Geotechnical Report

Nile Valley Landslide

State Route 410, Mile Post 107.55 to 108.30
Yakima County, Washington
DME-057 & XL-3695

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EXECUTIVE SUMMARY

On Sunday morning October 11th, 2009 a very large landslide destroyed more than 2000 feet of State Route 410 at mile post (MP) 108, which is located about 25 miles northwest of Yakima, Washington (Fig. 1). Four of the five private residences sited on the landslide were severely damaged, and the other was entirely buried in the debris. A gravel mine operating on the southern flank of the landslide was similarly inundated by the debris. Landslide-related uplift of the Naches River channel and runout of landslide debris diverted the river flow onto the right bank of the floodplain. The unchannelized flow of the river subsequently caused significant flood damage to four additional private residences. Fortunately, no injuries or deaths resulted, and an existing county road situated on the opposite side of the river was available as a convenient 3-mile-long detour route for the highway. State and Federal emergency declarations were made shortly following the landslide to aid in the emergency response efforts. In the weeks immediately following the landslide, a massive effort was undertaken by federal, state, and county agencies to acquire private property and to construct a new river channel and a more flood-resistant detour route around the landslide.

In response to this catastrophic landslide event, a geotechnical study has been undertaken by the WSDOT Geotechnical Division to:

1. identify and characterize factors contributing to landsliding;
2. evaluate the current stability of the landslide portion adjacent to the highway; and,
3. if feasible, develop alternatives to reestablish the highway on or near the existing alignment.

The landslide is located on the semi-arid, lower eastern slope of the Cascade Mountains within the relatively narrow and incised Naches River valley at around 1900 feet elevation (Figs. 1 and 2). Bedrock within the landslide area consists of Grande Ronde Basalt (GRB) flows separated by sedimentary interbeds of claystone/siltstone, sandstone, and conglomerates. Tectonic compression has unfavorably tilted bedrock southwest toward the valley between approximately 10° and 20° (Fig. 3). Large-scale landsliding is common within the area (Fig. 4). The primary geologic control on these large landslides is believed to involve the weak sedimentary interbeds between GRB flows or sedimentary and/or pyroclastic units beneath the GRB, combined with the unfavorable effects of tectonic folding.

The earliest aerial photographs from 1949 show an abundance of interpreted landslide and slope deformation features over the entire Nile Valley landslide area (Fig.5). A large slope failure occurred in the western limits of the landslide area in Domain A in 1956. Mining of the gravel pit started around 1956. Aerial photographs from 1998 show the first development of a tension crack in the upper cliffs above the mine and progressive growth until the landslide occurred in October 2009 (Figs. 6 and 7). This 11-year period represents the initial phase of landslide development.

The first substantive movement started around 11am Saturday October 10th, 2009, and following a 12-hour hiatus, began to fully develop around 2 am Sunday October 11th. By 8am the highway was completed inundated/destroyed by a slowly advancing debris front, representing failure along a shallow interpreted failure zone. Around 9:45am, a second phase of movement, involving a much deeper zone of failure, produced a nearly continuous zone of uplift beyond the

debris front. This second phase of movement persisted for hours into the afternoon-evening. Based on the eyewitness accounts and geomorphic interpretation of the landslide features, the landslide initiated near the western margin of the Simmons Pit along Domains C and D, and spread westward into Domains B and A (Figs. 8 and 9).

From the borings, we have interpreted a shallow and a deep failure zone, both of which we believe were involved in landsliding. The shallow failure zone is located at the base of the cobble-boulder deposits that blanket the landslide mass, typically to depths of 60 to 110 feet (Figs, 13, 14, and 15). A wet, very weak, clay-rich zone was encountered at the base of these surficial landslide deposits, overlying sedimentary or basalt rock units. The geologic contact between these units is characteristically planar and coincident with slope, dipping downslope between 13° and 18°. With the dip of this contact being at or somewhat steeper than its residual shear strength, a condition of marginal stability or instability exists within this clay-rich zone and the overlying landslide deposits. We have interpreted a deep failure zone within a 20-foot-thick unit of highly disrupted and hydrothermally altered, very weak claystone/siltstone on top of the Grouse Creek Basalt, located between 225 and 265 feet below the ground surface and which dips downslope between 17° and 22° (Figs. 14 and 15). This unit is associated with an extremely pressurized aquifer at the contact with the Grouse Creek Basalt that generates a piezometric surface more than 100 feet above the ground surface.

Prior to the October 11th, 2009 landslide, there was abundant geomorphic evidence of multiple small to large-scale landslide events of unknown age within the landslide area. A number of unfavorable geologic and hydrogeologic conditions predispose the landslide area to both shallow failure within the overlying surficial deposits and deep failure within the bedrock. Both failure mechanisms result primarily from the nature and orientation of the underlying bedrock within the synclinal structure along the valley margin. We envision that the evolution of landsliding involves a continual process of back-wasting of the upper cliffs, primarily by rockfall, and the accumulation of thick talus deposits along the upper margin of the landslide area. This back-wasting and accumulation accelerates immediately following large-scale landslide events, like the October 11th event, due to the expanded oversteepened area produced along the new headscarp. These accumulated deposits surcharge the upper landslide area, and thereby reduce stability within both the shallow and deep failure zones. Landsliding within the shallow failure zone is likely the dominant mechanism controlling the small to moderate-scale landslide events, effectively acting as a conveyor belt to episodically/continually transport and disperse these coarse cobble-boulder deposits downslope. At less frequent intervals, conditions of instability are sufficient to generate deep failures within the bedrock and large-scale landslides.

The trigger(s) for the acceleration and growth in lateral and vertical extent of the October 11th, 2009 landslide event is not known. The landslide did not occur during or following a period of heavy precipitation, nor were any proximal seismic events of significance recorded in the year preceding failure. The influence of mining within the Simmons Pit on slope stability was outside the scope of our investigation, and remains an unanswered question. It has been our experience that a rapid increase in landslide movement can develop after a long period of slow strain, with no apparent triggering mechanism. Further study by others is required, and even after such effort, a triggering mechanism(s) might not be confidently determined.

Based on the monitoring data to date, very little movement has occurred within the landslide area since the October 11th event.

Slope movement and development of the tension crack within Domain A was accommodated within the shallow failure zone; bedrock apparently was not involved (Fig. 13). Since very little change in the slope profile occurred in Domain A, the surficial deposits remain marginally stable. Based on the available data, the calculated factor of safety for a deep failure within the bedrock is at least 1.25, and thus the failure risk is believed to be relatively low.

There was considerable change from the pre- to the post-landslide topography within Domain B (Fig. 14). As a result, there has been a significant improvement in the stability of Domain B for the shallow and deep failure zones, FS≈1.3 and 1.5, respectively.

Despite the large magnitude of landslide movement within Domain C, the change between the pre- and post-landslide topography is relatively minor (Fig. 15). The calculated factors of safety for the current conditions for the shallow and deep failure zones are both around 1.04, indicating that the slope remains marginally stable for both failure conditions.

The current state of stability within Domain D was not investigated and is therefore not known.

Several hundred feet of lateral displacement of the Nile Valley landslide generated a very steep, 100 to 200-foot-high headscarp along the upper cliffs. As the cliffs are comprised of debris from the Sanford Pasture landslide complex, there is a potential concern for loss of toe support and the resultant destabilization/reactivation of a portion of the Sanford Pasture complex. We have interpreted the Nile Valley landslide and the Sanford Pasture landslide complex as two separate landslides with different basal failure zones and separated by the Nile thrust fault. Geomorphic conditions of these landslides suggest that the Nile Valley landslide has been a feature of recurrent instability, whereas the western portion of the Sanford Pasture complex has been a comparatively dormant/metastable feature. For these reasons, we think the recent movement of the Nile Valley landslide likely had very little adverse impact on the Sanford Pasture landslide.

Our evaluation of the current state of stability found that Domain B exceeds our design standard of FS≥1.25 for both the shallow and deep failure zones for static conditions (no seismic loads). Domains A and C, however, remain very marginally stable in their current state, so mitigation will be required for alignment alternatives on or near the landslide toe area within these domains.

For Domain A, a shear key-buttress constructed on the midslope bench, possibly with some regrading of the upper area, could mitigate for the current marginal state of stability (Fig. 18). It may be possible to utilize on-site materials to construct the buttress through relatively minor regrading of the slope. Three to five additional deep borings will be needed to confirm the viability of this stabilization concept and to develop PS&E-level design recommendations.

As the current stability of Domain B meets our design standard (FS≥1.25), no additional stabilization work is required for alignment alternatives within this domain.

Within Domain C, we have developed two potential alignment alternatives around the toe of the landslide through this domain (Fig. 19). The first is an avoidance alternative that routes the highway on a large fill section roughly 200 feet beyond the landslide toe. Because no landslide stabilization is involved with this avoidance alternative, the highway remains at some risk to runout of debris from future potential landsliding. In our judgment, the risk of future inundation by landslide debris for this alternate alignment option is low. A second alternative would involve stabilizing the landslide with a large berm located on the landslide toe, which could also include some regrading of the upper landslide area. Conceptually, the berm would be on the order of 30 to 70 feet high and 200 to 300 feet in width, resulting in a new highway grade about 50 feet in elevation above the former highway grade. Along with the berm, we considered regrading of the upper landslide area, which potentially could provide on-site materials for the berm.

The allowance and potential impacts of future mining within or near Domain C cannot be fully anticipated at this time. Due to the proximity of these alignment alternatives near/on the landslide toe, future mining plans should be geotechnically evaluated and modified, if necessary, to ensure no adverse impacts to a new highway facility in this location.

INTRODUCTION

On Sunday morning October 11th, 2009 a very large landslide destroyed more than 2000 feet of State Route 410 at mile post (MP) 108, which is located about 25 miles northwest of Yakima, Washington (Fig. 1). Four of the five private residences sited on the landslide were severely damaged, and the other was entirely buried in the landslide debris. A gravel mine operating on the southern flank of the landslide, along with several pieces of construction equipment, was similarly inundated by the landslide debris. Landslide-related uplift of the Naches River channel and runout of landslide debris diverted the river flow onto the right bank of the floodplain. The unchannelized flow of the river subsequently caused significant flood damage to four additional private residences. Fortunately, no injuries or deaths resulted, and an existing county road situated on the opposite side of the river was available as a convenient temporary 3-mile-long detour route for the highway. However, with the pending winter highway closure at Chinook Pass and the imminent threat of heightened fall-winter river flows flooding the detour route, more than 500 up-valley residents faced being cut off. State and Federal emergency declarations were made shortly following the landslide to aid in the emergency response efforts. In the weeks immediately following the landslide, a massive effort was undertaken by federal, state, and county agencies to acquire private property and to construct a new river channel and a more flood-resistant detour route around the landslide. To date, about $15 million have been spent on restoring access, building the temporary detour route, constructing a new river channel, and investigating long-term alternatives for reestablishing the highway.

In response to this catastrophic landslide event, this geotechnical study has been undertaken by the WSDOT Geotechnical Division to:

1. identify and characterize factors contributing to landsliding;
2. evaluate the current stability of the landslide portion adjacent to the former highway; and,
3. if feasible, develop alternatives to reestablish the highway on or near the existing alignment.

GEOTECHNICAL INVESTIGATION

The investigation phase of this study consisted of the following elements:

- Review of available geologic and geotechnical maps, papers, and reports of the area
- Compilation of eyewitness reports of the landslide occurrence
- Review of seismic records before, during and after the landslide, as well as seismic monitoring after the landslide
- Review of aerial photographs from 1949 to 2009
- Geomorphic and geologic mapping of the site and surrounding area
- Drilling test borings and installing geotechnical instrumentation
- Oriented borehole logging of sedimentary interbeds
- Monitoring landslide movement with instrumentation and remote sensing methods
- Laboratory testing of soil and rock samples

LITERATURE REVIEW

Extensive geologic mapping has been ongoing in the area since the late 1970s, and numerous published and unpublished maps and reports are available or have been considered by later

workers. Some of this work culminated recently in the 1:24,000-scale geologic mapping of the immediate area by Hammond (2009). Limited geotechnical documents are available that are relevant to our investigation. We also queried and reviewed water well reports from the Washington Department of Ecology Well Logs database (WDOE, 2010). In addition, we reviewed various documents provided to us by the Washington Department of Natural Resources regarding surface mining inspection and regulatory oversight of the Simmons Pit.

EYEWITNESS REPORTS

Interviews of eyewitnesses were conducted by the WSDOT Geotechnical Division to determine the timing and varied nature of the landslide deformation. Some of the reports were supplemented with photo and video documentation. These reports were compared with seismic records supplied by the Pacific Northwest Seismograph Network office at the University of Washington to better constrain the timing of major landslide events. A timeline was prepared from these eyewitness reports and supporting data, which is summarized in a spreadsheet in Appendix E.

SEISMIC MONITORING

Two permanent seismic stations located near Naches and Ellensburg, which are monitored by the Pacific Northwest Seismograph Network (PNSN), detected seismic signals on both Saturday October 10th and Sunday October 11th, 2009 that were associated with major landslide events. PNSN provided WSDOT a time history plot of these seismic events, which is included in Appendix E. At their initiative, PNSN also deployed additional seismometers on site for several months after the landslide to monitor for seismic activity related to further potential landslide movement. Real-time monitoring was possible when cellular phone service was available and when sufficient daylight could recharge solar-powered batteries. Data from the on-site seismometers were often useful for comparing with other sources of deformation monitoring.

AERIAL PHOTOGRAPHY INTERPRETATION

Historical aerial photographs were acquired from federal and state sources for interpretation of land use, geologic conditions, and prior landslide activity (Table 1).

Table 1. Historical aerial photographs

DATE	SCALE	PHOTO #	SOURCE
7/1/49	1:24,000	NL-7F-108 to 7F-110 and NL-7F-52 to 7F-54	USDA
8/6/58	1:14,800	A-44-1-1 to A-44-1-3	WSDOT
8/21/61	1:6,000	E55-3-23 to E55-3-26	WSDOT
8/19/66	1:24,000	5-410 3-36 to 3-37	WSDOT
7/24/80	1:24,000	5-410 31-302 to 31-303	WSDOT
6/20/92	1:24,000	5-410 36-346 to 36-348	WSDOT
7/18/98	1:24,000	Yakima County 5-97 to 5-98	WSDOT
9/19/05	1:24,000	Yakima County 3-37 to 3-39 and 4-37 to 4-39	WSDOT
2006	1:24,000	Yakima County orthophotos	NAIP
6/2/09	1:24,000	WA090602A 0012-0016	WDNR
10/12/09	1:6,000	3907-0-24 12-6 to 12-8 and 13-4 to 13-7	WSDOT

GEOLOGIC MAPPING

Following the landslide, high resolution topographic data was acquired, initially by high density laser scanning and later by airborne LiDAR, to develop a digital terrain model. In addition, low elevation aerial photography was flown. Together, these data sources were used for detailed geologic and geomorphic mapping of the landslide and surrounding area. Good quality orthophotos were also available from 2005, from which a pre-landslide digital terrain model was prepared using photogrammetric methods. These two data sets allowed for a comparison of pre- and post-landslide topography.

Published and unpublished 1:24,000 geologic mapping by Hammond was referred to for more detailed mapping of the landslide area. Our mapping included documentation of landslide and other geomorphic features in the vicinity of the landslide, geologic units exposed within the immediate area, and hydrologic features. GPS measurements were used to locate some of the landslide features, and conventional surveying was used to locate test borings. These data were compiled in GIS for various map products.

Pre- and post-landslide topography for four critical cross sections, labeled A-A', B-B', C-C', and D-D', were extracted from the LiDAR and photogrammetric data, and geologic, geomorphic, and hydrogeologic information identified from the mapping and borings were then added. Sections A, B and C were then used as a basis for stability analyses and the evaluation of mitigation alternatives.

SUBSURFACE EXPLORATION

As part of this investigation, 23 test borings were drilled at 14 locations between October 2009 and January 2010 (Fig. 2). Nineteen of the test borings were drilled by WSDOT personnel using track and truck-mounted drill rigs. The other four borings, which were located on the upper portion of the landslide (H-12si09, H-13p-09, H-22vw-09, and H-24vw-09), were drilled by CRUX Subsurface using two helicopter-supported drill rigs. Borings were advanced by wet rotary method using an HQ3 triple tube core barrel. HW casing with a tricone-type advancer, and sometimes larger diameter PW casing, was used through the surficial deposits and socketed into rock to ensure drill fluid return and to aid in the installation of instrumentation. Due to the coarse-grained nature of the surficial deposits, Standard Penetration Tests (ASTM D 1586) were performed where feasible in the surficial deposits and intermittently within sedimentary interbeds. Over-sized drive samplers were sometimes used to improve sample recovery in some degraded and/or critical zones. Samples were collected and drilling conditions were logged by a WSDOT drill inspector under guidance from a WSDOT licensed engineering geologist. Descriptions of subsurface soil and rock encountered, groundwater conditions, relative soil density, and borehole completion were recorded following WSDOT Geotechnical Division protocol. All recovered samples and core were reviewed in detail by a licensed WSDOT engineering geologist prior to finalizing boring logs, which are included in Appendix A.

To better characterize the continuity and orientation of bedrock units between borings, sedimentary units within three borings (H12-09, H-23-09, and H24-09) were surveyed with a proprietary downhole method, referred to as CRUX optical borehole logging (COBL). The instrument provides location and structural orientation of features exposed in the borehole wall. The data was then screened with core photographs and sample inspection to extract bedding

surfaces. These data were then plotted on equal angle stereonets and further evaluated for consistency. The methods and results of the COBL along with the stereonets for each boring are included in Appendix B.

GEOTECHNICAL INSTRUMENTATION

Geotechnical instrumentation was installed within the landslide area. Instrumentation was used to monitor precipitation at the site, groundwater conditions within and around the landslide, and to characterize the depths, direction, and rates of landslide movement.

Precipitation at the site was monitored with a tipping-bucket rain gauge connected to an electronic data logger, which collected data on four-hour intervals.

During drilling, fluid levels within the drill casing were typically measured every morning prior to the resumption of drilling. Slug tests were also periodically performed in a number of borings during and/or after termination of drilling. Prior to constructing piezometers, test borings were flushed with clean water and often bailed to monitor recharge. Two types of piezometers were installed in ten of the borings to monitor groundwater conditions. Vibrating wire piezometers were permanently grouted into zones of pressurized groundwater or other zones of interest within the sedimentary interbeds and basalt units. Open standpipe piezometers were installed within shallow unconfined aquifers in the surficial deposits. Groundwater levels within the standpipes were monitored with vibrating wire pressure transducers. All piezometers were connected to electronic data loggers, which collected data on four-hour intervals. Graphs of piezometric levels with precipitation are included in Appendix C.

Two types of instrumentation were installed in 14 of the test borings to measure lateral movement within the landslide. Slope inclinometer casing was installed in 11 borings, and coaxial cable was installed in three of the deepest borings and monitored by time domain reflectometry (TDR) method. Within the inclinometer casing, an inclinometer probe measures the biaxial inclination (N-S and E-W) of the casing on 2-foot intervals with an accuracy of about 0.01 inch. Subsequent measurements are compared to an initial reading to determine depth, direction, and rates of horizontal movement. TDR is a method that measures electrical impedance in a coaxial cable caused by deformation in the cable. An advantage over inclinometer casing is that the more flexible coaxial cable can withstand greater deformation and still yield data. TDR is considerably less accurate and precise than inclinometers; gross movements of around an inch that occur within a short discrete shear zone should be detectable. However, more disperse zones of movement may not be detectable. TDR cable was installed in the two 500-foot-deep borings (H-22-09 and H-24-09), due to the logistical difficulties of monitoring inclinometers at these sites. TDR cable was also installed in H-16-09 that encountered extreme hydrostatic pressures, due to the difficulties of installing the inclinometer casing. Inclinometer and TDR plots are provided in Appendix C.

SURVEYING AND REMOTE SENSING

A variety of airborne and ground-based remote sensing methods were used to develop digital terrain models (DTM) and to monitor for slope movement. WSDOT Geographic Services produced a pre-landslide DTM from 9/19/2005, 1:24,000-scale orthophotography with an approximate accuracy of ±5.0 ft. A post-landslide DTM was produced at a scale of 1:10,000

from 10/20/09, 1:6,000-scale photography with an approximate accuracy of ±0.5 ft merged with airborne LiDAR (acquired by Watershed Sciences on October 27-28th, 2009) with an approximate accuracy of ±0.1 ft.

WSDOT Geographic Services employed their short-range laser scanner to periodically monitor for slope movement along the landslide toe. The laser scanner has a reported accuracy of 6 mm at a range of 50 meters. Comparative scans taken on October 15th, 2009 and again on February 16th, 2010 are presented in Appendix C.

WSDOT Geographic Services also set sixteen monuments on and around the landslide to monitor for landslide movement using differential GPS (Fig. 2). This survey technique allows for millimeter-level accuracy. A summary of the survey data is included in Appendix C.

WSDOT contracted with the Australian-based company GroundProbe for their slope stability radar. The technology provides for real-time monitoring for slope deformation of large slopes. The radar unit continually scans the designated area, while integrated software makes a variety of atmospheric and other corrections, and then transmits the data to off-site users for analysis. To obtain an unobstructed view of the entire landslide, the radar unit was located on the opposite (southwest) side of the valley. The radar unit subdivides the scanned area into pixels, whose size is a function of the distance of the unit to the slope; typical pixel sizes for this project were between 25 and 50 feet measured from a distance of 4000 to 6000 feet. Deformation is calculated for each pixel from an averaged value of the signal returns to a reported sub-millimeter-level accuracy. The equipment was deployed on October 23rd, 2009 and was demobilized on January 21st, 2010.

LABORATORY TESTING

Laboratory testing was performed on representative samples of surficial deposits and bedrock for the purposes of classification and to aid in the evaluation of engineering soil and rock properties. Natural moisture contents, sieve analyses, and Atterberg limits of soil samples were tested by the WSDOT Materials Laboratory in general accordance with ASTM and AASHTO standards. Atterberg limits were also performed on representative degraded/sheared zones encountered within the sedimentary interbeds. Residual shear strength of characteristic clay-rich zones identified within the surficial deposits and degraded/sheared zones in the siltstone interbeds were further evaluated by ring shear testing on six representative samples performed for WSDOT by Landslide Technology.

Rock samples were tested for dry density and uniaxial compressive strength tests by the WSDOT Materials Laboratory. In addition, the Washington State University GeoAnalytical Laboratory performed x-ray fluorescence on 22 basalt samples to determine the geochemistry of the basalt units encountered in our borings and in outcrops proximal to the landslide. Titanium and magnesium oxide concentrations of our samples were then correlated with the known chemistry of the Grande Ronde Basalt flows mapped in the area (Hammond, 2009 and references within). Our interpretations of the chemistry data were checked by Paul Hammond (personal communication, 2010).

Laboratory test data is included in Appendix D.

SITE CONDITIONS

PHYSIOGRAPHY

The landslide is located at around 1900 feet elevation on the lower eastern slope of the Cascade Mountains along the western margin of the Columbia River Plateau within the relatively narrow and incised Naches River valley (Figs. 1 and 2). Mountainous terrain surrounds this NW/SE-trending reach of the valley. The landslide is situated on and immediately adjacent to the left bank of the river below Cleman Mountain, which rises moderately steeply to nearly 5000 feet elevation. From the confluence with Rattlesnake Creek, the Naches River flows along the left bank through the landslide area, tightly constraining the highway between the river and the base of Cleman Mountain.

Mean annual precipitation near the project area is around 10 to 15 inches that dominantly falls during late fall and early spring and often as snowfall. In this semi-arid region, vegetation consists of grasses and sage brush with sparse conifers, while aspen and cottonwood usually predominate in wetter areas.

GEOLOGIC SETTING

During the Upper Oligocene to Lower Miocene (24 to 34 Ma), the present-day eastern slope of the Cascades was dominated by a number of volcanic centers that generated a suite of volcanic flow, pyroclastic and volcaniclastic sedimentary rocks. These rocks, which form much of the core of the ancestral Cascade volcanic arc, comprise the oldest exposed bedrock in the area that most proximally outcrop about 5 miles west of the landslide (Hammond, 2009 and references within). A period of quiescence followed, and erosion of this topographic high ensued. Between 15.6 and 16.5 Ma, an effusion of basaltic lava of the Grande Ronde Basalt (GRB) flooded the Columbia River Plateau and lapped onto the older suite of Cascade volcanic rocks (Tolan et al., 2009 and references within). Hammond (2009) has mapped 6 distinct GRB flows in the area (Fig. 3). The top three flows are part of the normal-magnetic-polarity N_2 Sentinel Bluffs Member (Rocky Coulee, Cohasset, and McCoy Canyon flows), which are underlain by the N_2 Orltey flow and the reverse-magnetic-polarity R_2 Grouse Creek (locally referred to as Meeks Table) and Wapshilla Ridge flows. These basalt flows often inundated and burrowed into unconsolidated sediments and/or were subsequently buried by fluvial and lacustrine sediments eroded from the Cascades. As a result, most (and perhaps all) of the basalt flows are separated by sedimentary interbeds of claystone, siltstone, sandstone, and/or conglomerate. Following their emplacement, volcaniclastic sediments were deposited on the basalts. These sediments are mapped as Ellensburg Formation and outcrop as prominent ridges on the west side of the Naches valley. Quaternary-age (< 1.6 Ma) surficial deposits mantle portions of the bedrock and include alluvium in the drainages, and fan, talus and an abundance of landslide deposits on the adjacent slopes. As the terminus of alpine glaciation lies far up valley, glacial deposits are absent in the lower Naches valley, with the possible exception of some intercalated outwash within the alluvium.

The area is situated within the Yakima Fold Belt, a western subprovince of the Columbia River Plateau, which was formed by N-S tectonic compression resulting in NW/SE-trending anticlinal ridges, synclinal valleys, and thrust faults. These structures primarily developed between 3 and 7 Ma after the emplacement of the GRB and Ellensburg Formation (Reiners et al, 2002). Cleman Mountain is a prominent anticlinal ridge with the bedding on the SW limb adjacent to Naches

valley steepening from around 15º near the crest to more than 50º at the valley (Fig. 3). The Naches valley lies within a syncline, which is separated from the Cleman Mountain anticline by a major thrust fault named the Nile Thrust (Campbell, 1988; Hammond, 2009). The region remains seismically active, dominated by mostly shallow seismicity. Table 2 presents earthquakes detected by the Pacific Northwest Seismic Network (PNSN) in 2009 within a 30 km radius of the landslide, with a magnitude of 2.5 being the largest recorded event (P. Bodin, 2009 personal communication). Records dating back to 1995, around the time when possible movement of the Nile landslide is first discernable in the aerial photographs, reveal that more than 300, mostly shallow, low energy earthquakes have occurred, none of which exceeded a magnitude of 2.9.

Table 2. Proximal earthquakes in 2009 recorded by PNSN

Date	Time	Latitude	Longitude	Depth (*km*)	Magnitude
2/14/09	15:34:01	46.849	-120.718	0.03	2
3/17/09	4:55:11	46.865	-120.751	10.56	1.4
3/20/09	10:34:19	46.771	-120.696	16.07	2
3/25/09	17:07:23	46.826	-121.112	69.82	0.1
5/6/09	23:31:47	46.798	-121.182	11.08	0.9
6/6/09	13:22:12	46.734	-120.853	6.39	2.5
7/12/09	4:51:01	46.716	-121.204	11.02	0.9
9/11/09	18:38:43	46.741	-120.818	8.03	2.2
12/14/09	19:10:46	46.784	-120.901	0.04	1.3

Landsliding is a prolific geomorphic process within the GRB in the western portion of the Yakima Fold Belt. These landslides are most commonly translational slides and earthflows and often occur within complexes of coalescing and nested landslides. A number of the landslides in the immediate area are very large (≥1 mi^2 in aerial extent) with estimated thicknesses exceeding 100 ft (Hammond, 2009). The primary geologic controls on these large landslides are believed to involve, 1) the weak sedimentary interbeds between GRB flows or sedimentary and/or pyroclastic units beneath the GRB combined with 2) the unfavorable effects of folding, which include adverse bedding orientation along folded structures and flexural slip (shearing) within the weak interbeds to accommodate structural shortening (Campbell, 1988; Newcomb, 1969; Price, 1982; Anderson, 1987). Another important control on initiation of these landslides may be the undercutting and exposure of adversely oriented bedding on folds and other tilted strata (Campbell, 1987). Cleman Mountain, and the anticline from which it is formed, hosts one of the largest landslides in the area (nearly 12 mi^2) known as the Sanford Pasture landslide complex (Fig. 4) (Bentley et al., 1988). Landslide deposits interpreted as originating from the Sanford Pasture landslide are mapped on the opposite valley wall approximately 1000 feet in elevation above current river level (Hammond, 2009). The initiation age of the Sanford Pasture landslide is not known, but may be as much as several million years old (late Tertiary) when the base level of the Naches River was considerably higher; the landslide is thought to currently be dormant (Hammond, 2009 personal communication).

PRE-FAILURE CONDITIONS OF THE NILE VALLEY LANDSLIDE

A review of historical documents and aerial photography was carried out to evaluate the stability of the Nile landslide prior to its failure on October 11th, 2009. Due to the differing slope

morphology and inferred failure mechanics, the landslide was subdivided into four domains, A-D ordered from northwest to southeast, for discussion and analytical purposes.

The earliest discovered aerial photographs are from July 1949. These show the Naches River and the highway in their current location, along with several small buildings on the southern margin of the landslide on both sides of the highway (Fig. 5). The photographs show an abundance of interpreted landslide and slope deformation features over much of the landslide area. These features include arcuate scarps and series of linear troughs and ridges in the upper portions of the slope, and mounded debris with some hummocky topography near the base of the slope. The ages of the features are not determinable from the photographs, but none appeared to be recently active.

In 1956, a large slope failure occurred along the northern margin of the landslide area within Domain A and involved the slope area above the highway (Fig. 5). The cause or geologic controls on the slope failure are not known, but the failure occurred during/following the wettest winter period (October 1st to March 1st) on record (Desert Research Institute, Yakima WSO AP station, 1946 to 2006). Based on reports of overtopping (rather than displacement of) the highway and the apparent intact basalt in the existing highway cut, the failure was constrained to the slope above the highway. Runout of the debris reportedly covered about 600 feet of the highway up to a depth of 10 feet and partially filled the channel of the Naches River. A project removed the debris and regraded the upper slope, which involved an estimated 75,000 yds^3 of excavation.

Aerial photographs from August 1958 show that an access road and a new residence had been constructed in the now Simmons Pit and a small mined area had been opened in the pit. Very little mining occurred through 1966. Between 1966 and 1980, mining activities increased substantially and continued through the late 1990s (Fig. 6). In 1996, a small borrow area was opened by WSDOT in Domain B along the highway for constructing emergency flood repairs. In aerial photographs from July 1998, a discontinuous linear break in the upper talus slopes above the Simmons Pit is first noticeable. The lineament (tension crack) coincides with the headscarp of the October 11th, 2009 landslide. We interpret the tension crack to be associated with the onset of large-scale global instability of the landslide. Mining continued through 2005, and the interpreted tension crack grew in length and offset (Fig. 6). In the 2005 aerial photographs, a new residence (belonging to the Martins) has been constructed on a hillock located between the highway and Simmons Pit.

In mid-September 2005, during a regulatory inspection of the Simmons Pit, the Washington Department of Natural Resources (DNR) noticed "… (open) tension cracks and reactivation of old landslide scarps" upslope and north of the permit highwall near the base of the upper talus slope (DNR memorandum, September 26th, 2005). At the request of DNR, the pit operator retained an engineering firm, PLSA Engineering & Surveying, to assess the observed slope instability above the mine and to monitor movement of the upper slope. Two survey targets set due north of the pit near the base of the upper talus slopes were monitored from the hillock on the south side of the pit (Fig. 7). Annual measurements of the one surviving target taken between October 2006 and April 2009 yielded a total of 3.84 feet of movement towards the mine (PLSA, 2010 personal communication). Annualized rates of movement were initially more than

2 feet per year and tapered to around 1 foot per year. This measured movement was accompanied by increased lengthening and offset of the tension crack.

A June 2009 WDNR aerial photograph shows an apparent tension crack in Domain A beneath the upper bedrock cliffs that is concordant with the October 11th, 2009 tension crack. This feature is not evident in 2006 NAIP photographs.

Prior to October 11th, 2009, no evidence of slope distress was observed in the slopes adjacent to the highway within the landslide limits (C. Laidler, 2009 personal communication).

FAILURE OF THE NILE VALLEY LANDSLIDE

Failure of the Nile Valley landslide was observed by numerous eyewitnesses. Their reports along with PNSN records from nearby seismic stations provide very useful information for determining when and how portions of the landslide initiated and subsequently developed, for characterizing the current stability and future potential instability, and to evaluate mitigation alternatives. Notable limitations of the eyewitness accounts for interpretations on the development of the landslide include:

- Reactivation of the landslide on Sunday morning began in the darkness around 2:00 am and sunrise did not occur until after 7:00 am, well after much of the lower portion of the eastern landslide had started to move.
- Many of the eyewitnesses had restricted views of the entire landslide area, and could not see the upper portion of the landslide.
- Reported times are often only approximate, and the development of noted landslide features may have occurred prior to when they were first noticed.

For these reasons, the exact sequence and extent of the reported events related to the landslide progression cannot be definitively determined nor can they be used to firmly establish the cause of the landslide. Figure 8 shows the landslide areas referred to in the eyewitness accounts and the estimated time period when movement initiated and ceased.

In mid-September 2009, approximately one month before the landslide, Scott Lockert, a fisherman that frequents the Nile Valley reach of the Naches River, remembers seeing unusually large plumes of dust originating from upper talus slopes above the Simmons Pit that would float over SR 410 and the Naches River before dissipating.

On October 8th and 9th, just prior to the landslide, Steve and Mary Smith, whose home was located immediately west of the access road into the Simmons Pit, noticed their driveway narrowing. They reported that rocks falling from the adjacent slope had to be removed each day from the driveway by a front-end loader from the Simmons Pit.

At 10:20 am on October 10th, the Ellensburg and Naches seismic stations monitored by the PNSN, detected a seismic event characteristic of a large rockfall signature (J. Vidale, 2009 personal communication) (Fig. 8). At around 11:00 am, the Smiths observed numerous rockfalls from the slopes around their house and heard faint, unfamiliar, “thunder-like sounds” from the hill above their home. By noon, the Smiths noted that the hillside above their home was moving and their driveway was significantly narrowing as rocks continued to fall around their house. By 1:00 pm, falling/moving debris overwhelmed their garden shed and was advancing toward their

carport and home. Around 2:00 pm, Steve Smith notified emergency authorities of the landslide and its continued movement, expressing concern that it might reach the highway. At 2:30 pm, Steve Smith, Ron, Ernie and Robbin Simmons, and Chuck Laidler (WSDOT Maintenance Supervisor) arrived onsite to assess the situation. They saw no deformation in the pit walls or floor and noted that the landslide movement appeared to have slowed/stopped. Ernie and Robbin Simmons began moving construction equipment to the eastern portion of the pit. Around 4:00 pm, Washington State Patrol (WSP) Sgt. Patrick Lunning arrived and noted that approximately 20 feet of the Smith's driveway had been blocked by landslide debris. He noted that the landslide movement had stopped about 50 feet from the highway and 12 feet from the Smith's home. Faint rumbling noises beneath the ground reportedly stopped by 4:30 pm. With a general consensus that landslide movement had likely stopped, WSP and WSDOT personnel departed the site. This initial lobe of the landslide was described as a 30- to 50-foot-wide rock pile moving laterally that formed a large open tension crack "that cars could fit in" located approximately 100 to 200 feet upslope of the Smith's home (Fig. 8).

Around 2:30 am on October 11th, the Smiths heard rocks hitting the garden shed and their house. At 4:12 am, small seismic rumbles were recorded by the PNSN. Around the same time, Ron and Mary Beth Simmons (next door neighbors to the Smiths) and the Smiths were awakened by rocks hitting the Smith's home and went outside to investigate. They noted that the initial landslide lobe was moving again, engulfing the Smith's carport and pushing the remains of the garden shed into the house. Ron Simmons then went up to the pit, where he heard small rocks falling from the pit slopes. He also heard sounds under the pit floor "like the moaning and groaning of a glacier moving on a hot day". At 4:41 and 4:48 am, the PNSN recorded more small seismic rumbles.

Around 5:00 am, Steve Smith notified emergency authorities that the landslide was pushing their house from its foundation and landslide debris was likely going to inundate the highway. WSP Sgt. Lunning was notified and arrived around 5:30 am. By the time he arrived, the Nile Fire Department and Steve Smith had closed the highway as the landslide was moving into the shoulder of the westbound lane. The landslide debris approaching the highway was approximately 20 feet wide by 20 feet high with a near-vertical slope. Five more seismic pops were recorded by the PNSN at 5:48 am. Sgt. Lunning noticed that approximately 200 feet west of the initial landslide lobe the highway ditch was closing. Several eyewitnesses described the landslide movement as constant rock raveling off the oversteepened toe as the hillside moved laterally. Due to the darkness, no one was able to see far from the highway.

Around 6:00 am, WSP Sgt. Seth Berghoff arrived on site and established a roadblock on the east end of the highway at the Blue Church, while the Nile Valley Fire Department began to set up a road block on the west end of the landslide. Ernie and Robbin Simmons attempted to move the remaining construction equipment in the pit to the east edge of the pit floor. No movement was yet noticed in the pit slopes or floor.

WSDOT Maintenance (Chuck Laidler) arrived on the east side near the pit entrance at around 6:45 am. He reported that the landslide lobe at the westbound shoulder of the highway was approximately 30 to 40 feet wide and was moving "like lava", observing about 3 feet of lateral

movement in 15 minutes. By 7:00 am, the westbound lane was entirely covered by landslide debris.

At 7:05 am, Ernie and Robbin Simmons noticed an increase in rockfall on the west highwall in the pit and heard a series of booming and cracking thunder sounds coming from upslope of the pit. Sunrise occurred at 7:12 am, which is about the time when they observed a 60-foot by 60-foot area and a D-8 bulldozer at the base of the west highwall starting to uplift (Fig. 8).

At approximately 7:30 am, a firefighter walking toward the landslide from the west side noticed that the highway felt like it was moving under his feet and immediately retreated to the west road closure. Meanwhile, the Smith's house continued to be overwhelmed by the initial lobe. Sgt. Berghoff witnessed tension cracks developing in the hillside farther upslope of the Smith's residence, continued raveling of the west highwall, and uplift of the pit floor. The sounds beneath the ground reportedly grew in volume, and at 7:38 am a large seismic burst was recorded by the PNSN. Mr. Laidler was positioned at the west road block when the western landslide area rapidly failed. He said, "You could watch it punch the highway straight up in the air approximately 35 feet before sliding horizontally into the Naches River. The roadway pavement then slid off the top of the new mound to the toe of the landslide." Sgts. Lunning and Berghoff, Don Dexter, Ernie and Robbin Simmons, and Sherry Gillespie watched from the east road block at the Blue Church. All the eyewitnesses describe the western slope failure as initially quick, but slow enough that it was like "slow motion". The western landslide continued to move "like lava" into the river channel. New tension cracks were noticed just below the basalt cliffs west of the western landslide headscarp (Fig. 8).

By 7:45 am, the pit floor had been uplifted about 10 feet. Mary Smith heard sounds beneath the ground getting louder in the pit area, and observed constant rockfall from the highwalls as the west highwall moved laterally toward the rock crusher. Ernie and Robbin Simmons were evacuated from the pit area and watched the eastern landslide from the eastern road block move across the pit floor. They described the landslide movement in the eastern landslide as, "the big slide goes down in the upper mountain area and comes back up at the pit."

Between 8:08 am and 9:43 am, steady seismic popping was recorded by the PNSN.
Denise and Roger Martin were evacuated from their home, located on the eastern knob, in the east uplift block (Fig. 8). They gathered some of their belongings and left, but observed no movement on their property as late as 8:30 am. Sgt. Berghoff, stationed at the east road block, indicated that the sounds beneath the ground grew louder, describing them as "deafening, like standing next to a waterfall". At 8:45 am, Davey Walker and his family positioned themselves on a ridge across the valley to watch the landslide. Around 9:00 am, Sgt. Patrick Lunning began evacuating the Simmons, Don Dexter, and the other homeowners adjacent to SR 410, because the eastern landslide continued to move into the pit area.

As Mr. Laidler stood outside the Eagle Rock Incident Command Center around 9:00 am, he noticed a large tension crack forming in the cliffs above the upper eastern landslide area. He went into the ICC for a meeting and came out around 9:43 am to witness the east landslide headscarp completely exposed (Fig. 8). Davey Walker, watching from the opposing valley ridge, describes the landslide movement as, "volcanic eruptions of dust coming from the moving

ground area with the western landslide area moving faster than the eastern landslide area, but everything is moving at once". The loudest seismic bursts were recorded between 9:43 am and 9:55 am by the PNSN. Several eyewitnesses observed a significant horizontal movement in the eastern landslide area around 9:43 am that lasted between 10 and 20 seconds, resulting in a dust cloud that filled much of the valley for about 10 minutes.

At 9:45 am, Roger Martin and Keelan McPhee were driving in opposite directions on the Nile Loop Road across the Naches River from the western landslide. They stopped to observe a crack forming in the pavement and subsequent uplift of the pavement approximately 1.5 feet over the next 15 minutes. Ms. McPhee observed that the western landslide had blocked the river and had pushed against the opposite stream bank. She described the landslide movement as very noisy, with constant rockfall from the western landslide toe as it moved toward Nile Loop Road. Jason Smith, Don Whitehouse, Craig Broadhead, and Scott Anfinson of WSDOT arrived at the deforming Nile Loop Road around 10:15 am and watched an adjacent log cabin home being destroyed by the uplifting ground at the Nile Loop Road.

Around 10:15 am, Denny Sveen and his family, observing from a vantage on the opposing valley ridge, noticed that the Simmons', Dexter's, and Martin's homes on the east knob, and SR 410 were starting to deform (Fig. 8). Mr. Walker saw the rock crusher in the pit and the remainder of the Smith's home being overwhelmed around 10:45 am. Ongoing deformation and uplift was observed in the eastern uplift block past noon. By noon, the western landslide had completely blocked the Naches River and the river began to flow around the western landslide toe into the Brown's pasture.

By 1:00 pm, most of the dust had settled in the upper western and eastern landslide areas. Although landslide movements had significantly slowed, deformation continued in the eastern uplift block. At 2:00 pm, Ray Leonard and Steve Smith visited the Simmons' home on SR 410 to find that the property was deforming but the house had not yet experienced any significant uplift. By 3:30 pm, much of the landslide movement had stopped or slowed, so homeowners began to reenter the landslide area to survey the damage. Around 4:00 pm, Don Dexter and Ron Simmons visited their homes to survey the damage. Mr. Dexter found that his backyard had been completely inundated. The slope behind his house had moved laterally across the backyard and had pushed his house off the foundation. Mr. Simmons reported his house was actively uplifting at 4:00pm. At 4:20 pm, the Martins returned to find that their home on the east knob had been severely deformed and was uninhabitable.

Around 8:00 am on October 12th, Ron Simmons returned to his home and measured approximately 10 feet of vertical uplift and between 7 and 12 feet of horizontal movement to the south. He indicated that the house was in good shape and not even a dish had fallen from the cupboards. When asked about the condition of his home, he stated, "It was like someone just jacked the house up all at once without breaking it up."

Jason Smith (WSDOT) indicated that the Nile Loop Road area may not have stopped uplifting until 3:00 pm on October 12th.

LANDSLIDE MORPHOLOGY

Major geomorphic features of the Nile Valley landslide are presented on a base aerial photograph taken on October 12th, the day following the slide (Fig. 9). The Nile Valley landslide is situated on the northeast margin of the Naches River floodplain and is nested within a large, steep, bowl-shaped feature at the base of Cleman Mountain. The moderately steep (~30 to 40º) slopes immediately above the landslide consist of scattered outcrops and discontinuous bands of basalt cliffs that are mantled with talus and colluvium derived from weathering and abundant rockfall from the basalt outcrops. The landslide headscarp cuts across and below the lowermost band of cliffs between elevations 2300 to 2600 feet for a length of about 3000 feet. Vertical offset on the steep (~70º) headscarp ranges from 5 to 10 feet in Domain A on the northwest end of the slide and increases to nearly 200 feet in Domain D on the southeast end. A flattened to down-dropped graben up to 500 feet across defines a broad zone of extension/lateral displacement just below the headscarp (Fig. 10). The landslide body appears as a flattened irregular-shaped mound of debris, 3000 to 4000 feet in breadth, nested within the bowl, which extends onto the valley floor more than 2000 feet on a shallow inclination of around 10º. No surface drainage features were present within the landslide prior to the recent failure. The landslide body contains numerous areas that exhibit differing deformation and failure mechanics. Subdivision of the landslide into the four domains (A through D) was based on prominent lateral scarps and internal deformation characteristics (i.e., sets of tension cracks, extent of vertical/lateral displacements, etc.).

Within Domain A, the overall slope orientation of the landslide mass is steeper (~20º) than most of the landslide in the adjacent domains; grading for the 1956 landslide repair in Domain A may partially explain this difference. Despite the 5 to 10 feet of offset on the headscarp, surficial evidence of deformation is not readily apparent within the main landslide body or on the northwestern lateral margin, and the distal extent of the slope deformation (toe area) was not observable. Nor were tension or shear cracks observed in the graded catroad at elevation 2070 ft. Apparently undisturbed basalt is exposed in the entire length of the highway cut below the headscarp, and there was no evidence of pavement deformation. From these observations, we infer that the toe area of this slope deformation lies just above the graded catroad at an elevation of approximately 2070 ft. A lateral scarp with 10s of feet of offset defines the boundary between Domains A and B (Fig. 9).

The overall inclination of the landslide body within Domain B is about 10º. The surface is largely blanketed with basaltic cobbles and boulders that lack matrix. Two subsidiary 50 to 70-ft-high headscarps separated by numerous parallel tension cracks cut the highly deformed slide mass (Fig. 9). The lowermost subsidiary scarp defines a sizeable graben near the location of the former highway. The toe area consists of a broad dispersed lobe of debris that extends entirely across the former channel of the Naches River. A small slump occurred on the toe lobe shortly after its emplacement. A deformation zone involving 3 to 5 feet of uplift developed approximately 200 feet beyond the toe lobe, which damaged a residence and the Nile Road (Fig. 11). An abrupt lateral scarp on the southeastern margin of Domain B crosscuts the topography and landslide features within the northwestern margin of Domain C (Fig. 9), and thus followed or lagged behind the landsliding within Domain C.

