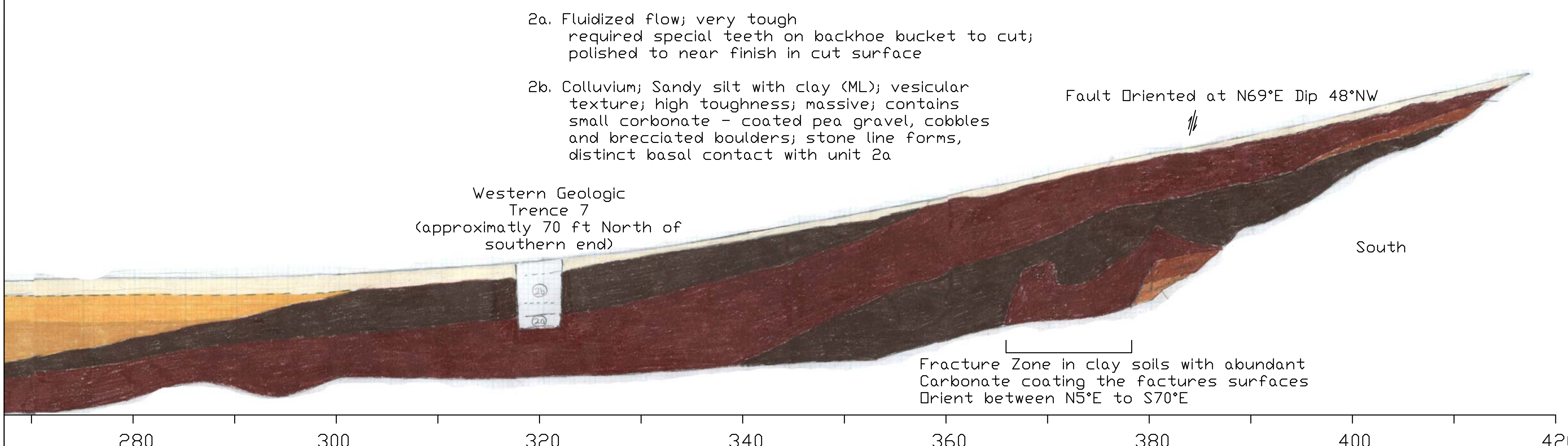
Salt Lake City, Utah
(801) 270-9400
(801) 270-9401 Fax

LANDSLIDE INVESTIGATION
THREE FALLS RANCH
ALPINE, UTAH
TRENCH 2 LOG

PLOT DATE: 7/20/05

DESIGNED BY: -		APPROVED BY: -	
DRAWN BY: DLB	DATE: 7/20/05	PLOT SCALE	1=1
CHECKED BY: DFN	DATE: 7/20/05	DWG SCALE	1"=10'
PROJECT: 00608-005		REVISION NO:	1
DRAWING NO. -		Plate	A-10b



MARK	REVISIONS	DATE	BY	CHK	MARK	REVISIONS	DATE	BY	CHK

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Salt Lake City, Utah
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LANDSLIDE INVESTIGATION
THREE FALLS RANCH
ALPINE, UTAH
TRENCH 2 LOG

PLOT DATE: 7/20/05

DESIGNED BY: DATE:	-	APPROVED BY: DATE:	-
DRAWN BY: DATE:	DLB 7/20/05	PLOT SCALE	1=1
CHECKED BY: DATE:	DFN 7/20/05	DWG SCALE	1"=10'
PROJECT:	00608-005	REVISION NO:	1
DRAWING NO.	-	Plate	A-10c

UNIT 12

Clayey SILT (ML) and Silty CLAY (CL) with varying amounts of sand and some cobbles, organic, roots, pinholes, dark brown, A horizon.

UNIT 11

Clayey SILT (ML) with sand, some gravels, subangular clasts of sandstone, some subangular to sub-rounded clasts of limestone, valley fill slopewash some weak bedding, some iron oxide staining, some clasts forming weak bedding trends dipping into the valley.

UNIT 10

Sandy SILT (ML) with trace to some gravel, iron oxide staining, weak horizontal bedding with iron oxide staining, lower portion dated to 19,400-21,360 yr cal B.P., possibly loess deposit.

UNIT 9

Silty CLAY (CL)/ Clayey SILT (ML) with sand, trace fine to medium gravel, low to medium plasticity, subangular clasts of sandstone/quartzite and trace to some limestone appears to be weathering from unit 7 possibly unit 6, massive with some clasts forming weak bedding dipping into the valley, valley fill slope wash.

UNIT 8

Silty SAND (SM) with gravel and trace cobbles, fine gravelly sized clasts of granite and some limestone decomposing cobbles of granite, possibly fill of the Dry Creek advance(Biek, 2005), middle Pliestocene.

UNIT 7

Clay (CH) with gravel – brown to red brown, containing angular to subangular clasts of sandstone/quartzite (orthoquartzite), typically massive with some clasts forming weak bedding features dipping into the valley depression.

Trench Log Unit Descriptions
Three Falls Ranch
Alpine, Utah

Plate A-11a

UNIT 6

Clayey GRAVEL (GC) – red-brown, highly plastic clay (CH), containing angular clasts of very strong to strong sandstone/weak quartzite (orthoquartzite), overlies unit 5.

UNIT 5

Poorly graded GRAVEL (GP) brecciated (crushed) orthoquartzite, (Doughnut Formation, Upper Mississippian, (Biek, 2005)), brecciated limestone and marble is overlain by similar calcareous sandstone and orthoquartzite, highly fractured (Biek, 2005) – orange, consisting of very angular to angular clasts of very strong sandstone/weak quartzite, in some areas consists of highly fractured cobble and relic boulders; overlies units 2 and 3.

UNIT 4

Silty GRAVEL (GM) with cobbles of limestone and sandstone. Quartzite, carbonate coated clasts.

UNIT 3

Silty GRAVEL (GM) with cobbles and boulders of limestone, carbonate coatings, subangular to subrounded clasts, appears to be weathering from units 1 and 2.

UNIT 2

Highly weathered Limestone/Marbleized Limestone – very closely spaced fractures, crushed to pulverized, highly to completely weathered, relic rock features such as calcite veins; in some areas material is thinly foliated with near vertical orientations with variations, the material has a sheared appearance (Trench 2 at approx. 45 and 70 feet).

UNIT 1

Limestone/Marbleized Limestone bedrock (Doughnut Formation, Upper Mississippian, (Biek, 2005)) – moderate to closely spaced fractures, fractures open with carbonate precipitate with popcorn appearance on surfaces, moderately to highly weathered, strong to moderately strong.

Trench Log Unit Descriptions
Three Falls Ranch
Alpine, Utah

Plate
A-11b

APPENDIX B

Plate			
B-1a	Landslide Investigation Three Falls Ranch Alpine, Utah	**B-1 Core Photo Log** **0 to 26.9 Feet**	IGES Project Number – 00608-005

Plate **B-1b**	Landslide Investigation Three Falls Ranch Alpine, Utah	**B-1 Core Photo Log** **26.9 to 43.8 Feet**	IGES Project Number – 00608-005


Box 5


Box 6

Plate B-1d	Landslide Investigation Three Falls Ranch Alpine, Utah	**B-1 Core Photo Log** **61.1 to 78.5 Feet**	IGES Project Number – 00608-005

Plate **B-1e**	Landslide Investigation Three Falls Ranch Alpine, Utah	**B-1 Core Photo Log** **78.5 to 95.6 Feet**	IGES Project Number – 00608-005


Box 11

South

North

0'

80'

IGES

Project Number – 00608-005

Trench 1 Photo Log
0 to 80 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Plate
B-2a

South

North

80’

160’

Project Number – 00608-005

Trench 1 Photo Log
80 to160 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Plate
B-2b

South

North

160’