The landslide body within Domain C consists of a shallowly inclined (~10º) upper portion, and a lower steeper (~20-30º) portion (Fig. 9). The surface of the upper portion is mostly covered with

basaltic cobbles and boulders that lack matrix; some soil and vegetation cover localized areas near the graben and primary headscarp. A prominent subsidiary scarp separates the upper portion of the landslide body from the lower portion. The lower portion, located immediately above the former highway, appears light tan colored, due to the fresh exposure of underlying surficial deposits. Two sets of tension cracks cut the upper landslide surface in Domain C: a NW/SE-trending set and an E/W-trending set. The NW/SE set of tension cracks dominantly occurs just above and sub-parallel to the subsidiary scarp. This NW/SE set denotes movement in a westerly direction toward the highway/river. The E/W set ties into the tension cracks that dominate in Domain D. These E/W tension cracks within Domain C denote a mostly southerly direction of movement toward the Simmons Pit. A peculiar zone of small mounds protrudes the upper portion above the subsidiary scarp near the margin between Domains C and D, which we suspect are associated with the displacements of the two intersecting sets of tension cracks. The broad light colored zone that defines the lower portion of Domain C contains up to six smaller arcuate scarps with associated overlapping lobes of displaced debris that runout to the former highway. A broad area of uplift developed beyond this zone thrusting up the former river channel 30 to 40 feet in height; little to no lateral displacement was discernable within the uplift area (Fig. 11). A prominent lateral scarp with 10s of feet of vertical and horizontal offset defines the boundary between Domains C and D and crosscuts the E/W set of tension cracks. The lateral scarp appears related to the NW/SE set of tension cracks with westerly movement toward the highway/river. This crosscutting relationship implies that the initial large-scale movement in Domain C was southward toward the pit, followed by westerly movement toward the highway/river.

The landslide body within Domain D consists of a shallowly inclined (~10º) upper portion, and a lower steeper (~30º) portion (Fig. 9). The surface of the upper portion consists of several sub-parallel E/W-trending bands of basaltic cobbles and boulders lacking any matrix separated by areas with some soil and vegetation cover. The upper portion is cut by a series of E/W-trending tension cracks that denotes a southward direction of movement toward the pit. A prominent subsidiary scarp separates the upper portion of the landslide body from the lower portion. This lower portion, located immediately above the pit, appears light tan colored, due to the fresh exposure of underlying surficial deposits. Extensive deformation of this lower portion resulted in the inundation of several hundred feet of the former pit floor with landslide debris. A small 100-ft-high hillock, situated nearly 1000 feet beyond the former pit floor, experienced more than 7 feet of lateral displacement to the southwest and at least several feet of uplift (Fig. 11). This uplift zone ties into the uplift zone in Domain C. A prominent lateral scarp defines the southeastern boundary of the landslide.

SUBSURFACE CONDITIONS – NILE VALLEY LANDSLIDE

From regional and site geologic mapping and test borings, nine engineering geologic units were identified within the project area. Included are two interpreted failure zones, a shallow and a deep failure zone, that correspond with eyewitness reports of two distinct episodes and styles of slope failure as well as subsurface conditions encountered in the borings. An engineering geologic map shows the distribution of the exposed geologic units (Fig. 12).

> Alluvium *(Qa)* – Three test borings (H-2-09, H-3-09, and H-4-09) encountered up to 99 feet of alluvium, which is found in the valley bottom as river-transported and deposited

sediment. This unit consists of dense to very dense, subrounded to rounded gravel, cobbles, and boulders of mixed lithology within a sand or sandy silt matrix.

Talus/Colluvium-Landslide Deposits *(Qls)* – Thirteen test borings (H-10, 11, 12, 13, 14, 16, 17, 20, 21, 22, 23, and 24-09) encountered up to 113 feet of this unit, which consists of the surficial deposits within the active slide mass that mantle the slope directly above the highway. These deposits are interpreted as rockfall talus and colluvial debris generated from the upper cliffs, and remobilized landslide debris derived from the Sanford Pasture landslide complex. This unit generally consists of very loose to very dense, angular to subangular, basaltic gravel, cobbles, and boulders within a sand or sandy silt matrix; surface exposure of these deposits often lack matrix. Occasional boulders and larger masses of siltstone and sandstone are also present in this unit.

Shallow Failure Zone *(SFZ)* – We have interpreted the existence of a shallow failure zone between the talus/colluvium-landslide deposits and the underlying sedimentary interbeds, to which we attribute the majority of the landslide deformation. Ten test borings (H-12, 13, 14, 16, 17, 20, 21, 22, 23, and 24-09) located within the active slide area penetrated this interpreted failure zone. This unit typically consists of silt and clay with sand, gravel, and cobbles; the matrix exhibits disrupted texture with slickensides. Atterberg limits on eight samples yielded liquid limits of 50 to 89, plastic limits of 30 to 57, plasticity indices of 12 to 39, and cohesive indices of 0.32 to 1.11. Ring shear tests were performed on three remolded samples and yielded residual frictional strengths of 8º to 19º.

Sanford Pasture Landslide Debris *(T-Qls)* – No test borings were located within this unit. This interpreted unit consists of landslide debris associated with the Sanford Pasture landslide complex. This unit is mapped by Hammond (2009) above the active Nile Valley slide limits up to near the crest of Cleman Mountain and as debris runout onto the opposite valley wall. Very large blocks, hundreds of feet in dimension, are included within these deposits. This unit is interpreted to be relatively intact and slightly lithified, so some cohesion was included with frictional strength in our stability analyses.

McCoy Canyon and Ortley Basalts *(Tgm and Tgo)* – McCoy Canyon Basalt (*Tgm*), which was identified based on whole rock geochemistry, was encountered in six test borings (H-1, 2, 6, 7,10 and 11-09) and outcrops in the highway cut on the northwest side of the slide. The basalt is aphanitic to fine-grained, black, very strong, highly fractured (typical RQDs 0-50%), and slightly weathered to fresh. The presence of basaltic glass (tachylite?) and peperite (brecciated texture from the intrusion of lava into wet sediments) near the flow boundaries and in bounding interbeds suggest McCoy Canyon Basalt was invasive (penetrated into and displaced unconsolidated sediments). Ortley Basalt (*Tgo*) (also identified by whole rock geochemistry) lies stratigraphically below *Tgm* and was encountered throughout the slide area in twelve test borings (H-3, 4, 6, 8, 10, 14, 16, 17, 20, 21, 22, and 23-09). The basalt is very fine-grained, black, very strong, highly fractured (widely ranging RQDs), and slightly weathered to fresh. Basaltic glass and peperite near the flow boundaries and in bounding interbeds infer that the Ortley Basalt was also invasive. One uniaxial compressive strength test of the Ortley yielded results exceeding 30,000 psi. Due to the similarity between these units, they were grouped into a single engineering unit.

Sedimentary Interbeds *(Tgib)* – Twenty-one test borings (H-1, 3, 4, 5, 5si, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 20, 21, 22, 23, and 24-09) penetrated sedimentary interbeds with thicknesses up to 129 feet throughout and outside of the landslide area. Sedimentary interbeds often lie directly below the talus/colluvium-landslide debris (Qls) and were encountered between all basalt flows. The interbeds consist of dark brownish gray to gray, massive to laminated, claystone/siltstone, sandstone, and lesser conglomerates. Interbeds range from thick intact sections with RQDs of 100% to intensely sheared and slickensided sections with soft, soil-like zones and RQDs of 0%. Atterberg limits on seven fine-grained samples yielded liquid limits of 46 to 63, plastic limits of 24 to 43, plasticity indices of 14 to 39, and cohesive indices of 0.44 to 1.63. Six uniaxial compressive strength tests on the claystones/siltstones yielded values between 610 and 1680 psi. A ring shear test performed on a remolded sample of an intensely sheared and altered claystone/siltstone yielded a residual frictional strength of 7º.

Deep Failure Zone *(DFZ)* – We have interpreted the existence of a deep failure zone within a hydrothermally altered claystone/siltstone that lies on top of the Grouse Creek Basalt (*Tgg*), which we relate to the broad uplift zone in Domains B, C, and D. The maximum observed thickness of this unit is around 25 feet. Six test borings (H-14, 16, 17, 22, 23, and 24-09) located within the active slide area penetrated this interpreted unit. This unit typically consists of grayish green claystone/siltstone with brecciated texture and extensive slickensides; soft, soil-like zones are also present. The brecciated texture along with the greenish color infers that this unit has been altered and disturbed, possibly through invasive emplacement of the underlying Grouse Creek Basalt and/or tectonic shearing during regional folding. Atterberg limits on six samples yield liquid limits of 56 to 90, plastic limits of 28 to 54, plasticity indices of 14 to 43, and cohesive indices of 0.29 to 1.00. Four uniaxial compressive strength tests on intact claystone/siltstone cores yielded values between 410 and 800 psi. Ring shear tests performed on two remolded samples of intensely sheared claystone/siltstone yielded residual frictional strengths of 7º to 15º.

Grouse Creek Basalt *(Tgg)* – This unit is also locally referred to as Meeks Table Basalt (Hammond, 2009). Six test borings (H-14, 16, 17, 22, 23, and 24-09) located within the active slide area encountered this unit, which was identified based on whole rock geochemistry. The maximum observed thickness of this basalt flow exceeded 259 feet; no borings fully penetrated this unit. The basalt is very fine-grained, black, very strong, highly fractured (widely ranging RQDs), and slightly weathered to fresh. Basaltic glass and peperite near the upper flow boundaries and in overlying sedimentary interbeds infer that the Grouse Creek Basalt was invasive. Two uniaxial compressive strength tests of this unit yielded results exceeding 30,000 psi.

Older Tertiary Rocks *(Tvr)* – This unit includes the basal flow of the Grand Ronde Basalt within the area (Wapshilla Ridge Basalt - *Tgw*) and lower, unidentified sedimentary interbeds and volcanic rocks. One test boring (H-12-09) encountered what we interpret to be intact Wapshilla Ridge Basalt and underlying sedimentary interbeds. This unit also is interpreted to underlie the Sanford Pasture landslide deposits (*T-Qls*).

Hydrogeologic Conditions

A shallow unconfined aquifer exists within the unconsolidated alluvial deposits of the floodplain, which is hydraulically linked to the Naches River. Water levels within this aquifer are typically

within 10 feet of the ground surface. At least two groundwater regimes were encountered within the Nile Valley landslide and adjacent slopes. The shallowest is an unconfined aquifer within the talus/colluvium-landslide deposits (*Qls*), where groundwater is perched on the underlying rock units, typically consisting of sedimentary interbeds (*Tgib*). Measured water levels are deep within these surficial deposits, typically saturating only the lower 10 feet of the deposits and the top of the underlying sedimentary interbeds. Within the underlying sequence of basalt flows and sedimentary interbeds, various piezometric levels were measured that were mostly below the ground surface and near the groundwater levels measured in the shallow unconfined aquifer, suggesting some hydraulic connections between the surficial deposits and the underlying rock units. One notable exception was a highly pressurized aquifer that was encountered in nearly all the borings that penetrated the Grouse Creek Basalt (*Tgg*). This deep aquifer, located between 250 and 285 feet, is confined by a laterally continuous, hydrothermally altered claystone/siltstone bed. Measured piezometric levels ranged between 100 and 135 feet above the ground surface, and voluminous artesian flow was typically encountered. Presumably, this deep confined aquifer is pressurized by an aquifer(s) from the flank of Cleman Mountain.

Critical Geologic Sections

A critical geologic section was developed through each of the four landslide domains (Fig. 11). The sections extend from the floodplain up to the upper cliffs above the landslide headscarp. The subsurface conditions encountered in the test borings and measured in the geotechnical instrumentation are summarized for each landslide domain.

Domain A

Section A-A' depicts the encountered and interpreted subsurface conditions within this domain (Fig. 13). Seven test borings were sited at three locations on this critical section. Prior to re-channelizing of the river, the river was situated at the base of the slope about 20 feet in elevation below the highway. Alluvium is interpreted to fill the river channel to an undetermined depth. The highway section consists of a 15 to 20-ft-high cut on the uphill side and an approximately 20 ft-high embankment on downslope side. Based on surface exposure, the embankment consists of mostly coarse, well-graded material. Borings H-6vw-09 and H-7si-09, which were located in the westbound lane of the highway, both encountered approximately 40 feet of McCoy Canyon Basalt beneath the pavement. The basalt was underlain by sandstone and claystone/siltstone with localized highly fractured and clay gouge zones with slickensides. Between 80 and 100 feet, peperite and tachylite was noted within the sedimentary interbeds. At around 100 feet Ortley Basalt was encountered along with a highly pressurized confined aquifer that produced strong artesian flow (~50 gpm). A vibrating wire piezometer installed within this pressurized aquifer has measured a piezometric surface up to 43 feet above the ground surface. At around 125 feet, another zone of sedimentary interbeds consisting of claystone/siltstone and sandstone was encountered that also contained localized, highly fractured, clay gouge zones with slickensides. To date, the inclinometer installed in H-7si-09 to a depth of 80 feet has not detected definitive slope movement.

McCoy Canyon Basalt is exposed in the adjacent cutslope, which is mantled with surficial deposits consisting of silt to small boulder-sized material interpreted to be talus/colluvium and landslide debris derived from the Sanford Pasture landslide.

Approximately 22 feet of well-graded surficial deposits underlain by a similar bedrock sequence were encountered in a series of borings (H-10si-09, H-11p-09, and H-26p-09) on a midslope bench above the highway. Thus, we assume that there is stratigraphic continuity of the bedrock units within this portion of the slope. These midslope borings, however, did not encounter a similar pressurized aquifer. Piezometers isolated within the bedrock and surficial deposits yielded groundwater levels at 52 feet and 18 feet below the ground surface, respectively.

Two borings (H-12si-09 and H-13p-09) were located on the uppermost bench just below the headscarp. These borings penetrated a much thicker section of coarse, well-graded surficial deposits up to 88 feet, and are interpreted to be talus/colluvium and landslide debris derived from the Sanford Pasture landslide. These surficial deposits were underlain by a 10-foot-thick claystone/siltstone unit that was highly fractured with slickensides and softened, gouge-like zones. Atterberg limit and ring shear tests from a sample at 77 feet indicate this fine-grained material to be plastic (PI=23 to 26) and to have very weak residual strength ($\phi_r = 11^o$). This weakened sheared zone is underlain by a series of sandstone and claystone/siltstone interbeds to around 144 feet. COBL measurements of bedding orientation of two sandstone beds within this sequence were contradictory, suggesting this sedimentary sequence is not in place. About 40 feet of peperite and another 34 feet of Wapshilla Ridge Basalt were encountered to a depth of 218 feet, below which another sequence of sandstone and claystone/siltstone was penetrated. COBL measurements of bedding surfaces within the upper sandstone bed indicated consistent orientation dipping out of the slope (WNW) at around 24º, which also conforms to the expected orientation on this portion of the anticline. Thus, we infer that the basalt unit and this lower sedimentary sequence are likely in place. A vibrating wire piezometer installed within a shear zone in a claystone/siltstone unit at 130 feet and a standpipe piezometer isolated within the surficial deposits yielded similar groundwater levels of 81 feet and 72 feet below the ground surface, respectively, suggesting some hydraulic connection between these units. To date, the inclinometer installed in H-13si-09 to a depth of 80 feet has not detected definitive slope movement.

Domain B

Section B-B' depicts the encountered and interpreted subsurface conditions (Fig. 14). Four test borings were sited at three locations on this critical section. Boring H-2si-09 was located in the uplift zone along the Nile Road on the opposite side of the former Naches River channel. Gravels and cobbles of mixed lithology interpreted as alluvium were encountered to a depth of 65 feet. This unit was underlain by broken basalt gravel, cobbles and small boulders to at least 115 feet; beneath this depth the basalt had a more intact appearance to a depth of 124 feet. Chemistry indicated this to be McCoy Canyon Basalt. The water level measured within the drill steel at the completion of the drilling was around 11 feet below the ground surface. To date, the inclinometer installed in H-2si-09 to a depth of 124 feet has not detected definitive slope movement.

A large uplifted lobe of alluvium and landslide debris occupies the former Naches River channel. Boring H-14si-09 was drilled in the graben upslope of the uplifted lobe, which is just upslope of the former highway. Approximately 60 feet of coarse landslide deposits was underlain by a one-foot-thick zone of silty sand with small disrupted chunks of plastic silt-clay. This transitioned into a sandstone unit with tachylite to 78 feet, where highly fractured Ortley Basalt was

encountered. At 196 feet, brownish gray claystone/siltstone with localized highly fractured and clay gouge zones with slickensides was encountered. Around 237 feet, the claystone/siltstone became greenish gray and disrupted in appearance. Water levels measured within the drill casing prior to this were around 45 feet below the ground surface. At 253 feet, Grouse Creek Basalt peperite was encountered and strong artesian flow began. A pneumatic packer was installed just above this zone, and 56 psi of pressure was recorded approximately 7 feet above the ground surface, which equates to a piezometric surface about 136 feet above the ground. To date, the inclinometer installed in H-14si-09 to a depth of about 285 feet has not detected definitive slope movement.

Nearly identical subsurface and hydrogeologic conditions were encountered in the uppermost borings (H-16vw-09 and H-17si-09), and thus we assume lateral continuity of the rock units within this portion of the slope. A slug test performed at the base of landslide deposits at about 70 feet resulted in a stabilized water level after 15 minutes at 62 feet below the ground surface. At 260 feet, Grouse Creek Basalt peperite was encountered and strong artesian flow began. A pneumatic packer was installed just above this zone, and 56 psi of pressure was recorded approximately 7 feet above the ground surface, which equates to a piezometric surface about 136 feet above the ground. Upon completion of the drilling of H-16-09 around November 18th, 2009, the steel drill casing became stuck. A downhole camera was sent down the casing, and multiple kinks in the casing were noted between 200 and 260 feet with up to an inch of offset. We assume that these kinks in the casing were the result of slope movement. The casing was cut at multiple locations at 5 to 10 foot intervals until it could be freed and was left in the hole. A TDR cable was installed to 297 feet and a vibrating wire piezometer was installed to 259 feet within the abandoned and cut casing. To date, the TDR cable has not detected definitive slope movement. H-17si-09 was advanced to 290 feet to install an inclinometer; highly pressurized groundwater complicated the installation. To date, the inclinometer installed in H-17si-09 to a depth of about 285 feet has not detected definitive slope movement. The recorded deformation between 200 and 275 feet may be due to poor fixity of the inclinometer casing to the borehole, resulting from highly pressurized groundwater conditions within this zone.

Domain C

Section C-C' depicts the encountered and interpreted subsurface conditions (Fig. 15). Five test holes were advanced at three locations on this critical section. Borings H-20si-09 and H-21p-09 were sited in the toe area directly above the former highway. The borings penetrated about 34 feet of coarse landslide deposits, beneath which silt, sand and subrounded gravel and cobbles of mixed lithology (interpreted to be alluvium) were encountered to a depth of around 59 feet. Between 59 and 101 feet, an interbedded sequence of highly weathered sandstone, basalt, sandstone (with 20º laminations) and claystone/siltstone was encountered beneath the alluvium. Disrupted zones with clay gouge and slickensides were present within the claystone/siltstone between 93 and 99 feet. This interbed sequence was underlain by Ortley Basalt to 198 feet, where another interbed sequence of sandstone and claystone/siltstone with 20º laminations was penetrated. Between November 24th and December 28th, 2009, an inclinometer installed to 239 feet in H-20si-09 detected compression in the casing. Due to concern that the compression may have been due to movement below the inclinometer casing, boring H-23-09 was advanced nearby to install a deeper inclinometer. COBL measurements of bedding surfaces within sandstone and claystone/siltstone beds between 199 and 239 feet yielded consistent bedding

orientation dipping out of the slope (WSW) at around 19º, which conforms to the bedrock stratigraphy between the upslope borings and the mapped regional structure of the Nile Valley syncline. At 255 feet, greenish gray, altered claystone/siltstone was encountered. Between 255 and 273 feet, disrupted zones containing slickensides and gouge were present. Atterberg limit and ring shear tests from samples at 270 and 272 feet indicate this fine-grained material to be plastic (PI=28) and to have very weak residual strength (ϕ_r = 7º). At 273 feet, Grouse Creek Basalt with highly pressurized groundwater was encountered. Voluminous artesian flow (> 75 gpm) ejected an estimated 5 cubic yards of sand to cobble-sized pieces of claystone/siltstone from the drill casing. A pneumatic packer was installed just above this zone, and 56 psi of pressure was recorded approximately 5 feet above the ground surface, which equates to a piezometric surface about 134 feet above the ground. Difficulties with the pressurized aquifer prevented the installation of instrumentation in this boring.

Boring H-22tdr/vw/p-09 was located about 600 feet upslope of the lower borings. Approximately 113 of feet coarse landslide deposits were underlain by a one-foot-thick, plastic (PI=25), brecciated claystone with slickensides and gouge. Between 114 and 137 feet, conglomerate was encountered, followed by a change to Ortley Basalt. At 217 feet, another sedimentary interbed sequence was encountered consisting of sandstone with tachylite and palagonite underlain by claystone/siltstone with localized disrupted zones slickensides and gouge between 223 and 264 feet. An Atterberg limit and ring shear test from a sample at 255 feet indicate this fine-grained material to be plastic (PI=28) and to have very weak residual strength (ϕ_r = 7º). A 2-foot-thick sandstone bed with 20º laminations separated another claystone/siltstone bed that was greenish gray with disrupted zones of slickensides and clayey gouge. Atterberg limit and ring shear tests from a sample at 275 feet indicate this fine-grained material to be plastic (PI=15 to 28) and to have weak residual strength (ϕ_r = 15º). At 285 feet, the bedrock changed to peperite with tachylite transitioning around 306 feet to Grouse Creek Basalt. Apparent peperite was noted around 487 feet to the bottom of the boring at 497 feet. TDR cable was installed full depth in the boring. To date, no definitive slope movement has been detected. Vibrating wire piezometers were installed at the bottom of the hole in the Grouse Creek Basalt and at 268 feet within the disrupted greenish gray claystone/siltstone. Piezometric levels in the lowermost vibrating wire piezometer have been steady at 401 feet below the ground surface. The piezometric level within the disrupted claystone/siltstone rose steadily following installation to 102 feet above the ground surface, but has since stabilized around 104 feet. Curiously at the time of drilling, no artesian flow was experienced within this zone. A standpipe piezometer was also installed in this boring to 110 feet within the coarse landslide deposits, and the water level to date has been at 110 feet below the ground surface.

Boring H-24tdr/vw/p-09 encountered somewhat similar subsurface and hydrogeologic conditions as H-22. About 112 feet of coarse landslide deposits overlie a thick sequence of sedimentary claystone/siltstone/sandstone/conglomerate interbeds, with the uppermost unit consisting of a 10-foot-thick claystone bed with disrupted and slickensided texture and localized clay gouge. An Atterberg limit and ring shear test from a sample at 119 feet indicate this fine-grained material to be plastic (PI=36) and to have very weak residual strength (ϕ_r = 8º). COBL measurements of bedding surfaces within a claystone/siltstone bed between 168 and 181 feet yielded an eastward dip into the slope of about 34º, which is inconsistent with the regional geologic structure or the underlying stratigraphy. We assume these sedimentary interbeds and those above to be out of

place, possibly representing a back-rotated block. Near 224 feet, a change occurred to greenish gray claystone/siltstone with disrupted and slickensided texture and localized clay gouge. Tachylite stringers were also present within this bed. At 241 feet, the bedrock changed to peperite with tachylite transitioning to Grouse Creek Basalt. Several apparent shear zones with slickensides (tachylite?) were noted between 483 and 490 feet near the bottom of the boring. TDR cable was installed full depth in the boring. To date, no definitive slope movement has been detected. Vibrating wire piezometers were installed at the bottom of the hole in the Grouse Creek Basalt and at 235 feet within the disrupted greenish gray claystone/siltstone. Piezometric levels in the vibrating wire piezometers in the disrupted claystone/siltstone have been steady at 143 feet below the ground surface, while the deep piezometer has been gradually dropping with the latest level at 136 feet. A standpipe piezometer was also installed in this boring to 112 feet within the coarse landslide deposits, yielding a steady water level at 103 feet below the ground surface.

Domain D

Section D-D' depicts the encountered and interpreted subsurface conditions (Fig. 16). Only one test boring, H-3si-09, was drilled on this critical section, which was located beyond the landslide toe/uplift zone on the south side of the highway. Approximately 100 feet of alluvial sand, gravel and cobbles of mixed lithology were underlain by a claystone/siltstone unit with lesser sandstone interbeds. Several clayey gouge zones were encountered between 123 and 128 feet. Tachylite was noted 5 feet before bedrock changed to Ortley Basalt at 136 feet. The water level measured within the drill steel at the completion of the drilling was around 23 feet below the ground surface. To date, the inclinometer installed in H-3si-09 to a depth of 154 feet has not detected definitive slope movement.

Boring H-4si-09 was drilled just beyond the uplift zone within the highway right-of-way about 600 feet northwest of the critical section. About 74 feet of alluvial sand, gravel and cobbles of mixed lithology were underlain by a sequence of sandstone and claystone/siltstone interbeds. Slickensides were noted between 85 and 90 feet. At 109 feet, peperite and Ortley Basalt was encountered. The water level measured within the drill steel during drilling was around 15 feet below the ground surface. To date, the inclinometer installed in H-4si-09 to a depth of 150 feet has not detected definitive slope movement.

Borings H-8si-09 and H-9p-09 were drilled within the uplift zone near the pit entrance within the highway right-of-way. Approximately 22 feet of alluvial sand, gravel and cobbles of mixed lithology was underlain by a one-foot-thick disrupted clay zone with slickensides. An Atterberg limit and ring shear test from a sample at 23 feet indicate this fine-grained material to be plastic (PI=30) and to have weak residual strength ($\phi_r = 19^o$). Conglomerate, sandstone, and claystone/siltstone beds were encountered to 92 feet, where peperite and Ortley Basalt was encountered. Near 113 feet, another sequence of claystone/siltstone and sandstone interbeds was penetrated. Zones of disrupted and slickensided texture with clay gouge were noted in the claystone/siltstone beds. A standpipe piezometer installed to 55 feet within the first sequence of interbeds detected a water level about 6 feet below the ground surface. To date, the inclinometer installed in H-8si-09 to a depth of 140 feet has not detected definitive slope movement.

Additional subsurface information along the critical section was gained from a Washington Department of Ecology water well log (#AKL629) for a domestic well located on the hillock between the highway and the Simmons Pit. The well log notes cobbles and boulders to 18 feet, underlain by basalt to 118. A 4-foot-thick clay zone was then noted to 122 feet, which was followed by gravel and boulders to 178 feet. The reported water level at completion was 119 feet below the ground surface.

Observations of the mine slope and discussions with the pit owners indicated that the mined material primarily consists of coarse basaltic cobbles and boulders. A 2005 photograph provided by DNR showed an apparent block of sedimentary rock about 10 feet in dimension exposed in a mined face just above the pit floor. Frozen ground was also frequently encountered in the mine excavations.

SUBSURFACE CONDITIONS – UPPER CLIFFS

Geochemical tests of two samples taken from the most prominent and lowermost band of bedrock cliffs that outcrop along the landslide headscarp (sample locations shown on Fig. 12) indicate these to be Wapshilla Ridge Basalt, the stratigraphically lowest (oldest) Grande Ronde Basalts (GRB) in the area. This lowermost cliff band exhibits layered flow structure with a flat-lying to approximately 10º northeasterly dip into the slope (Fig. 9). As the dip of the flow structure opposes the 30-50º southwesterly dip of the Cleman Mountain anticline, as well as a lesser 15-20º dip on the Nile Valley syncline, Hammond (personal communication, 2010) and we interpret that the upper cliffs are a back-rotated block of the Sanford Pasture landslide complex (Fig. 3). Further inference from this interpretation would put the failure zone of the northwestern portion of the Sanford Pasture landslide within the Wapshilla Ridge Basalt or, more likely, beneath the GRB in older Tertiary volcanic/volcaniclastic rocks.

Previous regional geologic mapping (Campbell, 1988; Hammond, 2009) have interpreted the existence of a northeast-dipping thrust fault, referred as the Nile thrust fault, somewhere near the base of Cleman Mountain, breaking the ridge-forming anticline from the valley-forming syncline of Nile Valley (Fig. 3). As interpreted, bedrock on the SW-dipping anticlinal flank is thrust over the NE limb of the syncline. Borings H-10-09 and H-12-09 within Section A-A' may constrain the location of this thrust fault on the northwestern corner of the landslide (Fig. 13). As the Wapshilla Ridge Basalt encountered in the uppermost borings (H-12 and 13) lies stratigraphically below the McCoy Canyon and Ortley Basalts encountered in the lower borings (H-6, 7, and 10), there must be some geologic structure (i.e., fault, landslide failure zone) that cuts through Section A-A' and offsets these basalt flows. Based on the intact appearance and expected bedding orientation of the Wapshilla Ridge Basalt and the overlying and underlying sedimentary interbeds, we have interpreted a northeast-dipping thrust fault between borings H-10-09 and H-12-09. We presume its position to continue southeastward along the base of the upper cliffs. These data and interpretations suggest that the Sanford Pasture landslide and the recent Nile Valley landslide are two separate and largely unrelated landslides. In other words, assuming these interpretations are correct, the Nile Valley landslide would not be a reactivation of a portion of the Sanford Pasture landslide.

SLOPE STABILITY ANALYSES

To evaluate the current stability and mitigation alternatives for the landslide activity identified and characterized from our geotechnical investigation, limit-equilibrium slope stability analyses were performed using the computer program SLIDE® version 5.0 by Rocscience. This analysis method compares forces resisting instability against those driving instability and expresses this as a dimensionless ratio referred to as the factor of safety (FOS). Values above unity (FOS ≥ 1.0) are considered stable, and those below are unstable. Models used for the analyses require data and/or interpretations for surface topography, subsurface stratigraphy, hydrogeologic conditions, zones/geologic units controlling slope failure, engineering properties for each geologic unit, and search limits and failure modes. A series of analyses were conducted for the critical sections developed for each of the landslide domains (Figs. 13-16). These analyses are specifically used to:

- supplement lab testing to better characterize material properties,
- identify potential failure zones,
- refine subsurface models,
- characterize threshold conditions of instability,
- determine current stability of preexisting landslides, and
- evaluate mitigation alternatives.

ENGINEERING GEOLOGIC UNIT PROPERTIES

Shear strength parameters were developed for each of the nine engineering geologic units identified from our field investigation. For noncohesive soils, shear strength parameters were selected based on limited Standard Penetration Test data and experience with similar geologic materials. Cohesive soils and degraded fine-grained rock units were characterized by plasticity indices correlations and ring shear tests to estimate residual shear strengths. Rock units were characterized using Hoek-Brown nonlinear failure criterion to estimate in situ rock mass shear strength (Hoek, 2007). Properties for the nine engineering geologic units are summarized in Table 2.

Table 3. Engineering geologic unit properties

Engineering Geologic Unit	Unit Weight	Cohesion	Friction Angle
Alluvium (*Qa*)	120 pcf	0 psf	35°
Talus/Colluvium - Landslide Deposits (*Qls*)	120 pcf	0 psf	35°
Shallow Failure Zone (*SFZ*)	100 pcf	0 psf	8° – 19°
Sanford Pasture Landslide Debris (*T-Qls*)	140 pcf	500 psf	35°
McCoy Canyon & Ortley Basalts (*Tgm* & *Tgo*)	170 pcf	0 – 19.5 ksf	49° – 50°
Sedimentary Interbeds (*Tgib*)	120 pcf	1.0 – 2.1 ksf	12° – 18°
Deep Failure Zone (*DFZ*)	100 pcf	0 psf	7° – 15°
Grouse Creek Basalt (*Tgg*)	170 pcf	19.5 ksf	49°
Older Tertiary Rocks (*Tvr*)	140 pcf	1.0 ksf	40°

BACK-ANALYSES, CURRENT STABILITY, AND MITIGATION ALTERNATIVES

Stability analyses were first performed to evaluate subsurface conditions at the time of failure, a technique referred to as back-analyses. Pre-landslide topography is used, and search limits and the type of search (circular or noncircular/translational failure) for the most critical (lowest factor of safety) failure surfaces are set to replicate actual limits of failure. In the absence of

instrumentation data confirming actual landslide movement, we focused our searches primarily within two aerially extensive, very weak, disrupted zones. These included 1) a saturated clay-rich zone at the base of talus/colluvium-landslide deposits, representing the shallow failure zone; and 2) an altered claystone/siltstone unit on top of the Grouse Creek Basalt containing an extremely pressurized confined aquifer, representing the deep failure zone. Given the generally planar orientation and long length of these interpreted failure zones, a translational (rather than a circular) type failure mode was judged to be the most appropriate search model. Back-analyses were performed for Domains A, B, and C. Back-analyses were not performed for Domain D, due to the absence of subsurface data and the limited relevance to this study's primary purpose of developing mitigation alternatives for reestablishing a permanent route for State Route 410.

Utilizing the stability models derived from the back-analyses, we then evaluated the current state of landslide stability within Domains A, B, and C for both shallow and deep failure zones.

Based on our site characterization and analyses of the current state of landslide stability, we considered stabilization and avoidance alternatives where stability was less than WSDOT design standards for slopes (FOS ≥ 1.25). For those alternatives that were judged to be both feasible and constructible, conceptual-level design analyses were performed to develop the approximate size and extent of the requisite work. Typical WSDOT design standards for these mitigation alternatives were sought.

SUMMARY OF FINDINGS

PRE-FAILURE CONDITIONS OF THE NILE VALLEY LANDSLIDE

The earliest available aerial photographs from 1949 show the Nile Valley landslide area to be largely unmodified by human activities, with the exception of the highway and other minor developments located along the base of the slope. Abundant geomorphic features are evident in the photography demonstrating prior and widespread landslide activity in all domains (A through D). These include linear depressions (grabens) along the base of the cliffs, trough-and-ridge topography oriented perpendicular to slope, and numerous arcuate scarps with associated evacuated areas (depletion zones) and debris mounds at the base of the slope (representing accumulation zones). In the late winter-spring of 1956, a sizeable slope failure occurred in the slope above the highway in Domain A, which inundated the highway and a portion of the river with debris. The failure apparently occurred within the overlying surficial deposits and did not involve the underlying rock units. This event coincided with the wettest winter recorded in Yakima for the period of 1946 to 2006.

Sometime in the 1950s, mining of the Simmons Pit area started. A significant increase in the mined area occurred between 1966 and 1980. In 1998, tension cracks are noticeable in the upper talus slopes, which correspond with the location of the 2009 landslide headscarp. A regulatory inspection of the Simmons Pit in 2005 noted "… (open) tension cracks and reactivation of old landslide scarps" upslope and north of the permit highwall near the base of the upper talus slope. Successive photos through the summer of 2009 just prior to the landslide show growth of the tension crack in length and offset. Survey monitoring of the slope above the pit between October 2006 and April 2009 detected nearly 4 feet of slope movement toward the pit. The slope deformation noted in the photography and survey data correspond with active mining throughout this 11-year period. The slope deformation occurring over this 11-year period likely represents

the initial deformational episode of the Nile Valley landslide. This initial phase of landslide movement is represented by the E/W-trending set of tension cracks that are prominent throughout Domains C and D and denote a southerly direction of movement toward the pit.

The apparent tension crack noted in Domain A that appears on June 2009 photographs, and its inference of slope instability well beyond and separated from Domains C and D, cannot be confirmed from other sources and remains an unanswered question. We did not find evidence of pending instability within Domain B prior to the October 11th event that would suggest movement of the entire landslide mass.

FAILURE OF THE NILE VALLEY LANDSLIDE

Eyewitness accounts coupled with recorded seismic signals, along with geomorphic mapping of the landslide area, provide a detailed picture of the timing and development of the landslide. The first evidence interpreted as landslide initiation occurred on October 8th and 9th involving slope movement and resultant rockfall from the slope on the west side of the pit access road along the margin between Domains C and D. The first recorded seismic signal occurred on October 10th at 10:20 am, which was followed by the first major episode of landslide movement between 11:00 am and 2:30 pm occurring within the same slope area. The movement was described as an advancing wall of debris. After a 12-hour hiatus, landslide movement resumed in this portion of the slope accompanied by additional seismic signals between 4 and 5 am. It was during this time that subterranean noises and rockfall were noted within the Simmons Pit, indicating the initiation of landsliding in Domain D. The laterally advancing debris front had widened in extent and began to inundate the highway within much of Domain C by around 5:30 am. Movement in the mine slope was first noticed around 7 am along with uplift of the pit floor. At 7:38 am, a large seismic burst was recorded, which coincided with the rapid failure of Domain B. Movement in Domains C and D continued unabated and seismic noises were detected until 9:43 am to 9:55 am when the most energetic seismic bursts were recorded. Significant lateral movement in Domain D was noted during this time. Uplift of the Nile Road across from Domain B began around 9:45 am, several hours after the major pulse of movement in Domain B but still during continued lateral advance of the landslide toe lobe. Uplift continued in Domain B well past noon, and maybe until as late as 5:00 pm. Lateral displacement and uplift of the hillock and the surrounding residences in Domain D were first noticed around 10:15 am while lateral advance of the landslide continued to inundate the pit. Uplift in Domain D continued until at least 4:00 pm.

The eyewitness accounts document that the landslide initiated on the northwestern margin of the active mine slope along the boundary between Domains C and D. Domains C and D became fully involved, and then spread northwest into Domain B (Fig. 8). The tension crack in Domain A was first noticed after the failure initiated in Domain B. The cross-cutting relations of both the lateral scarps separating landslide domains and the NW/SE-trending tension cracks in Domain C with the E/W set that dominates in Domains C and D are consistent with the eyewitness accounts of a westward progression of landslide initiation (Fig. 9).

These eyewitness accounts infer two mechanisms associated with a shallow and a deep zone of landslide failure. Initial movement in Domains C and D primarily involved advancing debris fronts accompanied in Domain D with proximal localized zones of uplift. Numerous localized failures developed on the leading edge from progressive oversteepening of the advancing debris

front. We believe this initial phase of movement within Domains C and D was associated with movement along a relatively shallow failure zone. The location of this interpreted shallow failure zone within Domain C must have been beneath the highway, because the highway was pushed laterally more than a hundred feet. In Domain B, the interpreted shallow failure zone was also located beneath the highway, as the initial phase of movement involved very rapid uplift of the highway. This initial phase of shallow movement is represented in the seismic records as a noisy period punctuated by relatively low energy bursts up until around 9:45 am. The second phase of movement, lagging the initial phase by an hour or more and reportedly lasting for up to 6 hours or more, is represented by the distal zone of uplift. This contiguous zone includes the hillock in Domain D, the river bed in Domain C, and the Nile Road in Domain B. A photograph from Domain C shows the different characteristics of the landslide toes associated with the shallow and deep failure zones (Fig. 17). We believe that the most energetic seismic episode between 9:43 and 9:55 am is largely associated with the initiation of this deep failure zone. Uplift of the hillock in Domain D is the most compelling basis for a deep failure zone, for there seems no other conceivable way to achieve this uplift nearly a thousand feet beyond the inundated pit on an essentially horizontal surface. Given its elevational position nearly 100 feet above the valley bottom and apparent basalt core, the hillock may have developed and grown through multiple, large-scale landslide events with associated uplift and southward lateral displacement. Additional evidence for a deep failure zone is the observed deformation of the steel drill casing between 200 and 260 feet in H-14-09 during drilling. Unfortunately to date, geotechnical instrumentation has not been able to confirm the existence of either the shallow or deep failure zone, due to the lack of movement within the inclinometer casings and TDR cables.

Test borings drilled within the landslide mass revealed that the landslide deposits overlie very weak sedimentary interbeds. The geologic contact between these units is characteristically planar and coincident with slope, dipping downslope between 13° and 18°. Soft, clay-rich zones with disrupted and slickensided texture were typically recovered around this geologic contact and/or within underlying claystone/siltstone interbeds. In our experience, this condition is commonly associated with failure zones in moderately sloping, translational landslides. Laboratory testing of these clay-rich zones yielded very weak to weak residual shear strengths, ranging between 8° and 19°. Piezometers determined the overlying landslide deposits to be mostly unsaturated with a narrow saturated zone (less than 10 feet) perched on the bedrock surface, resulting in saturation of this interpreted clay-rich failure zone. With the dip of this contact being at or somewhat steeper than the residual shear strength, a condition of marginal stability or instability exists within this clay-rich zone and the overlying landslide deposits. We interpret the clay-rich zone, and possibly the upper portion of the sedimentary interbeds, to represent the shallow failure zone.

Sedimentary interbeds encountered between basalt flows contained numerous thin disrupted zones characterized by brecciated, sometimes softened/soil-like, claystone/siltstone with slickensides. These weakened zones may be associated with landsliding (or tectonic folding), but likely are not the most basal zone of failure. Six deep test borings within Domains B and C encountered a 15 to 20-foot-thick unit of highly disrupted and hydrothermally altered claystone/siltstone on top of the Grouse Creek Basalt between 225 and 265 feet below the ground surface. Downslope dip between borings of this aerially extensive unit range from 17° to

22°. Laboratory testing of softened/soil-like zones within this unit yielded very weak to weak residual shear strengths, ranging between 7° and 15°. In five of the six test borings, this unit was associated with an extremely pressurized aquifer at the contact with the Grouse Creek Basalt that generates a piezometric surface more than 100 feet above the ground surface. A vibrating wire piezometer in H-22-09, isolated within this claystone/siltstone unit, demonstrates that very high hydrostatic pressures penetrate into this unit from the underlying confined aquifer. The hydrostatic pressures result in very low effective stresses within the claystone/siltstone, despite the more than 250 feet of overburden stress. We interpret this hydrothermally altered and disrupted claystone/siltstone unit to represent the deep failure zone. This is the same unit where the drill casing in H-14-09 was observed to be deformed.

Utilizing the subsurface models depicted in Sections A, B, and C, the selected engineering properties of the soil and rock units in Table 3, and the groundwater conditions encountered in the borings and measured in the piezometers, we back-analyzed the conditions of failure for the shallow failure zones in Domains A, B, and C and the deep failure zones in Domains B and C. We did not analyze for a deep failure zone in Domain A, because the failure was apparently confined to the overlying surficial deposits and did not involve the underlying rock units. For all domains, failure conditions (FS≤1.0) were reached for both the shallow and deep failure zones. To achieve failure of the deep failure zone in Domain B, the overlying Ortley Basalt had to be modeled with low to no cohesive strength for the expected high frictional strength (49° to 50°). Given the highly fractured condition of the basalt and the apparent long history of landsliding, this assumed strength condition of low to no cohesion seems plausible. If this assumed condition of low to no cohesive strength is unrealistic, then we have no other means to geotechnically account for the observed conditions supporting the existence of a deep failure zone for this domain. Domain C, however, is considerably less stable, and failure conditions can be reasonably modeled for much higher cohesive strength for the overlying Ortley basalt.

Prior to this most recent failure, there was abundant geomorphic evidence of multiple small to large-scale landslide events of unknown age within the landslide area. A number of unfavorable geologic and hydrogeologic conditions predispose the landslide area to both shallow failure within the overlying surficial deposits and deep failure within the bedrock. Both failure mechanisms result primarily from the nature and orientation of the underlying bedrock within the synclinal structure along the valley margin. We envision that the evolution of landsliding involves a continual process of back-wasting of the upper cliffs, primarily by rockfall, and the accumulation of thick talus deposits along the upper margin of the landslide area. This back-wasting and accumulation accelerates immediately following large-scale landslide events, like the October 11th event, due to the expanded oversteepened area produced along the new headscarp. These accumulated talus deposits surcharge the upper landslide area, and thereby reduce stability within both the shallow and deep failure zones. Landsliding within the shallow failure zone is likely the dominant mechanism controlling the small to moderate-scale landslide events, effectively acting as a conveyor belt to episodically/continually transport and disperse these coarse cobble-boulder deposits downslope. At less frequent intervals, conditions of instability are sufficient to generate deep failures within the bedrock and large-scale landslides.

The trigger(s) for the acceleration and growth in lateral and vertical extent of the October 11th, 2009 landslide event is not known. The landslide did not occur during or following a period of

heavy precipitation, nor were any proximal seismic events of significance recorded in the year preceding failure. The influence of mining within the Simmons Pit on slope stability was outside the scope of our investigation, and remains an unanswered question. It has been our experience that a rapid increase in landslide movement can develop after a long period of slow strain, with no apparent triggering mechanism. Further study by others is required, and even after such effort, a triggering mechanism(s) might not be confidently determined.

CURRENT STATE OF STABILITY

Since the landslide occurred on October 11th, 2009, there has been scant evidence of further landslide movement. This evidence includes:

- deformation of H-14-09 drill casing between 200 and 250 feet below the ground surface on/around November 18th, 2009;
- up to one half-foot of localized and shallow instability of the toe lobe in Domain B and in the mine slope in Domain D that were detected in short-range laser scans during the period of October 15th, 2009 and February 16th, 2010 (Appendix C);
- compression within inclinometer H-20si-09 between November 24th, 2009 and March 17th, 2010 (the cause of the compression could be due to consolidation of the landslide debris or uplift being generated by movement along the deep failure zone located below the bottom of the casing); and,
- approximately 1 inch of northwest movement of the monuments for borings H-16/17-09 between January 30th, 2010 and February 17th, 2010.

No movement has been detected in the inclinometers or the TDR cable that can be confidently attributed to movement along either the shallow or deep failure zones within the landslide area. Continuous radar scanning of the landslide area during its service between late October 2009 and mid January 2010 only detected rockfalls along the oversteepened headscarp; no widespread movement within the landslide area was detected during this period.

Based on the monitoring data, very little movement has occurred within the landslide area since the October 11th event. To quantify the current state of stability, analyses were performed for Domains A, B, and C using the back-calculated strength parameters gained from the back-analyses and the post-landslide topography.

Slope movement and development of the tension crack within Domain A was accommodated within the shallow failure zone; the underlying rock units apparently were not involved. As expected, since very little change in the slope profile occurred in Domain A, analyses confirmed that there has been very little change in its state of stability. We believe the current factor of safety to be only slightly greater than unity (FS≤1.05), and the surficial deposits remain marginally stable. The bedrock stratigraphy between the mid-slope and upper borings is not continuous, and there is considerable variability in the groundwater conditions within the bedrock units. These conditions result in some uncertainty about the current state of stability within the bedrock. Based on the available data, the calculated factor of safety for a deep failure within the bedrock is at least 1.25, and thus the failure risk within the bedrock is believed to be low.

There was considerable change from the pre- to the post-landslide topography within Domain B (Fig. 14). As a result, there has been a significant improvement in the stability of Domain B for the shallow and deep failure zones, FS≈1.3 and 1.5, respectively.

Despite the large magnitude of landslide movement within Domain C, the change between the pre- and post-landslide topography is relatively minor. The calculated factors of safety for the current conditions for the shallow and deep failure zones are both around 1.04, indicating that the slope remains marginally stable for both failure conditions.