247’

![IGES]

Project Number – 00608-005

Trench 1 Photo Log
160 to 247 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Plate
B-2c

North

South

0’

80’

IGES

Project Number – 00608-005

Trench 2 Photo Log
0 to 80 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Plate
B-3a

North

South

80’

160’

Trench 2 Photo Log
80 to 160 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

IGES

Project Number – 00608-005

Plate

B-3b

North

South

160’

240’

IGES

Project Number – 00608-005

Trench 2 Photo Log
160 to 240 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Plate
B-3c

North

South

240’

320’

IGES

Project Number – 00608-005

Trench 2 Photo Log
240 to 320 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Plate
B-3d

North

South

410’

320’

Trench 2 Photo Log
320 to 410 Feet

Landslide Investigation
Three Falls Ranch
Alpine, Utah

Project Number – 00608-005

Plate
B-3e

APPENDIX C

Dr. David Nielsen | Report Date: 6/27/2005

IGES | Material Received: 6/17/2005

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 205978	17080 +/- 290 BP	-23.0 o/oo	17110 +/- 290 BP

SAMPLE : IGESTRENCH2 220@10
ANALYSIS : Radiometric-Priority delivery (bulk low carbon analysis on sediment)
MATERIAL/PRETREATMENT : (organic sediment): acid washes
2 SIGMA CALIBRATION : Cal BC 19410 to 17450 (Cal BP 21360 to 19400)

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23:lab. mult=1)

Laboratory number: **Beta-205978**

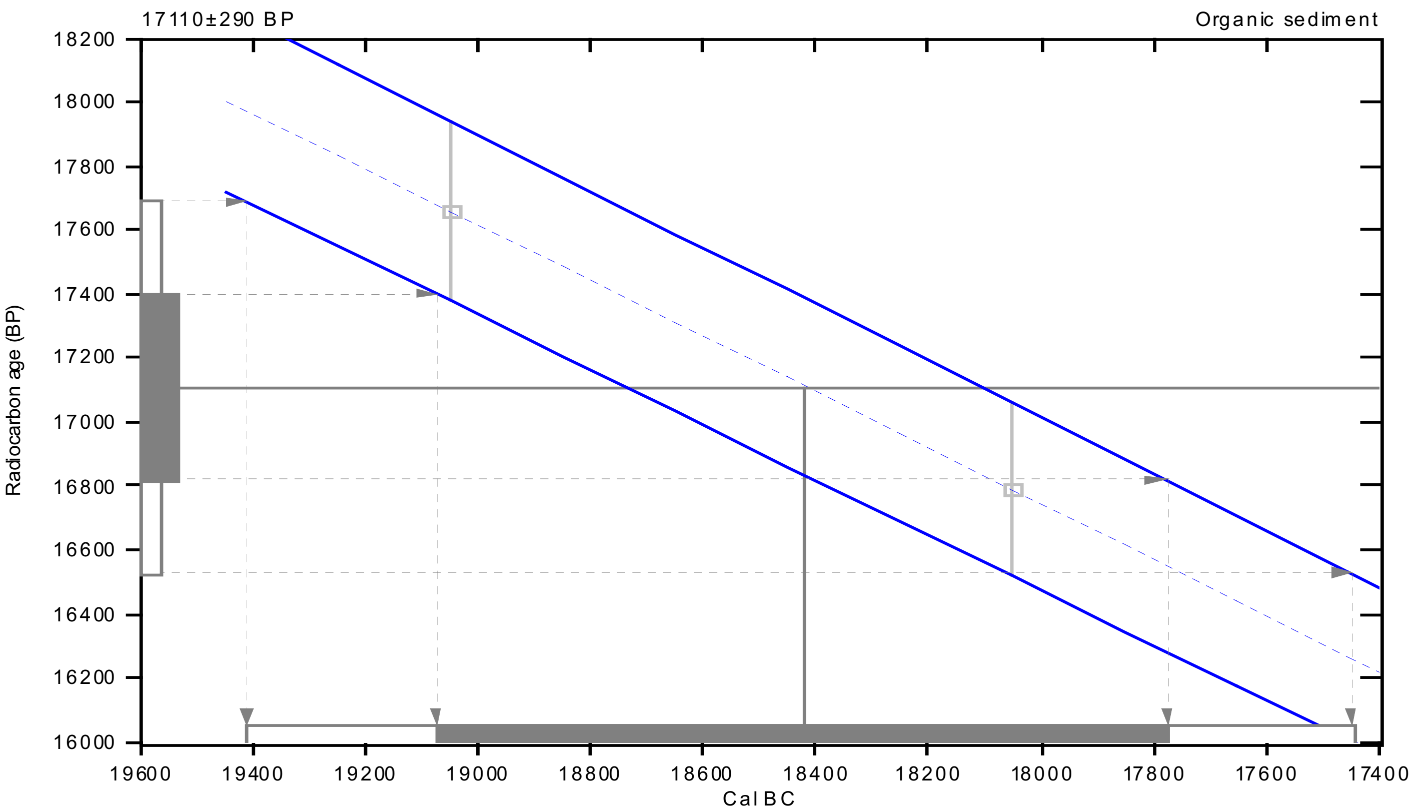
Conventional radiocarbon age: **17110±290 BP**