The current state of stability within Domain D was not investigated and is therefore not known.

Several hundred feet of lateral displacement of the Nile Valley landslide generated a very steep, 100 to 200-foot-high headscarp along the upper cliffs. As the cliffs are comprised of debris from the Sanford Pasture landslide complex, there is a potential concern for loss of toe support and the resultant destabilization/reactivation of a portion of the Sanford Pasture complex. We have interpreted the Nile Valley landslide and the Sanford Pasture landslide complex as two separate landslides with different basal failure zones and separated by the Nile thrust fault. Geomorphic conditions of these landslides suggest that the Nile Valley landslide has been a feature of recurrent instability, whereas the western portion of the Sanford Pasture complex has been a comparatively dormant/metastable feature. For these reasons, we believe the recent movement of the Nile Valley landslide has had very little adverse impact on the Sanford Pasture landslide.

RECOMMENDATIONS

The primary study objective has been to determine the feasibility and required mitigation for reestablishing the highway on or near the existing alignment and in close proximity to the landslide. Our evaluation of the current state of stability found that Domain B exceeds our design standard of FS≥1.25 for both the shallow and deep failure zones for static conditions (no seismic loads). Domains A and C, however, remain marginally stable in their current state, so mitigation will be required for alignment alternatives on or near the landslide within these domains.

Mitigation alternatives can be categorized into avoidance, protection, and stabilization measures. Due to the potential magnitude of landsliding, protection measures alone were judged not to be viable mitigation alternatives. When evaluating stabilization and avoidance alternatives for this landslide, there are two basic geotechnical criteria to address. The first criterion is to satisfy local and global stability standards (FS≥1.25) for critical failure surfaces that could impact or diminish the performance of the mitigation measure. The same limit-equilibrium analytical method is used, and provided the input parameters are well characterized, a solid quantitative solution can be achieved. The second criterion to satisfy is to ensure that for avoidance alternatives, where the potential for future landsliding remains, the potential runout of landslide debris is sufficiently mitigated. Because we lack quantitative methods to evaluate runout distance for this type of landsliding, we must rely mostly on geomorphic evidence of past landsliding and experienced judgment.

For Domain A, avoidance alternatives would require either 1) moving a portion of the river channel to the south to gain additional distance from the base of the slope, or 2) two bridges to

realign the highway onto the opposite side of the river through this reach. Due to the anticipated costs and environmental impacts associated with these options, we focused our evaluation on stabilization alternatives. These alternatives included removal of the landslide mass, dewatering, and passive toe support with a shear key-buttress. Removal would completely mitigate further risk of landsliding of the surficial deposits, but potentially reduces the stability of the upper cliffs. The subsurface conditions for this upslope area are currently not well defined, and further investigation is needed to evaluate the viability and risks associated with this alternative. Since the surficial deposits are already mostly dry and the thin wet clay zone controlling instability is impractical to drain, dewatering was not considered to be a viable alternative. Lastly, we evaluated a combination of a shear key-buttress with some regrading of the upper area (Fig. 18). Conceptually, the shear key-buttress would be constructed on the midslope bench around borings H-10/11/26-09. As basalt bedrock was encountered within 20 feet of the ground surface, we expect that a standard shear key could be reasonably exacavated and constructed, avoiding more complicated structural elements (i.e., cylinder piles) for shear resistance. It may also be possible to utilize on-site materials to construct the buttress through relatively minor regrading of the slope. Three to five additional deep borings will be needed to confirm the viability of this stabilization concept and to develop PS&E-level design recommendations.

As the current stability of Domain B meets our design standard (FS≥1.25), no additional stabilization work is required for alignment alternatives within this domain.

Within Domain C, the landslide remains marginally stable for both the shallow and deep failure zones. We have developed two alignment alternatives around the toe of the landslide through this domain. The first is an avoidance alternative that routes the highway on a large fill section roughly 200 feet beyond the landslide toe (Fig. 19). With this alternative, critical failure surfaces within this new roadway prism for both the deep and shallow failure zones exceed a factor of safety of 1.3. Because no landslide stabilization is involved with this avoidance alternative, the highway remains at some risk from runout of debris from future potential landsliding. In our judgment, the risk of future inundation by landslide debris for this offset distance is low. A second alternative would involve stabilizing the landslide with a large berm around the landslide toe, which could also include some regrading of the upper landslide area (Fig. 19). Conceptually, the berm would be on the order of 30 to 70 feet high and 200 to 300 feet in width, resulting in a new highway grade about 50 feet in elevation above the former highway grade. The berm alone satisfies design standards for the deep failure zone, though it is slightly less than required (FS≈1.22) for overtopping from the shallow failure zone. We expect that with further modifications to the berm, we can achieve design standards if necessary. Along with the berm, we considered regrading of the upper landslide area, which potentially could provide on-site materials for the berm. This regrading provides no significant improvement in stability for the shallow failure zone, but does for the deep failure zone. Six to eight additional deep borings will be needed to confirm the viability of this stabilization concept and to develop PS&E-level design recommendations.

The allowance and potential impacts of future mining within or near Domain C cannot be fully anticipated at this time. Due to the proximity of these alignment alternatives near/on the

landslide toe, future mining plans should be geotechnically evaluated and modified, if necessary, to ensure no adverse impacts to a new highway facility sited in this location.

LIMITATIONS

The findings and recommendations contained in this report are based on the Geotechnical Division's understanding of the project and site conditions that existed during the course of our investigation. We assume that the test borings are representative of the subsurface conditions throughout the project area. The findings and recommendations are not intended as final design recommendations; additional geotechnical investigation and design will be needed to develop any of the presented alternatives.

If there are any questions regarding the recommendations contained in this geotechnical report, please contact Tom Badger at (360) 709-5461 or Steve Lowell at (360) 709-5460.

ACKNOWLEDGMENTS

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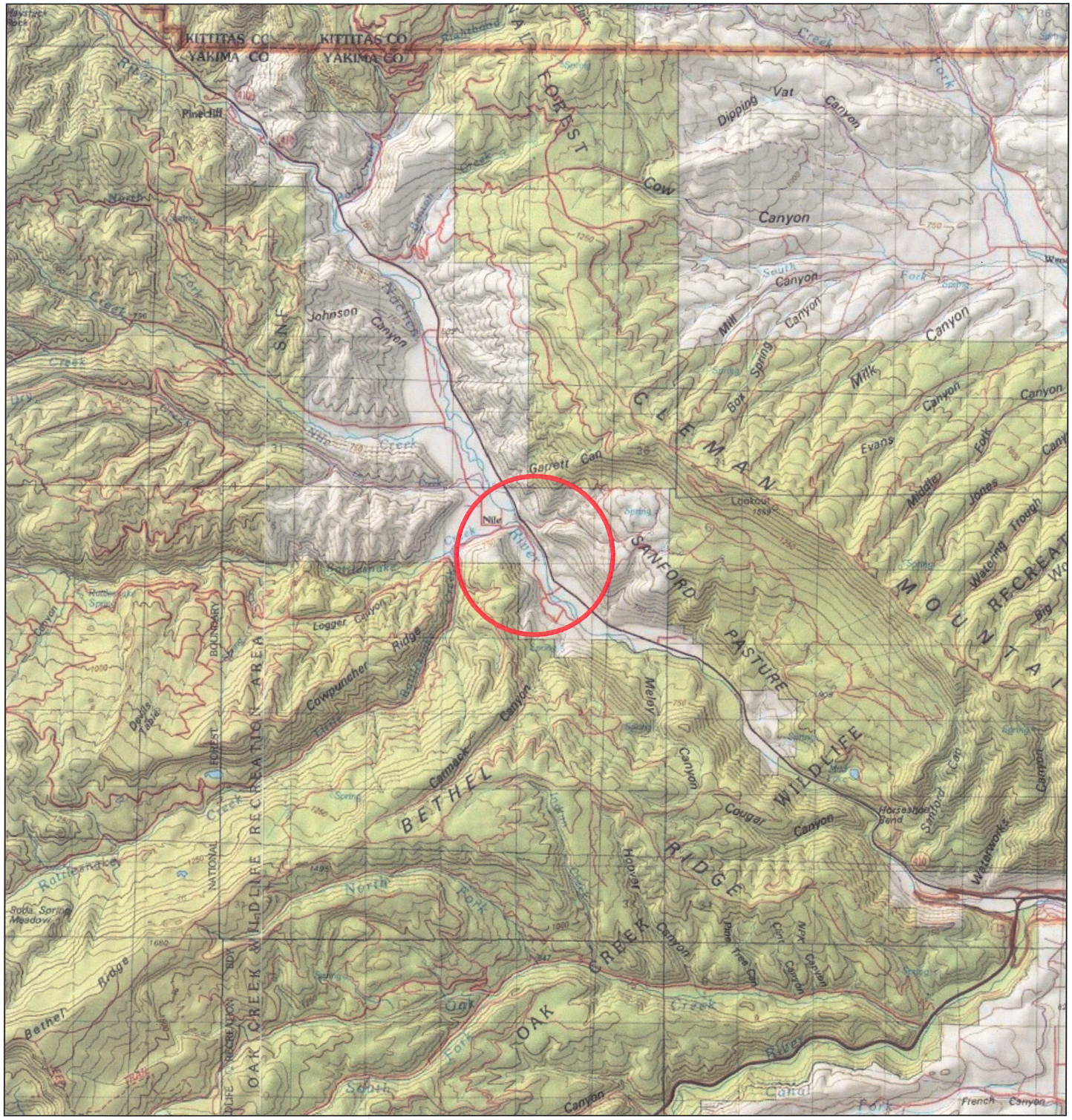
Figures



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1 inch = 10,000 feet

JOB # XL-3695 STATE ROUTE 410 MILEPOST(S) 108

FIGURE 1: LOCATION MAP

SR 410

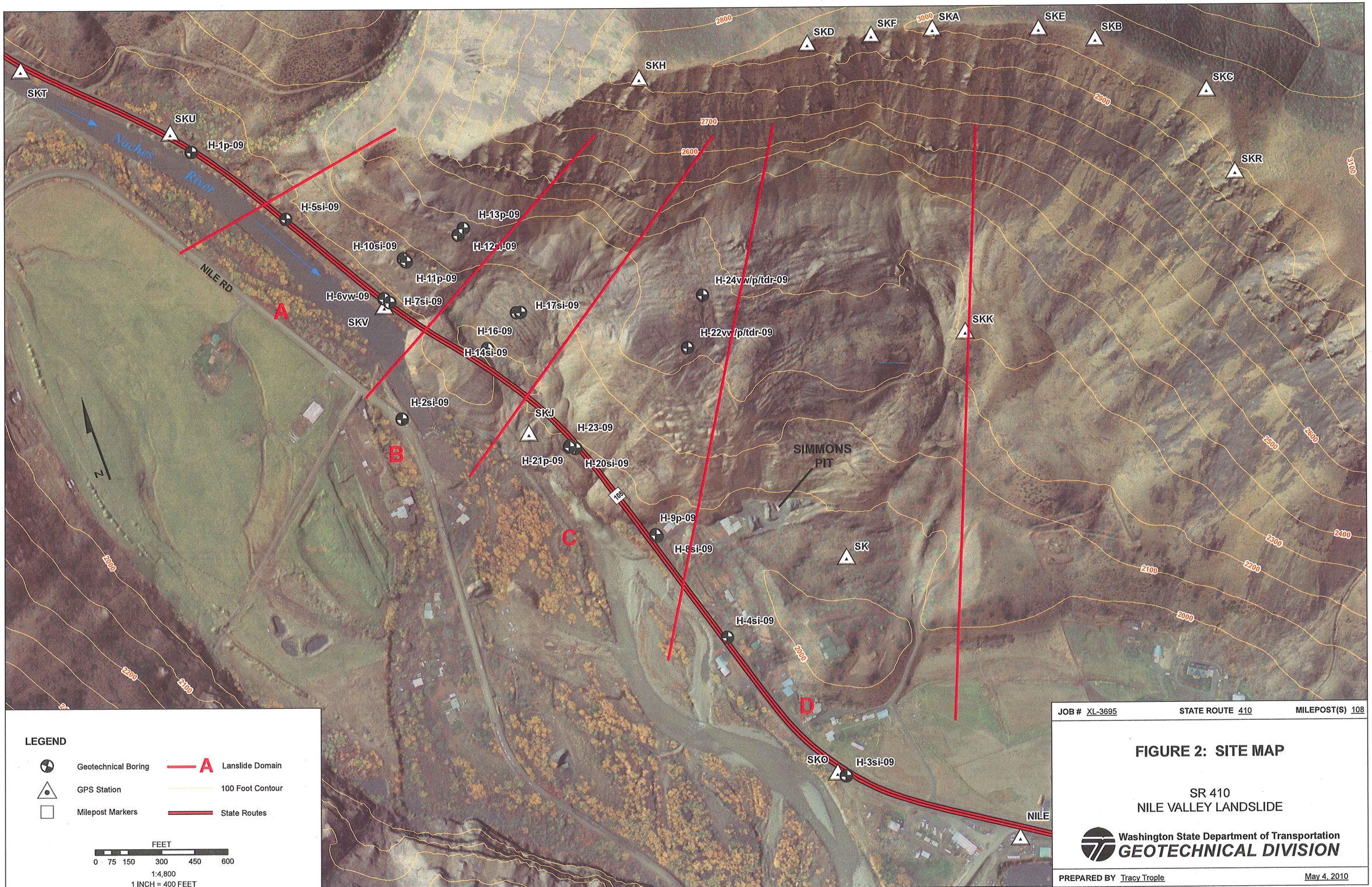
NILE VALLEY LANDSLIDE

Washington State Department of Transportation

GEOTECHNICAL DIVISION

PREPARED BY Tracy Trople DATE March 17, 2010

File Location: M:\GEOGIS\Projects\SR-410\SR410-XL3695-\Products\SR410-SL3695-TB-NileLandslide-Fig1-SiteVicinity.mxd



JOB # XL-3695 STATE ROUTE 410 MILEPOST(S) 108

FIGURE 2: SITE MAP

SR 410
NILE VALLEY LANDSLIDE

Washington State Department of Transportation
GEOTECHNICAL DIVISION

PREPARED BY Tracy Trople May 4, 2010

File Location: M:\GEOGIS\Projects\SR-410\SR410-XL3695-\Projects\SR410-XL3695-Fig2-SiteMap.mxd

DESCRIPTION OF MAP UNITS

Quaternary Surficial Deposits

- **Qa** — **Alluvium**—Gravel, sand, and mud deposited in stream flow, sheet flood, overbank, and lake deposits; includes loess and colluvium.
- **Qaf** — **Alluvial fan**—Rock and sand; restricted lateral extent at or near mouth of tributary stream at marked change in gradient.
- **Qta** — **Talus**—Rock, generally monolithic; restricted extent at base of cliff or steep, rocky slope; commonly partly overgrown.
- **Qls** — **Landslide**—Boulders and cobbles; consists of rock avalanche, slump, or earthflow deposits composed of locally derived rock and soil.
- **Qgt** — **Glacial till**—Boulders, cobbles, and pebbles in a matrix of sand, silt, and clay; brown; thin veneer along valley floors and slopes.

Middle to Upper Miocene Stratified Volcanic Deposits

- **Tev** — **Ellensburg Formation, volcanic facies**—Interstratified conglomerate, tuff-breccia, sandstone, siltstone, and tuff of dacite.

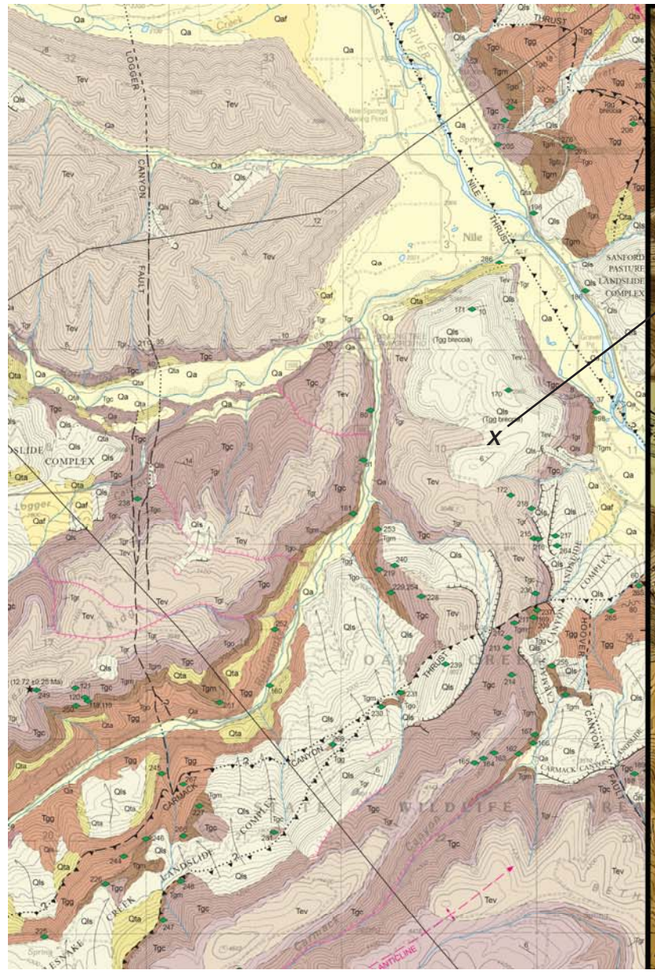
Grande Ronde Basalt—Six single lava flows of basaltic andesite. All flows generally form steep benched slopes, rims, or cliffs.

Divided into:

- **Tgr** — **Rocky Coulee lava flow**
- **Tgc** — **Cohassett lava flow**
- **Tgm** — **McCoy Canyon lava flow**
- **Tgo** — **Ortley lava flow**
- **Tgg** — **Grouse Creek lava flow**
- **Tgw** — **Wapshilla Ridge lava flow**
- **Tgib** — **Interbeds in Grande Ronde Basalt**

GEOLOGIC SYMBOLS

- Contact—Long-dashed where approximately located; short-dashed where inferred; dotted where concealed; showing dip; queried where uncertain
- Unconformity—Queried where uncertain; cross sections only
- Bedding lines—Short dashed where inferred; cross sections only
- Fault, unknown offset—Long-dashed where approximately located; short-dashed where inferred; dotted where concealed; queried where uncertain
- Thrust fault—Sawteeth on upper plate; long-dashed where approximately located; dotted where concealed; in cross sections arrows show relative movement
- High-angle dip-slip fault—Relative motion shown by U and D; long-dashed where approximately located; short-dashed where inferred; dotted where concealed; queried where uncertain; in cross sections arrows show relative movement
- Reverse fault, R on upthrown side—Dashed where inferred; dotted where concealed
- Fracture—Long-dashed where approximately located; short-dashed where inferred
- Anticline—Long-dashed where approximately located; dotted where concealed; showing plunge
- Syncline—Long-dashed where approximately located; dotted where concealed; showing plunge
- Monocline—Anticlinal bend; dashed where approximately located
- Landslide scarp—Hachures on downslope side
- Potential or incipient landslide scarp—Hachures on downslope side; lighter-colored where concealed
- Direction of landslide movement
- Shear—Showing strike and dip
- Inclined bedding—Showing strike and dip
- Inclined bedding—Showing approximate strike and dip
- Flow layering in lava flow or fluidal layering in plutonic rock—Showing strike and dip
- Vertical flow layering in lava flow or fluidal layering in plutonic rock—Showing strike
- Joint—Showing strike and dip
- Geochemistry sample location
- Age-date sample, zircon fission-track
- Age-date sample, K-Ar
- Age-date sample, Ar-Ar



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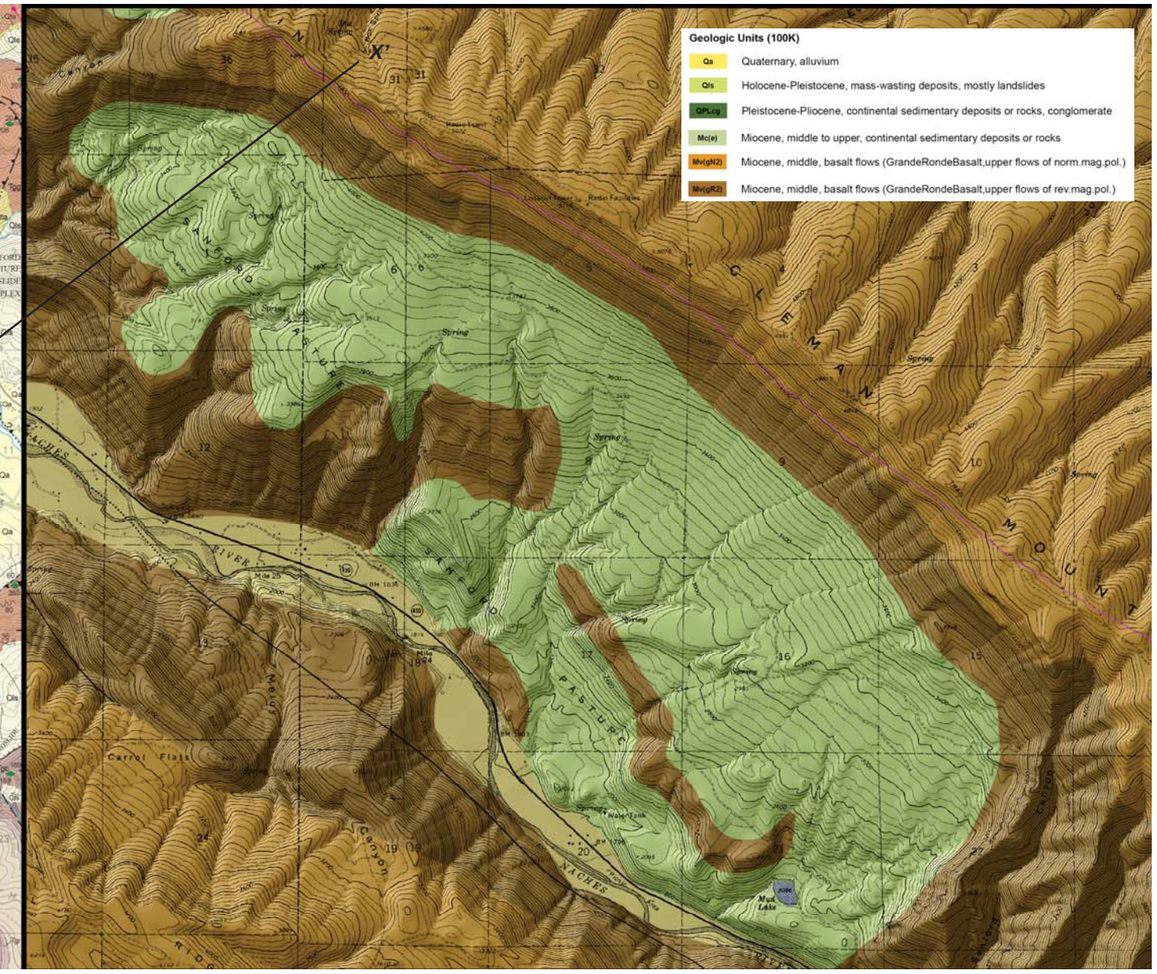

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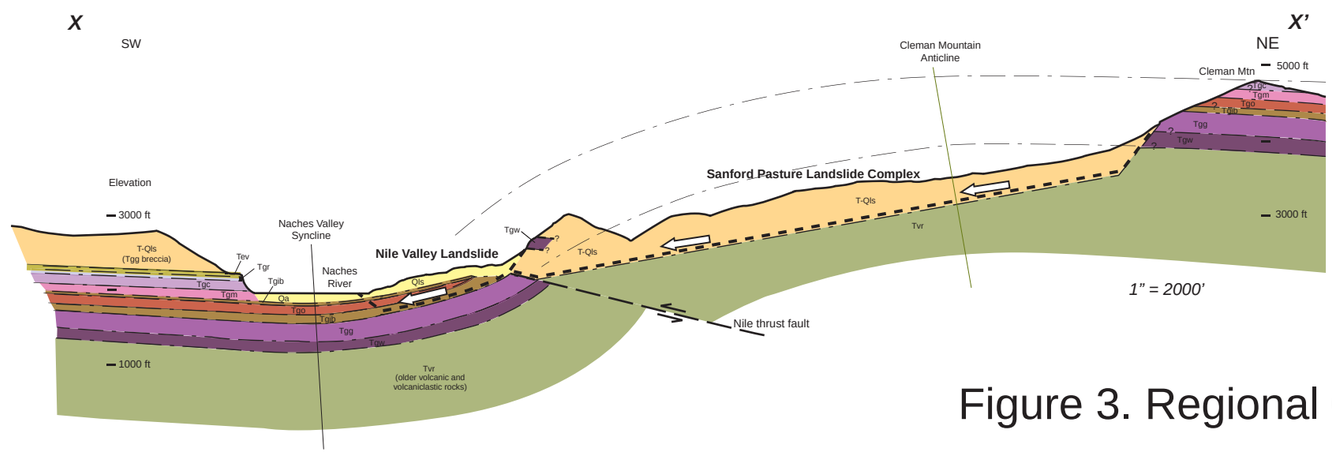
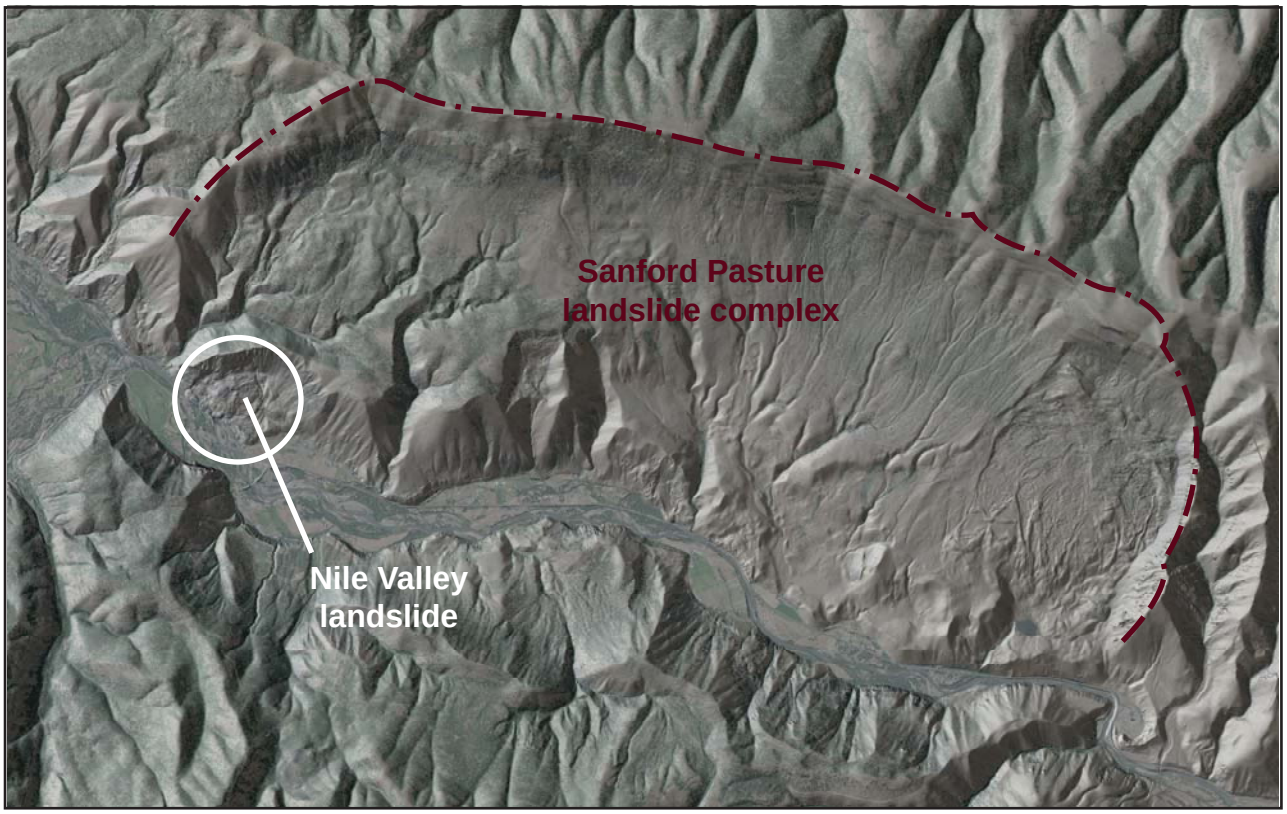


Figure 3. Regional Geologic Map and Section



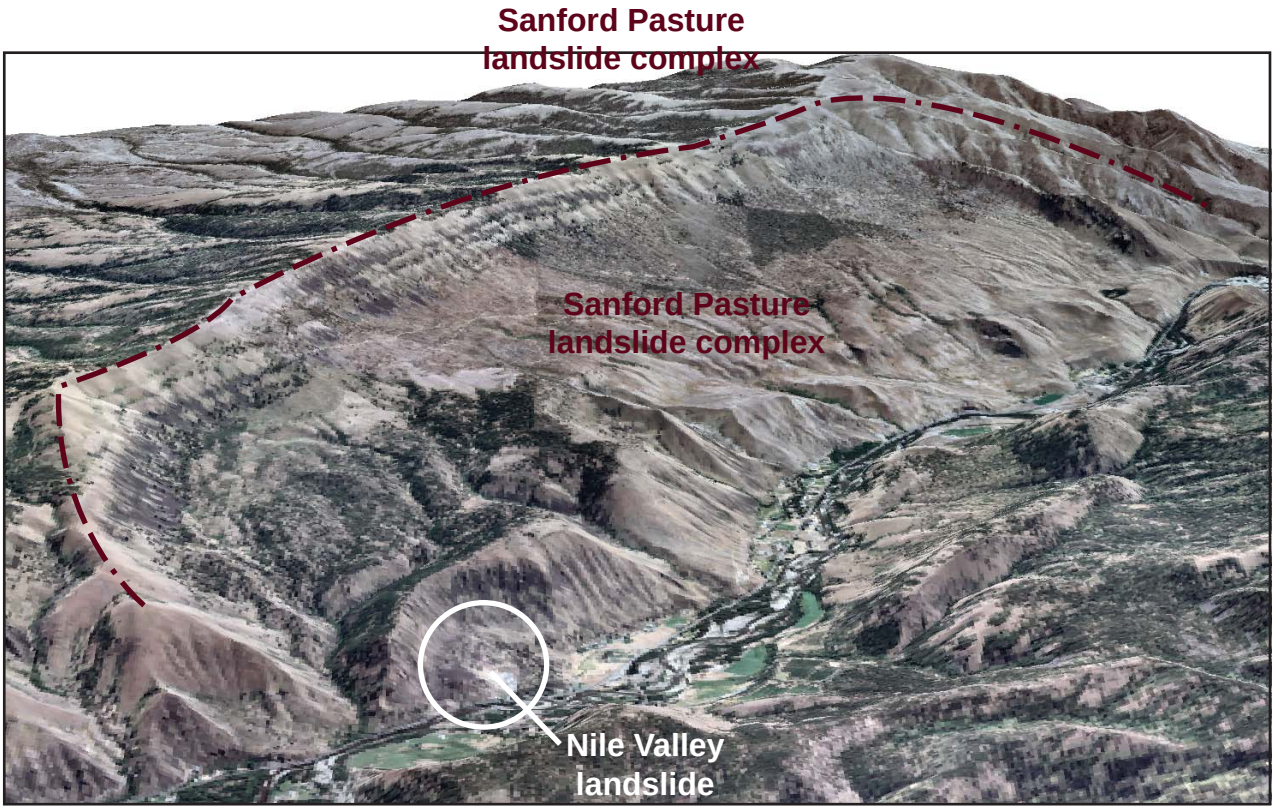


Figure 4: Sanford Pasture Landslide Complex

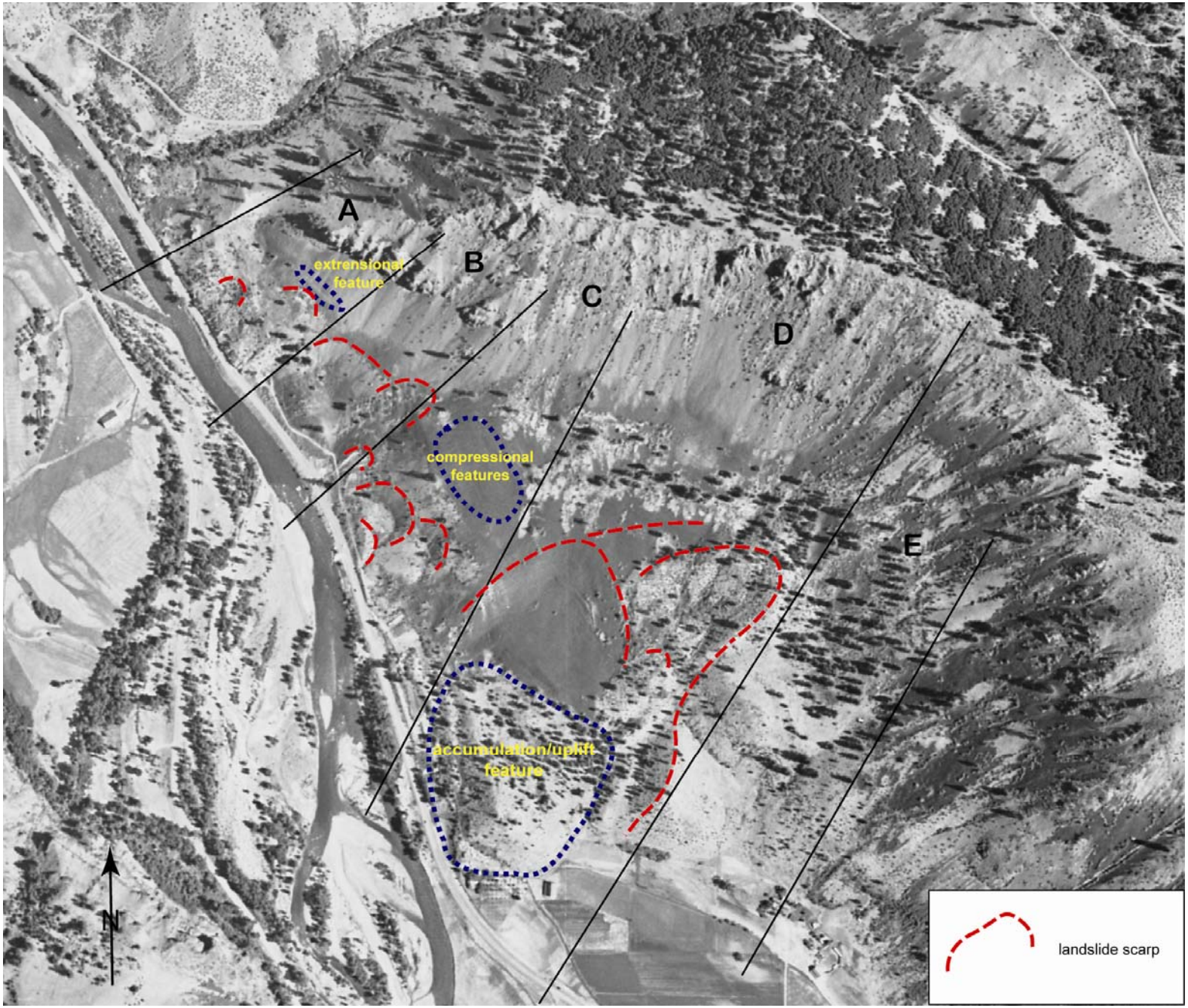
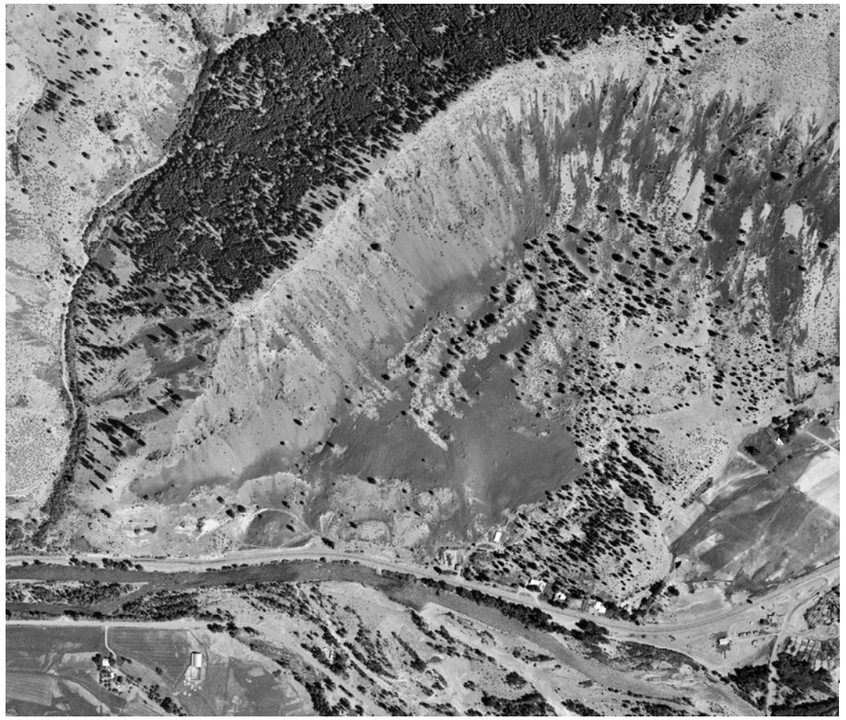
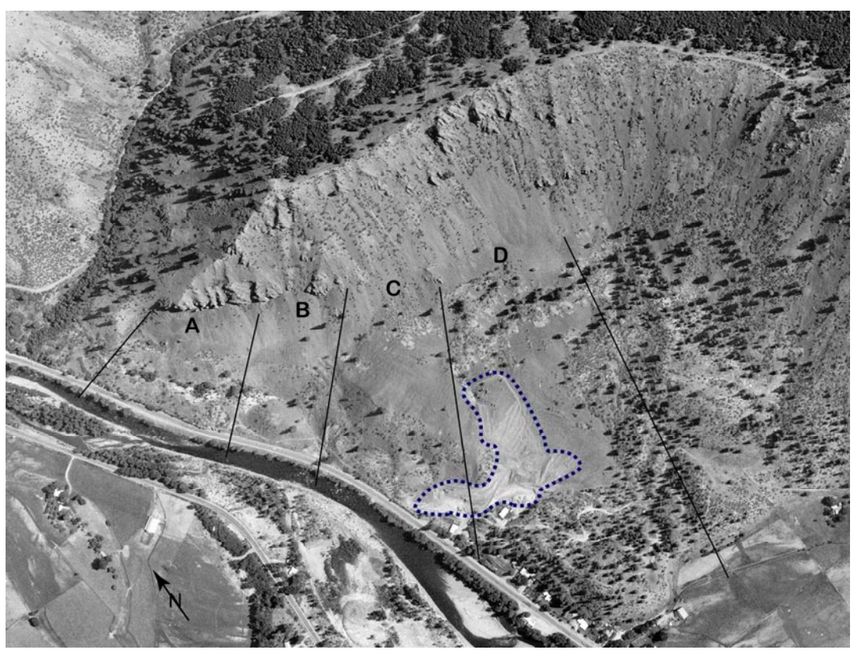


Figure 5: 1949 Aerial Photograph



Photograph from August 1966 shows small mining operation in Simmons Pit.

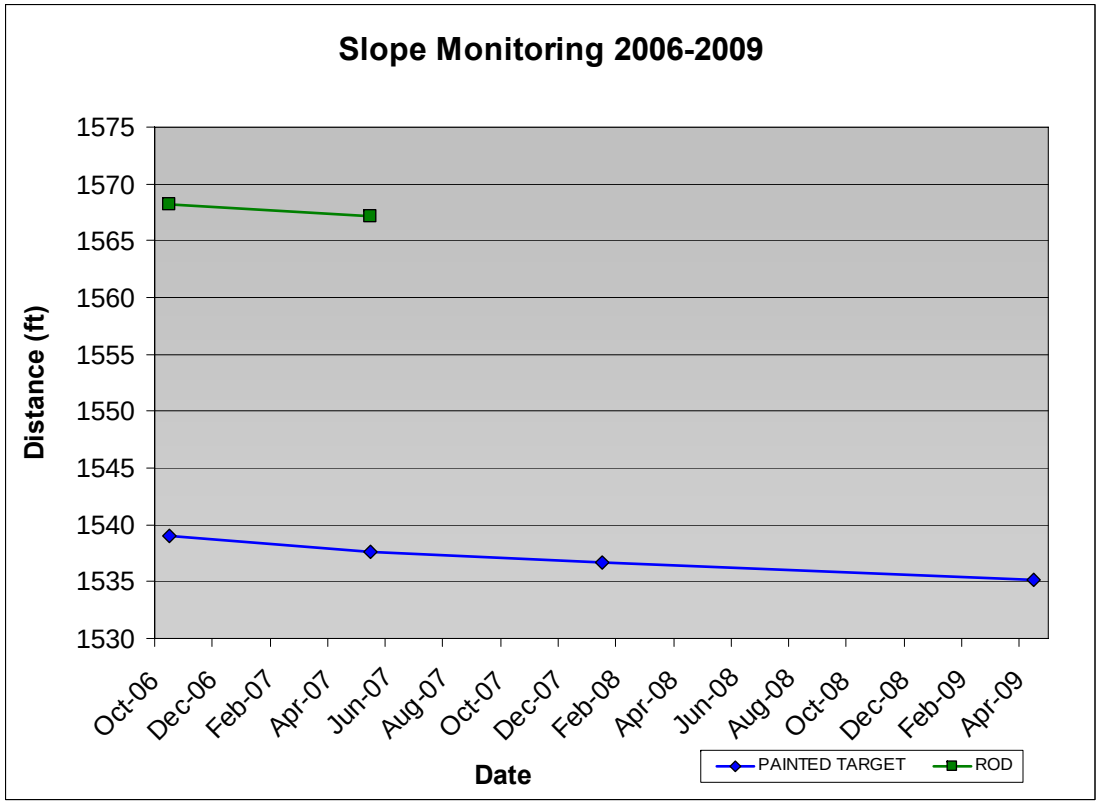
Photograph from July 1998 shows first indication of tension crack (red dashed line) above pit.

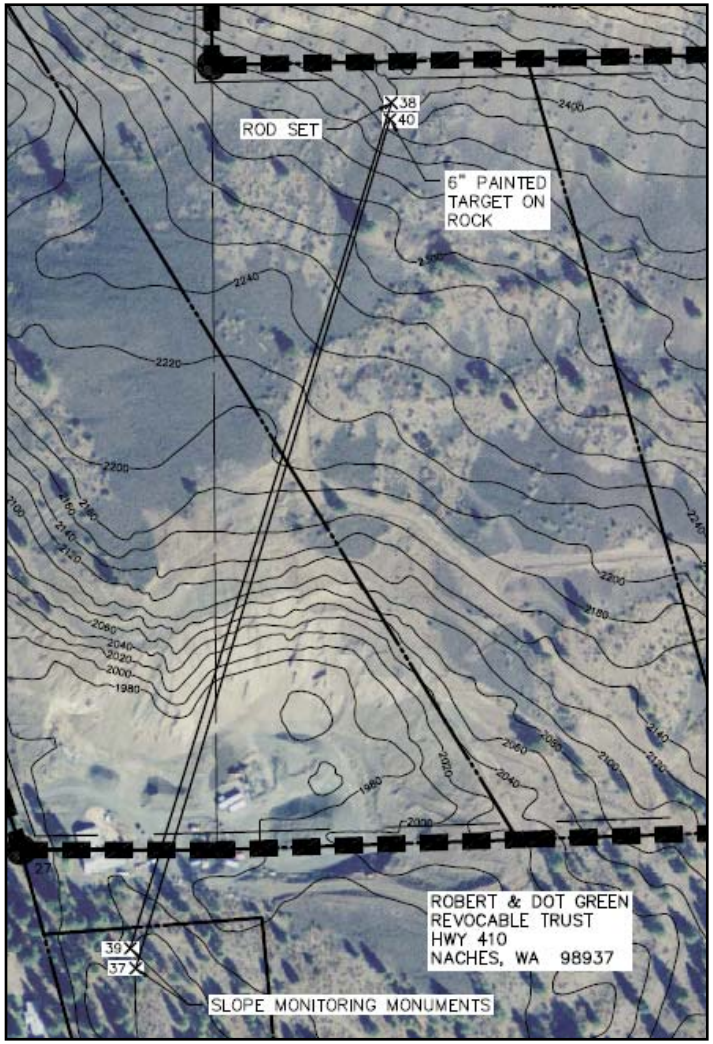


Photograph from July 1980 shows significant increase in mining activity.

Photograph from September 2005 shows lengthening and increased offset of tension crack (red dashed line).

Figure 6: Mining Activity 1966 to 2005

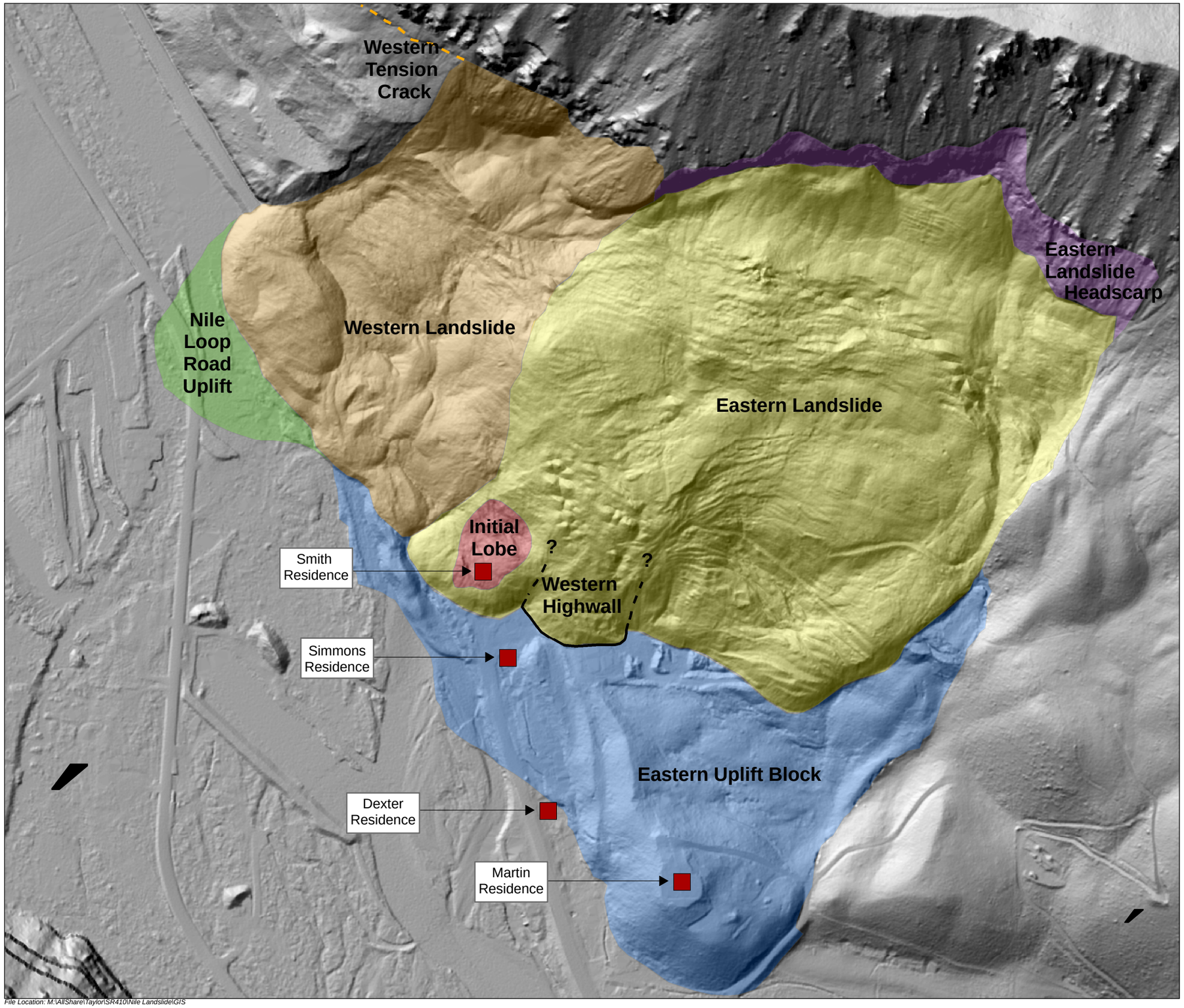




Date	Distance to Rod *(ft)*	Δ *(ft)*	Distance to Painted Target *(ft)*	Δ *(ft)*	Annualized Rate of Movement *(ft/yr)*
10/12/2006	1568.16		1538.968		-
5/22/2007	1567.1	-1.06	1537.655	-1.313	2.16
1/3/2008	-	-	1536.625	-1.03	1.66
4/23/2009	-	-	1535.13	-1.495	1.15

** data provided by PLSA Engineering & Surveying, 2009*

Figure 7. Simmons Pit Slope Monitoring 2006 - 2009



File Location: M:\AllShare\Taylor\SR410\Nile Landslide\GIS

Landslide movement observed by eyewitnesses

Initial Lobe

Sat 10/10/09 11:00 AM to 2:00 PM

Eastern Landslide

Sun 10/11/09 4:15 AM to ~ 12:00 PM

Western Pit Highwall

Sun 10/11/09 7:15 AM

Western Landslide

Sun 10/11/09 7:38 AM to ~ 12:00 PM

Western Tension Crack

Sun 10/11/09 ~ 7:38 AM

Eastern Landslide Headscarp

Sun 10/11/09 9:00 AM to ~ 9:45 AM

Nile Loop Road Uplift

Sun 10/11/09 9:45 AM to ~ 5:00 PM

Eastern Uplift Block

Sun 10/11/09 10:15 AM to ~ 4:00 PM

FEET

0 125 250 500 750 1,000

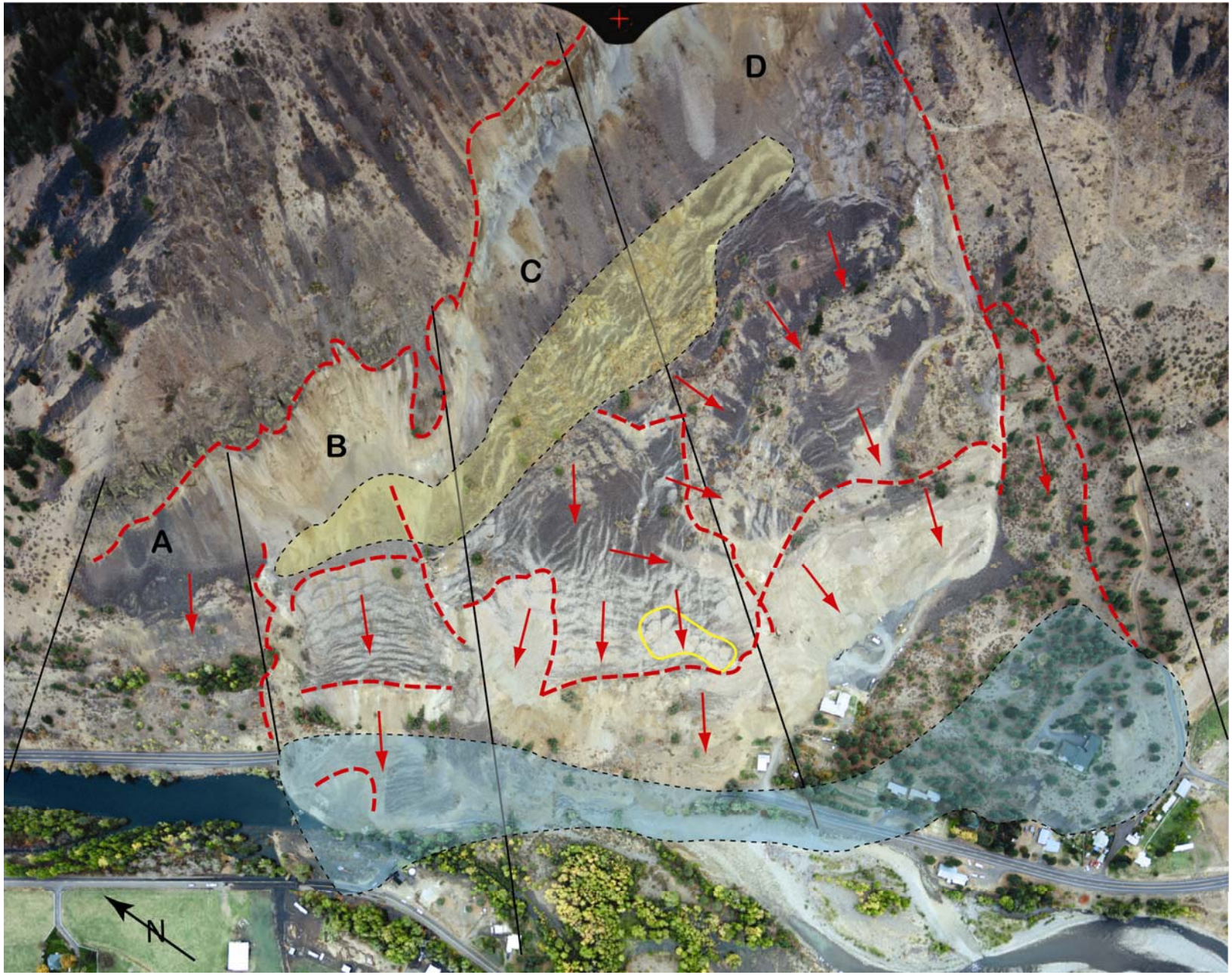
1:3,600

1 INCH = 300 FEET

FIGURE 8:
Site map for eyewitness reports

Washington State Department of Transportation
GEOTECHNICAL DIVISION

PREPARED BY Gabriel Taylor **DATE** January, 26, 2010



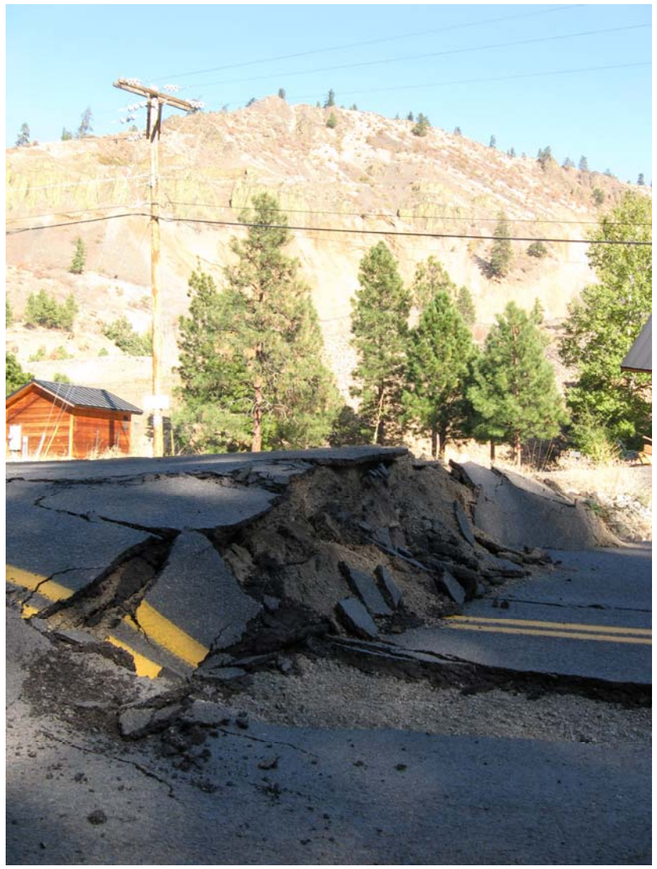
Red dashed lines depict major landslide scarps. Arrows depict inferred direction of movement based on orientation of tension cracks. Yellow shaded area depicts graben area, and shaded blue area approximately depicts zone of uplift. The yellow outlined polygon in Domain C defines a peculiar zone of small mounds that protrude the ground surface.

Figure 9. Nile Valley Landslide Geomorphology

Domain B headscarp and graben

Domain C and D headscarp and graben

Figure 10. Headscarp and Graben Areas



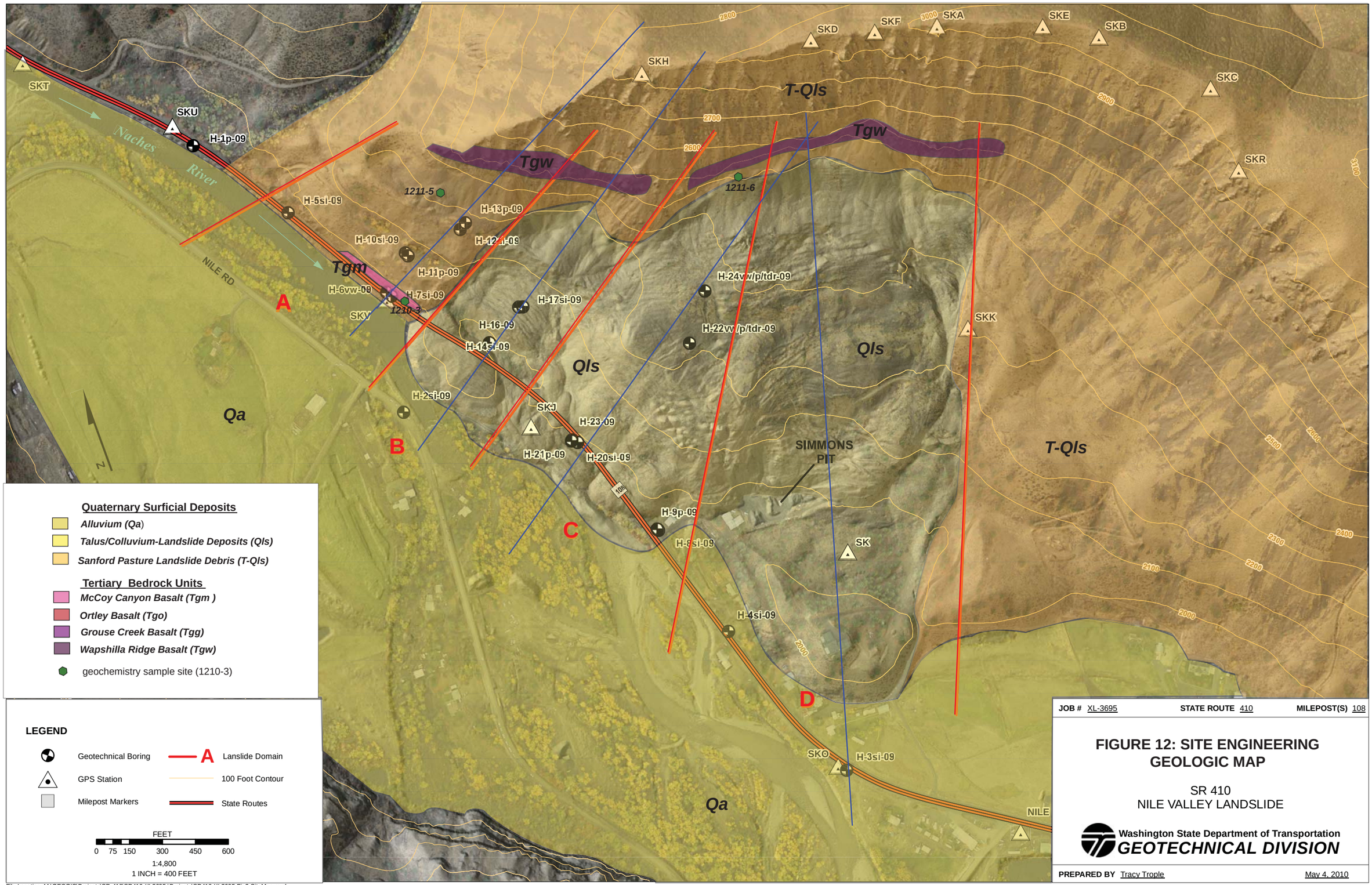
Domain B uplift on Nile Road

Domain C uplift of Naches River channel

Domain D uplift on north side of SR 410 below hillock

Domain D uplift on hillock at Martin residence

Figure 11. Uplift Zone in Toe Area



File Location: M:\GEOGIS\Projects\SR-410\SR410-XL3695-\Projects\SR410-XL3695-Fig2-SiteMap.mxd

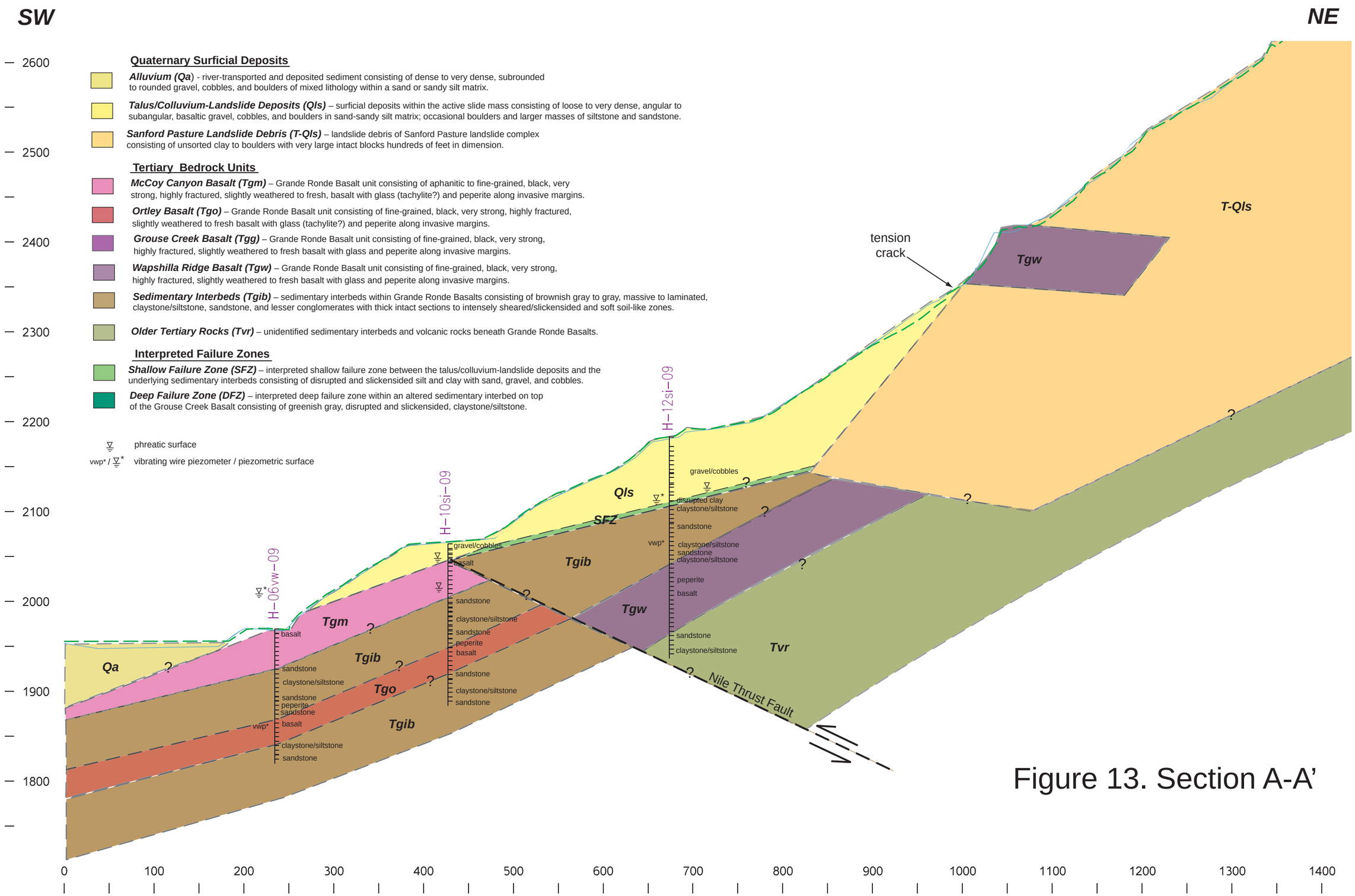


Figure 13. Section A-A'

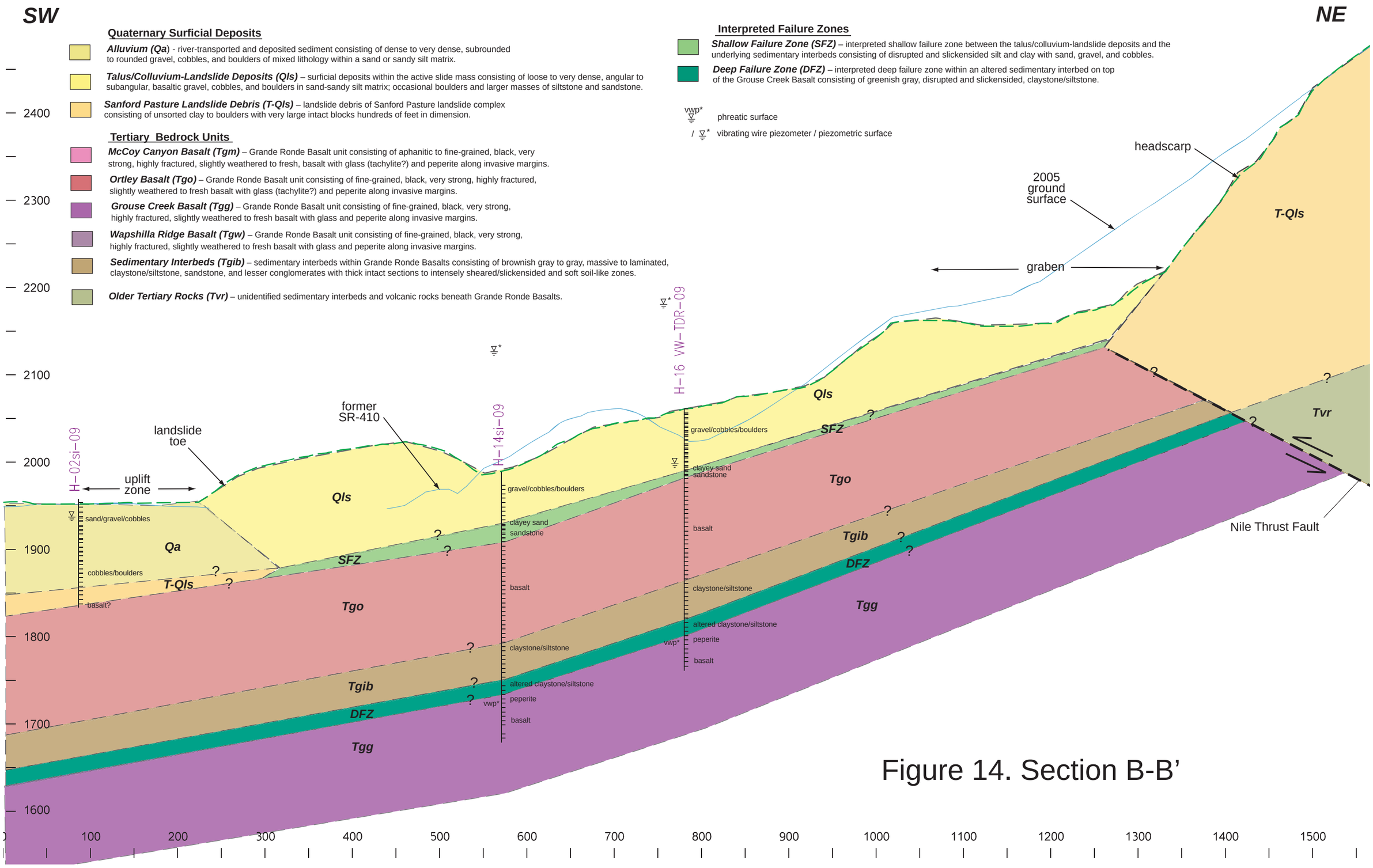


Figure 14. Section B-B’

Quaternary Surficial Deposits

Alluvium (Qa) - river-transported and deposited sediment consisting of dense to very dense, subrounded to rounded gravel, cobbles, and boulders of mixed lithology within a sand or sandy silt matrix.

Talus/Colluvium-Landslide Deposits (Qls) – surficial deposits within the active slide mass consisting of loose to very dense, angular to subangular, basaltic gravel, cobbles, and boulders in sand-sandy silt matrix; occasional boulders and larger masses of siltstone and sandstone.

Sanford Pasture Landslide Debris (T-Qls) – landslide debris of Sanford Pasture landslide complex consisting of unsorted clay to boulders with very large intact blocks hundreds of feet in dimension.

Tertiary Bedrock Units

McCoy Canyon Basalt (Tgm) – Grande Ronde Basalt unit consisting of aphanitic to fine-grained, black, very strong, highly fractured, slightly weathered to fresh, basalt with glass (tachylite?) and peperite along invasive margins.

Ortley Basalt (Tgo) – Grande Ronde Basalt unit consisting of fine-grained, black, very strong, highly fractured, slightly weathered to fresh basalt with glass (tachylite?) and peperite along invasive margins.

Grouse Creek Basalt (Tgg) – Grande Ronde Basalt unit consisting of fine-grained, black, very strong, highly fractured, slightly weathered to fresh basalt with glass and peperite along invasive margins.

Wapshilla Ridge Basalt (Tgw) – Grande Ronde Basalt unit consisting of fine-grained, black, very strong, highly fractured, slightly weathered to fresh basalt with glass and peperite along invasive margins.

Sedimentary Interbeds (Tgib) – sedimentary interbeds within Grande Ronde Basalts consisting of brownish gray to gray, massive to laminated, claystone/siltstone, sandstone, and lesser conglomerates with thick intact sections to intensely sheared/slickensided and soft soil-like zones.

Older Tertiary Rocks (Tvr) – unidentified sedimentary interbeds and volcanic rocks beneath Grande Ronde Basalts.

Interpreted Failure Zones

Shallow Failure Zone (SFZ) – interpreted shallow failure zone between the talus/colluvium-landslide deposits and the underlying sedimentary interbeds consisting of disrupted and slickensided silt and clay with sand, gravel, and cobbles.

Deep Failure Zone (DFZ) – interpreted deep failure zone within an altered sedimentary interbed on top of the Grouse Creek Basalt consisting of greenish gray, disrupted and slickensided, claystone/siltstone.

phreatic surface

vwp* / vibrating wire piezometer / piezometric surface

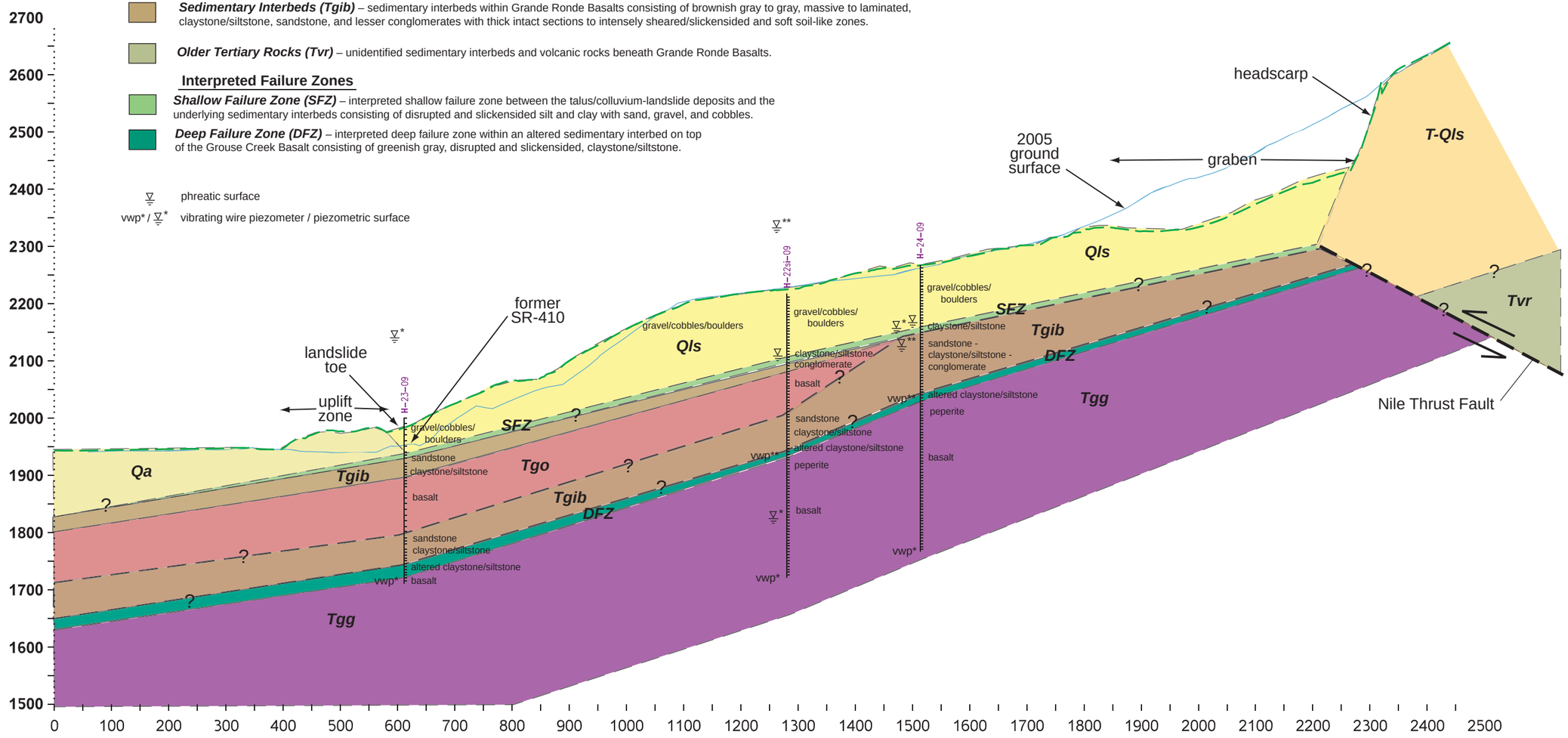


Figure 15. Section C-C’

Quaternary Surficial Deposits

Alluvium (Qa) - river-transported and deposited sediment consisting of dense to very dense, subrounded to rounded gravel, cobbles, and boulders of mixed lithology within a sand or sandy silt matrix.

Talus/Colluvium-Landslide Deposits (Qls) – surficial deposits within the active slide mass consisting of loose to very dense, angular to subangular, basaltic gravel, cobbles, and boulders in sand-sandy silt matrix; occasional boulders and larger masses of siltstone and sandstone.

Sanford Pasture Landslide Debris (T-Qls) – landslide debris of Sanford Pasture landslide complex consisting of unsorted clay to boulders with very large intact blocks hundreds of feet in dimension.

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phreatic surface

vwp* / vibrating wire piezometer / piezometric surface

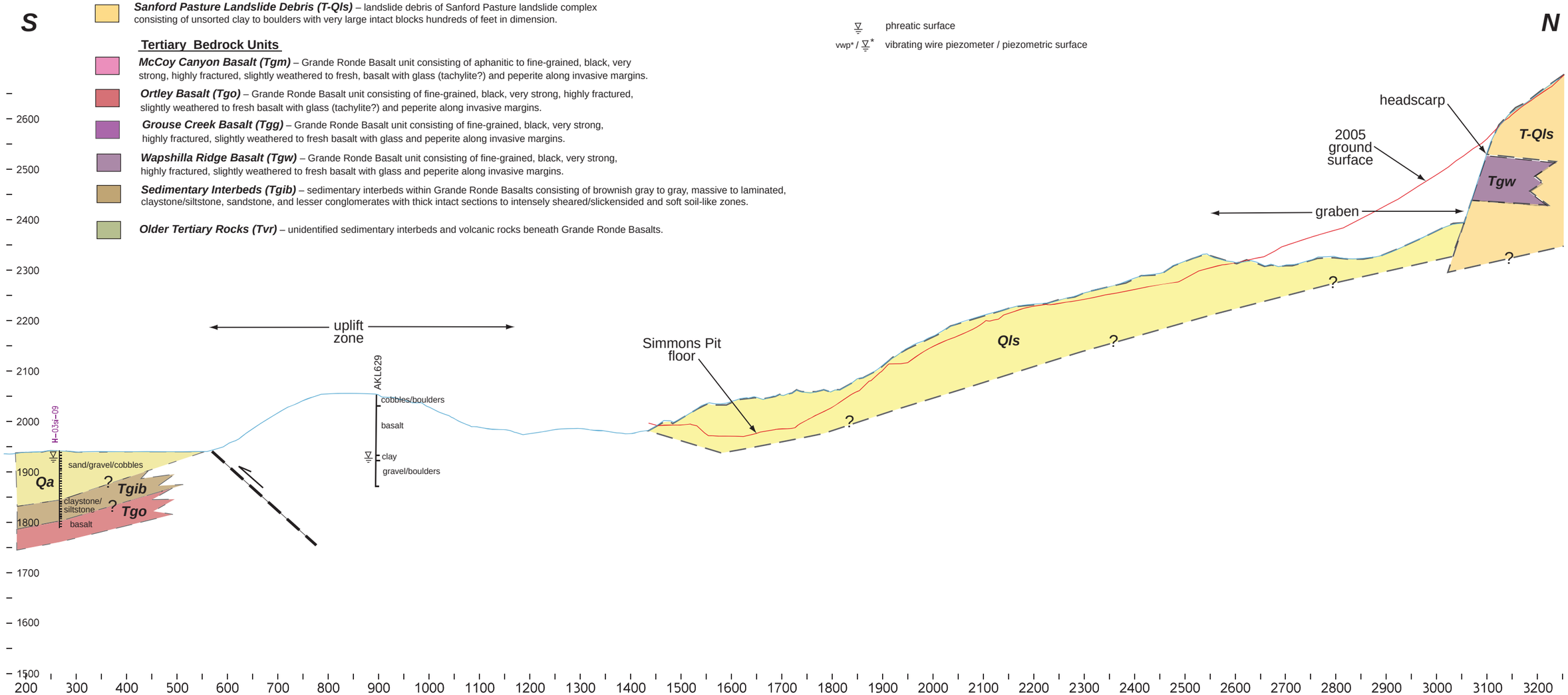

Figure 16. Section D-D’

Domain C shows two juxtaposed toe features. The feature on the left is comprised of landslide debris (*Qls*) and is associated with a shallow interpreted failure zone. The feature on the right is comprised of alluvium (*Qa*) and represents an uplift feature associated with deep interpreted failure zone, which developed after movement associated with the shallow failure zone had ceased.

Figure 17: Toe Features of the Shallow and Deep Failure Zones

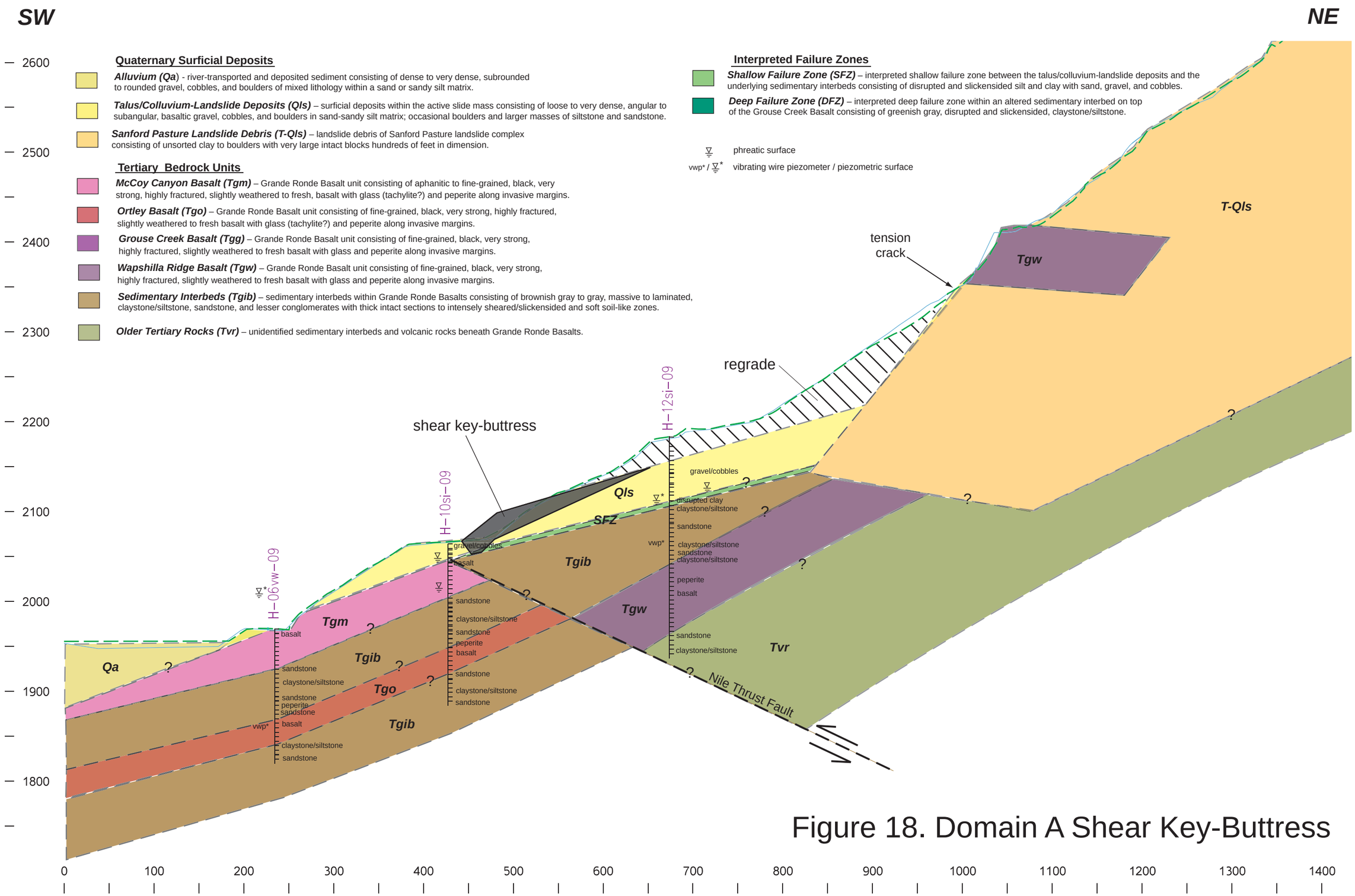

Figure 18. Domain A Shear Key-Buttress

Quaternary Surficial Deposits

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phreatic surface

vwp* / vibrating wire piezometer / piezometric surface

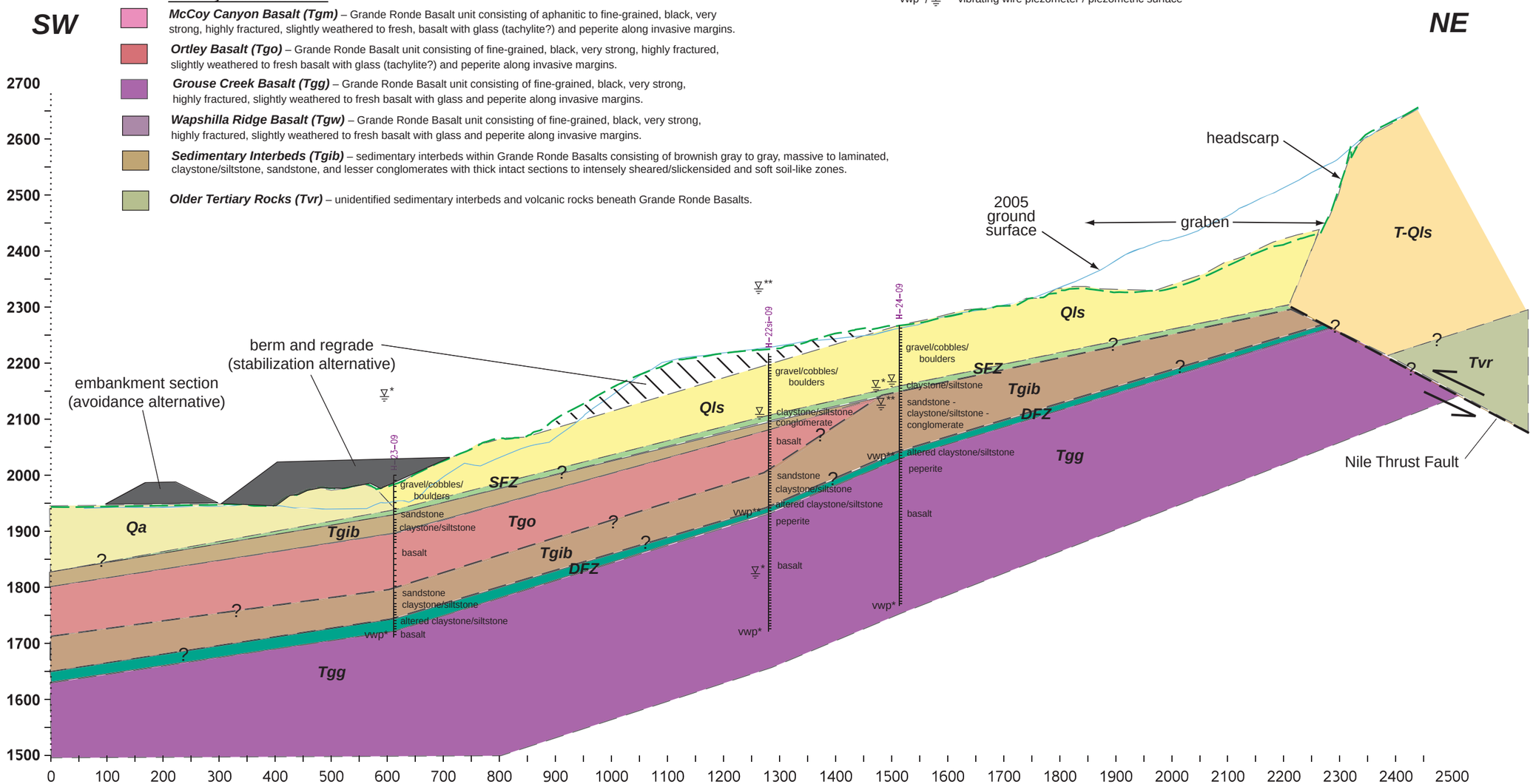

Figure 19. Domain C Avoidance & Stabilization Alternatives

Appendix A

Boring Logs

Test Boring	Northing (*ft*)	Easting (*ft*)	Elevation (*ft*)	Hole Depth (*ft*)	Instrumentation
H-1p-09	542052.02	1533453.543	1966.098	94	standpipe piezometer
H-2si-09	540584.881	1533938.028	1957.595	124	slope inclinometer
H-3si-09	538364.67	1535275.056	1942.363	154	slope inclinometer
H-4si-09	539141.079	1534986.341	1943.669	150	slope inclinometer
H-5-09	541617.08	1533754.653	1964.814	90.5	none
H-5si-09	541617.164	1533754.516	1964.852	85	slope inclinometer
H-6vw-09	541124.402	1534049.439	1969.051	150	vibrating wire piezometer
H-7si-09	541099.771	1534066.739	1969.344	80	slope inclinometer
H-8si-09	539682.355	1534844.342	1945.504	140	slope inclinometer
H-9p-09	539691.171	1534839.461	1945.321	55	standpipe piezometer
H-10si-09	541233.696	1534214.648	2067	180	slope inclinometer
H-11p-09	541243.014	1534204.843	2067	100	standpipe piezometer
H-12si-09	541278.429	1534464.297	2183.9	247	slope inclinometer
H-13p-09	541299.259	1534496.905	2195.183	131	standpipe piezometer
H-14si-09	540749.014	1534412.299	1988.28	310	slope inclinometer
H-16vw-09	540855.073	1534593.47	2060.99	300	vibrating wire piezometer
H-17si-09	540850.342	1534612.656	2061.42	290	slope inclinometer
H-20si-09	540185.123	1534635.444	1991.435	239	slope inclinometer
H-21p-09	540200.301	1534611.269	1990.495	103	standpipe piezometer
H-22vw-09	540435.346	1535267.871	2216.859	497	2 vibrating wire piezometers; standpipe piezometer; TDR cable
H-23-09	540185.196	1534635.412	1990	290	none
H-24vw-09	540634.306	1535414.003	2266.665	500.4	2 vibrating wire piezometers; standpipe piezometer; TDR cable
H-26p-09	541246.258	1534207.735	2067	22.5	standpipe piezometer

* - Datum State Plane South coordinate system.

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Washington State
Department of Transportation

Test Boring Legend

Sampler Symbols

	Standard Penetration Test
	Oversized Penetration Test (Dames & Moore, California)
	Shelby Tube
P	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
B	Bag Sample

Well Symbols

	Cement Surface Seal
	Piezometer Pipe in Granular Bentonite Seal
	Piezometer Pipe in Sand
	Well Screen in Sand
	Granular Bentonite Bottom Seal
	Inclinometer Casing in Concrete Bentonite Grout

Laboratory Testing Codes

UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
UC	Unconfined Compression Test
DS	Direct Shear Test
CN	Consolidation Test
GS	Grain Size Distribution
MC	Moisture Content
SG	Specific Gravity
OR	Organic Content
DN	Density
AL	Atterberg Limits
PT	Point Load Compressive Test
SL	Slake Test
DG	Degradation
LA	LA Abrasion
HT	Hydrometer Test

Soil Density Modifiers

Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
(REF)	Refusal	31-60	Hard
		>60	Very Hard

Angularity of Gravel & Cobbles

Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers

Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure

Stratified	Alternating layers of varying material or color at least 6mm thick; note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 6mm thick; note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, somtimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCL Reaction

No HCL Reaction	No visible reaction.
Weak HCL Reaction	Some reaction with bubbles forming slowly.
Strong HCL Reaction	Violent reaction with bubbles forming immediately

Degree of Vesicularity of Pyroclastic Rocks

Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total

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Washington State
Department of Transportation

Test Boring Legend

Grain Size

Fine Grained	< 1mm	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	1mm to 5mm	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 5mm	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength

Grade	Description	Field Identification	Uniaxial Compressive Strength approx
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be cut with a pocket knife.	150-3500 psi
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	3500-7500 psi
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer.	7500-15000 psi
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	15000-30000 psi
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	Greater than 30000 psi

Discontinuities

Spacing	
Very Widely	Greater than 3 m
Widely	1 m to 3 m
Moderately	0.3 m to 1 m
Closely	50 mm to 300 mm
Very Closely	Less than 50 mm

RQD (%)

$$\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$$

Condition	
Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 1 mm, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 1 mm, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 5 mm thick, or open discontinuities 1 to 5 mm.
Very Poor	Soft gouge greater than 5 mm thick, or open discontinuities greater than 5 mm.

Fracture Frequency (FF) is the average number of fractures per 300 mm of core.
Does not include mechanical breaks caused by drilling or handling.

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-01p-09

Sheet 1 of 5

Job No. XL3695 SR 410 Elevation 1966.0 ft

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Site Address SR-410 and Nile rd

Inspector Cooper, Kerry

Start October 20, 2009 Completion October 22, 2009 Well ID# BBL-074

Equipment CME 45 (9C4-2) - AH

Station Offset Hole Dia (inches) 4

Method Wet Rotary

Northing 542051.89 Easting 1533453.47 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1965.0									
				8 8 10 (18)		D-1		No Recovery		
5						C-2		Well graded GRAVEL with cobbles.		
	1960.0									
				18 30 50 (80)		D-3		Well graded GRAVEL with sand, sub-angular, very dense, gray, moist, stratified, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
10						C-4		Well graded GRAVEL with cobbles.	10/22/2009	
	1955.0									
			>>	50/5 (REF)		D-5 C-6		Well graded GRAVEL with sand, sub-angular, very dense, gray, moist, stratified, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft. Well graded GRAVEL with cobbles.		
15										
	1950.0									
			>>	41 50/2		D-7		Well graded GRAVEL with sand, sub-angular, very dense. Length Recovered:0.6 ft. Length Retained:0.6 ft.		
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-01p-09

Job No. XL3695 SR 410 Elevation 1966.0 ft

Sheet 2 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Field SPT (N) | Moisture Content | RQD (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
		(REF)		C-8		Well graded GRAVEL with cobbles.
	1945					
		50/2 (REF)		D-9 C-10		No Recovery Well graded GRAVEL with cobbles.
25	1940					
		19 22 26 (48)		D-11		Well graded GRAVEL with sand, sub-angular, dense, grayish brown, moist, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.
30				C-12		Well graded GRAVEL.
	1935					
		7 10 16 (26)		D-13		CLAYSTONE/SILTSTONE, dense, gray, moist, HCl not tested.
35				C-14		SILTSTONE, fine grained, slightly weathered, moderately strong rock. Discontinuities are moderately spaced and in good condition. Recovered:93% RQD:88 FF:1, slightly porcelaneous in upper 6" @~36' grades to silty sandstone with mica.
	1930					
		16 50/4 (REF)		D-15 C-16		Silty SANDSTONE, with organics and mica, very dense, gray, moist, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. SANDSTONE, fine grained, slightly weathered, moderately strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:33 FF:2 @~40.8', polished discontinuity dipping @~70 degrees organic laminae dipping 50 degrees(possible tachylite)
40	1925					
				C-17		SANDSTONE, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:91% RQD:61 FF:1. Apprent Calcaneous coating on jt surfaces.
		50/1 (REF)		D-18 C-19		No Recovery BASALT, fine grained, fresh, strong rock. Discontinuities are
45						

Groundwater | Instrument

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-01p-09

Job No. XL3695 SR 410 Elevation 1966.0 ft

Sheet 3 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Field SPT (N) | Moisture Content | RQD (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
						closely spaced and in good condition. Recovered:88% RQD:16 FF:5
	1920					
				C-20		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:98% RQD:15 FF:3
50						
	1915					
				C-21		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:36% RQD:13 FF:2
55						
	1910					
		>> 15 34 50/3 (REF)		D-22		SANDSTONE, very dense, greenish gray, moist, stratified, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft.
60				C-23		SANDSTONE, fine grained, micaceous with organics. Length Recovered:0 ft. Length Retained:0 ft.
	1905					~61.2' wood fragment(twig/root)and organic-coated discontinuity dipping at 45 degrees 61.8' ~1" thickorganic interbed with subhorizontal lamination.
						~62.7' , 6" lightweight organic-appearing layer; bottom contact dips~30 degrees (possible tachylite)
		>> 22 50/5 (REF)		D-24		SANDSTONE, very dense, greenish gray, moist, stratified, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.
65				C-25		SANDSTONE, With Mica. Length Recovered:4 ft. Length Retained:4 ft.
	1900					65'-66' ~1' thick zone of lose, wet, mottled greenish gray to gray sand
						67.4' apparent 1" diameter lapilli 67.7' disturbed zone 68,8'abundant coarse mica grains
		>> 17 36		D-26		SANDSTONE, with mica, very dense. Length Recovered:1.5 ft. Length Retained:1.5 ft.
70						

Groundwater | Instrument

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-01p-09

Job No. XL3695 SR 410 Elevation 1966.0 ft

Sheet 4 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1895			50/4 (REF)		C-27		SANDSTONE, greenish gray, micaceous		
								BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:53% RQD:38 FF:1		
						C-28		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:36 FF:2		
75	1890									
						C-29		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:48 FF:2		
80	1885									
						C-30		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:63 FF:2		
85	1880									
						C-31		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:65 FF:1		
90	1875									
95								Standpipe piezometer installed at 77 feet.		