2 Sigma calibrated result: (95% probability) **Cal BC 19410 to 17450 (Cal BP 21360 to 19400)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 18420 (Cal BP 20370)

1 Sigma calibrated result: (68% probability) Cal BC 19080 to 17780 (Cal BP 21030 to 19730)



References:

Database used
INTCAL98
Calibration Database
Editorial Comment
Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii
INTCAL98 Radiocarbon Age Calibration
Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory

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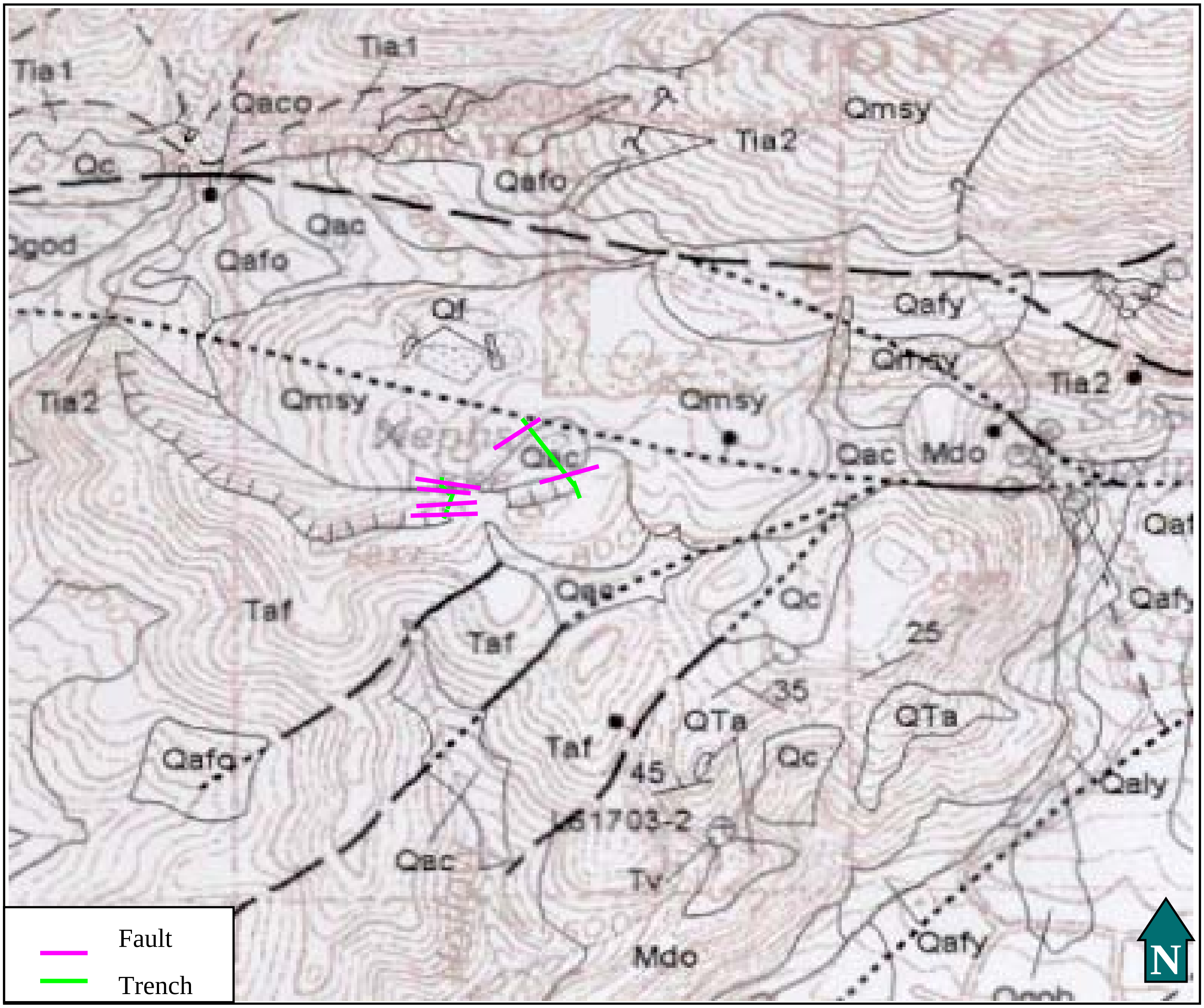
APPENDIX D