Washington State
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LOG OF TEST BORING

Start Card R-72793

HOLE No. H-01p-09

Job No. XL3695 SR 410 Elevation 1966.0 ft

Sheet 5 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Depth (ft)	Elevation (ft)	Profile	◆ Field SPT (N) ✚ Moisture Content ▨ RQD 20 40 60 80	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1870							A flush mount monument was installed on this boring. The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.)		
								End of test hole boring at 94 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
100										
	1865									
105										
	1860									
110										
	1855									
115										
	1850									
120										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-02si-09

Sheet 1 of 6

Job No. XL3695 SR 410 Elevation 1958.1 ft

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Site Address SR-410 and Nile rd

Inspector Cooper, Kerry

Start October 22, 2009 Completion October 25, 2009 Well ID# BBL-075

Equipment CME 45 (9C4-2) - AH

Station Offset Hole Dia (inches) 4

Method Wet Rotary

Northing 540584.91 Easting 1533937.90 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1955.0									
5				3 6 7 (13)		D-1		Well graded GRAVEL with sand, subangular, medium dense, gray, moist, stratified, HCl not tested. Length Recovered:0.6 ft. Length Retained:0.6 ft.		
	1950.0									
10				16 11 20 (31)		D-2		Well graded GRAVEL with sand, subangular, dense, gray, moist, stratified, HCl not tested. Length Recovered:0.6 ft. Length Retained:0.6 ft.	10/25/2009	
	1945.0									
15			>>	50/1" (REF)		D-3 C-4		No Recovery Well graded GRAVEL. Length Recovered:1.1 ft. Length Retained:1.1 ft.		
	1940.0									
20										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-02si-09

Job No. XL3695 SR 410 Elevation 1958.1 ft

Sheet 2 of 6

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

◆ Field SPT (N) ✚ Moisture Content ▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		15 27 28 (55)		D-5		Well graded GRAVEL with sand, subangular, very dense, gray, moist, stratified, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft.		
				C-6		Well graded GRAVEL. Length Recovered:1.6 ft. Length Retained:1.6 ft.		
	1935							
25		>> 50/3" (REF)		D-7 C-8		No Recovery Well graded GRAVEL. Length Recovered:1.3 ft. Length Retained:1.3 ft.		
	1930							
30		10 12 31 (43)		D-9		Well graded GRAVEL with sand, subangular, dense, gray, moist, stratified, HCl not tested. Minor orange clay/silt in sample. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
				C-10		Well graded GRAVEL, gray, moist, stratified, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft.		
	1925							
35		9 18 21 (39)		D-11		No Recovery		
				C-12		Well graded GRAVEL. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
	1920							
40		>> 50/1" (REF)		D-13 C-14		No Recovery Well graded GRAVEL. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
	1915							
45		>>						

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-02si-09

Job No. XL3695 SR 410 Elevation 1958.1 ft

Sheet 3 of 6

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Field SPT (N) | Moisture Content | RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		35 "50/5" (REF)		D-15		Well graded GRAVEL with sand, subangular, very dense, gray, moist, stratified, HCl not tested. Length Recovered:0.7 ft. Length Retained:0.7 ft.		
				C-16		Well graded GRAVEL. Length Recovered:1.6 ft. Length Retained:1.6 ft.		
	1910							
50		50/1" (REF)		D-17 C-18		No Recovery. Well graded GRAVEL with cobbles. Length Recovered:2.2 ft. Length Retained:2.2 ft.		
	1905							
55		34 "50/2" (REF)		D-19		Well graded GRAVEL with sand, subangular, very dense, gray, moist, stratified, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft.		
				C-20		Well graded GRAVEL. Length Recovered:1.7 ft. Length Retained:1.7 ft.		
	1900							
60		30 "50/3" (REF)		D-21		Well graded GRAVEL with sand, subangular, very dense, gray, moist, stratified, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
				C-22		Boulders and cobbles (basalt). Recovered:67% RQD:35 FF:2		
	1895							
65				C-23		Boulders and cobbles (basalt). Recovered:20% RQD:0 FF:2		
	1890							
70								

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-02si-09

Job No. XL3695 SR 410 Elevation 1958.1 ft

Sheet 4 of 6

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

◆ Field SPT (N) ✚ Moisture Content ▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
		8 13 50/2" (REF)		D-24		Well graded GRAVEL, very dense, subangular, gray, moist, homogeneous, HCl not tested. Length Recovered:0.3 ft. Length Retained:0.3 ft.
				C-25		Boulders and cobbles (basalt). Recovered:43% RQD:0 FF:4
	1885					
75		50/1" (REF)		D-26 C-27		No Recovery Boulders and cobbles (basalt) with gravel. Recovered:27% RQD:15 FF:1
	1880					
80		50/2" (REF)		D-28 C-29		No Recovery Boulders and cobbles (basalt) with gravel, subrounded, one broken, subrounded pebble of porphyritic andesite. Recovered:63% RQD:24 FF:2
	1875					
85		50/1" (REF)		D-30 C-31		No Recovery BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:81% RQD:20 FF:2
						Yellow mineral coating on joint surfaces
	1870					
90				C-32		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:53% RQD:0 FF:3
						Yellow mineral coating on joint surfaces
	1865					
95						

Groundwater | Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-02si-09

Job No. XL3695 SR 410 Elevation 1958.1 ft

Sheet 5 of 6

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-33		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:11 FF:5 Yellow and dark brown mineral coating on joint surfaces		
	1860									
100						C-34		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:16 FF:3 White-yellow mineral coating on joint surfaces		
	1855									
105						C-35		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:48% RQD:0 FF:5		
	1850									
110						C-36		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:98% RQD:0 FF:10 Yellow mineral coating on joint surfaces		
	1845									
115						C-37		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:15 FF:3		
	1840									
120										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-02si-09

Job No. XL3695 SR 410 Elevation 1958.1 ft

Sheet 6 of 6

Project SR-410 Nile Valley Landslide

Driller Cooper, Kerry Lic# 2552

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1835					C-38		BASALT, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:45 FF:2		
125								Slope inclinometer installed to 123 feet. A flush mount monument was installed on this boring. The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
	1830							End of test hole boring at 124 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
130										
	1825									
135										
	1820									
140										
	1815									
145										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-03si-09

Job No. XL3695 SR 410 Elevation 1942.4 ft

Sheet 1 of 7

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Site Address SR-410 and Nile Rd

Inspector Johnson, Vince #2532

Start October 13, 2009 Completion October 20, 2009 Well ID# BBL-072

Equipment CME 850 (9C2-2) - AH

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 538364.72 Easting 1535275.05 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection NE1/4 of NW1/4 Section 11 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1940.0									
5			>>	50/1" (REF)		D-1		Silty SAND with gravel, very dense, brown, moist, homogenous, HCl not tested, Actual blow count 70/1". Followed with over-size SPT to try to retain sample. No recovery; drive on large gravel. Length Recovered:0.1 ft. Length Retained:0.1 ft.		
	1935.0									
			>>	50/1" (REF)		D-2		No Recovery		
10						C-3		Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:0.9 ft. Length Retained:0.9 ft. Started drilling with HQ core barrel.		
						C-4		Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:2.7 ft. Length Retained:2.7 ft.		
	1930.0									
15			>>	12 50/5" (REF)		D-5		Poorly graded GRAVEL, angular, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.3 ft. Length Retained:0.3 ft.		
						C-6		Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:3.4 ft. Length Retained:3.4 ft.	▽ 10/14/2009	
	1925.0									
20										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-03si-09

Job No. XL3695 SR 410 Elevation 1942.4 ft

Sheet 2 of 7

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		25 21 50 (71)		D-7 C-8		Silty GRAVEL with sand, subrounded, very dense, brown, moist, homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. Over-ream HWT to 20'. Well graded GRAVEL with cobbles, subangular, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:2.8 ft. Length Retained:2.8 ft.		
25	1920	38 50/2" (REF)		D-9 C-10		Poorly graded GRAVEL with sand, angular, very dense, dark gray, wet, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft. 10/18/2009 Poorly graded GRAVEL, subrounded, with cobbles, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:4 ft. Length Retained:4 ft.	▼	
30	1915	50 50/2" (REF)		D-11 C-12		Silty GRAVEL with sand, angular, very dense, grayish brown, moist, stratified, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft. Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:2.1 ft. Length Retained:2.1 ft.		
35	1910	20 25 38 (63)		D-13 C-14		Silty GRAVEL with sand, subangular, very dense, brown, moist, stratified, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. Over-ream HWT casing to 35'. Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:2.9 ft. Length Retained:2.9 ft. Over-ream PW casing to 37'.		
40	1905	50 (50)		D-15 C-16		Silty GRAVEL with sand, subrounded, very dense, grayish brown, moist, homogenous, HCl not tested, Actual blow count 72/6". Length Recovered:0.4 ft. Length Retained:0.4 ft. Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:2.9 ft. Length Retained:2.9 ft.		
45	1900							

Washington State
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LOG OF TEST BORING

Start Card R-72791

HOLE No. H-03si-09

Job No. XL3695 SR 410 Elevation 1942.4 ft

Sheet 3 of 7

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		47 50/3" (REF)		D-17 C-18		Silty GRAVEL with sand, subrounded, very dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft. Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:3.1 ft. Length Retained:3.1 ft.		
	1895							
50		34 "50 (84)		D-19 C-20		Silty GRAVEL with sand, subrounded, very dense, grayish brown to light yellowish brown, moist, stratified, HCl not tested, Actual blow count 34, 71/6". Length Recovered:0.7 ft. Length Retained:0.7 ft. Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:3.2 ft. Length Retained:3.2 ft.		
	1890							
						Over-ream HWT casing to 54'.		
55		50/1" (REF)		D-21 C-22		No Recovery Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:3.2 ft. Length Retained:3.2 ft.		
	1885							
						Over-ream HWT casing to 59'.		
60		31 50/3" (REF)		D-23 C-24		No Recovery		
						Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:3.1 ft. Length Retained:3.1 ft.		
	1880							
65		50/3" (REF)		D-25 C-26		Poorly graded GRAVEL with sand, angular, very dense, dark gray, wet, homogenous, HCl not tested. Actual blow count 71/3". Length Recovered:0.2 ft. Length Retained:0.2 ft. Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:3.6 ft. Length Retained:3.6 ft.		
	1875							
70								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-03si-09

Job No. XL3695 SR 410 Elevation 1942.4 ft

Sheet 4 of 7

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) | Moisture Content | RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		50/5" (REF)		D-27 C-28		Poorly graded GRAVEL, angular, very dense, dark gray, moist, homogenous, HCl not tested. Actual blow count 100/6". Length Recovered:0.4 ft. Length Retained:0.4 ft. Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, trace sand and silt. Most fines washed out. Length Recovered:3.4 ft. Length Retained:3.4 ft.		
1870								
75		50/3" (REF)		D-29 C-30		No Recovery Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out.. Length Recovered:2.5 ft. Length Retained:2.5 ft.		
1865								
80		50/5 (REF)		D-31 C-32		Poorly graded GRAVEL with sand, angular, very dense, dark gray to light yellowish brown, moist, stratified, HCl not tested, Trace silt. Length Recovered:0.4 ft. Length Retained:0.4 ft. Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:2.6 ft. Length Retained:2.6 ft.		
1860								
85		39 50/4" (REF)		D-33 C-34		Silty GRAVEL with sand, subrounded, very dense, brown, wet, homogenous, HCl not tested. Length Recovered:0.6 ft. Length Retained:0.6 ft. Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:4 ft. Length Retained:4 ft.		
1855								
90		50/5" (REF)		D-35 C-36		Poorly graded GRAVEL with sand, subrounded, very dense, dark grayish brown, wet, homogenous, HCl not tested. Actual blow count 100/6". Trace silt. Length Recovered:0.5 ft. Length Retained:0.5 ft. Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:3.6 ft. Length Retained:3.6 ft.		
1850								
95								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-03si-09

Job No. XL3695 SR 410 Elevation 1942.4 ft

Sheet 5 of 7

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) | Moisture Content | RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		50/4" (REF)		D-37 C-38		Poorly graded GRAVEL with sand, angular, very dense, grayish brown, moist, homogenous, HCl not tested, Actual blow count 100/4". Length Recovered:0.3 ft. Length Retained:0.3 ft. Poorly graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested. Trace silt. Most fines washed out. Length Recovered:2.3 ft. Length Retained:2.3 ft. Trace of black silt coating gravels at bottom of sample.		
1845								
100		38 38 50/4" (REF)		D-39 C-40		Drilling indicated change to siltstone. SILT(siltstone), very dense, very dark grayish brown, moist, stratified, blocky, HCl not tested, Trace sand. Length Recovered:1.3 ft. Length Retained:1.3 ft. SILTSTONE, very dark grayish brown, fine grained, fresh, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:65% RQD:58 FF:2 Upper 6", possible gouge - pebble and minor sand entrained in dark silt matrix with polished surfaces. Lower 4", highly fractured, moist, plastic, scattered polished surfaces.		
1840								
105		25 50/2" (REF)		D-41 C-42		SILTSTONE, very dense, very dark grayish brown, moist, stratified, HCl not tested. Length Recovered:0.7 ft. Length Retained:0.7 ft. SILTSTONE, very dark grayish brown, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:100 FF:1 Laminae have generally shallow dip but are undulatory. 2' stick of massive siltstone - bedding unreliable, but single lamina dips ~25 degrees.		
1835								
110		50/5" (REF)		D-43 C-44		SILTSTONE, very dense, very dark grayish brown, moist, stratified, blocky, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft. SILTSTONE, very dark grayish brown, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in excellent condition. Recovered:91% RQD:100 FF:0 2' stick of massive siltstone at 111.2', 1/2" wide lenticular organic stripes (subhorizontal).		
1830								
115		31 50/5" (81)		D-45 C-46		SILTSTONE, very dense, very dark grayish brown, moist, stratified, slickensided, blocky, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft. From 115.5 to 115.6, slickensided, blocky, black material (low grade coal). SILTSTONE , very dark grayish brown, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:83% RQD:65 FF:2 Bedding dips ~25 to 35 degrees - bedding undulatory.		
1825								
120								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-03si-09

Job No. XL3695 SR 410 Elevation 1942.4 ft

Sheet 6 of 7

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) | Moisture Content | RQD (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		12 46 50/5" (REF)		D-47		SILTSTONE, very dense, very dark grayish brown, moist, stratified, blocky, HCl not tested. Length Recovered:1.4 ft. Length Retained:1.4 ft.		
	1820			C-48		SILTSTONE , very dark grayish brown, fine grained, fresh, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:58 FF:4 Slickenside at top of sample: @122.5' polished tight discontinuity @123.1' 2" gouge zone: @123.6' slickenside @124.2'-124.7' Brecciated zone @124.9' slickenside		
125		29 38 50/4" (REF)		D-49		SILTSTONE, very dense, very dark grayish brown, moist, stratified, slickensided, blocky, HCl not tested. Length Recovered:1.3 ft. Length Retained:1.3 ft.		
	1815			C-50		SILTSTONE , very dark grayish brown, fine grained, fresh, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:70% RQD:27 FF:4 @127.0'- 128.3' brecciated zone with clay and slickensides. @128.4', 4" gouge zone		
130		18 31 43 (74)		D-51		SILTSTONE, very dense, very dark grayish brown, moist, stratified, slickensided, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
	1810			C-52		SILTSTONE, very dark grayish brown to black, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:74% RQD:11 FF:3, Sand bedding. @132'-133' apparent tachylite with numerous polished surfaces @133'-134' cross-bedded sandstone @134'-135' sandstone grades to sandy siltstone with apparent tachylite fragments and mica.		
135		50/5" (REF)		D-53 C-54		SILTSTONE, very dense, very dark grayish brown, moist, stratified, blocky, HCl not tested, stratified with sand layers. Length Recovered:0.4 ft. Length Retained:0.4 ft. BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:33 FF:4, Top 0.8' of core is SANDSTONE transitioning to BASALT.		
	1805							
140		50/2" (REF)		D-55 C-56		No Recovery BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:52% RQD:15 FF:5		
	1800					142 to 143.5 drilling indicated a soil unit; did not recover.		
145								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-03si-09

Job No. XL3695 SR 410 Elevation 1942.4 ft

Sheet 7 of 7

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				50/1" (REF)		D-57 C-58		No Recovery BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:98% RQD:39 FF:4		
	1795									
150						C-59		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:40 FF:5		
	1790									
155								Ended boring at 154.0 due to core bit breaking. Slope inclinometer installed to 154 feet. A flush mount monument was installed on this boring.		
	1785							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
160								End of test hole boring at 154 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
	1780									
165								Bail/Recharge test: Hole Diameter: 6 Depth of boring during bail test: 154' Depth of casing during bail test: 152' Bailed bore hole water level to 33.4' Recharge after 1 minutes :28.9' Recharge after 2 minutes :28.1' Recharge after 3 minutes :25.6' Recharge after 4 minutes :24.9' Recharge after 5 minutes :24.5' Recharge after 10 minutes :24.1' Recharge after 15 minutes :24' ' Bailed hole for 20 min.		
	1775									
170										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-04si-09

Sheet 1 of 7

Job No. XL3695 SR 410 Elevation 1943.7 ft

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Site Address Vicinity of SR-410 Slide

Inspector Andrews, Cleo #1677

Start October 20, 2009 Completion October 24, 2009 Well ID# BBL-073 (Slope Incl. x 150') Equipment CME 850 (9C2-2) - AH

Station Offset Hole Dia (inches) 4 Method Wet Rotary

Northing 539147.03 Easting 1534986.25 Collected by Geographic Services Datum State Plane South

County Yakima Subsection NE1/4 of NW1/4 Section 11 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Well graded GRAVEL with cobbles, subrounded, dark gray, fines washed away. Length Recovered:1.4 ft. Length Retained:1.4 ft.		
	1940.0									
5				18 35 19 (54)		D-2		Silty GRAVEL with sand, subrounded, very dense, brown, wet, homogenous, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.	▽ 10/24/2009	
						C-3		Silty GRAVEL with sand and cobbles, subrounded, dark gray, trace of silt. Most fines washed away. Length Recovered:1.4 ft. Length Retained:1.4 ft.		
	1935.0									
10				11 14 30 (44)		D-4		Silty GRAVEL with sand, subrounded, dense, brown, wet, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
						C-5		Well graded GRAVEL with cobbles, subangular, dark gray, fines washed away. Length Recovered:2.6 ft. Length Retained:2.6 ft.		
	1930.0									
15			>>	50/2" (REF)		D-6 C-7		No Recovery. Silty GRAVEL with sand and cobbles, subrounded, dark gray, fines washed away. Length Recovered:2.9 ft. Length Retained:2.9 ft.	▼ 10/23/2009	
	1925.0									
20			>>							

SOILA XL-3695_DME-057 SR410 LANDSLIDE.GPJ SOIL.GDT 5/7/10

Washington State
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LOG OF TEST BORING

Start Card R-72791

HOLE No. H-04si-09

Job No. XL3695 SR 410 Elevation 1943.7 ft

Sheet 2 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

◆ Field SPT (N)
✚ Moisture Content
▨ RQD
20 40 60 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		40 "50/4" (REF)		D-8		Silty GRAVEL with sand, subangular, very dense, brown, wet, homogenous, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
				C-9		Poorly graded GRAVEL with sand and cobbles, subrounded, dark gray, fines washed away. Length Recovered:1.7 ft. Length Retained:1.7 ft.		
	1920							
25		50/5" (REF)		D-10		Silty GRAVEL with sand, subangular, very dense, grayish brown, wet, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
				C-11		Poorly graded GRAVEL with cobbles, subangular, grayish brown, fines washed away. Length Recovered:2.1 ft. Length Retained:2.1 ft.		
	1915							
30		50/5" (REF)		D-12		Silty GRAVEL with sand, subangular, very dense, grayish brown, wet, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
				C-13		Poorly graded GRAVEL with cobbles, subrounded, dark gray, fines washed away. Length Recovered:2.4 ft. Length Retained:2.4 ft.		
	1910							
35		37 "50/5" (REF)		D-14		Silty GRAVEL with sand, subangular, very dense, grayish brown, wet, homogenous, HCl not tested. Length Recovered:0.6 ft. Length Retained:0.6 ft.		
				C-15		Poorly graded GRAVEL with cobbles, subangular, dark gray, fines washed away. Length Recovered:1.4 ft. Length Retained:1.4 ft.		
	1905							
40		50/5" (REF)		D-16		Silty GRAVEL with sand, subangular, very dense, grayish brown, wet, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
				C-17		Well graded GRAVEL with cobbles, subangular, dark gray, fines washed away. Length Recovered:1.9 ft. Length Retained:1.9 ft.		
	1900							
45								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-04si-09

Job No. XL3695 SR 410 Elevation 1943.7 ft

Sheet 3 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) | Moisture Content | RQD (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
		50/5" (REF)		D-18 C-19		Silty GRAVEL with sand, subangular, very dense, grayish brown, wet, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft. Well graded GRAVEL with cobbles, subangular, dark gray, fines washed away. Length Recovered:2.3 ft. Length Retained:2.3 ft.
	1895					
50		44 "50/5" (REF)		D-20 C-21		Silty GRAVEL with sand, subangular, very dense, gray, wet, homogenous, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft. Well graded GRAVEL with cobbles, subangular, dark gray, fines washed away. Length Recovered:3.3 ft. Length Retained:3.3 ft.
	1890					
55		50/2" (REF)		D-22 C-23		Well graded GRAVEL with sand, subrounded, very dense, gray, wet, homogenous, HCl not tested. Length Recovered:0.1 ft. Length Retained:0.1 ft. Well graded GRAVEL with cobbles, subrounded, gray, fines washed away. Length Recovered:3.0 ft. Length Retained:3.0 ft.
	1885					
60		50/5" (REF)		D-24 C-25		Well graded GRAVEL with sand, subrounded, very dense, gray, wet, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft. Well graded GRAVEL, subrounded, gray, fines washed away. Length Recovered:3.8 ft. Length Retained:3.8 ft.
	1880					
65		50/5" (REF)		D-26 C-27		No Recovery Well graded GRAVEL, subrounded, dark gray, fines washed away. Length Recovered:1.8 ft. Length Retained:1.8 ft.
	1875					
70						

Groundwater | Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-04si-09

Job No. XL3695 SR 410 Elevation 1943.7 ft

Sheet 4 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) | Moisture Content | RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		50/1" (REF)		D-28 C-29		No Recovery Well graded GRAVEL, subrounded, with a 0.8' cobble in top of core; sandstone, highly weathered, olive yellow with yellowish orange mottled stain, dark gray. Length Recovered:4.9 ft. Length Retained:4.9 ft.		
	1870							
75		37 "50/5" (REF)		D-30 C-31		@ 74.6', 1/4" to 1/2" thick clay zone with slickensides (apparent gouge zone); below gouge zone is 2" zone of semiconsolidated yellowish sandstone with subrounded pebbles; below 2" sandstone is 1" gray sandstone with flat cemented top; below 1" sandstone is 5" of yellowish unconsolidated completely weathered sandstone. SANDSTONE, very dense, olive yellow, moist, homogenous, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft. SANDSTONE, olive yellow. Length Recovered:1.0 ft. Length Retained:1.0 ft. Bedding dips ~25 degrees Sandstone is poorly indurated		
	1865							
80		25 "50/5" (REF)		D-32 C-33		SANDSTONE, very dense, olive yellow, moist, homogenous, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft. No Recovery		
	1860							
85		23 38 50/5" (REF)		D-34 C-35		Sandy SILTSTONE, with traces of mica sand and dark red mottled stain, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:1.4 ft. Length Retained:1.4 ft. SILTSTONE with sub-horizontal layering and scattered organics, black in color, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0		
	1855					Discontinuities have polished slickensided surfaces; scattered pumice fragments; grades to ss @ 89.4'; 2" low grade coal seam @ 90.0'. Bedding dips at 30 degrees.		
90		50/5" (REF)		D-36 C-37		SANDSTONE, traces of light brown mottled stain, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft. SANDSTONE, highly weathered with siltstone interbeds, grayish black in color in bottom of core, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:61 FF:1 2"-6" diameter apprent vesicular basalt(angular) clasts in fine sandy matrix (possible intrusion or ejecta) @ 92'-93.5' numerous organic rip-up clasts, bedding ~10 degrees in laminated zone at bottom of run.		
	1850							
95								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-04si-09

Job No. XL3695 SR 410 Elevation 1943.7 ft

Sheet 5 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Description of Material
		21 "50/5" (REF)	D-38	SANDSTONE, very dense, gray, moist, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.
			C-39	SANDSTONE with horizontal layering, grayish black in color, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0 bedding dips ~10-15 degrees in upper part of run; grades to siltstone @~99'
	1845			
100		16 31 50/3" (REF)	D-40	SILTSTONE, with light gray sub-horizontal fine grained sand lenses, very dense, dark gray, moist, HCl not tested. Length Recovered:1.2 ft. Length Retained:1.2 ft.
			C-41	SILTSTONE with grayish black subhorizontal layering, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:60% RQD:86 FF:1
	1840			
105		8 45 39 (84)	D-42	SILTSTONE, with black horizontal layering and one fine grained sand lens in middle of sample, very dense, dark gray, moist, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.
			C-43	SILTSTONE with pumice clasts, basalt clasts (possible peperite) open mineral coated fractures with slickensided and highly fractured basalt in end of core from 108.9' to 110.0', black, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:14 FF:2
	1835			
110			C-44	BASALT with quartz infillings, moderately vesicular, dark gray, fine grained, fresh, very strong rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0
	1830			
115			C-45	BASALT with quartz infillings, moderately vesicular, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:90 FF:1
	1825			
120				

Lab Tests | Groundwater | Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-04si-09

Job No. XL3695 SR 410 Elevation 1943.7 ft

Sheet 6 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-46		BASALT with quartz infillings, highly fractured, dark grayish black, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:0		
	1820									
125						C-47		BASALT with quartz infillings, highly fractured, dark grayish black, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:0		
	1815									
130						C-48		BASALT with quartz infillings, highly fractured, traces of vesicular, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:0		
	1810									
135						C-49		BASALT with quartz infillings, highly fractured, trace vesicles, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:0		
	1805									
140						C-50		BASALT with quartz infillings, highly fractured, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:33 FF:3		
	1800									
145										

Washington State
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HOLE No. H-04si-09

Job No. XL3695 SR 410 Elevation 1943.7 ft

Sheet 7 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1795					C-51		BASALT with quartz infillings, moderately fractured, trace vesicles, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:48 FF:2, Pictures taken of samples, drill site and surrounding area.		
150								Slope inclinometer installed to 150 feet. A flush mount monument was installed on this boring.		
	1790									
155								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
	1785							End of test hole boring at 150 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
160										
	1780									
165										
	1775									
170										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-42555

HOLE No. H-05-09

Sheet 1 of 4

Job No. XL3695 SR 410 Elevation 1964.9 ft

Project SR-410 Nile Valley Landslide Driller Henderson, Danny Lic# 2742

Site Address Vicinity of SR 410 Slide Inspector Andrews, Cleo #1677

Start October 25, 2009 Completion October 27, 2009 Well ID# Equipment CME 850 (9C2-2) - AH

Station Offset 8ft Lt. Hole Dia (inches) 4 Method Wet Rotary

Northing 541630.69 Easting 1533749.59 Collected by Geographic Services Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Silty GRAVEL with sand, subangular, with a 1.2' boulder and 0.5' of asphalt in top of core, dark gray, homogenous, stratified. Length Recovered:2.5 ft. Length Retained:2.5 ft.	10/26/2009	
5	1960.0			5 4 5 (9)		D-2		Silty GRAVEL with sand, subangular, loose, grayish brown, moist, homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft.		
						C-3		Well graded GRAVEL, subangular, dark gray, homogenous, most fines washed away. Length Recovered:1 ft. Length Retained:1 ft.		
10	1955.0			11 18 19 (37)		D-4		Well graded GRAVEL with sand, subangular, dense, brown, moist, homogenous, HCl not tested, traces of mica sand. Length Recovered:0.3 ft. Length Retained:0.3 ft.		
						C-5		Well graded GRAVEL, subangular, dark gray, homogenous, trace of silt, most fines washed away. Length Recovered:2 ft. Length Retained:2 ft.		
15	1950.0			7 9 7 (16)		D-6		Silty GRAVEL with sand, subangular, medium dense, brown, moist, homogenous, HCl not tested. Length Recovered:0.6 ft. Length Retained:0.6 ft.		
						C-7		Well graded GRAVEL with sand, with a 0.7' cobble and 0.6' of sandy silt with gravel, subangular dark brown to yellowish brown in color, dark gray, homogenous. Length Recovered:2 ft. Length Retained:2 ft.		
20	1945.0									

Washington State
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LOG OF TEST BORING

Start Card S-42555

HOLE No. H-05-09

Job No. XL3695 SR 410 Elevation 1964.9 ft

Sheet 2 of 4

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		4 5 4 (9)		D-8		Silty GRAVEL with sand, subangular, loose, brownish gray, moist, homogenous, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
				C-9		Well graded GRAVEL, subangular; 1.2' of siltstone, highly weathered, greenish gray in bottom of core, homogenous. Length Recovered:2 ft. Length Retained:2 ft.		
25	1940	6 20 24 (44)		D-10		SILTSTONE, highly weatherd, traces of brownish orange mottle, dense, greenish gray, moist, homogenous, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-11		SILTSTONE with brownish orange mottled stain infillings, highly fractured, bottom 0.3' gray in color , greenish gray, fine grained, moderately weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:57% RQD:0 FF:0		
30	1935	5 6 6 (12)		D-12		SILTSTONE, completely weathered, medium dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:1.2 ft. Length Retained:1.2 ft.		
				C-13		BASALT with 0.2' of highly weathered apparent tachylite with polished surfaces, black in color in top of sample, highly fractured, dark grayish black, fine grained, moderately weathered, strong rock. Discontinuities are very widely spaced and in very poor condition. Recovered:42% RQD:15 FF:0 0.5' of siltstone at bottom of core run, greenish gray		
35	1930	>> 34 39 50/5" (REF)		D-14		SILTSTONE, completely weathered, very dense, greenish gray, moist, homogenous, HCl not tested. Length Recovered:1.4 ft. Length Retained:1.4 ft. bedding dipps ~20 degrees		
				C-15		SILTSTONE with 1.3' of sandstone in bottom of sample, gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:0 FF:0		
40	1925	>> 50/5" (REF)		D-16 C-17		SANDSTONE, with fine grained mica sand, very dense, gray, moist, homogenous, HCl not tested, traces of mica sand. Length Recovered:0.4 ft. Length Retained:0.4 ft. SANDSTONE, gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0 with silty interbeds and scattered organics, cross-bedded bedding dips ~15-20 degrees		
45	1920	>>						

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card S-42555

HOLE No. H-05-09

Job No. XL3695 SR 410 Elevation 1964.9 ft

Sheet 3 of 4

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		20 "50/4" (REF)		D-18		SANDSTONE, highly weathered, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. SANDSTONE with dark brown an black subhorizontal bedding (organics), dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0		
				C-19				
50	1915	25 "50/4" (REF)		D-20		SANDSTONE, with grayish black horizontal bedding, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. SANDSTONE with grayish black subhorizontal bedding, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0 bedding dips ~20 degrees		
				C-21				
55	1910	25 "50/5" (REF)		D-22		SANDSTONE, with gray and black horizontal bedding, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. SANDSTONE with dark brown and black horizontal bedding, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0		
				C-23				
60	1905	29 "50 (79)		D-24		SANDSTONE, with organic, dark brown in color, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft. SILTSTONE with gray and black subhorizontal to 20 degree layering, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0		
				C-25				
65	1900			C-26		SILTSTONE with light gray and black subhorizontal to 20 degree bedding, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0		
70	1895							

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-42555

HOLE No. H-05-09

Job No. XL3695 SR 410 Elevation 1964.9 ft

Sheet 4 of 4

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-27		SILTSTONE with light gray and black horizontal bedding, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:100 FF:0		
75	1890					C-28		SILTSTONE with gray and black horizontal bedding, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0		
80	1885					C-29		SILTSTONE with slickensides and healed joints, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:80% RQD:66 FF:1, Encountered artesian flow at -88.0'. @80.3' slickensided discontinuity dipping ~ 30 degrees, bedding dips ~20 degrees @82.3' slickensided discontinuity dipping ~ 25 degrees @82.8' slickensided discontinuity dipping ~ 30 degrees @83.3', 1/2" to 1" diameter siltstone pebbles @83.5' healed fractures/vugs filled with medium grained sand,and one truncated by slickensided surface		
85	1880					C-30		SILTSTONE with slickensides, open joints and 0.7' of completely weathered siltstone in end of sample, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:76% RQD:54 FF:2. Artesian flow rate through 4" ID casing 45 seconds =five gallons with a 2.0' head. 1 minute 5 seconds= 5 gallons with 8.5' head. 1 minute 15 seconds 5 gallons with a 12' head.		
90	1875			>> 50/5" (REF)		D-31		SANDSTONE, completely weathered, very dense, gray, moist, homogenous, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
95	1870							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.") End of test hole boring at 90.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-05si-09

Job No. XL3695 SR 410 Elevation 1964.9 ft

Sheet 1 of 4

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Site Address Vicinity of SR 410 Slide

Inspector Andrews, Cleo #1677

Start October 27, 2009 Completion October 28, 2009 Well ID# BBL-076 (Slope Incl. x 85') Equipment CME 850 (9C2-2) - AH

Station Offset 8ft Lt. Hole Dia (inches) 4 Method Wet Rotary

Northing 541617.16 Easting 1533754.52 Collected by Geographic Services Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Silty GRAVEL with sand, subangular, 0.5' of asphalt in top of core, dark gray. All cores discarded. Length Recovered:0 ft. Length Retained:0 ft.		
									10/26/2009	
5	1960.0									
						C-2		Well graded SAND with gravel, grayish brown. Length Recovered:0 ft. Length Retained:0 ft.		
10	1955.0									
15	1950.0					C-3		Silty GRAVEL with sand, subangular, dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
20	1945.0									

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LOG OF TEST BORING

Start Card R-72793

HOLE No. H-05si-09

Job No. XL3695 SR 410 Elevation 1964.9 ft

Sheet 2 of 4

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-4		Well graded GRAVEL with sand, subangular, with siltstone from 23.8' to 25.0, dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
25	1940					C-5		SILTSTONE , dark gray, fine grained, highly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:0% RQD:0 FF:0		
30	1935					C-6		BASALT highly fractured, dark grayish black, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:0% RQD:0 FF:0		
35	1930					C-7		SILTSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:0% RQD:0 FF:0		
40	1925					C-8		SANDSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:0% RQD:0 FF:0		
45	1920									

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-05si-09

Job No. XL3695 SR 410 Elevation 1964.9 ft

Sheet 3 of 4

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
50	1915					C-9		SANDSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:0% RQD:0 FF:0		
55	1910									
60	1905					C-10		SANDSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:0% RQD:0 FF:0		
						C-11		SILTSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:0% RQD:0 FF:0		
65	1900									
70	1895									

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-05si-09

Job No. XL3695 SR 410 Elevation 1964.9 ft

Sheet 4 of 4

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-12		SILTSTONE, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in very poor condition. Recovered:0% RQD:0 FF:0		
75	1890									
80	1885					C-13		SILTSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in very poor condition. Recovered:0% RQD:0 FF:0		
85	1880									
								Slope inclinometer installed to 85 feet. A flush mount monument was installed on this boring. The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.") End of test hole boring at 85 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
90	1875									
95	1870									

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-06vw-09

Sheet 1 of 7

Job No. XL3695 SR 410 Elevation 1969.1 ft

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Site Address SR-410 Vicinity of Nile Road

Inspector Andrews, Cleo #1677

Start November 2, 2009 Completion November 5, 2009 Well ID# BBI-077 (VW x 108') Equipment CME 850 (9C2-2) - AH

Station Offset Hole Dia (inches) 4 Method Wet Rotary

Northing 541124.40 Easting 1534049.44 Collected by Geographic Services Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		0.2' of asphalt and 0.8' of well graded gravel in top of sample BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are very widely spaced and in very poor condition. Recovered:90% RQD:0 FF:0		
	1965.0									
5			>>	50/4" (REF)		D-2 C-3		No Recovery BASALT highly fractured, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:0		
	1960.0									
10						C-4		BASALT moderately fractured, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:33 FF:1		
	1955.0									
15						C-5		BASALT highly fractured, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:18 FF:0		
	1950.0									
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-06vw-09

Job No. XL3695 SR 410 Elevation 1969.1 ft

Sheet 2 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-6		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0		
	1945									
25						C-7		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0		
	1940									
30						C-8		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:56 FF:1		
	1935									
35						C-9		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:25 FF:1		
	1930									
40						C-10				
								SANDSTONE , gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:1 Bedding dips ~20 degrees @42.5' slickensides approx. along bedding @42.9 slickensides @43.0' irregular 1/2" gouge zone along siltstone interbed		
	1925									
45										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-06vw-09

Job No. XL3695 SR 410 Elevation 1969.1 ft

Sheet 3 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-11		SILTSTONE, medium gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:88 FF:1 Grades to SILTSTONE at 45.5' @47.0' 1/2" brecciated zone with slickensides bedding dips ~20 degrees		
	1920									
50						C-12		SILTSTONE, medium gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:100% RQD:100 FF:0 bedding dips ~20 degrees		
	1915									
55						C-13		SILTSTONE, medium gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:100% RQD:100 FF:0 bedding dips ~20 degrees		
	1910									
60						C-14		SILTSTONE, medium gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in fair condition. Recovered:100% RQD:100 FF:0		
	1905									
65						C-15		SILTSTONE, medium gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:96% RQD:48 FF:1, @~67.1', slickensides @~67.5',6" brecciated zone with clay and slickensides @~68.0'to~69.0' highly fracture zone with fines washed away;slickensides on remnant pieces; and subrounded siltstone fragments @~69.0' to~70.0' resistant siltstone with slickensides		
	1900									
70										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-06vw-09

Job No. XL3695 SR 410 Elevation 1969.1 ft

Sheet 4 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) | Moisture Content | RQD (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
				C-16		SILTSTONE, medium gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:27% RQD:0 FF:3, Changed to highly weathered sandstone at 71.4'. ~1.4' of fractured siltstone with slickensides and scattered subrounded siltstone pebbles recovered at top of core run. Possible artesian flow.
	1895					
75		>> 50/4" 0 (REF)		D-17 C-18		SANDSTONE, very dense, gray, moist, homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. SANDSTONE , gray, fine grained, highly weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:33% RQD:0 FF:0
	1890					
80		>> 50/3" (REF)		D-19 C-20		Volcanic CONGLOMERATE (peperite), very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft. Volcanic CONGLOMERATE (peperite), black, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0
	1885					
85				C-21		Volcanic CONGLOMERATE (peperite), black, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:100 FF:0
	1880					
90				C-22		Volcanic CONGLOMERATE , black, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0
	1875					
95						

Groundwater | Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-06vw-09

Job No. XL3695 SR 410 Elevation 1969.1 ft

Sheet 5 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Sample No. (Tube No.)	Description of Material
		C-23	SANDSTONE with organic siltstone interbeds (possible tachylite), 0.2' of volcanic conglomerate in top of sample, open joints and fractures, black in color, greenish gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:66 FF:1 @ 98.5' 3" organic siltstone with slickensides @ 99.0' 4" organic siltstone with slickensides @ 99.5'-100'volcanic breccia with slickensides
100	1870	C-24	BASALT, with tachylite, quartz infillings and traces of conglomerate in rock mass, black, fine grained, vesicular, slightly weathered, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:75 FF:1
105	1865	C-25	BASALT, with tachylite, black to dark gray, fine grained, moderately weathered, strong rock. Discontinuities are very closely spaced and in very poor condition. Recovered:80% RQD:0 FF:0, Artesian flow rate with 110.0' of HQ 3" ID casing with 3.5' stick up =5 gallons per 35 seconds.
110	1860	C-26	BASALT, highly fractured, gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:0
115	1855	C-27	BASALT, highly fractured, gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:0
120	1850		

Blows/6" (N) and/or RQD FF | Sample Type | Lab Tests | Groundwater | Instrument

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-06vw-09

Job No. XL3695 SR 410 Elevation 1969.1 ft

Sheet 6 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
					C-28		BASALT, with quartz infillings, gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:63 FF:1		
	1845								
125					C-29		SILTSTONE, with 0.3' of basalt in top of sample, quartz infillings and slickensides, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:51 FF:2 @~129.5' 1/4" to 1/2" gouge zone with slickensides		
	1840								
130					C-30		SILTSTONE, with slickensides, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:66 FF:1 bedding dips ~20 degrees @132.5', slickensides @133.0', slickensides		
	1835								
135					C-31		SILTSTONE, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in very poor condition. Recovered:96% RQD:65 FF:1 @~138.4'- 139.0 highly fractured/weathered siltstone with apparent clayey gouge zones with slickensides.		
	1830								
140			>>◆ 50/4" (REF)		D-32 C-33	MC AL	MC=28%, PI=39 SILTSTONE, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.3 ft. Length Retained:0.3 ft. SANDSTONE, with 0.5' of siltstone in top of sample, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:66 FF:1		
	1825								
145									

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-06vw-09

Job No. XL3695 SR 410 Elevation 1969.1 ft

Sheet 7 of 7

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1820					C-34		SANDSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in excellent condition. Recovered:100% RQD:100 FF:0, Artesian flow rate with 10 feet of HWT 4" ID casing and 150' of HQ 3" ID casing with 3.5' stick up 9 seconds per 5 gallons. Next day 10' 4" ID casing 2' head = 6 second for 5 gallons. @147.3' slickensides @148'-149' rip-up clasts		
150								Vibrating piezometer installed at 108 feet. A standpipe monument was installed on this boring.		
	1815							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
155										
	1810							End of test hole boring at 150 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
160										
	1805									
165										
	1800									
170										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-07si-09

Job No. XL3695 SR 410 Elevation 1969.3 ft

Sheet 1 of 4

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Site Address SR-410 vic of Nile Rd

Inspector Johnson, Vince #2532

Start November 5, 2009 Completion November 18, 2009 Well ID# BBL-081

Equipment CME 850 (9C2-3) - AH

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 541101.99 Easting 1534064.85 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		0.7' asphalt, 1.3' well graded gravel in top of sample.		
								BASALT, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in very poor condition. Recovered:70% RQD:0 FF:0,		
	1965.0									
5						C-2		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are very closely spaced and in very poor condition. Recovered:100% RQD:0 FF:0		
	1960.0									
10						C-3		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:0 FF:0		
	1955.0									
15						C-4		BASALT Highly fractured, dark gray, fine grained, fresh, very strong rock. Discontinuities are very closely spaced and in very poor condition. Recovered:100% RQD:13 FF:2		
	1950.0									
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-07si-09

Job No. XL3695 SR 410 Elevation 1969.3 ft

Sheet 2 of 4

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-5		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:48 FF:1		
	1945									
25						C-6		BASALT, dark gray, iron-stained, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:30 FF:1		
	1940									
30						C-7		BASALT, dark gray, iron-stained, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:36 FF:1		
	1935									
35						C-8		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:96% RQD:22 FF:3, Bottom 0.9 SANDSTONE with SILTSTONE.		
	1930									
40						C-9		SANDSTONEwith siltstone interbeds, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:94% RQD:47 FF:3 @40.1' and 40.3' slickensides bedding dips ~25 degrees, cross-bedding visible, grades to siltstone at ~ 43'.		
	1925									
45										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-07si-09

Job No. XL3695 SR 410 Elevation 1969.3 ft

Sheet 3 of 4

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-10		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 bedding dips ~20 degrees		
	1920									
50						C-11		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 @52.5' leaf fossil on bedding plane bedding dips ~20 degrees		
	1915									
55						C-12		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:98 FF:0		
	1910									
60						C-13		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:82 FF:1		
	1905									
65						C-14	MC AL	MC=23%, PI=25 SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:88% RQD:36 FF:5 @~65.5' slickensides @66.0' to 66.8' apparent gouge zone with ~2" thick clayey zone underlain by sub-rounded siltstone pebbles; ~dip on clay zone = 20 degrees @~ 66.8', more intact siltstone with slickensides		
	1900									
70										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-07si-09

Job No. XL3695 SR 410 Elevation 1969.3 ft

Sheet 4 of 4

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-15		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:94% RQD:28 FF:4 @~70.5' slickensides @~80.0' slickensides		
	1895									
75						C-16		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:24% RQD:0 FF:6, Washed out soils below SILTSTONE. Installed slope inclinometer. @~77' slickensides @~77.9' slickensides Drilling indicated soils change.-assumed to be sand/siltstone		
	1890									
80								Slope inclinometer installed to 79 ft. A standpipe monument was installed on this boring.		
	1885							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.)		
85										
	1880							End of test hole boring at 80 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
90										
	1875									
95										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-08si-09

Sheet 1 of 7

Job No. XL3695 SR 410 Elevation 1945.5 ft

Project SR-410 Nile Valley Landslide Driller Nelson, Brad Lic# 2969T

Site Address SR-410 and Nile Rd Inspector Johnson, Vince #2532

Start November 2, 2009 Completion November 5, 2009 Well ID# BBL-098 Equipment CME 55 (9C7-1) - AH

Station Offset Hole Dia (inches) 6 Method Wet Rotary

Northing 539685.79 Easting 1534845.46 Collected by Geographic Services Datum State Plane South

County Yakima Subsection NE1/4 of NW1/4 Section 11 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1945.0									
5	1940.0		◆	14 16 12 (28)		D-1		Poorly graded GRAVEL, subrounded, dense, dark gray, moist, homogenous, HCl not tested, trace sand. Most fines washed out. Length Recovered:0.2 ft. Length Retained:0.2 ft. 11/3/2009	▽	
10	1935.0		◆	50 13 13 (26)		D-2		11/4/2009 Silty GRAVEL with sand, subangular, dense, brown, moist, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.	▼	
						C-3		Well graded GRAVEL with cobbles, subangular, dark gray, homogenous, HCl not tested, trace silt and sand. Most fines washed out. Length Recovered:1.7 ft. Length Retained:1.7 ft. Switched from HWT casing to HQ core barrel.		
15	1930.0		◆	12 17 15 (32)		D-4		Silty GRAVEL with sand, angular, dense, grayish brown, wet, homogenous, HCl not tested. Length Recovered:0.6 ft. Length Retained:0.6 ft.		
						C-5		Well graded GRAVEL with cobbles, angular, dark gray, homogenous, HCl not tested, trace silt. Most fines washed out. Length Recovered:2.9 ft. Length Retained:2.9 ft.		
20			◆							

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-08si-09

Job No. XL3695 SR 410 Elevation 1945.5 ft

Sheet 2 of 7

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1925	10 12 10 (22)		D-6		Silty GRAVEL with sand, subangular, medium dense, dark yellowish brown to dark grayish brown, moist, stratified, HCl not tested. Length Recovered:0.7 ft. Length Retained:0.7 ft.		
				C-7	GS MC AL	MH, M.C. = 24%, PI = 21 Elastic SILT, to CONGLOMERATE, dark gray to olive brown, moist, stratified, HCl not tested, Top 0.8 GRAVEL, middle 1.1 SILT, bottom 1.6 CONGLOMERATE. Length Recovered:3.5 ft. Length Retained:3.5 ft.		
25	1920	>> 50/5" (REF)		D-8 C-9		CONGLOMERATE, very dense, dark yellowish brown, moist, homogenous, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
						SANDSTONE , strong brown to brown, coarse grained, completely weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:100 FF:1, Top 0.8 CONGLOMERATE, bottom 2.7 SANDSTONE.		
30	1915	19 28 39 (67)		D-10		SANDSTONE, very dense, strong brown to yellowish brown, wet, stratified, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-11		SANDSTONE , strong brown to light yellowish brown, coarse grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:77% RQD:60 FF:2		
35	1910	23 31 44 (75)		D-12		SANDSTONE, very dense, strong brown, wet, stratified, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-13		SANDSTONE , dark yellowish brown to strong brown, coarse grained, moderately weathered, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:43% RQD:14 FF:3		
40	1905	18 19 46 (65)		D-14		SANDSTONE, very dense, yellowish brown to strong brown, wet, stratified, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-15		SANDSTONE , dark yellowish brown to strong brown, coarse grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:57% RQD:14 FF:2		
45								

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-08si-09

Job No. XL3695 SR 410 Elevation 1945.5 ft

Sheet 3 of 7

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
	1900	14 33 49 (82)		D-16		SANDSTONE, very dense, strong brown to yellowish brown, wet, stratified, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.
				C-17		SANDSTONE, dark yellowish brown, coarse grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:23% RQD:23 FF:0
50	1895	>> 19 32 50/5" (REF)		D-18		SANDSTONE, very dense, dark yellowish brown, wet, stratified, HCl not tested. Length Recovered:1.4 ft. Length Retained:1.4 ft.
				C-19		No Recovery
55	1890	27 50 (77)		D-20		SANDSTONE, very dense, yellowish brown to strong brown, wet, stratified, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.
				C-21		
						SILTSTONE, dark gray with sandstone interbeds, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:55% RQD:43 FF:1 Drilling indicated SILTSTONE at 57.8 ft. Sandstone, siltstone, sharp depositional contact bedding dips ~10 degrees.
60	1885	6 10 24 (34)		D-22		SILTSTONE, dense, dark gray, moist, slickensided, blocky, disrupted, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.
				C-23		SILTSTONE with sandstone interbeds, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:86% RQD:43 FF:3 Cross-bedding visible in sandstone interbed @~63.2' to 64.7', scattered slickensides
65	1880	5 14 21 (35)		D-24		SILTSTONE, dense, dark gray, moist, slickensided, blocky, disrupted, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.
				C-25		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:40 FF:2, 67.1 to 67.4 coal. Coal to 67.4 (~4" thick) @~68.7' to 69.5', fracture zone @70.4', slickenslides
70						

Groundwater | Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-08si-09

Job No. XL3695 SR 410 Elevation 1945.5 ft

Sheet 4 of 7

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1875	7 21 24 (45)		D-26		SILTSTONE, dense, gray, moist, stratified, blocky, HCl not tested, trace organics. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-27		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:83 FF:0 Cross-bedding visible in core.		
75	1870	5 14 22 (36)		D-28		Sandy SILTSTONE, dense, dark gray, moist, stratified, slickensided, blocky, HCl not tested, trace organics, trace mica. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-29		SILTSTONE with sandstone interbeds and organics, med to fine grained, dark gray, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0. Coal and organics embedded in bottom of core. Cross-bedding visible in core.		
80	1865	13 26 21 (47)		D-30		SILTSTONE, dense, dark gray, moist, stratified, slickensided, blocky, HCl not tested, trace organics, mica throughout. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-31		SILTSTONE, organic layering, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0 @ 84.5', slickensides		
85	1860	6 21 24 (45)		D-32		SANDSTONE, dense, gray, moist, stratified, blocky, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-33		SANDSTONE, dark gray, medium grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:1. @ ~89', 3" irregular organic-appearing zone (possibly tachylite).		
90	1855	5 16 36 (52)		D-34		SANDSTONE, very dense, dark gray, moist, blocky, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-35		BASALT, med to fine grained., dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:65 FF:3 Drilling indicated BASALT @ 92.1' @ ~92.1', irregular contact, possibly intrusive.		
95								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-08si-09

Job No. XL3695 SR 410 Elevation 1945.5 ft

Sheet 5 of 7

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1850					C-36		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:86% RQD:38 FF:2 @ ~95' to 95.5', highly fractured, broken, with mineral coating; some of remnant pebbles are subrounded (possible peperite)		
100	1845					C-37		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:66 FF:2		
105	1840					C-38		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:94 FF:1 @ ~109', slickensides		
110	1835					C-39		BASALT to SILTSTONE, strong to mod weak rock, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:76 FF:2		
								Drilling encountered SILTSTONE.		
115	1830					C-40		SILTSTONE to SANDSTONE, fine to med grained, weak to very weak rock, dark gray to gray, slightly weathered. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:80 FF:2, SANDSTONE with SILTSTONE. @ ~115.3, ~3" gouge zone with slickensides, moist clay, organics and subrounded siltstone pebbles at siltstone/sandstone contact. Sandstone has organic interbeds, minor coal and slickensides. Bedding dips ~10 degrees; sandstone poorly indurated.		
120										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-08si-09

Job No. XL3695 SR 410 Elevation 1945.5 ft

Sheet 6 of 7

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1825			25 50 (75)		D-41		SANDSTONE, very dense, gray, wet, stratified, HCl not tested, Trace organics. Length Recovered:1 ft. Length Retained:1 ft.		
						C-42		SILTSTONE, med to fine grained, very weak to mod weak, gray to dark gray, fine grained, slightly weathered. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:58 FF:2, Top 1.5 SANDSTONE, bottom 2.5 SILTSTONE. @ ~123', slickensides, dipping ~25 degrees bedding dips ~ 15 degrees		
125	1820					C-43		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:58 FF:2 bedding dips ~15 degrees joint set dips ~35 degrees @ ~129.5', 3" brecciated zone with slickensides		
130	1815					C-44		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:90 FF:1		
135	1810					C-45		SILTSTONE , dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:86% RQD:76 FF:1 @ ~137.5', slickensides		
140	1805							Slope inclinometer installed to 139 feet. A flush mount monument was installed on this boring. The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.)		
145										

Washington State
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LOG OF TEST BORING

Start Card R-72791

HOLE No. H-08si-09

Job No. XL3695 SR 410 Elevation 1945.5 ft

Sheet 7 of 7

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Depth (ft)	Elevation (ft)	Profile	◆ Field SPT (N) ✚ Moisture Content ▨ RQD 20 40 60 80	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1800							End of test hole boring at 140 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
150	1795									
155	1790									
160	1785									
165	1780									
170										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-09p-09

Job No. XL3695 SR 410 Elevation 1945.3 ft

Sheet 1 of 4

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Site Address SR-410 and Nile Rd

Inspector Johnson, Vince #2532

Start November 5, 2009 Completion November 6, 2009 Well ID# BBL-099

Equipment CME 55 (9C7-1) - AH

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 539691.17 Easting 1534839.46 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection NE1/4 of NW1/4 Section 11 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1945.0									
								11/6/2009 100% lost circulation 11/6/2009		
5	1940.0					C-1		Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:1.2 ft. Length Retained:1.2 ft.		
10	1935.0					C-2		Well graded GRAVEL with cobbles and boulders, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:1.8 ft. Length Retained:1.8 ft.		
15	1930.0					C-3		Well graded GRAVEL with cobbles, subrounded, dark gray, homogenous, HCl not tested, fines washed out. Length Recovered:0.9 ft. Length Retained:0.9 ft.		
								Drilling indicated soils change at 18'.		
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-09p-09

Job No. XL3695 SR 410 Elevation 1945.3 ft

Sheet 2 of 4

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1925					C-4		Well graded GRAVEL, subrounded, dark gray, homogenous, HCl not tested, trace silt. Fines washed out. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
25	1920					C-5	MC AL	MC=28%, PI=31 CONGLOMERATE to SANDSTONE, dark gray to dark yellowish brown, coarse grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:92 FF:0, Top 0.4 SILT, middle 2.0 CONGLOMERATE, bottom 1.6 SANDSTONE. Over-ream HWT casing to 25.0'. Approx. 60% circ return after over-reaming. Silt appears to be brecciated zone. Sandstone is poorly indurated and Fe stained.		
30	1915					C-6		SANDSTONE, dark yellowish brown, coarse grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:30% RQD:10 FF:2		
35	1910					C-7		SANDSTONE, strong brown to dark yellowish brown, coarse grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:100 FF:0 Bedding dips ~20 degrees		
40	1905					C-8		SANDSTONE, dark yellowish brown to strong brown, coarse grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:80 FF:1 Poorly indurated		
45										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-09p-09

Job No. XL3695 SR 410 Elevation 1945.3 ft

Sheet 3 of 4

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1900					C-9		SANDSTONE, strong brown to dark yellowish brown, coarse grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:90 FF:0 Poorly indurated		
50	1895					C-10		SANDSTONE, strong brown to yellowish brown, coarse grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:66% RQD:60 FF:1 Poorly indurated		
55	1890							Standpipe piezometer installed to 55 feet. A flush mount monument was installed on this boring.		
60	1885							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
65	1880							End of test hole boring at 55 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
70								Bail/Recharge test: Hole Diameter: 6 Depth of boring during bail test: 55' Depth of casing during bail test: 52' Bailed bore hole water level to 9' Recharge after 1 minutes :7.3' Recharge after 2 minutes :6.8' Recharge after 3 minutes :6.2'		

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72791

HOLE No. H-09p-09

Job No. XL3695 SR 410 Elevation 1945.3 ft

Sheet 4 of 4

Project SR-410 Nile Valley Landslide

Driller Nelson, Brad Lic# 2969T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1875							Recharge after 4 minutes :5.8' Recharge after 5 minutes :5.7' Recharge after 10 minutes :5' Recharge after 15 minutes :4.8' ' Bailed hole for 15 min., could not draw water past 9.0'.		
75	1870									
80	1865									
85	1860									
90	1855									
95										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 1 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Site Address SR-410 vic of Nile Rd

Inspector Johnson, Vince #2532

Start November 10, 2009 Completion November 14, 2009 Well ID# BBL-082

Equipment CME 850 (9C2-3) - AH

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 541233.70 Easting 1534214.65 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Basalt GRAVEL, subangular, dark gray, HCl not tested, trace organics, (roots). Fines washed out. Length Recovered:1.5 ft. Length Retained:1.5 ft. 100% lost circulation.		
	2065.0									
5				4 12 9 (21)		D-2		Silty GRAVEL with sand, subangular, medium dense, dark brown, moist, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.	11/12/2009	
						C-3		Basalt GRAVEL with cobbles, subangular,dark gray, HCl not tested, fines washed out. Length Recovered:1.8 ft. Length Retained:1.8 ft.		
	2060.0									
10				6 8 9 (17)		D-4		Silty GRAVEL with sand, subangular, medium dense, grayish brown to strong brown, moist, stratified, HCl not tested. Length Recovered:0.7 ft. Length Retained:0.7 ft.		
						C-5		Silty GRAVEL with sand and cobbles, subangular, dark gray, moist, stratified, HCl not tested. Length Recovered:2.1 ft. Length Retained:2.1 ft.		
	2055.0							85% circ return.		
15				6 10 6 (16)		D-6		No Recovery		
						C-7		Silty GRAVEL, subangular, light yellowish brown, moist, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.		
	2050.0									
20			>>							

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 2 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		8 50/5" (REF)		D-8		Silty SAND, very dense, light yellowish brown to strong brown, moist, stratified, HCl not tested.		
				C-9		Length Recovered:0.9 ft. Length Retained:0.9 ft. BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:27 FF:3 Over-ream HWT casing to 21'. 100% lost circ. 85% circ return. ~4' zone of subangular to subrounded basalt pebbles at top of run.		
	2045							
25				C-10		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:36 FF:4		
	2040							
30				C-11		100% lost circ. BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:34 FF:4 Approx. 10% circ return.		
	2035							
35				C-12		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:30 FF:3 100% lost circ.		
	2030							
40				C-13		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:0 FF:6 Approx. 75% circ return.		
	2025							
45								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 3 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				C-14		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:14 FF:4		
	2020							
50				C-15		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:60 FF:3		
	2015							
55				C-16		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:94% RQD:34 FF:3	▼ 11/14/2009	
	2010							
60				C-17		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:46% RQD:0 FF:6		
						Drilling indicated soils/color change.		
	2005							
65		19 33 50 (83)		D-18		Silty SANDSTONE, very dense, dark yellowish brown to gray, moist, stratified, HCl not tested, trace sand and mica. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-19		SANDSTONE strat with SILTSTONE, medium to fine grained, very weak to mod weak rock, gray, medium grained, fresh. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:1 Bedding dips ~20 degrees		
	2000							
70								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 4 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		18 50/5" (REF)	D-20		SANDSTONE, very dense, gray, moist, stratified, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.
			C-21		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:93 FF:1, organic interbeds near bottom of core. Microfaulting and folding and scattered polished surfaces, last 2' of run.
	1995				
75		22 50/5" (REF)	D-22		SILTSTONE, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft. @ 77' to 78', subvertical irregular fracture with polished surface
			C-23		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0
	1990				
80		30 50/5" (REF)	D-24		SILTSTONE, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft. @ ~86.9', polished surface dipping ~25 degrees @ ~83', ~2mm thick gouge zone with slickensides dipping ~20 degrees
			C-25		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:90 FF:1
	1985				
85		25 50/5" (REF)	D-26		SILTSTONE, very dense, dark gray, moist, stratified, blocky, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft. @ ~86.9', slickenside surface dipping ~55 degrees @ ~87.7', 1" thick gouge zone with slickensides ~88' to 89.5, highly fractured zone with slickensides and scattered gouge zones.
			C-27		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:90% RQD:37 FF:4
	1980				
90		18 26 38 (64)	D-28		SILTSTONE, very dense, dark gray, moist, slickensided, blocky, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.
			C-29	MC AL	MC=38%, PI=17 SILTSTONE , dark gray, fine grained, fresh, moderately weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:23 FF:5 @ 91.5, ~2.5" thick gouge zone with very moist (~1mm thick) slip surface dipping ~40 degrees in center of gouge zone
	1975				
95					

Groundwater | Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 5 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		17 25 34 (59)		D-30		SILTSTONE, very dense, dark gray, slickensided, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
				C-31		SANDSTONE, gray, coarse grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0, Top 0.1 SILTSTONE slickensided. @96.6', 1/4" organic layer with slickensides between siltstone and sandstone		
	1970							
100		>> 50/4" (REF)		D-32 C-33		SANDSTONE, very dense, gray, wet, homogenous, HCl not tested. Length Recovered:0.3 ft. Length Retained:0.3 ft. SANDSTONE, gray, coarse grained, fresh, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:94% RQD:81 FF:1, organic bedding. @ ~104', organic layer dips ~25 degrees		
	1965							
105		>> 50/4" (REF)		D-34 C-35		SANDSTONE, very dense, gray , wet, homogenous, HCl not tested. Length Recovered:0.3 ft. Length Retained:0.3 ft. SANDSTONE, gray, coarse grained, fresh, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:85% RQD:68 FF:1		
	1960							
110		>> 50/5" (REF)		D-37 C-38		SANDSTONE, very dense, gray, wet, homogenous, HCl not tested, trace organics.. Length Recovered:0.4 ft. Length Retained:0.4 ft. SANDSTONE, gray, coarse grained, fresh, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:87% RQD:63 FF:2 sandstone becomes poorly indurated at bottom of core run		
	1955							
115		>> 50/4" (REF)		D-39 C-40		SANDSTONE, very dense, gray, wet, homogenous, HCl not tested. Length Recovered:0.3 ft. Length Retained:0.3 ft. Volcanic CONGLOMERATE (peperite), dark gray, coarse grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:96% RQD:60 FF:2. Drilling indicated soils change at 115.7'. @ ~119.2, slickensides		
	1950							
120								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 6 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
					C-41		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:96% RQD:20 FF:4, 120.7 to 121.3 CONGLOMERATE. @ ~121.3', subvertical slickensides		
	1945								
125					C-42				
							BASALT, highly vesicular, mod weak to strong rock., dark gray, fine grained, fresh. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:44 FF:3 @ 126' to 126.7', highly fractured zone with polished surfaces in siltstone @ ~129', apparent "ropey" texture in basalt (possible pillow structure)		
	1940								
130					C-43		BASALT, highly to mod vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:76 FF:2, Light yellowish brown SILTSTONE (possible palagonite) at 132.1. @ ~133.5', slickensides		
	1935								
135					C-44		BASALT, sightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:1		
	1930								
140					C-45		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:82 FF:1		
	1925								
145									

Washington State
Department of Transportation

LOG OF TEST BORING

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HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 7 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
				C-46		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:32% RQD:16 FF:3, SILT in bottom of core.
						Drilling indicated soils change at 146.3'.
	1920					
150		>>◆ 24 50/5" (REF)		D-47		SANDSTONE, very dense, gray, dry, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft. Bedding dips ~20 degrees
				C-48		SANDSTONE with siltstone beds, dark gray, medium grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:90% RQD:78 FF:1
	1915					
155				C-49		SANDSTONE with siltstone beds, dark gray, medium grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:70 FF:2 @ ~158.5', ~2mm thick dark brown organic layer with slickensides @ ~158.8', slickensides 100% lost circ.
	1910					
160				C-50		SILTSTONE with sandstone beds, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:80% RQD:70 FF:1 siltstone/sandstone contact sharp at 160.2' cross-bedding visible in siltstone @ ~164.8', ~1/4" gouge zone with slickensides
	1905					
165				C-51		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:84 FF:1 bedding dips ~40 degrees in sandstone from 165' to 167' (possible cross-bedding) @169/5' subvertical fracture with slickensides.
	1900					
170						

Groundwater | Instrument

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 8 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1895					C-52		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:100 FF:0 Cross-bedding, rip-up clasts, visible in core. @ ~173' to 173.3', slickensides		
175						C-53		SANDSTONE, dark gray, medium grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:96 FF:1, SILTSTONE present in core. Rip-up clasts visible in core @ 178', slickensided surface, dipping ~35 degrees		
	1890									
180								Slope inclinometer installed to 180 feet. A standpipe monument was installed on this boring.		
	1885							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
185										
	1880							End of test hole boring at 180 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
190										
	1875							Bail/Recharge test: Hole Diameter: 6 Depth of boring during bail test: 160' Depth of casing during bail test: 157' Bailed bore hole water level to 59.2' Recharge after 1 minutes :58.5' Recharge after 2 minutes :58.2' Recharge after 3 minutes :57.9'		
195										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-10si-09

Job No. XL3695 SR 410 Elevation 2068.8 ft

Sheet 9 of 9

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Recharge after 4 minutes :57.9' Recharge after 5 minutes :57.9' Recharge after 10 minutes :57.9' ' Performed first bail test at 40'. Casing depth 38'. Bailed hole to 40'. After 3 minutes, no recharge water at 40'. Bailed hole at 65.5' due to soils change. Casing depth at 64, water level after bail 59, 1 min 58.7, 2 min, 58.5, 3 min 58.4 4 min 58.3, 5 min 58.3, 10 min 58.1, 15 min 58, 20 min 58. Bailed hole at 100.3, casing depth 98, water level after bail 50.7, 1 min 50.5, 2 min 50.4, 3 min 50.3, overnight 50.1.		
	1870									
200										
	1865									
205										
	1860									
210										
	1855									
215										
	1850									
220										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-11p-09

Sheet 1 of 5

Job No. XL3695 SR 410 Elevation ft

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Site Address SR-410 vic of Nile Rd

Inspector Johnson, Vince #2532

Start November 15, 2009 Completion November 17, 2009 Well ID# BBL-083

Equipment CME 850 (9C2-3) - AH

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 541246.55 Easting 1534200.24 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Gravel and cobbles with sand at surface. Started hole with HWT casing to 5'. 100% lost circ.		
5						C-1		Basalt GRAVEL, angular, dark gray, HCl not tested, trace silt. Most fines washed out. Length Recovered:1 ft. Length Retained:1 ft.		
								Approx. 90% circ return.		
10						C-2		Silty GRAVEL with cobbles, angular, dark brown to dark gray, moist, HCl not tested, Most fines washed out. Length Recovered:1.6 ft. Length Retained:1.6 ft. 100% lost circ.		
15						C-3		GRAVEL, subangular, dark grayish brown, moist, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft. Drilling indicated soil change at 15.5'		
									11/16/2009	
				4 6 7 (13)		D-4		No Recovery Approx. 85% circ return.		
20						C-5		GRAVEL, subangular, dark gray, HCl not tested, trace silt. Length Recovered:0.5 ft. Length Retained:0.5 ft.		

Washington State
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LOG OF TEST BORING

Start Card R-72793

HOLE No. H-11p-09

Job No. XL3695 SR 410 Elevation ft

Sheet 2 of 5

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				6 13 24 (37)		D-6		No Recovery		
						C-7		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:86% RQD:11 FF:6, Top 0.5 SILT with gravel, light yellowish brown. Drilling indicated soils change at 22.6'		
25						C-8		BASALT slightly vesicular, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:80% RQD:8 FF:6		
30						C-9		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:36 FF:3		
35						C-10		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:48 FF:3		
								Approx. 90% lost circ.		
40						C-11		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:30 FF:3		
								Approx. 80% circ return.		
45										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-11p-09

Job No. XL3695 SR 410 Elevation ft

Sheet 3 of 5

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-12		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:36 FF:3		
50						C-13		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:34 FF:3		
55						C-14		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:94% RQD:36 FF:3	11/17/2009	
60						C-15		BASALT, dark gray to strong brown to yellowish brown, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:34 FF:3, Top 3.0 BASALT, bottom 2.0 SANDSTONE. Tachylite in BASALT fracture near SANDSTONE contact. @ ~61.8', healed FeO-stained fracture dipping ~35 degrees in basalt @ ~62.8', subhorizontal slickensides on ~30 degree dipping fracture in basalt subrounded basalt pebbles at contact with sandstone SANDSTONE contact. Bedding dips ~18 degrees in sandstone Joint in sandstone dips ~40 degrees		
65						C-16		SANDSTONE with siltstone beds, yellowish brown to gray, medium grained, slightly weathered, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Bedding dips ~20 degrees		
70										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-11p-09

Job No. XL3695 SR 410 Elevation ft

Sheet 4 of 5

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-17		SILTSTONE with sandstone beds, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 bedding dips ~20 degrees @ ~70.5', fracture with polished surface and minor slickensides, surface dips ~40 degrees @ ~71.1', fracture with slickensides, dipping ~30 degrees and ~ opposite direction from bedding		
75						C-18		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~76.8', polished slickensided surface dipping ~45 degrees, ~opposite bedding, dipping ~20 degrees		
80						C-19		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:90 FF:1 bedding dips ~20 degrees @ ~84.5', polished, clay-coated joint, dipping ~30 degrees; also subhorizontal slickensided surface.		
85						C-20		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:94 FF:1 @ 85', polished surface, dipping ~25 degrees @ ~88', subvertical slickensided surface, dipping ~85 degrees @ ~88.8', slickensided surface dipping ~20 degrees and random polished surfaces		
90						C-21		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:64 FF:2 @ 90' to 91.5', highly fractured zone with slickensides slickensides present throughout run siltstone grades to claystone, waxy feel		
95										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-11p-09

Job No. XL3695 SR 410 Elevation ft

Sheet 5 of 5

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-22		SILTSTONE, dark gray to gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:58 FF:2, SILTSTONE to SANDSTONE, fine grained to coarse grained, mod weak to very weak rock. slickensided surface @ siltstone/sandstone contact dipping ~20 degrees, ~concordant with sandstone bedding SANDSTONE contact. Sandstone massive to cross bedded and poorly indurated		
100								Standpipe piezometer installed to 100 feet. A standpipe monument was installed on this boring.		
105								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
110								End of test hole boring at 100 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
115								Bail/Recharge test: Hole Diameter: 6 Depth of boring during bail test: 100' Depth of casing during bail test: 95' Bailed bore hole water level to 78.1' Perform bail/recharge test at 65' due to soils change. Casing depth 62'. Water level after bail test 64'. 1 min 63.8, 2 min 63.9, 3 min 63.5, 8 min 62.6, 13 min 62, 18 min 61.5.		
120										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-12si-09

Sheet 1 of 11

Job No. XL3695 SR 410 Elevation 2183.9 ft

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Site Address SR-410 vicinity of Nile Rd.

Inspector Cooper, Kerry / Fetterly, Jamie

Start December 19, 2009 Completion January 7, 2010 Well ID# BBL-084 Equipment Burly 4500 () - CH

Station Offset Hole Dia (inches) 5 Method Wet Rotary

Northing 541290.62 Easting 1534452.45 Collected by Region Survey Crew Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Cobbles, boulders and gravels at the surface.		
						C-1		GRAVEL, sub-angular, gray, moist, HCl not tested. Length Recovered:4.2 ft. Length Retained:4.2 ft. Brown silty sand adheres to some fragments. Scoria fragments present.		
	2180.0									
5										
	2175.0									
10										
						C-2		GRAVEL, sub-angular, gray, moist, HCl not tested. Length Recovered:2.8 ft. Length Retained:2.8 ft.		
	2170.0									
15										
						C-3		GRAVEL, sub-angular, gray, moist, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
	2165.0									
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 2 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-4		GRAVEL, sub-angular, gray, moist, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
	2160									
25										
						C-5		GRAVEL, sub-angular, with cobbles, gray, moist, stratified, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
	2155									
30										
						C-6		GRAVEL, sub-angular, with cobbles, gray, moist, HCl not tested. Length Recovered:2.4 ft. Length Retained:2.4 ft.		
	2150									
35										
						C-7		GRAVEL, sub-angular, gray, moist, stratified, HCl not tested. Length Recovered:1.6 ft. Length Retained:1.6 ft.		
	2145									
40										
						C-8		GRAVEL, sub-angular, gray, moist, stratified, HCl not tested. Length Recovered:1.2 ft. Length Retained:1.2 ft.		
						C-9		GRAVEL, sub-angular, with cobbles, gray, moist, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
	2140									
45										

Washington State
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LOG OF TEST BORING

Start Card R-72793

HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 3 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-10		Basalt Boulders, gray, moist, HCl not tested. Length Recovered:4 ft. Length Retained:4 ft.		
	2135									
50										
						C-11		GRAVEL, sub-angular, with cobbles, gray, moist, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
	2130					C-12		GRAVEL, sub-angular, with cobbles, gray, moist, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
55										
						C-13		GRAVEL, sub-angular, with cobbles, gray, moist, stratified, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
	2125									
60										
						C-14		GRAVEL, sub-angular, with cobbles, gray, moist, stratified, HCl not tested. Length Recovered:1.2 ft. Length Retained:1.2 ft. Mainly scoria fragments		
	2120							100% drill fluid loss from the start of boring		
65								100% drilling fluid return		
						C-15		GRAVEL, sub-angular, with silt and cobbles, , gray, moist, stratified, HCl not tested. Length Recovered:1.6 ft. Length Retained:1.6 ft. At top of samle, thoroughly brecciated basalt fragments with slickensides and a few subrounded basalt pebbles At bottom third of ~3" shear zone with slickensides and variegated colors		
	2115									
70										

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LOG OF TEST BORING

Start Card R-72793

HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 4 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-15		GRAVEL, sub-angular, stratified with siltstone, gray, moist, HCl not tested. Length Recovered:1.8 ft. Length Retained:1.8 ft. Most fragments subrounded with fines washed away. ~4" siltstone fragment has bottom of apparent gouge zone at top of sample.		
75	2110									
						C-16	MC AL	MC=38%, PI=26 SILTSTONE, gray to green, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:98% RQD:62 FF:1 @ ~72.3 to 72.8', brecciated zone, completely disrupted. @ ~77.8', 3" gouge zone with slickensides; slip plane is inclined ~25 degrees, green alteration. @ ~80.8 to 81.8', highly fractured zone.		
80	2105									
						C-17		SILTSTONE, gray to green, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:58 FF:1 @ ~82.8', ~4" zone of subrounded pebbles with fines washed away. @ ~83.8', ~4" brecciated zone with some subrounded pebbles.		
85	2100									
						C-18		SANDSTONE, grayish brown, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:80 FF:0 Sandstone is poorly indurated Bedding inclined ~25 degrees.		
90	2095									
						C-19		SANDSTONE, grayish brown, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:90% RQD:90 FF:0 Crossbedding visible in core sample.	▽	
95	2090							1/6/2009		

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 5 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-20		SANDSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0		
						C-21		SANDSTONE, with siltstone interbeds, gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0 Cross-bedding and microfaulting visible.		
	2085									
100										
						C-22		SANDSTONE, with siltstone interbeds, gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0 Sandstone is poorly indurated.		
	2080									
105										
						C-23				
								SILTSTONE, dark gray, fine grained, slickensided, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
	2075									
110										
						C-24	MC AL	MC=26%, PI=14 SILTSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:100 FF:0, greenish gray disrupted siltstone @ 115' to 117', interbedded with gray lean clay @ ~112.2', polished surface dipping ~60 degrees @ ~112.4', slickensided surface dipping ~30 degrees @ ~114.1', apparent black tachylite @ ~115 to 115.5', clayey gouge zone with slickensides		
	2070									
115										
						C-25		SILTSTONE, greenish gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:92% RQD:92 FF:0 @ ~120 to 121', highly fractured zone with slickensides		
	2065									
120										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 6 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-26		SILTSTONE, greenish gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 slickensides throughout core run		
125	2060									
						C-27		SANDSTONE, gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0 Bedding inclined ~35 to 40 degrees (average 38)		
130	2055									
						C-28		SANDSTONE, with black laminations, gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Bedding inclined ~30 degrees Microfaulting and cross-bedding visible. Microfault dips ~70 degrees @ ~135.5', contact with siltstone @ ~135.7', ~1" gouge zone with slickensides		
135	2050									
						C-29		SILTSTONE, with light gray silty sandstone laminations, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:0 Throughout core run; slickensided surfaces, includes a set incluned ~55 degrees and a set inclined ~20 degrees, dipping approximately opposite each other.		
140	2045									
						C-30		SANDSTONE, dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:100 FF:0 @ ~144.3', contact between sandstone and volcanic conglomerate (peperite).		
145	2040									

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HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 7 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-31		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:67 FF:1 @ ~147.5 to 148.6', zone of angular and subrounded basalt pebbles with fines washed away.		
150	2035					C-32		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:80 FF:1		
155	2030					C-33		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:82 FF:0 @ ~157 to 158', zone of angular to subrounded basalt pebbles with fines washed away.		
160	2025					C-34		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:92% RQD:82 FF:1		
165	2020					C-35		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:85% RQD:67 FF:1		
170	2015									

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LOG OF TEST BORING

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HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 8 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-36		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:85% RQD:75 FF:1 @ ~174.1', ~3" apparent silty sandstone fragment entrained in peperite and empregnated with volcanic glass (tachylite) @ ~175 to 175.5', zone of angular to subrounded basalt pebbles with fines washed away.		
175	2010					C-37		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, slightly weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:32 FF:4 @ ~177 to 177.7', zone of angular to subrounded basalt pebbles with fines washed away - also from 178.4 to ~178.9 and from ~179.6' to end of core run.		
180	2005					C-38		Volcanic CONGLOMERATE (Peperite), dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:30 FF:4		
185	2000					C-39		BASALT, slightly vesicular, dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:40 FF:3 Locally breciated		
190	1995					C-40		BASALT, dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:60% RQD:13 FF:10 Several brecciated zones with fines washed away.		
195	1990									

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HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-41		BASALT, dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:30 FF:5 Several brecciated zones with fines washed away; peperite texture locally; scattered vesicles.		
	1985									
200										
						C-42		BASALT, dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:60% RQD:25 FF:5 Brecciated locally.		
	1980									
205										
						C-43		BASALT, dark gray, fine grained, slightly weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:70 FF:2 Brecciated locally, with apparent tachylite infilling.		
	1975									
210										
						C-44		BASALT, dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:35 FF:2 Brecciated locally, with apparent tachylite infilling, scattered vesicles.		
	1970									
215										
						C-45		SANDSTONE, bluish gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:92 FF:1, contact is flat, zero degrees Contact with sandstone is sharp with apparent tachylite inclusions in ~3/4" thick chilled margin.		
	1965									
220										

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Start Card R-72793

HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 10 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-46		SANDSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0		
	1960									
225										
						C-47		SANDSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0, black laminations to 12 degrees Contact with siltstone at 229'. Slickensided throughout core run. Bedding inclined ~25 degrees.		
	1955									
230										
						C-48		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Cross-bedding visible in core. Slickensided throughout core run. @ ~239.5 to 239.9', apparent black tachylite @ ~240 to 242', scattered irregular apparent stringers of black tachylite		
	1950									
235										
						C-49		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0, black strati from 239.5' to 240' Scattered irregular apparent stringers of black tachylite		
	1945									
240										
						C-50		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Scattered irregular apparent stringers of black tachylite		
	1940									
245										

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HOLE No. H-12si-09

Job No. XL3695 SR 410 Elevation 2183.9 ft

Sheet 11 of 11

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Cobel camera logged hole A standpipe monument was installed on this boring.		
	1935									
250								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.)		
	1930									
255								End of test hole boring at 247 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
	1925									
260										
	1920									
265										
	1915									
270										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-13p-09

Sheet 1 of 6

Job No. XL3695 SR 410 Elevation 2195.2 ft

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Site Address SR-410 vicinity of Nile Rd.

Inspector Fetterly, Jamie #2507

Start December 28, 2009 Completion January 7, 2010 Well ID# BBL-085 Equipment Burley 4500 () - CH

Station Offset Hole Dia (inches) 5 Method Wet Rotary

Northing 541299.26 Easting 1534496.91 Collected by Geographic Services Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2195.0					C-1		Cobbles, boulders, and gravels at the surface. GRAVEL, subangular, dark gray, moist, stratified, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
5	2190.0					C-2		GRAVEL, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
10	2185.0					C-3		GRAVEL, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
15	2180.0					C-4		GRAVEL, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
20										

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LOG OF TEST BORING

Start Card R-72793

HOLE No. H-13p-09

Job No. XL3695 SR 410 Elevation 2195.2 ft

Sheet 2 of 6

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2175					C-5		GRAVEL, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
25	2170					C-6		Basalt cobbles and boulders, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:3.5 ft. Length Retained:0 ft.		
30	2165					C-7		GRAVEL, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
35	2160					C-8		GRAVEL with cobbles, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
40	2155					C-9		GRAVEL with cobbles, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
45										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-13p-09

Job No. XL3695 SR 410 Elevation 2195.2 ft

Sheet 3 of 6

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2150					C-10		GRAVEL with cobbles, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
50	2145					C-11		GRAVEL with cobbles, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
55	2140					C-12		GRAVEL with cobbles, subangular, dark gray, moist, HCl not tested, 100% drill fluid loss. Length Recovered:1 ft. Length Retained:0 ft.		
60	2135					C-13		GRAVEL, subangular, dark gray, moist, HCl not tested. Length Recovered:1 ft. Length Retained:0 ft.		
65	2130					C-14		GRAVEL, subangular, dark gray, moist, HCl not tested. Length Recovered:1 ft. Length Retained:0 ft.		
70										

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LOG OF TEST BORING

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HOLE No. H-13p-09

Job No. XL3695 SR 410 Elevation 2195.2 ft

Sheet 4 of 6

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2125					C-15		GRAVEL, subangular, dark gray, moist, HCl not tested. Length Recovered:1 ft. Length Retained:0 ft.		
75	2120					C-16		GRAVEL, subangular, dark gray, moist, HCl not tested. Length Recovered:1 ft. Length Retained:0 ft.		
80	2115					C-17		1/6/2010		
								Silty GRAVEL, subangular, dark gray, moist, HCl not tested. Length Recovered:0.6 ft. Length Retained:0 ft.		
85	2110					C-18		Silty GRAVEL, subangular, dark gray, moist, HCl not tested. Length Recovered:0.6 ft. Length Retained:0 ft.		
90	2105					C-19		SILTSTONE, stratified with silty gravel, greenish gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:50% RQD:50 FF:0		
95										

Washington State Department of Transportation

LOG OF TEST BORING

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HOLE No. H-13p-09

Job No. XL3695 SR 410 Elevation 2195.2 ft

Sheet 5 of 6

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2100					C-20				
100	2095					C-21		SANDSTONE, stratified with siltstone, bluish gray, fine grained, fresh, very weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:0, fractures in siltstone are orientated to 20 degrees		
105	2090					C-22		SANDSTONE, with black laminations, bluish gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0, black laminations from 102' to 103.5'		
110	2085					C-23		SANDSTONE, interbedded with brownish gray siltstone, bluish gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0.		
115	2080					C-24		SANDSTONE, interbedded with brownish gray siltstone, with slickensides, gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0, siltstone/sandstone contact is inclined approximately 40 degrees.		
120								SILTSTONE, interbedded with sandstone with black laminations, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:0, one 60 degree slickensided fracture at 120.5		

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LOG OF TEST BORING

Start Card R-72793

HOLE No. H-13p-09

Job No. XL3695 SR 410 Elevation 2195.2 ft

Sheet 6 of 6

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2075									
						C-25		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:92% RQD:78 FF:0, disrupted from 121.3' to 122.4'		
125	2070									
						C-26		SILTSTONE stratified with a 1" layer of black material, stratified with disrupted greenish gray siltstone, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:60 FF:1		
130	2065									
								Vibrating wire piezometer (#92549) installed at 129 feet. Standpipe piezometer installed to 78 feet. A standpipe monument was installed on this boring.		
135	2060							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
140	2055							End of test hole boring at 131 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
145										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 1 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Site Address SR-410 and Nile Road

Inspector Andrews, Cleo #1677

Start November 29, 2009 Completion December 17, 2009 Well ID# BBL-086(Slope Incl. x 295.0') Equipment CME 55 (9C1-1) - AH

Station Offset Hole Dia (inches) 4 Method Mud Rotary

Northing 540747.01 Easting 1534412.30 Collected by Region Survey Crew Datum State Plane South

County Yakima Subsection SW/14 of SW-1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Cobbles, boulders and gravels at the surface, disrupted slide material.		
	1985.0									
5										
	1980.0									
10										
	1975.0									
15						C-1		GRAVEL, sub-angular, dark gray, homogenous. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
	1970.0									
20										

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LOG OF TEST BORING

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HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 2 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-2		GRAVEL, sub-angular, with cobbles, dark gray. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
	1965								12/2/2009	
25						C-3		GRAVEL, sub-angular, with cobbles, dark gray. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
	1960									
30						C-4		GRAVEL, sub-angular, dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
	1955									
35						C-5		GRAVEL, sub-angular, dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
	1950									
40						C-6		GRAVEL, sub-angular, dark gray. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
	1945									
45										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 3 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-7		GRAVEL, sub-angular, with cobbles, dark gray. Length Recovered:2 ft. Length Retained:2 ft. 12/8/2009		
	1940									
50						C-8		GRAVEL, sub-angular, with cobbles, dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
	1935									
55						C-9		GRAVEL, sub-angular, with cobbles, dark gray. Length Recovered:1.3 ft. Length Retained:1.3 ft.		
	1930									
60				9 12 11 (23)		D-10		Silty SAND, disrupted,with chunks of silt, sand with coal, medium dense, yellowish brown, moist, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
						C-11		silt with sand into sand into sandstone		
	1925							Poorly graded SAND (sandstone), with traces of gravel, grayish brown, homogenous and FeO staining. Length Recovered:1.3 ft. Length Retained:1.3 ft.		
65				9 15 21 (36)		D-12		Poorly graded SAND (sandstone), disrupted, stratified with silt and apparent organics, black and dark gray in color, dense, olive brown, moist, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
						C-13		Poorly graded SAND (sandstone), with apparent organic inclusions (possibly tachylite), stratified, slickensides at 68.0', dark gray. Length Recovered:3.5 ft. Length Retained:3.5 ft. bedding dips ~20 to 25 degrees		
	1920									
70										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 4 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Field SPT (N) | Moisture Content | RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		12 32 50/4" (REF)		D-14		Silty SAND (sandstone), very dense, dark gray, moist, HCl not tested. Length Recovered:1.3 ft. Length Retained:1.3 ft.		
				C-15		SANDSTONE stratified with maca, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:92% RQD:60 FF:1 Bedding dips ~20 degrees sandstone		
75	1915	28 50/4" (REF)		D-16		SANDSTONE, very dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft.		
				C-17		SANDSTONE, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in fair condition. Recovered:95% RQD:67 FF:1 cross bedding visible sharp contact with basalt		
	1910					Basalt at 78'		
80				C-18		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:45 FF:3		
	1905							
85				C-19		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:68 FF:2		
	1900							
90				C-20		BASALT, medium gray, fine grained, slightly weathered, very strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:43 FF:2 @ ~94', prominent fracture dips ~70 degrees		
	1895							
95								

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 5 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-21		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:6 FF:4 @ ~98', prominent fracture with FeO staining, dips ~80 degrees		
	1890									
100						C-22		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:86% RQD:0 FF:5		
	1885									
105						C-23		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:17 FF:3		
	1880									
110						C-24		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:10 FF:5		
	1875									
115						C-25		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:93% RQD:0 FF:5		
	1870									
120										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 6 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
					C-26		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:97% RQD:6 FF:5		
	1865								
125					C-27		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:95% RQD:18 FF:4		
	1860								
130					C-28		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:38 FF:3		
	1855								
135					C-29		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:41 FF:3		
	1850								
140					C-30		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:40 FF:3		
	1845								
145									

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LOG OF TEST BORING

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HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 7 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-31		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:23 FF:3		
	1840									
150						C-32		BASALT, medium gray, fine grained, slightly weathered, strong rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:25 FF:3		
	1835									
155						C-33		BASALT, medium gray, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:83 FF:1		
	1830									
160						C-34		BASALT, medium gray, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:93 FF:1 @ ~160.5', prominent FeO-stained fracture, dipping ~65 degrees		
	1825									
165						C-35		BASALT, medium gray, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:88 FF:1, HWT 4" ID casing 82.0', HQ 3" ID casing 168.0'. Water table at 38.5'. Bailed hole to 45.0'. Over week end reading was 45.6', 12-8-09		
	1820									
170										

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HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 8 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1815					C-36		BASALT with quartz infillings, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:83 FF:1		
175						C-37		BASALT with quartz infillings, fine grained, fresh, strong rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0		
	1810									
180						C-38		BASALT with quartz infillings, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:81 FF:1		
	1805									
185						C-39		BASALT with quartz infillings, fine grained, fresh, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:36 FF:5 @ ~ 189.5', prominent subvertical, rough-textured discontinuity with apparent pyrite mineral staining.		
	1800									
190						C-40		BASALT with quartz infillings, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:56 FF:3		
	1795									
195										

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HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

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Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
					C-41		BASALT, massive, light gray to grayish black in color, fine grained, slightly weathered, strong rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:68 FF:3 apparent pillow structure at contact with siltstone Siltstone at 195.5 upper 4" of siltstone apparent bake zone bedding dips ~30 degrees		
	1790								
200					C-42		SILTSTONE, light gry to grayish black in color, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in excellent condition. Recovered:100% RQD:100 FF:0		
	1785								
205					C-43		SILTSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in excellent condition. Recovered:100% RQD:100 FF:0		
	1780								
210					C-44		SILTSTONE with one open healed joint with slickensided from 213.7' to 214.0', dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:88 FF:1 @ ~213.5', slickensided surface dipping ~25 degrees @ ~214', slickensides		
	1775								
215					C-45		SILTSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in excellent condition. Recovered:100% RQD:100 FF:0, Water table over night reading was at 36.0'. Bailed hole to 84.0', after five minutes delay recharged to 83.6', 10 minutes 83.6'. @ ~219.9', 1/4" thick gouge zone with slickensides		
	1770								
220									

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HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

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Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-46	MC AL	MC=44%, PI=21 SILTSTONE , dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in very poor condition. Recovered:86% RQD:41 FF:3 @ ~221.9', 6" thick highly fractured zone with subrounded pebbles (possible gouge zone) @ 224.5', 6" clayey gouge zone with slickensides		
	1765									
225						C-47		SILTSTONE, with 1.5' of low grade coal from 225.0' to 226.5', stratified, light gray to black with slickensided, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:88% RQD:31 FF:9 @ ~227.5', ~3" thick gouge zone @ ~229', subvertical slickensided surface. bedding dips ~15 to 20 degrees		
	1760									
230						C-48		SILTSTONE, stratified, light gray to black in color, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:85 FF:1		
	1755									
235						C-49				
	1750							Altered SILTSTONE, with 1.9' of dark siltstone from 235.0' to 236.9' in top of core, dark green, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:88% RQD:75 FF:2 (has appearance of weathered tuff) gradational contact @ ~237.8', slickensides @ ~239.4', 2" thick gouge zone slickensides throughout core run basalt, artesian pressure 250' to 255.0' Altered SILTSTONE, dark green, fine grained, moderatly weathered, moderatly strong rock, discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:70 FF:2 gRADATIONAL CONTACT WITH DARK SILTSTONE		
240						C-50				
	1745									
245										