Qsmy	**Younger Landslide deposits (Holocene to late Pleistocene) –** very poor sorted, clay- to boulder- size locally derived material deposited by rotational and translational movement; hummocky topography.
Qafy/ Qafo	**Younger undifferentiated and Older alluvial-fan deposits (Holocene to uppermost Pleistocene) –** Qafy is equivalent to modern and level-2 alluvial-fan deposits, but undifferentiated because units are complexly overlapping or too small to show separately; upper parts of fans are locally deeply incised. Qafo is similar to (Qafy), but forms deeply dissected alluvial apron truncated by, and thus predating, the Bonneville shoreline
Qac/ Qaco	**Alluvial and colluvial deposits (Holocene to upper Pleistocene) –** Poorly to moderately sorted, generally poorly stratified, clay- to boulder-size, locally derived sediment deposited in swales, small drainages, and upper reaches of larger ephemeral streams by fluvial, slopewash, and creep processes.
Qc/Q mso	**Colluvial deposits over older mass-movement deposits (Holocene to upper Pleistocene) –** Interpreted to be older landslide deposits concealed by a thick cover of colluvium, both of which were derived from highly fractured Oquirrh Group orthoquartzite in a sandy matrix.
Tia1	**Fault slip zone –** Consists of cataclasite and phyllonite that each contain two syndeformational mineral assemblages, including an early, higher temperature epiodote-chlorite-sericite-magnetite assemblage and a later, lower temperature laumontite-prehnite-hematite assemblage found in cross-cutting veins.
Tia2	**Transition zone –** Hydrothermally altered and fractured monzogranite and granodiorite of Little Cottonwood stock; weathers to grussified soils.
Mdo	**Doughnut Formation –** White to light-gray, medium- to coarse grained marble and marble breccia overlain by similarly brecciated calcareous sandstone and orthoquartzite.

BASE MAP: INTERIM GEOLOGIC MAP OF THE LEHI QUADRANGLE, SALT LAKE AND UTAH COUNTIES, UTAH By Robert F. Biek Published by the Utah Geological Survey, 2005

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Landslide Investigation
Three Falls Ranch
Alpine, UT

SITE GEOLOGIC MAP

Plate D-1