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HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

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Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
					C-51		SILTSTONE, with 1.5' of altered siltstone from 245.0' to 246.5', stratified with black and gray siltstone interbeds, dark gray, fine grained, moderatly weathered, moderatly strong rock. Discontinuities are moderately spaced and in poor condition. Recovered:80% RQD:50 FF:6, Water table over night reading was 38.6', 12/11/09 @ 249 TO 250', hightly fractured zone with slickensides.		
	1740								
250					C-52		SILTSTONE, with basalt at 252.5', disrupted from 251.3' to 252.5', top of rock, dark gray, fine grained, slightly weathered, moderately strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:60 FF:3, Some rounded pebbles. Possible void 256.0' to 256.5', top of rock. @ ~250.2', polished, slickensided surface, dipping ~40 degrees. Contact with basalt dips ~ 70 degrees, with slickensides and apparent chilled border. basalt, artesian pressure 250' to 255.0'		
	1735								
255					C-53		BASALT, peperite structure and tachylite at 258.5' to 259.0', dark gray, fine grained, slightly weathered, very strong rock. Artesian flow rate 5 gallons every 20 seconds. Pulled back to 240.0' , flow rate was at 43 gallons per minute. Pressure gauge reading measured at 6' above the ground surface was at 56 psi. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:45 FF:3		
	1730								
260					C-54		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:90 FF:2		
	1725								
265					C-55		BASALT, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:95% RQD:40 FF:4 @ ~266.5' to 269.5', peperite texture with pissible tachylite @ 267.8'		
	1720								
270									

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LOG OF TEST BORING

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HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 12 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
					C-56		BASALT, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:13 FF:5 @ ~275' to 277', peperite texture		
	1715								
275					C-57		BASALT, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:33 FF:4 Highly vesicular zone at ~277'		
	1710								
280					C-58		BASALT, vesicular, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in poor condition. Recovered:92% RQD:25 FF:3		
	1705								
285					C-59		BASALT, moderately vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:2 FF:5		
	1700								
290					C-60		BASALT, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:0 FF:6		
	1695								
295									

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-14si-09

Job No. XL3695 SR 410 Elevation 1988.3 ft

Sheet 13 of 13

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-61		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:45 FF:3		
	1690									
300						C-62		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock, Discontinuities are closely spaced and in fair condition. Recovered:100% RQD: 70% FF:3		
	1685									
305						C-63		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities moderately spaced and in fair condition. Recovered:100% RQD=78% FF=2 Ended Test boring at 310.0' below ground elevation.		
	1680									
310								Installed slope inclinometer at a depth of 295.0 feet. A standpipe monument was installed on this boring. The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
	1675									
315								End of test hole boring at 310 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
	1670							Bail/Recharge test: Hole Diameter: 4 Depth of boring during bail test: 112' Depth of casing during bail test: 112' Bailed bore hole water level to 43' '		
320										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

Sheet 1 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Site Address SR-410 Vicinity of Nile Road

Inspector Andrews, Cleo #1677

Start November 10, 2009 Completion December 3, 2009 Well ID# BBL-088 V.W.(PN52611050/S/N 09-2992) Equipment CME 850 (9C2-2) - AH

Station Offset Hole Dia (inches) 4 Method Wet Rotary

Northing 540855.07 Easting 1534593.47 Collected by Geographic Services Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Cobbles, boulders and gravels at the surface. GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:2.5 ft. Length Retained:2.5 ft.		
	2060.0									
5				3 2 2 (4)		D-2		GRAVEL, subangular, very loose, gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
	2055.0					C-3		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
10				10 10 2 (12)		D-4		GRAVEL, subangular, medium dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.1 ft. Length Retained:0.1 ft.		
	2050.0					C-5		GRAVEL with cobbles, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
15				4 13 31 (44)		D-6		No Recovery		
	2045.0					C-7		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

Sheet 2 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

◆ Field SPT (N)
✚ Moisture Content
▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		2 1 1 (2)		D-8		No Recovery		
	2040			C-9		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.		
25		4 5 1 (6)		D-10		No Recovery		
	2035			C-11		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
30		5 5 3 (8)		D-12		GRAVEL, subangular, loose, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.1 ft. Length Retained:0.1 ft.		
	2030			C-13		GRAVEL with cobbles, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
35		2 1 2 (3)		D-14		No Recovery		
	2025			C-15		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
40		12 13 4 (17)		D-16		GRAVEL, subangular, medium dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
	2020			C-17		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.		
45								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

Sheet 3 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2015	4 14 18 (32)		D-18		GRAVEL, subangular, dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
				C-19		GRAVEL with cobbles, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
50	2010	4 6 8 (14)		D-20		GRAVEL, subangular, medium dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
				C-21		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.		
55	2005	4 4 4 (8)		D-22		GRAVEL, subangular, loose, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
				C-23		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
60	2000	>> 8 17 50/1" (REF)		D-24		GRAVEL, subangular, very dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
				C-25		GRAVEL, subangular, dark gray, moist, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.	▽ 11/13/2009	
65	1995	18 20 10 (30)		D-26		GRAVEL, subangular, dense, dark gray, moist, homogenous, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
				C-27		GRAVEL, subangular, with 0.1' of silt with gravel in end of sample, dark gray, moist, homogenous, HCl not tested. Possible failure zone from 67.0' to 70.0'. Length Recovered:0.9 ft. Length Retained:0.9 ft. Apparent clayey gouge adhering to basalt fragment at bottom of core run		
70								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆
Moisture Content ✚
RQD ▨

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
		18 20 35 (55)		D-28		Silty SAND (sandstone), with mica, very dense, brownish gray Length Recovered:1.5 ft. Length Retained:1.5 ft.
	1990			C-29		SANDSTONE, with mica, mottled, dark yellowish brown, fine grained, highly weathered, very weak rock. Discontinuities are moderately spaced and in very poor condition. Recovered:100% RQD:26 FF:2 bedding dips ~35 degrees
75		>>◆ 32 "50/5" (REF)		D-30		SANDSTONE, completely weathered with black mottled staining, very dense, brown. Length Recovered:0.8 ft. Length Retained:0.8 ft.
	1985			C-31		BASALT highly vesicular with quartz infillings, dark gray, fine grained, slightly weathered, very strong rock; 0.8' of sandstone in top of sample. Discontinuities are widely spaced and in fair condition. Recovered:100% RQD:64 FF:1 sandstone/basalt contact sharp, mineralized, dipping ~20 degrees cross-bedding visible in sandstone
80				C-32		BASALT, highly vesicular, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:75 FF:1
	1980					
85				C-33		BASALT, slightly vesicular, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0
	1975					
90				C-34		BASALT, slightly vesicular, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0
	1970					
95						

Groundwater

Instrument

Washington State
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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1965					C-35		BASALT, slightly vesicular, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
100	1960					C-36		BASALT, slightly vesicular, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
105	1955					C-37		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
110	1950					C-38		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
115	1945					C-39		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
120										

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Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1940					C-40		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
125	1935					C-41		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
130	1930					C-42		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
135	1925					C-43		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
140	1920					C-44		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
145										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1915					C-45		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
150	1910					C-46		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
155	1905					C-47		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:85 FF:1 @ ~156.2', prominent joint with FeO staining, dipping ~70 degrees		
160	1900					C-48		BASALT, with iron mineral infillings, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:86 FF:1 @ ~163.2', prominent joing with FeO staining, dipping ~70 degrees 11/14/2009	▼	
165	1895					C-49		BASALT, with iron mineral infillings, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~168', prominent joing with FeO staining, dipping ~80 degrees		
170										

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Department of Transportation

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HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1890					C-50		BASALT, with iron mineral infillings, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
175	1885					C-51		BASALT, with iron mineral infillings, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
180	1880					C-52		BASALT, with iron mineral infillings, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
185	1875					C-53		BASALT, with quartz and iron mineral infillings, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
190	1870					C-54		BASALT, with quartz and iron metal infillings, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~93', ~2 mm thick healed fracture, dipping ~70 degrees		
195										

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Department of Transportation

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HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1865				C-55		BASALT, highly fractured, dark gray, fine grained, slightly weathered, very strong rock, discontinuities are moderately spaced and in good condition. 1.7' of siltstone with sand lamine, black in color in bottom of core run. Recovered: 100% RQD: 26 FF:3 Changed to siltstone at 198.0' Possible pillow structure at basalt/siltstone contact, bedding dips ~20 degrees microfaulting visible in siltstone core		
							Siltstone		
200	1860				C-56		SILTSTONE, stratified, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:26 FF:3 bedding dips ~20 degrees		
205	1855				C-57		SILTSTONE, stratified, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~206' to 206.8', slickensides @ ~208', ~1/4" gouge zone with slickensides @ ~209.2', slickensided surface dipping ~50 degrees		
210	1850				C-58		SILTSTONE, dark gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Water level in casing 37.1'. Bailed to 64.0', 1 minute delay same. Overnight reading 11/14/09 =102.5.		
215	1845				C-59		SILTSTONE, dark gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~217', slickensides @ ~218, 1/2" to 1" shear zone with slickensides		
220									

Washington State
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LOG OF TEST BORING

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HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

Sheet 10 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1840			C-60		SILTSTONE, dark gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in very poor condition. Recovered:83% RQD:80 FF:0, Missing 8" of core at from 220.0' to 225.0'. @ ~222.8', slickensides @ ~224.8', slickensides		
225	1835			C-61		SILTSTONE, stratified with 1.0' of highly fractured washed siltstone with shiny surfaces in top of sample, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are very widely spaced and in poor condition. Recovered:100% RQD:80 FF:0 @ ~225' to 226', highly fractured zone @ ~226', 6" gouge zone with slickensides and an entrained polished siltstone pebble within gouge within gouge zone slip surface in center dips ~30 degrees. Below gouge is 2" coal seam with slickensides @ ~228.3', ~4" greenish gray gouge zone with slickensides - possible altered siltstone or tuff, upper 1" resistant and waxy @ ~229.5', shear zone with slickensides, dipping ~50 degrees		
230	1830			C-62		SILTSTONE, stratified, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in fair condition. Recovered:96% RQD:85 FF:1 bedding dips ~20 degrees		
235	1825			C-63		SILTSTONE, with slickensides and 0.5' of lapilli tuff, green in color in end of sample, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are very widely spaced and in very poor condition. Recovered:100% RQD:16 FF:2 @ ~236.5', slickensides @ 237 to 238', highly broken zone with slickensides		
240	1820			C-64		Altered SILTSTONE, green, fine grained, slightly weathered, altered waxy, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
245								

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1815					C-65		Altered SILTSTONE, green, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~248', slickensided surface, dipping ~60 degrees @ ~249', sub-vertical slickensides		
250	1810					C-66		Altered SILTSTONE, with slickensides, green, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in very poor condition. Recovered:83% RQD:31 FF:2 @ 251' to 254', highly fractured zone with slickensides @ ~252', gradational color change to brownish gray, massive, still waxy.		
255	1805					C-67		Altered SILTSTONE, green, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in very poor condition. Recovered:90% RQD:36 FF:1 upper 2.0' highly fractured with slickensides @ 255' to 255.5, zone of residual pebbles, some subrounded, some slickensided @ 259' to 260', layers of low-density organic-looking material (possible tachylite and/or bake zone)		
260	1800					C-68		BASALT, with slickensides and black basaltic zones (possible tachylite and peperite), dark grayish black, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in very poor condition. Recovered:100% RQD:0 FF:0, Encountered artesian flow at 260.0'. Flow rate test with 20.0' of HWT 4" ID casing and 265.0' of HQ 3" ID casing, with 2.0' stickup water flow rate 5 gallons 17 seconds.		
265	1795					C-69		BASALT, with slickensides, 2.0' of volcanic conglomerate and black basalt (apparent peperite with tachylite) inend of sample, traces of blue and white stains, dark grayish black, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in very poor condition. Recovered:90% RQD:0 FF:0		
270										

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LOG OF TEST BORING

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HOLE No. H-16 VW-TDR-09

Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1790					C-70		BASALT, with black basalt zones (possible peperite and tachylite) and slickensides, traces of white and blue stains, dark grayish black, fine grained, moderately weathered, very weak rock. Discontinuities are very closely spaced and in very poor condition. Recovered:100% RQD:0 FF:0		
275	1785					C-71		BASALT, with quartz infillings, dark grayish black, fine grained, fresh, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:0 FF:0		
280	1780					C-72		BASALT, dark grayish black, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:15 FF:3		
285	1775					C-73		BASALT, with traces of crystalline vug infilling and mineral staining, dark grayish black, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:0 FF:0		
290	1770					C-74		BASALT, with white and green staining, dark grayish black, fine grained, slightly weathered, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:100% RQD:0 FF:0 numerous healed fractures		
295										

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Job No. XL3695 SR 410 Elevation 2061.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1765					C-75		BASALT, with green staining, dark grayish black, fine grained, slightly weathered, very weak rock. Discontinuities are very widely spaced and in poor condition. Recovered:90% RQD:0 FF:0 Numerous randomly-oriented healed fractures with slickensides.		
300	1760							TDR cable installed to 297 feet. Vibrating wire piezometer (PN526110501N09-2992) installed at 259 feet. Water pressure measured at surface following initial unsuccessful attempt at grouting of pressurized aquifer was 50 psi.		
305	1755							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
310	1750							End of test hole boring at 300 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
315	1745							Bail/Recharge test: Hole Diameter: 4" Depth of boring during bail test: 70' Depth of casing during bail test: 70' Bailed bore hole water level to 64' Recharge after 1 minutes :64' '		
320										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

Sheet 1 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Site Address SR-410 Vicinity of Nile Road

Inspector Andrews, Cleo #1677

Start December 10, 2009 Completion December 30, 2009 Well ID# BBL-089 (Slope Incl. x 289') Equipment CME 850 (9C2-2) - AH

Station Offset Hole Dia (inches) 4 Method Wet Rotary

Northing 540850.34 Easting 1534612.66 Collected by Geographic Services Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Cobbles, boulders and gravels at the surface. GRAVEL, subangular. (No samples taken or retained until depth 64.0'), dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
	2060.0									
5										
	2055.0									
10										
	2050.0									
15										
	2045.0									
20										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

Sheet 2 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-2		GRAVEL, subangular, gray. Length Recovered:0 ft. Length Retained:0 ft.		
	2040									
25										
	2035									
30						C-4		GRAVEL, subangular, dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
	2030									
35										
	2025									
40						C-5		GRAVEL, subangular, dark gray. Length Recovered:0 ft. Length Retained:0 ft.		
	2020									
45										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

Sheet 3 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2015							
50				C-6		GRAVEL, subangular, dark gray, . Length Recovered:0 ft. Length Retained:0 ft.		
	2010							
55								
	2005							
60				C-7		GRAVEL, subangular, dark gray, homogenous. Length Recovered:0 ft. Length Retained:0 ft.		
	2000							
65		>>◆ 19 50/5" (REF)		D-8		SANDSTONE, completely weathered, traces of mica, black and dark reddish brown mottled stains, very dense, brown, homogenous, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft. Changed to sandstone at 64.9'		
	1995	>>◆ 20 50/4" (REF)		D-9		SANDSTONE, completely weathered, traces of mica and dark reddish brown and black mottled stains, very dense, brown, moist, homogenous, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
70		>>◆ 40 50/4"		D-10		SANDSTONE, completely weathered, traces of mica, black and red mottled stains, very dense, gray, moist,		

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LOG OF TEST BORING

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HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			1 (REF) 18 20 35 (55)		D-11		homogenous, HCl not tested. Length Recovered:0.8 ft. Length Retained:0.8 ft. SANDSTONE, traces of mica , very dense, brownish gray, moist, homogenous, HCl not tested.		
	1990				C-12		Length Recovered:1.5 ft. Length Retained:1.5 ft. SANDSTONE with quartz pockets, dark yellowish brown. Discontinuities are moderately spaced and in very poor condition . Recovered:100% RQD:26 FF:1 Sandstone		
75			>> 32 50/5" (REF)		D-13		SANDSTONE, completely weathered, very dense, brown, moist, homogenous, HCl not tested with black mottled stains. Length Recovered:0.8 ft. Length Retained:0.8 ft.		
	1985						Basalt at 75.9' BASALT (core not retained)		
80					C-15		BASALT (core not retained)		
	1980								
85									
	1975								
90					C-16		BASALT (core not retained)		
	1970								
95									

Washington State Department of Transportation

LOG OF TEST BORING

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HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

Sheet 5 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1965									
100						C-17		BASALT (core not retained)		
	1960									
105										
	1955									
110						C-18		BASALT (core not retained)		
	1950									
115										
	1945									
120										

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LOG OF TEST BORING

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HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

Sheet 6 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-19		BASALT (core not retained)		
	1940									
125										
	1935									
130						C-20		BASALT (core not retained)		
	1930									
135										
	1925									
140						C-21		BASALT (core not retained)		
	1920									
145										

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LOG OF TEST BORING

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HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

Sheet 7 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1915									
150						C-22		BASALT (core not retained)		
	1910									
155										
	1905									
160						C-23		BASALT (core not retained)		
	1900									
165										
	1895									
170										

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LOG OF TEST BORING

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HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-24		BASALT (core not retained)		
	1890									
175										
	1885									
180						C-25		BASALT (core not retained)		
	1880									
185										
	1875									
190						C-26		BASALT (core not retained)		
	1870									
								Changed to siltstone at 193.3'		
195										

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HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-27		SILTSTONE (core not retained)		
	1865									
200						C-28		SILTSTONE (core not retained)		
	1860									
205										
	1855									
210						C-29		SILTSTONE (core not retained)		
	1850									
215										
	1845									
220										

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HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-30		SILTSTONE (core not retained)		
	1840									
225										
	1835									
230						C-31		SILTSTONE (core not retained)		
	1830									
235						C-32		SILTSTONE changed to basalt at 239.5'. Discontinuities are and in . Recovered:0% RQD:0 FF:0		
	1825									
240						C-33		Altered SILTSTONE, dark green (core not retained)		
	1820									
245										

SOILA XL-3695_DME-057 SR410 LANDSLIDE.GPJ SOIL.GDT 5/7/10

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Job No. XL3695 SR 410 Elevation 2061.4 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1815					C-34		Altered SILTSTONE, dark green (core not retained)		
250	1810					C-35		BASALT (core not retained)		
255	1805					C-36		BASALT (core not retained)		
260	1800					C-37		BASALT (core not retained)		
265	1795					C-38		BASALT (core not retained)		
270										

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LOG OF TEST BORING

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Job No. XL3695 SR 410 Elevation 2061.4 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-39		BASALT (core not retained)		
	1790									
275						C-40		BASALT (core not retained)		
	1785									
280						C-41		BASALT (core not retained)		
	1780									
285						C-42		BASALT (core not retained)		
	1775									
290								Slope inclinometer installed to 290 feet.		
	1770							A standpipe monument was installed on this boring. Water pressure measured at approximately 3' above ground surface was 20 psi.		
295								The implied accuracy of the borehole location information displayed on this boring log is typically		

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-17si-09

Job No. XL3695 SR 410 Elevation 2061.4 ft

Sheet 13 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	◆ Field SPT (N) ✚ Moisture Content ▨ RQD 20 40 60 80	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
	1765									
								End of test hole boring at 290 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
300										
	1760									
305										
	1755									
310										
	1750									
315										
	1745									
320										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 1 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Site Address SR-410 and Nile Road

Inspector Cooper, Kerry #2552

Start November 10, 2009 Completion November 18, 2009 Well ID# BBL-092

Equipment CME 45 (9C4-2) - AH

Station

Offset

Hole Dia (inches) 4

Method Mud Rotary

Northing 540185.12 Easting 1534635.44 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Cobbles, boulders, and gravels at the surface No Recovery		
	1990.0									
				3 4 4 (8)		D-2		GRAVEL with sand, subangular, loose, brown, dry, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
5						C-3		No Recovery		
	1985.0									
				3 2 5 (7)		D-4		GRAVEL, subangular, loose, black, wet, HCl not tested. Length Recovered:0.3 ft. Length Retained:0.3 ft. No Recovery		
10										
	1980.0									
						10.5		GRAVEL, subangular, loose, black, wet, HCL not tested. Length Recovered:0.3 ft. Length Retained: 0.3 ft.		
15						C-7		No Recovery		
	1975.0									
				4 5		D-8		GRAVEL, subangular, medium dense, black, wet, HCl not tested.		
20										

SOILA XL-3695_DME-057 SR410 LANDSLIDE.GPJ SOIL.GDT 5/7/10

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 2 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		7 (12)		C-9		Length Recovered:0.3 ft. Length Retained:0.3 ft. No Recovery		
	1970							
		7 7 5 (12)		D-10		GRAVEL, subangular, medium dense, black, wet, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
25				C-11		No Recovery		
	1965							
		4 4 5 (9)		D-12		GRAVEL, subangular, loose, black, wet, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft.		
30				C-13		No Recovery		
	1960							
		5 7 9 (16)		D-14		GRAVEL with silt, subangular, iron stained, medium dense, black, wet, stratified, HCl not tested. Length Recovered:1.2 ft. Length Retained:1.2 ft.		
35				C-15		No Recovery		
	1955							
		3 2 3 (5)		D-16		GRAVEL, subangular, loose, black, wet, stratified, HCl not tested. Length Recovered:0.4 ft. Length Retained:0.4 ft.		
40				C-17		No Recovery		
	1950							
		5 7		D-18		Well graded GRAVEL with sand, subangular, medium dense, gray, wet, HCl not tested.		
45								

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 3 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Field SPT (N) ◆ | Moisture Content ✚ | RQD ▨ (20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		10 (17)		C-19		Length Recovered:0.4 ft. Length Retained:0.4 ft. Well graded GRAVEL with cobbles, subangular, gray, wet, HCl not tested, Checked water11-11-09 dry. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
1945								
		7 6 7 (13)		D-20		No Recovery		
50				C-21		Well graded GRAVEL with silt, subangular, Length Recovered:3.5 ft. Length Retained:3.5 ft.		
1940								
		5 4 8 (12)		D-22		No Recovery		
55				C-23		No Recovery @ 57' to 58', drilling very easy		
1935								
		7 11 15 (26)		D-24		Poorly graded SAND (sandstone), mottled, disturbed bedding, dense, orange gray brown, wet, stratified. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
60				C-25		No Recovery		
1930								
		>> 19 50/5 (REF)		D-26		Poorly graded SAND (sandstone), mottled, disturbed bedding, very dense, orange gray brown, wet, stratified, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft. sharp contact with basalt with ~1/2" thick yellowish siltstone (possible palagonite)		
65				C-27				
1925								
						BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:52 FF:1		
				C-28		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition.		
70								

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 4 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Recovered:93% RQD:25 FF:2 persistent (~2' exposed) subvertical fracture with FeO staining		
	1920									
						C-29		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:93% RQD:40 FF:1		
75										
	1915									
						C-30		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:80% RQD:30 FF:1		
80										
	1910							SILTSTONE with sandstone, gray, medium grained, slightly weathered, moderately weak rock. Discontinuities are very closely spaced and in fair condition. Recovered:86% RQD:65 FF:1 upper 6" of siltstone, black, porcelaneous with subvertical contact with basalt - possible bake zone @ ~82', sandstone/siltstone contact dips ~30 degrees FeO-stain dips ~65 degrees bedding dips ~20 to 22 degrees cross-bedding visible at bottome of core run		
						C-31				
85										
	1905									
						C-32		SILTSTONE, gray, medium grained, slightly weathered, moderately weak rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:46 FF:1 micro-faulting visible in upper part of run @ 93.5' to 94', highly fractured zone with clay infilling along fractures		
90										
	1900									
						C-33		SILTSTONE, gray, medium grained, slightly weathered, moderately weak rock. Discontinuities are very closely		
95										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 5 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								spaced and in good condition. Recovered:100% RQD:43 FF:2 @ 98', 4" gouge zone - completely disrupted siltstone with ~45 degrees, dipping slickensides on top and bottom @ 99.5', 5" zone when fines are washed away; few subrounded siltstone pebbles. Siltstone is slickensided to basalt contact, possible lapilli or pilow structure above basalt contact Possible lapilli and/or pillow detritus above basalt contact 3" lyer of low-density organic-looking material (possible tachylite and/or baked zone)		
100	1895					C-34				
	1890							BASALT, vesicular black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:45 FF:1		
105	1885					C-35		BASALT, vesicular, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:76% RQD:35 FF:2 Last 6 inches very broken, with FeO staining		
110	1880					C-36		BASALT, vesicular, black, fine grained, fresh, strong rock, FeO stains. Discontinuities are closely spaced and in good condition. Recovered:85% RQD:20 FF:4		
115	1875					C-37		BASALT, vesicular, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:18 FF:4		
120						C-38		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition.		

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HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 6 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Recovered:100% RQD:46 FF:4		
	1870									
						C-39		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:0 FF:6		
125										
	1865									
						C-40		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:15 FF:4		
130										
	1860									
						C-41		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:45 FF:3		
135										
	1855									
						C-42		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:40 FF:2		
140										
	1850									
						C-43		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition.		
145										

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HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 7 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Recovered:80% RQD:24 FF:2		
	1845									
						C-44		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:15 FF:5		
150										
	1840									
						C-45		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:15 FF:5		
155										
	1835									
						C-46		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:0 FF:4 @ 160.8', rough-textured joint in poor condition		
160										
	1830									
						C-47		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:13 FF:3		
165										
	1825									
						C-48		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition.		
170										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 8 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Recovered:100% RQD:0 FF:5		
	1820									
						C-49		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:66 FF:1		
175										
	1815									
						C-50		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:25 FF:3		
180										
	1810									
						C-51		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:50 FF:2		
185										
	1805									
						C-52		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:61 FF:2		
190										
	1800									
						C-53		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition.		
195										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 9 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Recovered:90% RQD:33 FF:3		
	1795									
						C-54		SANDSTONE, with organic interbeds, gray, medium grained, highly weathered, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:13% RQD:0 FF:5 Bedding dips ~20 degrees @ 202.5', 3" loose, poorly-indurated sandstone		
200										
	1790									
						C-55		SANDSTONE, gray, medium grained, highly weathered, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:76% RQD:21 FF:5		
205										
	1785									
			>>	50/5 (REF)		D-56		Poorly graded SAND (sandstone), with mica, very dense, gray, moist, homogenous, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft. bedding dips ~20 degrees		
						C-57		SANDSTONE, gray, medium grained, highly weathered, very weak rock. Discontinuities are very closely spaced and in poor condition. Recovered:61% RQD:60 FF:1		
210										
	1780									
						C-58		SANDSTONE, gray, medium grained, highly weathered, very weak rock. Discontinuities are very closely spaced and in fair condition. Recovered:100% RQD:55 FF:1 bedding dips ~20 degrees		
215										
	1775							SILTSTONE, gray, fine grained, moderately weathered, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:98% RQD:71 FF:1 @ 224.5', slickensides		
						C-59				
220										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-20si-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 10 of 10

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1770									
225						C-60		SILTSTONE, gray, fine grained, moderately weathered, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:55 FF:0		
	1765									
230						C-61		SILTSTONE, gray, fine grained, moderately weathered, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0		
	1760									
235						C-62		SILTSTONE, gray, fine grained, moderately weathered, moderately weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:80% RQD:80 FF:0		
	1755									
240								Slope inclinometer installed to 236 feet. A standpipe monument was installed on this boring. The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.)		
	1750							End of test hole boring at 239 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
245										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-21p-09

Sheet 1 of 5

Job No. XL3695 SR 410 Elevation 1990.5 ft

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Site Address SR-410 and Nile Road

Inspector Cooper, Kerry #2552

Start November 19, 2009 Completion November 29, 2009 Well ID# BBL-093

Equipment CME 55 Truck (9C1-3) - AH

Station Offset Hole Dia (inches) 4

Method Wet Rotary

Northing 540200.30 Easting 1534611.27 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1990.0					D-1		Cobbles, boulders, and gravels at the surface. GRAVEL (sample not retained).		
5	1985.0									
10	1980.0									
15	1975.0									
20										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-21p-09

Job No. XL3695 SR 410 Elevation 1990.5 ft

Sheet 2 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1970									
25	1965					D-2		GRAVEL (sample not retained).		
30	1960									
35	1955									
40	1950					D-3		GRAVEL (sample not retained).		
45										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-21p-09

Job No. XL3695 SR 410 Elevation 1990.5 ft

Sheet 3 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1945					D-4		Poorly graded SAND (sample not retained).		
50	1940									
55	1935									
						D-5		Poorly graded SAND (sample not retained).		
60	1930									
65	1925					D-6		Poorly graded SAND (sample not retained).		
70										

Washington State
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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-21p-09

Job No. XL3695 SR 410 Elevation 1990.5 ft

Sheet 4 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1920									
75	1915									
80	1910									
85	1905									
90	1900			37 38 41 (79)		D-7 D-8		SILTSTONE, very dense. Length Recovered:1.5 ft. Length Retained:1.5 ft. SILTSTONE (sample not retained).		
95										

SOILA XL-3695_DME-057 SR410 LANDSLIDE.GPJ SOIL.GDT 5/7/10

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-21p-09

Job No. XL3695 SR 410 Elevation 1990.5 ft

Sheet 5 of 5

Project SR-410 Nile Valley Landslide

Driller Cooper, Richard Lic# 2964T

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1895									
100	1890					D-9		BASALT (sample not retained).		
								Standpipe piezometer installed to 103 feet. A standpipe monument was installed on this boring.		
105	1885									
								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
110	1880									
								End of test hole boring at 103 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
115	1875									
120										

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-22si-09

Sheet 1 of 21

Job No. XL3695 SR 410 Elevation 2216.9 ft

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Site Address SR-410 and Nile Road

Inspector Judd, Joe #2454

Start November 18, 2009 Completion December 18, 2009 Well ID# BBL-094

Equipment Burley 4500 (Crux) - CH

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 540435.35 Easting 1535267.87 Collected by Geographic Services

Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Cobbles, boulders, and gravels at the surface.		
	2215.0									
5										
						C-1		GRAVEL, dark gray, dry, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
	2210.0									
10										
						C-2		GRAVEL, angular, dark gray, dry, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
	2205.0									
15										
						C-3		GRAVEL, angular, dark gray, dry, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
	2200.0									
20										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

Sheet 2 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2195					C-4		GRAVEL, angular, dark gray, dry, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
25										
	2190					C-5		GRAVEL, angular, dark gray, dry, homogenous, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
30										
	2185					C-6		GRAVEL, angular, dark gray, dry, homogenous, HCl not tested. Length Recovered:2.5 ft. Length Retained:2.5 ft.		
35										
	2180					C-7		GRAVEL, angular, dark gray, dry, homogenous, HCl not tested. Length Recovered:1 ft. Length Retained:1 ft.		
40										
	2175					C-8		GRAVEL, angular, dark gray, dry, homogenous, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
45										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

Sheet 3 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2170					C-9		GRAVEL with cobbles, angular, dark gray, dry, HCl not tested. Length Recovered:2.5 ft. Length Retained:2.5 ft.		
50										
	2165					C-10		GRAVEL with cobbles, angular, dark gray, dry, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
55										
	2160					C-11		GRAVEL with cobbles, angular, dark gray, dry, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
60										
	2155					C-12		GRAVEL with cobbles and boulders, angular, dark gray, dry, HCl not tested. Length Recovered:4 ft. Length Retained:4 ft.		
65										
	2150					C-13		GRAVEL with cobbles, subrounded to angular, dark gray, dry, HCl not tested, slide debris. Length Recovered:2 ft. Length Retained:2 ft.		
70										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

Sheet 4 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2145					C-14		GRAVEL, subrounded to angular, dark gray, dry, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
75										
	2140					C-15		GRAVEL, angular, dark gray, dry, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
80										
	2135					C-16		GRAVEL, angular, stratified with a 3" layer of silty gravel, dark gray, moist, stratified, HCl not tested. Length Recovered:2 ft. Length Retained:2 ft.		
85										
	2130		>>	50/4" (REF)		D-17 C-18		Silty GRAVEL, angular, very dense, grayish brown, moist, HCl not tested. Length Recovered:0.2 ft. Length Retained:0.2 ft. GRAVEL with cobbles, angular, dark gray, dry, homogenous, HCl not tested. Length Recovered:2.5 ft. Length Retained:2.5 ft.		
90										
	2125					C-19		GRAVEL, subrounded to angular, with cobbles, dark gray, dry, homogenous, HCl not tested. Length Recovered:1.5 ft. Length Retained:1.5 ft.		
95										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

Sheet 5 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2120					C-20		GRAVEL, angular, dark gray, dry, HCl not tested. Length Recovered:2.5 ft. Length Retained:2.5 ft.		
100										
	2115					C-21		GRAVEL, angular, with trace silt, dark gray, moist, HCl not tested. Length Recovered:2.5 ft. Length Retained:2.5 ft. Slickensides visible on some gravel/cobble fragments. Brown silty fine to coarse sand adhering to some rock fragments		
105										
	2110					C-22		GRAVEL, subrounded to subangular, with trace silt, dark gray, moist, homogenous, HCl not tested. Length Recovered:3 ft. Length Retained:3 ft.		
110										
	2105					C-23	MC AL	MC=42%, PI=25 GRAVEL, subrounded, dark gray, moist, disrupted, HCl not tested. SILTSTONE at 113.5' to 114.5'. Length Recovered:5 ft. Length Retained:5 ft.	12/5/2009	
115								SILTSTONE, brecciated zone with slickensides; ~1" thick clayey gouge zone with slickensides above conglomerate contact @ ~114.9', ~30 to 35 degrees dipping polished surface between fine conglomerate fragment and single basalt cobble.		
	2100					C-24		CONGLOMERATE with mixed lithology, light brownish gray, coarse grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:2		
120										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72792

HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

Sheet 6 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2095					C-25		CONGLOMERATE with mixed lithology, light brownish gray, coarse grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:2		
125										
	2090					C-26		CONGLOMERATE with mixed lithology, light brownish gray, coarse grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:2		
130										
	2085					C-27		CONGLOMERATE with mixed lithology, light brownish gray, coarse grained, fresh, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:100 FF:2 Bottom 2 feet brecciated		
135										
	2080					C-28		BASALT, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:0 FF:6, Basalt contact @ 137'		
140										
	2075					C-29		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, slightly weathered, very strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:20 FF:5		
145										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

Sheet 7 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2070					C-30		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:32 FF:5		
150										
	2065					C-31		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:45 FF:4		
155										
	2060					C-32		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:23 FF:5		
160										
	2055					C-33		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:38 FF:4		
165										
	2050					C-34		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:30 FF:4		
170										

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HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2045					C-35		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:47 FF:4		
175										
	2040					C-36		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:37 FF:4		
180										
	2035					C-37		BASALT, dark gray. RQD:0 FF:0, innerbarrel mislatched and ground up entire core run.		
185									12/8/2009	
	2030					C-38		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:52 FF:3		
190										
	2025					C-39		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:87 FF:2		
195										

Washington State Department of Transportation

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HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2020					C-40		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:77 FF:2		
200										
	2015					C-41		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:83 FF:2		
205										
	2010					C-42		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:85 FF:2		
210										
	2005					C-43		BASALT, with silt (FeO) filled fractures, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:65 FF:3 at contact with sandstone, 1/4 to 1/2" chilled border with apparent tachylite and palogonite		
215										
	2000					C-44		SANDSTONE, yellowish brown, medium grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:88% RQD:88 FF:0, Sandstone contact @ 217' @ ~217.5', slickensided surface in sandstone, dipping ~40 degrees sandstone is poorly indurated		
220										

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LOG OF TEST BORING

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HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-45				
	1995									
								SILTSTONE, stratified with sandstone, yellowish gray, fine grained, fresh, very weak rock. Discontinuities are moderatly spaced and in good condition. Recovered:87% RQD:87 FF:1, siltstone contact at 223' @ ~222.7', 1/2" siltstone interbed dipping ~15 degrees		
225										
						C-46		SILTSTONE, brown, fine grained, with clayey siltstone interbeds, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
	1990									
230										
						C-47		SILTSTONE, brown, fine grained, with clayey siltstone interbeds, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
	1985									
235										
						C-48		SILTSTONE, brown, fine grained, with clayey siltstone interbeds, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
	1980									
240										
						C-49		SILTSTONE, brown, fine grained, with clayey siltstone interbeds, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
	1975									
245										

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HOLE No. H-22si-09

Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Sample No. (Tube No.)	Lab Tests	Description of Material
	1970	C-50		SILTSTONE, grayish brown, fine grained wish clayey siltstone interbeds, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:95% RQD:100 FF:0 @ 246 to 246.2', highly fractured zone @249', 2" zone of subangular to subrounded siltstone fragments
250				
	1965	C-51	MC AL	MC=25%, PI=29 SILTSTONE, grayish brown, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~252.5', 1" thick moist clayey gouge zone with slickensides in highly fractured siltstone @ ~253.8', slickensides @ ~254.9 to 255.9', ~1' thick gouge zone with slickensides and polished siltstone pebbles @ 255.99', slickensides in resistant siltstone
255				
	1960	C-52		SILTSTONE, grayish brown, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:100 FF:0 @ 256' to 257', polished surfaces dipping ~30 degrees @ ~259 to 259.4', light greenish gray clayey gouge with slickensides
260				
	1955	C-53		SILTSTONE stratified with sandstone, gray, medium grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 bedding in sandstone dips ~20 degrees
265				
	1950	C-54		SILTSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:1, possibly disturbed VWP serial # 52611035 @ ~267.4', 4" clayey gouge zone with subangular to subrounded siltstone fragments. Slickensides dip ~25 degrees
270				

Field SPT (N) · Moisture Content · RQD (20 40 60 80)

Blows/6" (N) and/or RQD FF · Sample Type · Groundwater · Instrument

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Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ 20 40 60 80

Depth (ft)	Elevation (ft)	Sample No. (Tube No.)	Lab Tests	Description of Material
	1945	C-55	MC AL	MC=37%, PI=15 SILTSTONE, green, fine grained, fresh, very weak rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~274', slickensided surface, dipping ~35 degrees @ 274', contact between gray and green siltstone on sheared surface dipping ~45 degrees @ 274.3' to 275' gouge zone in green (altered) siltstone @ 274.6', slip surface dips ~30 degrees (blue-gray staining on slip surface) slickensides to bottom of core run
275				
	1940	C-56	MC AL	MC=47%, PI=13 SILTSTONE, green, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:0 FF:5 @ 278', to bottom of core run, disrupted and slickensided, slickensides horizontal and vertical blue-green alteration throughout
280				
	1935	C-57		SILTSTONE, green, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:0 FF:5 siltstone is disrupted@ 283', to 284' slickensided discontinuity, dipping ~75 degrees
285				@ ~285.5', ~3" of apparent tachylite @ 285.7' to bottom of run, apparent peperite
	1930	C-58		BASALT, gray, fine grained, slightly weathered, moderately strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:92 FF:1, Basalt contact @ 285' peperites common
290				
	1925	C-59		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:53 FF:2 peperites common
295				

Blows/6" (N) and/or RQD FF | Sample Type | Groundwater | Instrument

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Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1920					C-60		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:50 FF:3 peperites common		
300										
	1915					C-61		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:72 FF:1 peperites common		
305										
	1910					C-62		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:53 FF:2		
310										
	1905					C-63		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:50 FF:4 @ ~314' to 316', highly fractured; most fractures subhorizontal		
315										
	1900					C-64		BASALT, dark gray, slightly vesicular, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:25 FF:3		
320										

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Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1895					C-65		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:0.8		
325										
	1890					C-66		BASALT, dark greenish gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:25 FF:4 @ 328' to 330', vertical healed fracture with slickensides		
330										
	1885					C-67		BASALT, dark greenish gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:50 FF:3.2		
335										
	1880					C-68		BASALT, dark greenish gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:20 FF:5 vertical healed fractures with slickensides		
340										
	1875					C-69		BASALT, dark greenish gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:20 FF:4 vertical healed fractures with slickensides		
345										

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Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1870					C-70		BASALT, dark greenish gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:50 FF:3		
350										
	1865					C-71		BASALT, dark greenish gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:96 FF:2 @ 352 to 255.5', brecciated zone with apparent palagonite infilling		
355										
	1860					C-72		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:0 FF:4		
360										
	1855					C-73		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:80 FF:2		
365										
	1850					C-74		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:85 FF:2		
370										

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Job No. XL3695 SR 410 Elevation 2216.9 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1845					C-75		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:90 FF:2		
375										
	1840					C-76		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:85 FF:2 @ ~372', slickensides on ~30 degrees dipping joint		
380										
	1835					C-77		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:85 FF:2		
385										
	1830					C-78		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:2		
390										
	1825					C-79		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:2		
395										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1820					C-80		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:85 FF:2		
400										
	1815					C-81		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:55 FF:2 @ 401.1', irregular healed joint with apparent palogonite infilling, waxy feel		
405										
	1810					C-82		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:3		
410										
	1805					C-83		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:80 FF:1		
415										
	1800					C-84		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:94 FF:2		
420										

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Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1795					C-85		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:90 FF:2		
425										
	1790					C-86		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:2		
430										
	1785					C-87		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:20 FF:3		
435										
	1780					C-88		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:2		
440										
	1775					C-89		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:2		
445										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1770					C-90		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:90 FF:2 pyrite rosettes along fractures		
450										
	1765					C-91		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:95 FF:2 pyrite rosettes along fractures		
455										
	1760					C-92		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:87 FF:2		
460										
	1755					C-93		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:48 FF:4		
465										
	1750					C-94		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:90 FF:2 healed fractures with apparent palagonite infilling		
470										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1745					C-95		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:58 FF:3		
475										
	1740					C-96		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:85 FF:2		
480										
	1735					C-97		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:92 FF:2 healed fractures pyrite rosettes along fractures		
485										
	1730					C-98		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:85 FF:3 peperite texture		
490										
	1725					C-99		BASALT, dark gray, fine grained, fresh, very strong rock. Discontinuities are closely spaced and in poor condition. Recovered:80% RQD:55 FF:5, fractures look reworked and filled with greens,yellows,blacks peperite texture VWP serial # 52611050 TDR cable set @ 494'		
495										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1720									
500	1715							Standpipe piezometer installed at 110 feet. Vibrating wire piezometers installed at 267 and 494 feet. A standpipe monument was installed on this boring. The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
505	1710							End of test hole boring at 497 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
510	1705									
515	1700									
520										

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HOLE No. H-23-09

Job No. XL3695 SR 410 Elevation 2000.0 ft

Sheet 1 of 13

Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Site Address SR-410 and Nile Road

Inspector Andrews, Cleo #1677

Start January 5, 2010 Completion January 19, 2010 Well ID# Equipment CME 850 (9C2-2) - AH

Station Offset Hole Dia (inches) 4 Method Mud Rotary

Northing 540204.43 Easting 1534615.13 Collected by Geographic Services Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-1		Cobbles, boulders and gravels at surface. GRAVEL with cobbles and boulders, subangular, dark gray. All samples disgarded until 235.0'. Length Recovered:2.5 ft. Length Retained:0 ft. cobbles and boulders		
5	1995.0									
10	1990.0					C-2		GRAVEL with cobbles and boulders, subangular, dark gray. Length Recovered:3.0 ft. Length Retained:0 ft.		
15	1985.0									
20	1980.0									

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HOLE No. H-23-09

Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-3		GRAVEL with cobbles and boulders, subangular, dark gray. Length Recovered:3.0 ft. Length Retained:0 ft.		
25	1975									
30	1970					C-4		GRAVEL, subangular, dark gray. Length Recovered:1.0 ft. Length Retained:0 ft.		
35	1965									
40	1960					C-5		GRAVEL with cobbles and boulders, subangular, dark gray. Length Recovered:2.0 ft. Length Retained:0 ft.		
45	1955									

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Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								01/11/2010		
50	1950					C-6		GRAVEL with silt and sand, subangular, brownish orange mottled stain, dark gray. Length Recovered:1.5 ft. Length Retained:0 ft.		
								01/12/2010		
55	1945									
60	1940					C-7		SANDSTONE with brownish orange mottled stain, dark gray, fine grained, completely weathered, very weak rock. Discontinuities are very closely spaced and in very poor condition. Core not retained.		
65	1935					C-8		BASALT with silty sand infillings, vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Core not retained.		
70	1930									

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Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-9		BASALT, with silty sand infillings, vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
75	1925									
80	1920					C-10		SANDSTONE, stratified with 15-20 degree inclined interbed and brownish orange mottled stain, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in poor condition. Core not retained.		
85	1915					C-11		SANDSTONE, with siltstone, stratified with 15-20 degree black and gray inclined interbeds, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in fair condition. Core not retained.		
90	1910					C-12		SILTSTONE, with sandstone, stratified with 15-20 degree inclined interbeds, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are closely spaced and in fair condition. Core not retained.		
95	1905									

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HOLE No. H-23-09

Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-13		SILTSTONE, with black and gray inclined interbeds, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in fair condition. Core not retained.		
100	1900					C-14		BASALT, with iron mineral infillings and siltstone in top of core, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in poor condition. Core not retained.		
105	1895					C-15		BASALT, vesicular and iron mineral infillings, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in fair condition. Core not retained.		
110	1890					C-16		BASALT, slightly vesicular, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
115	1885					C-17		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
120	1880									

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HOLE No. H-23-09

Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-18		BASALT, slightly vesicular, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
125	1875									
130	1870					C-19		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
135	1865									
140	1860					C-20		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
145	1855									

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Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
150	1850					C-21		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
155	1845									
160	1840					C-22		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
165	1835									
170	1830									

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card S-26180

HOLE No. H-23-09

Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-23		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Core not retained.		
175	1825									
180	1820					C-24		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Core not retained.		
185	1815									
190	1810					C-25		BASALT, dark gray, fine grained, fresh, strong rock. Discontinuities are closely spaced and in fair condition. Core not retained.		
195	1805									

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HOLE No. H-23-09

Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-26		SANDSTONE, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Core not retained.		
200	1800									
205	1795									
210	1790					C-27		SANDSTONE, stratified with 5-10 degree black inclined interbeds, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Core not retained.		
215	1785					C-28		SANDSTONE, stratified with siltstone and 10-15 degree black and gray inclined interbeds, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Core not retained.		
220	1780									

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Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-29		SILTSTONE, stratified with black and gray 15-20 degree inclined interbeds, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Core not retained.		
225	1775									
230	1770					C-30		SILTSTONE stratified with 10-15 degree incline inner bedding, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Core not retained.		
235	1765					C-31		SILTSTONE, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in fair condition. Recovered:100% RQD:86 FF:2.		
240	1760					C-32		SILTSTONE, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:86% RQD:36 FF:3 @ ~240.3', ~3" thick gouge zone with entrained polished rounded pebbles. [NOTE: from 240 to 240.3', "simulated gouge appeas to be drilling-induced]		
245	1755									

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Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-33		SILTSTONE, stratified with sandstone, black and gray 15-20 degree inclined interbeds and slickensides, dark gray, fine grained, moderately weathered, very weak rock. Discontinuities are moderately spaced and in poor condition. Recovered:90% RQD:33 FF:3		
250	1750					C-34		SILTSTONE, with slickensides in top of core run, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:86 FF:2		
255	1745					C-35		Altered SILTSTONE, with 0.3' of dark siltstone in top of core, with slickensides, dark green, fine grained, moderately weathered, moderately weak rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:66 FF:2 @ ~255 to 255.5', brecciated zone with 1" thick gouge zone in center @ ~257.2', 2" brecciated zone		
260	1740					C-36		Altered SILTSTONE, moderately fractured, stratified with light gray 20-30 degree inclined interbeds and small scattered pockets, dark green, fine grained, moderately weathered, moderately strong rock. Discontinuities are moderately spaced and in poor condition. Recovered:100% RQD:46 FF:3		
265	1735					C-37		Altered SILTSTONE, with altered sandstone interbeds, disrupted, highly fractured with slickensides, dark green, fine grained, moderately weathered, very weak rock. Discontinuities are widely spaced and in very poor condition. Recovered:80% RQD:16 FF:8 @ ~267' to ~269', brecciated zone with subrounded altered siltstone pebbles with fines washed away; pebbles are slickensided. NOTE: Artesian conditions encountered at 265 feet. Fist-sized subrounded pebbles and cobbles of altered siltstone and apparent tachylite were collected as they blew out under artesian pressure - reportedly from this brecciated zone.		
270	1730									

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HOLE No. H-23-09

Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						C-38	MC AL	MC=49%, PI=28 Altered SILTSTONE, disrupted, siltstone fragments subangular to sub-rounded pieces showing slickenslides, dark green, fine grained, highly weathered, very weak rock. Discontinuities are closely spaced and in very poor condition. Recovered:100% RQD:0 FF:0 @ ~270 to 274', fault/slide plane breccia composed of subrounded to subangular altered siltstone pebbles in a ground mass of fine to coarse sand with silt, bluish alteration @ 274' to 174.6', pieces of resistant basalt, tachylite and altered siltstone @ 274.6 to 274.0', gouge zone with slickensides, very moist, plastic		
275	1725					C-39		Very strong artesian flow encountered at 274' BASALT, highly fractured with altered siltstone fragments from 275.0' to 275.9', dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are very closely spaced and in poor condition. Recovered:80% RQD:0 FF:6 @ 275 to 275.6', zone of subrounded basalt pebbles with fines washed away.		
280	1720					C-40		BASALT, highly fractured, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:0 FF:9		
285	1715					C-41		BASALT, moderately fractured with traces of vesicles and quartz, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:100% RQD:28 FF:6		
290	1710							At 290 feet, artesian flow rate measured of 5 gallons in 2 seconds. No instrumentation installed in boring due to extreme artesian flow. Water pressure measured at 5' above ground surface was 56 psi.		
295	1705									

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Job No. XL3695 SR 410 Elevation 2000.0 ft

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Project SR-410 Nile Valley Landslide

Driller Henderson, Danny Lic# 2742

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X, Y) when collected by the HQ Geotech Division and sub-centimeter in (X, Y, Z) when collected by the Region Survey Crew.		
								End of test hole boring at 290 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
300	1700									
305	1695									
310	1690									
315	1685									
320	1680									

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LOG OF TEST BORING

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

Sheet 1 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Site Address SR-410 and Nile Road

Inspector Cooper, Kerry #2552

Start November 19, 2009 Completion November 29, 2009 Well ID# BBL-096

Equipment Burley 4500 (Crux) - CH

Station Offset Hole Dia (inches) 4

Method Wet Rotary

Northing 540634.31 Easting 1535414.00 Collected by Region Survey Crew

Datum State Plane South

County Yakima Subsection SW1/4 of SW1/4 Section 2 Range 15 EWM Township 15 N

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Cobbles, boulders, and gravels at the surface.		
	2265.0									
5						C-1		GRAVEL, with cobbles and boulders, subangular, dark gray, moist. Recovered:38%		
	2260.0									
10										
	2255.0					C-2		GRAVEL, with cobbles and boulders, subangular, dark gray, moist. Recovered:30%		
15										
	2250.0					C-3		GRAVEL, with cobbles and boulders, subangular, dark gray, moist. Recovered:58%		
20										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

Sheet 2 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2245					C-4		GRAVEL, with cobbles and boulders, subangular, dark gray, moist. Recovered:56%		
25										
	2240					C-5		GRAVEL, with cobbles and boulders, subangular, dark gray, moist. Recovered:66%		
30										
	2235					C-6		GRAVEL, with sand, subangular, dark gray, moist. Recovered:64% Weathered scoria fragments and cobbles present.		
35										
	2230		>>	50/5" "0 (101)		D-7		GRAVEL, sub-angular, very dense, gray, moist, HCl not tested. Length Recovered:0.5 ft. Length Retained:0.5 ft.		
						C-8		Basalt BOULDERS/BLOCKS, dark gray, fine grained, moderately weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered: 94% RQD:0 FF:5		
40										
	2225					C-9		Basalt BOULDERS/BLOCKS, dark gray, fine grained, slightly weathered, strong rock. Discontinuities are closely spaced and in fair condition (some in filling). Recovered:96% RQD:0 FF:3 Apparent caliche on fracture and fragment surfaces		
45										

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LOG OF TEST BORING

Start Card R-72792

HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

Sheet 3 of 21

Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2220					C-10		Basalt BOULDERS/BLOCKS, dark gray, fine grained, moderately weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:64% RQD:14 FF:5 Caliche on fracture and fragment surfaces and in vugs.		
50										
	2215					C-11		Basalt BOULDERS/BLOCKS, dark gray, fine grained, moderately weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:80% RQD:0 FF:5 Caliche on fracture and fragment surfaces.		
55										
	2210					C-12		Basalt BOULDERS/BLOCKS, dark gray, fine grained, moderately weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:72% RQD:16 FF:2 caliche and FeO staining on fracture and fragment surfaces.		
60										
	2205					C-13		Basalt BOULDERS/BLOCKS, dark gray, fine grained, moderately weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:96% RQD:20 FF:5 Caliche and FeO staining on fracture and fragment surfaces.		
65										
	2200					C-14		Basalt BOULDERS/BLOCKS, dark gray, fine grained, moderately weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:83% RQD:25 FF:3 Caliche and FeO staining on fracture and fragment surfaces.		
70										

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Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2195					C-15		Basalt BOULDERS/BLOCKS, dark gray, fine grained, moderately weathered, strong rock. Discontinuities are closely spaced and in fair condition. Recovered:94% RQD:20 FF:3 Caliche and FeO staining on fracture and fragment surfaces.		
75										
	2190					C-16		GRAVEL, with cobbles, subangular, dark gray, moist.. Recovered:73% Caliche and FeO staining on fracture and fragment surfaces.		
80										
	2185					C-17		GRAVEL, with cobbles, subangular, dark gray, moist.. Recovered:44% Caliche and FeO staining on fracture and fragment surfaces.		
85										
	2180					C-18		GRAVEL, with cobbles and boulders, subangular, dark gray, moist. Recovered:64% @ ~89.3', 5" volcanic sandstone fragment, weathered.		
90										
	2175					C-19		GRAVEL, subangular, dark gray, moist. Recovered:38% Some fragments subrounded.		
95										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2170					C-20		GRAVEL, with cobbles, subangular, dark gray, moist. Recovered:74%		
100										
	2165					C-21		Basalt BOULDER, moderately vesicular, dark gray, fine grained, moderately weathered, moderately strong rock. Discontinuities are moderately spaced and in fair condition. Recovered:82% RQD:56 FF:1 Highly weathered, bottom 0.3% Slickensides on some rock fragments.		
105										
	2160					C-22		GRAVEL, subangular, dark gray, moist. Recovered:30% Slickensides on some rock fragments.		
110										
	2155					C-23	MC AL	MC=9%, PI=28 SILTSTONE, dark gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:98% RQD:100 FF:0 Upper 3" apparent gouge zone @ ~112.6', polished discontinuity in siltstone, dipping ~70 degrees Scattered polished surfaces in siltstone to end of core run.		
115										
	2150					C-24	MC AL	MC=33%, PI=12 SILTSTONE, dark gray, fine grained, slightly weathered, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~118.8 to 119.3', highly fractured zone @ ~119.3', subrounded siltstone pebbles @ ~119.3 to 120.3', clayey gouge zone with slickensides		
120										

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Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2145							@ ctc between dark gray clayey silt and green clayey silt, moist slip plane with slickensides, dipping ~60 degrees @ base of gouge zone, slickensided discontinuity dipping ~38 degrees. @ ~120.3 to 121.8', greenish gray cryptocrystalline rock (possible dike) @ ~121.8', 1" to 2" thick clayey gouge zone with slickensides between fine-grained greenish gray cryptocrystalline unit above and fine grained gray sandstone below @ ~122', sandstone		
						C-25		SANDSTONE, gray, fine grained, moderately weathered, very weak rock. Discontinuities are widely spaced and in fair condition. Recovered:100% RQD:100 FF:0 Sandstone is poorly indurated Siltstone ripup clasts in sandstone Crossbedding and microfaulting visible. 12/4/2009		
125										
	2140									
						C-26		SANDSTONE, with siltstone interbeds, gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~130.9', microfault (1 mm thick), dips ~ 80 degrees @ ~131.9', subvertical slickensides		
130										
	2135									
						C-27		SANDSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:94% RQD:100 FF:0 @ ~ 136.8', ~1" thick plastic gouge zone with subhorizontal slickensides.		
135										
	2130									
						C-28		SANDSTONE, with siltstone interbeds, gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 @ ~140.3 to 141.3', slickensides, dipping ~30 degrees @ ~142', bedding dips ~20 degrees		
140										
	2125									
						C-29		SANDSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Ripup clasts and microfaults visible, microfaults dip ~75 degrees.		
145										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2120									
						C-30		SANDSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Ripup clasts, microfaults, and possible bioturbation visible. @ ~151', subvertical and subhorizontal irregular polished surfaces, last 2 feet siltstone.		
150									12/7/2009	
	2115									
						C-31		SILTSTONE, gray, fine grained, fresh, very weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Subvertiacl and subhorizontal polished surfaces @ ~155.4', ~1/2" gouge zone with slickensides, moist, plastic, slickensided surface dips ~20 degrees. @ ~156.5', slickensides, siltstone with rounded gravel, last 6" of core run.		
155										
	2110									
						C-32		CONGLOMERATE, dark gray, coarse grained, moderately weathered, moderately strong rock. Discontinuities are closely spaced and in poor condition. Recovered:100% RQD:30 FF:2		
160										
	2105									
						C-33		CONGLOMERATE, dark gray, coarse grained, moderately weathered, moderately weak rock. Discontinuities are closely spaced and in poor condition. Recovered:96% RQD:52 FF:1 Shear surface with slickensides, dipping ~80 degrees at contact with siltstone. Slickensides below contact, most tip ~40 to 45 degrees.		
165										
	2100									
						C-34		SILTSTONE with sandstone interbeds, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensided, bedding dips ~35 to 40 degrees.		
170										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2095									
						C-35		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensides throughout core sample.		
175										
	2090									
						C-36		SILTSTONE, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:92% RQD:92 FF:0 @ ~181.8 to end of core run (182.3'), gouge zone, moist plastic, with entrained subrounded polished siltstone fragments.		
180										
	2085									
						C-37		SILTSTONE, grayish brown, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensided		
185										
	2080									
						C-38		SILTSTONE, grayish brown, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensided; most slickensides dipping ~40 to 60 degrees.		
190										
	2075									
						C-39		SILTSTONE, grayish brown, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensided; most slickensides dipping ~50 to 60 degrees.		
195										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2070									
						C-40		SILTSTONE, grayish brown, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensided.		
200										
	2065									
						C-41		SILTSTONE, gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensided.		
205										
	2060									
						C-42		SILTSTONE, gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:100 FF:0 Slickensided @ ~208.5', ~1/2" thick gouge zone @ ~209.5', slickensided surface dipping ~65 degrees @ ~210.0', gouge zone, 1/4" @ ~210.7 to 211.3', lighter-weight organic looking zone with wavey 1/4" bands of hard cryptocrystalline material - possible tachylite @ ~211.3', slight increase in induration		
210										
	2055									
						C-43		SILTSTONE with sandstone interbeds, gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:92% RQD:92 FF:0 @ ~212.3' to 213.3', reddish irregular and discordant stringers of apparent tachylite and palagonite.		
215										
	2050									
						C-44		SILTSTONE with sandstone interbeds, dark gray, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:94% RQD:94 FF:0 Bedding dips ~20 degrees @ 222.3', slickensided tight discontinuity dips ~55 degrees.		
220										

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Field SPT (N) ◆ Moisture Content ✚ RQD ▨ (20 40 60 80)

Depth (ft)	Elevation (ft)	Sample No. (Tube No.)	Lab Tests	Description of Material
	2045			
		C-45		SILTSTONE, green, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:92% RQD:55 FF:1 @ ~224.2', ~2" thick gouge zone with slickensides at contact between gay and green siltstone; slickensides dip ~20 degrees. @ ~226.8 to 227.3', disrupted zone with slickensides.
225				
	2040			
		C-46	MC AL	MC=44%, PI=16 SILTSTONE, green, fine grained, fresh, moderately weak rock. Discontinuities are widely spaced and in good condition. Recovered:100% RQD:92 FF:1 @ ~227.3 to ~228.5', poor recovery zone, fragments angular and altered to bluish gray @ 228.5' to end of core run, induration improves.
230				
	2035			
		C-47		SILTSTONE, green, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:80% RQD:41 FF:1
235				
	2030			
		C-48		SILTSTONE, green, fine grained, fresh, moderately weak rock. Discontinuities are moderately spaced and in good condition. Recovered:98% RQD:0 FF:0 @ ~240.3', contact between siltstone and peperite, minor apparent black tachylite and yellow palagonite at contact, peperite to end of core run at 242.3'
240				
	2025			
		C-49		BASALT, black, fine grained, fresh, strong rock. Discontinuities are very closely spaced and in good condition. Recovered:100% RQD:25 FF:4 Entire core run consists of basalt peperite with apparent black tachylite.
245				

Blows/6" (N) and/or RQD FF — Sample Type — Groundwater — Instrument

Washington State
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LOG OF TEST BORING

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	2020									
						C-50		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:76 FF:1 Peperite from 247.3' to ~249.3' Apparent scattered black tachylite fracture infilling.		
250										
	2015									
						C-51		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:45 FF:2 Subvertical fracture dips ~80 degrees.		
255										
	2010									
						C-52		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:75 FF:2 healed fracture with apparent tachylite infilling dips ~65 degrees.		
260										
	2005									
						C-53		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:88 FF:1		
265										
	2000									
						C-54		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:70 FF:1		
270										

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Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1995									
						C-55		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:90 FF:0 Slickensides; open vugs/vesicles up to 1" diameter.		
275										
	1990									
						C-56		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:43 FF:3		
280										
	1985									
						C-57		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:61 FF:2		
285										
	1980									
						C-58		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:85 FF:1 Scattered slickensides.		
290										
	1975									
						C-59		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:75 FF:1		
295										

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Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1970									
						C-60		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:88 FF:1		
300										
	1965									
						C-61		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:90 FF:0		
305										
	1960									
						C-62		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
310										
	1955									
						C-63		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
315										
	1950									
						C-64		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
320										

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Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1945									
						C-65		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
325										
	1940									
						C-66		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
330										
	1935									
						C-67		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
335										
	1930									
						C-68		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
340										
	1925									
						C-69		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
345										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1920									
						C-70		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Prominent healed fractures, dipping ~60 to 80 degrees.		
350										
	1915									
						C-71		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:88 FF:1		
355										
	1910									
						C-72		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
360										
	1905									
						C-73		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
365										
	1900									
						C-74		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
370										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1895									
						C-75		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:92 FF:1 Healed fractures with apparent palagonite infilling.		
375										
	1890									
						C-76		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:98 FF:0		
380										
	1885									
						C-77		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:88 FF:0		
385										
	1880									
						C-78		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:89 FF:0 Healed fracture with apparent palagonite and FeO staining.		
390										
	1875									
						C-79		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:88 FF:0 Healed fracture with apparent palagonite and FeO staining.		
395										

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Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1870									
						C-80		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:96 FF:0		
400										
	1865									
						C-81		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
405										
	1860									
						C-82		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:81 FF:1 Healed orthogonal joints with apparent palagonite infilling; one set dips 70 to 80 degrees, the other dips ~55 degrees.		
410										
	1855									
						C-83		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:50 FF:1 Scattered slickensides and apparent palagonite infilling of joints.		
415										
	1850									
						C-84		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:67 FF:1 Scattered slickensides and apparent palagonite infilling of joints.		
420										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1845									
						C-85		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:47 FF:1		
425										
	1840									
						C-86		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:70 FF:1 Scattered apparent palagonite infilling of joints. Scattered apparent pyrite rosettes along joint surfaces.		
430										
	1835									
						C-87		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:90 FF:0		
435										
	1830									
						C-88		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0		
440										
	1825									
						C-89		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Scattered apparent pyrite josettes on joint surfaces. apparent MnO staining on joint surfaces.		
445										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1820									
						C-90		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:92 FF:0		
450										
	1815									
						C-91		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:90 FF:0 Scattered slickensides.		
455										
	1810									
						C-92		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:45 FF:1 Scattered slickensides.		
460										
	1805									
						C-93		BASALT, black, fine grained, fresh, strong rock. Discontinuities are closely spaced and in good condition. Recovered:100% RQD:36 FF:2		
465										
	1800									
						C-94		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:90 FF:0		
470										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1795									
						C-95		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Healed fractures with slickensides.		
475										
	1790									
						C-96		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:100 FF:0 Healed fractures with slickensides.		
480										
	1785									
						C-97		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:86 FF:1 Scattered slickensides @ ~483.3' to ~483.9', highly fractured zone with yellowish green mineral infilling, presence of subrounded and mineral-coated fragments suggests a shear zone. Slickensided surface below shear zone dips ~45 degrees.		
485										
	1780									
						C-98		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:82 FF:1 @ ~489.3 to ~490.3', subvertical shear zone/healed fracture (dipping ~85 degrees), filled with 1 and 1/4" greenish gray clayey silt with basalt fragments.		
490										
	1775									
						C-99		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:80 FF:1 Healed fractures with yellowish green infilling (possibly palagonite), slickensides and scattered apparent pyrite rosettes on joint surfaces.		
495										

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HOLE No. H-24-09

Job No. XL3695 SR 410 Elevation 2266.7 ft

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Project SR-410 Nile Valley Landslide

Driller Tunison, Scott / CRUX Lic# 2628

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1770					C-100		BASALT, black, fine grained, fresh, strong rock. Discontinuities are moderately spaced and in good condition. Recovered:100% RQD:90 FF:0 Healed fractures with yellowish green infilling (possibly palagonite), slickensides, and scattered apparent pyrite rosettes on joint surfaces.		
500										
	1765							A standpipe monument was installed on this boring.		
505								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.")		
	1760									
510								End of test hole boring at 500.4 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
	1755									
515										
	1750									
520										

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-72793

HOLE No. H-26p-09

Sheet 1 of 2

Job No. XL3695 SR 410 Elevation 1991.4 ft

Project SR-410 Nile Valley Landslide

Driller Shepherd, Robert Lic# 2710

Site Address SR-410 vic of Nile Rd

Inspector Johnson, Vince #2532

Start November 17, 2009 Completion November 17, 2009 Well ID# BBL-100

Equipment CME 850 (9C2-3) - AH

Station Offset Hole Dia (inches) 6

Method Wet Rotary

Northing 540185.20 Easting 1534635.41 Collected by Region Survey Crew

Datum State Plane South

County Yakima Subsection NW1/4 of SW1/4 Section 2 Range 15 EWM Township 15

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Gravel and cobbles with sand at surface Boring location 4.5' North of H-11p-09. No Samples taken until 17.0'. 100% lost circ.		
	1990.0									
5										
	1985.0									
10								Approx. 90% circ return.		
	1980.0									
15										
	1975.0									
			◆	22 23 26 20 (49)		D-1		Silty GRAVEL with sand, angular, dense, dark gray, moist, HCl not tested. Length Recovered:0.9 ft. Length Retained:0.9 ft.	▽ 11/17/2009	
			◆	9 9		D-2		Sandy SILT, medium dense, yellowish brown, wet, stratified, HCl not tested, Sample moist to wet. FeO stains throughout.		
20										

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Department of Transportation

LOG OF TEST BORING

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HOLE No. H-26p-09

Job No. XL3695 SR 410 Elevation 1991.4 ft

Sheet 2 of 2

Project SR-410 Nile Valley Landslide

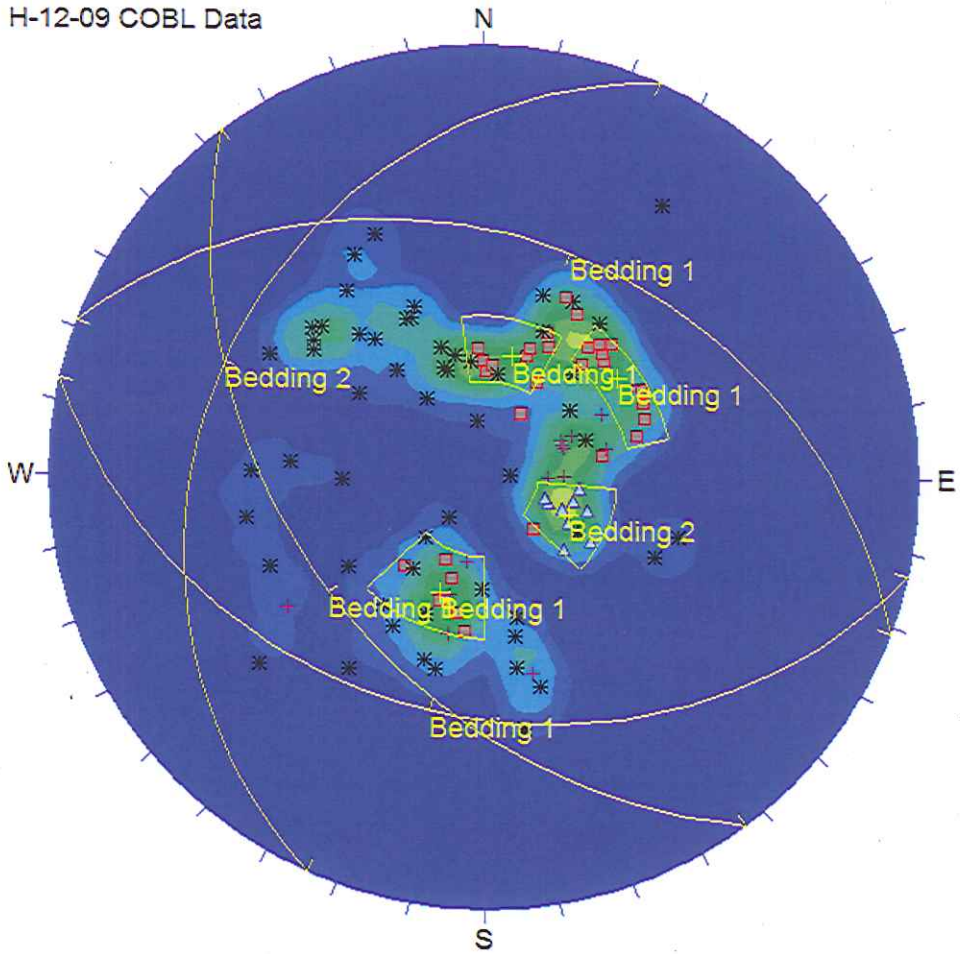
Driller Shepherd, Robert Lic# 2710

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				15 (24) 11 38		D-3		Trace angular gravel. Length Recovered:1.3 ft. Length Retained:1.3 ft. Sandy SILT, very dense, yellowish brown, moist, stratified, HCl not tested. Length Recovered:1.3 ft. Length Retained:1.3 ft.		
	1970			50/3 (REF)		D-4		No Recovery		
				50/1 (REF)				Drilling indicated BASALT. Refusal with advancer. Standpipe piezometer installed at 22.5 feet. A standpipe monument was installed on this boring.		
25	1965							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Division and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.)		
30	1960							End of test hole boring at 22.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
35	1955							Bail/Recharge test: Hole Diameter: 6 Depth of boring during bail test: 22.5' Depth of casing during bail test: 21' Bailed bore hole water level to 19.6' Recharge after 1 minutes :19.4' Recharge after 2 minutes :19.2' Recharge after 3 minutes :19.1' Recharge after 4 minutes :19' Recharge after 5 minutes :19' Recharge after 10 minutes :19' '		
40	1950									
45										

Appendix B

CRUX Oriented Borehole Logging Data

H-12-09 COBL Data



BEDDING

▫	B1 [31]
△	B2 [10]
✳	x [57]
+	x2 [14]

BEDDING DIP/DIP DRECTION

1: 32/021, 32/193, 42/233

2: 24/294

Equal Angle
Lower Hemisphere
112 Poles
112 Entries

COBL CRUX Oriented Borehole Logging	Company: Washington State Dept. of Transportation
	Location: Yakima, WA
	Project: SR 410 Slide

Date Logged:	January 5, 2010	Borehole ID:	H-12
File Name:	H12-1M.wcl	Logged By:	F G Kruger

Notes:

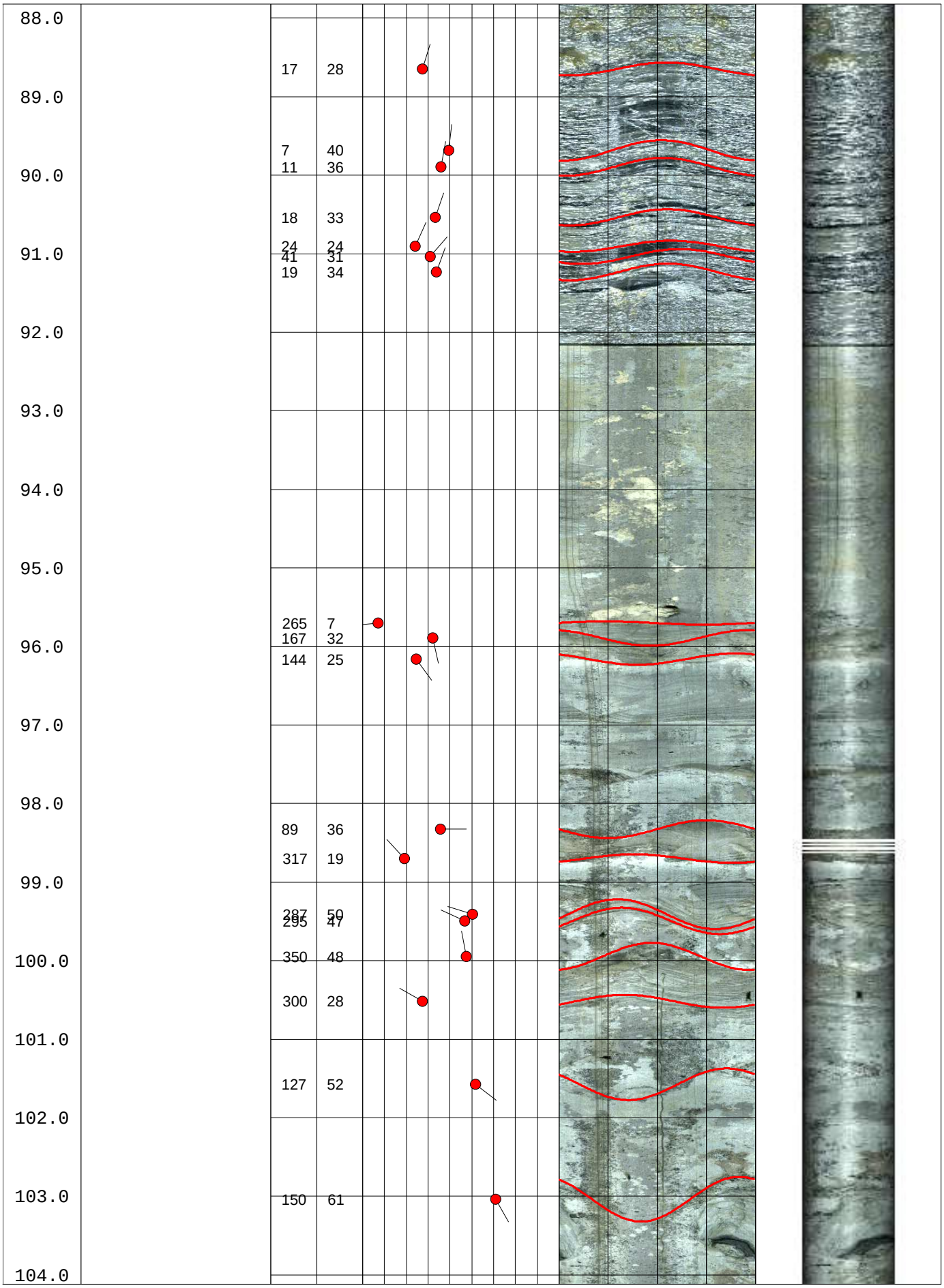
1) Azimuths reference True North. Magnetic declination of +16degrees applied.
2) 2.5x Horizontal Exaggeration on Televiewer Images.
3) Dip values presented in degrees from horizontal.
4) Dip direction presented in degrees of azimuth.
5) Simulated Core Image is viewed from north, east on left, west on right.

Depth	Comment	Dip AZ (deg)	True Dip (deg)
78.0			
79.0			
80.0			
81.0			
82.0			
83.0			
84.0		250	28
85.0		347	37
86.0			
87.0			

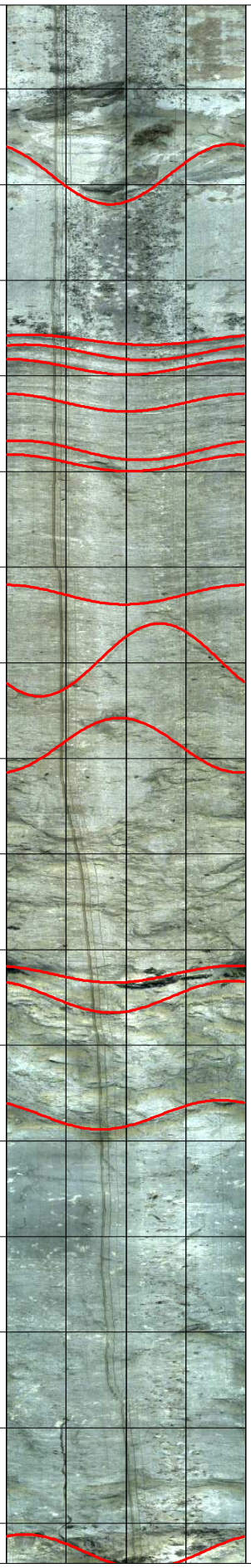
Tadpole - True Dip (0 – 90)

Tool.Image-NM1 Optical Trace (0° 90° 180° 270° 0°)

Simulated Core Image


88.0
89.0
90.0
91.0
92.0
93.0
94.0
95.0
96.0
97.0
98.0
99.0
100.0
101.0
102.0
103.0
104.0
17 28
7 40
11 36
18 33
24 24
41 31
19 34
265 7
167 32
144 25
89 36
317 19
287 50
295 47
350 48
300 28
127 52
150 61

105.0		
106.0	156	63
107.0		
108.0	211	19
	209	28
	182	27
	180	30
109.0	200	33
	185	29
110.0		
111.0	178	33
	50	68
112.0	351	61
113.0		
114.0		
115.0	161	29
	158	46
116.0	142	44
117.0		
118.0		
119.0		
120.0	207	49



121.0

217 48

122.0

123.0

345 53

124.0

125.0

120 59

126.0

94 48

127.0

232 28

128.0

210 47
205 49

226 42
224 43

129.0

221 38
224 46
219 42

130.0

221 44
250 43

131.0

241 45
255 40
260 31

132.0

245 44
174 15

133.0

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204 40

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213 74
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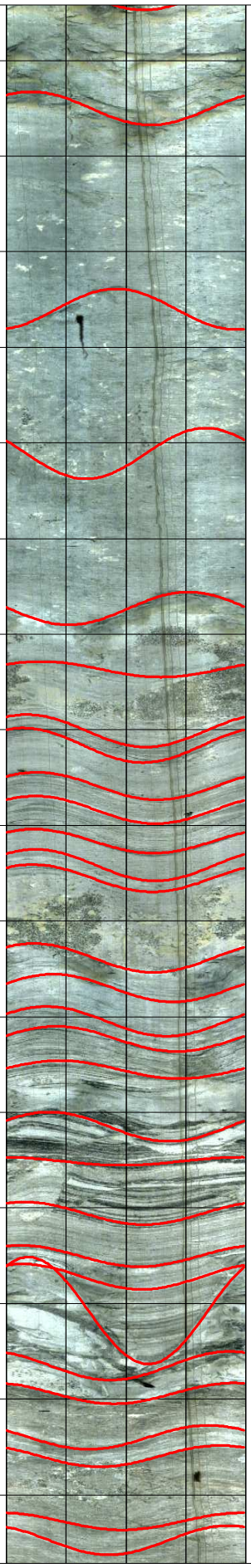
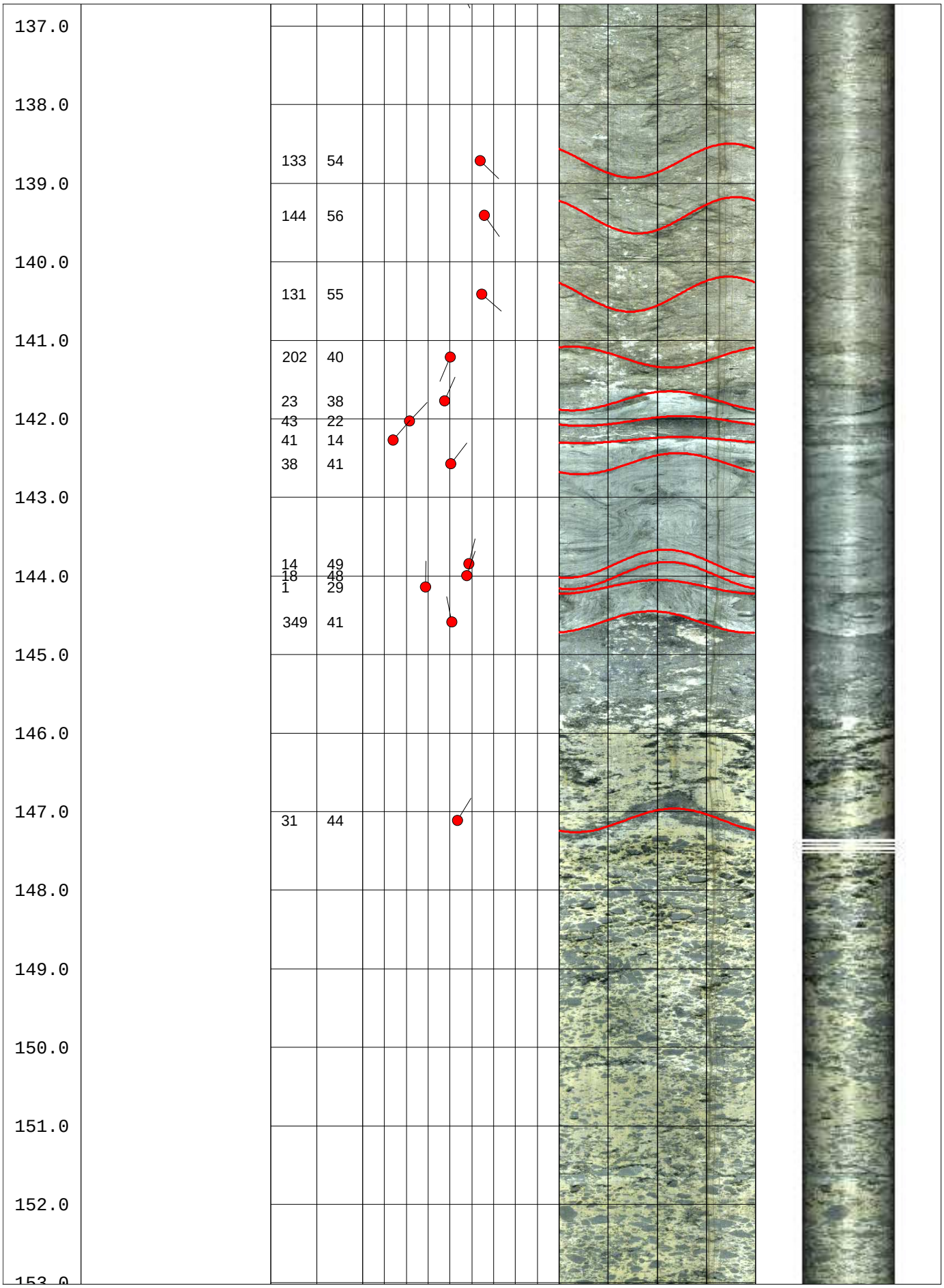
174 30
154 44

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152.0
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144 56
131 55
202 40
23 38
43 22
41 14
38 41
14 49
18 48
1 29
349 41
31 44

154.0	91 80	56 58	
	35	57	
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	56	41	
156.0			
157.0			
158.0			
159.0			
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166.0			
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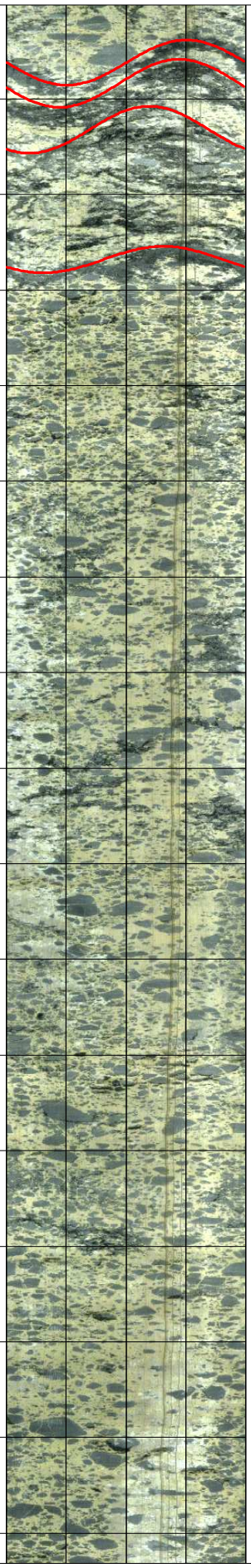

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174.0	188 221	27 35	
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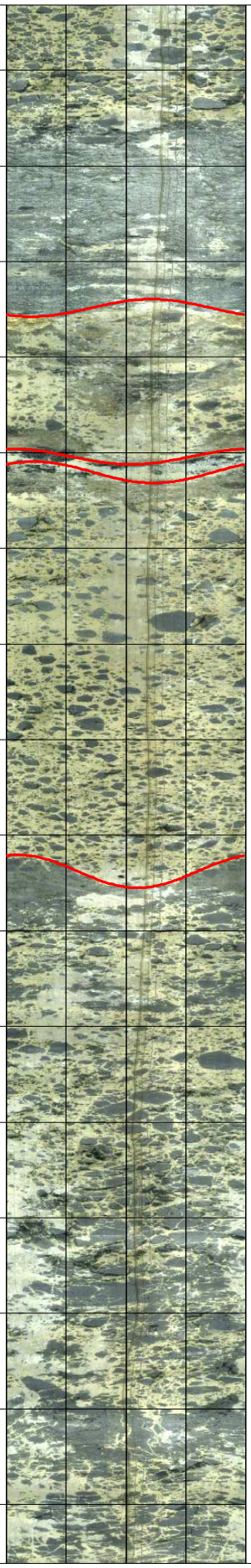

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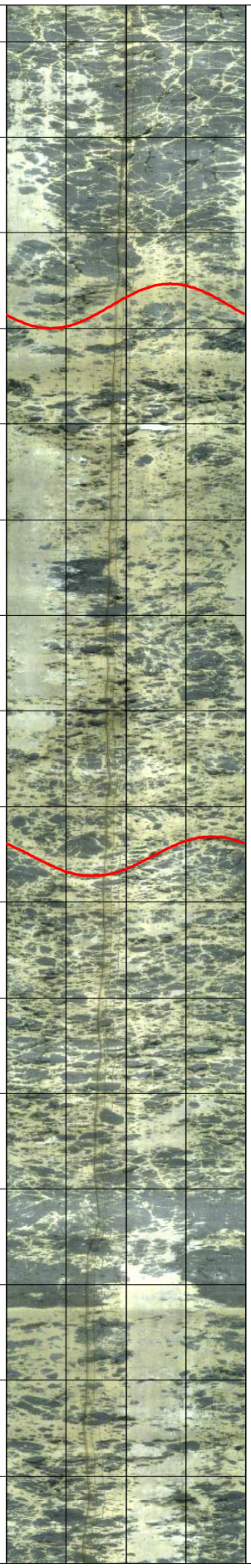
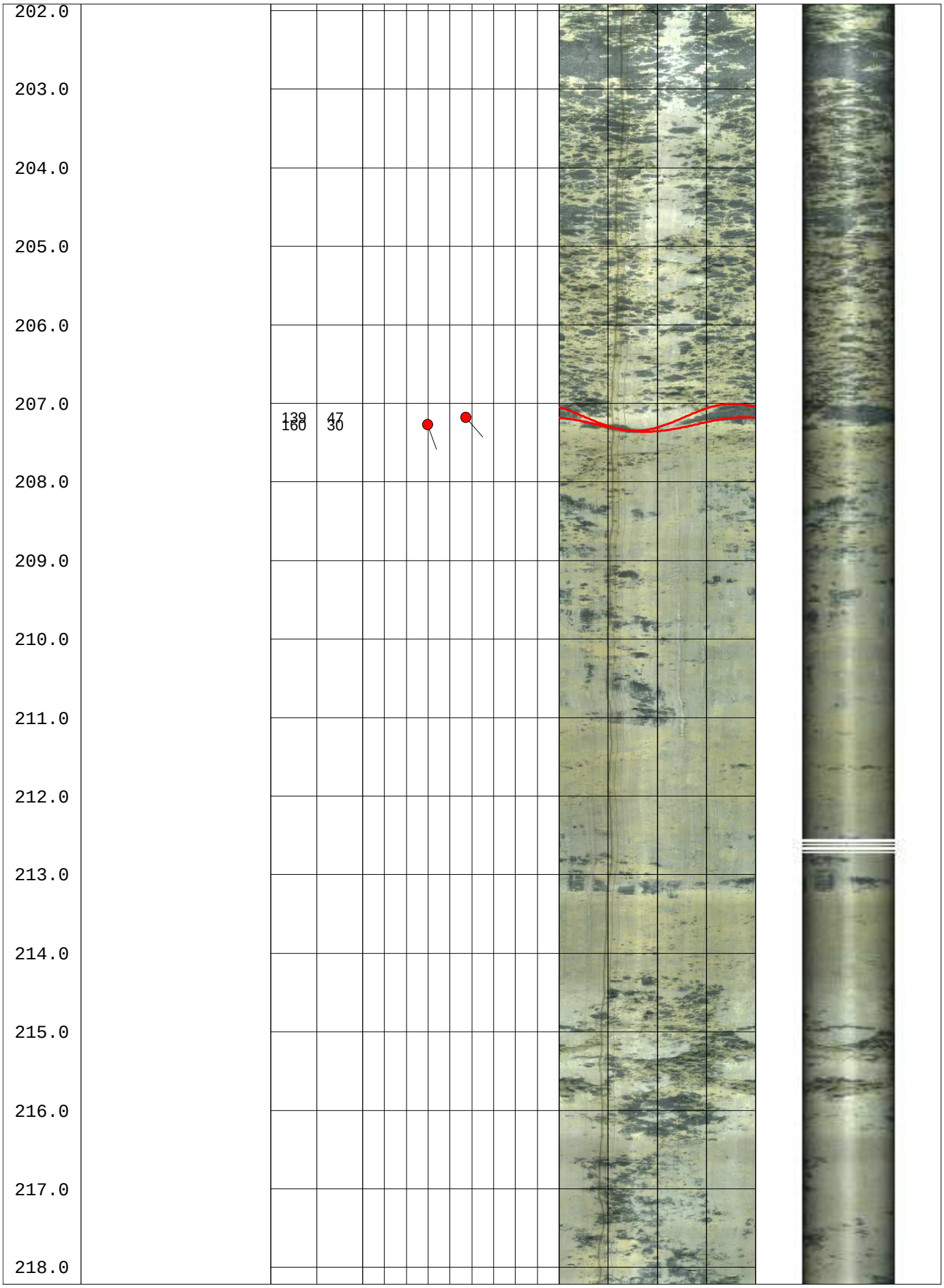
195.0	129	53	
196.0			
197.0			
198.0			
199.0			
200.0			
201.0			

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210.0
211.0
212.0
213.0
214.0
215.0
216.0
217.0
218.0
139
160
47
30

219.0

220.0

221.0

222.0

223.0

224.0

56 57

225.0

226.0

227.0

228.0

229.0

13 41

346 50

230.0

16 32

292 18

277 25

231.0

301 32

298 25

288 28

285 24

292 18

232.0

288 17

312 28

292 22

233.0

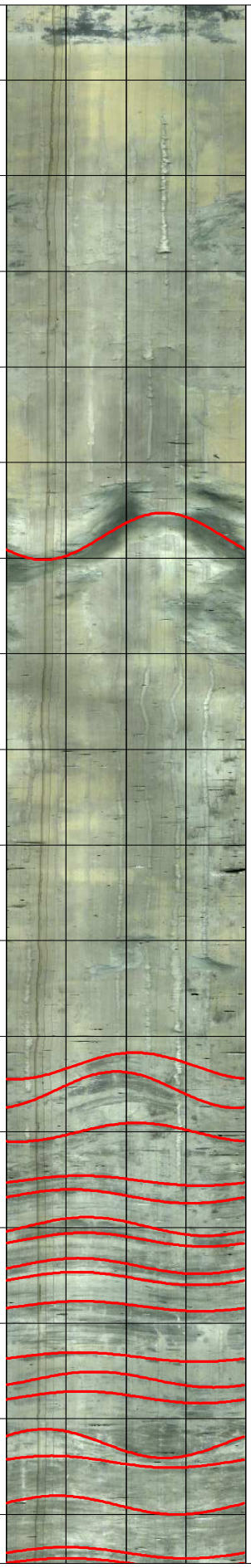
238 44

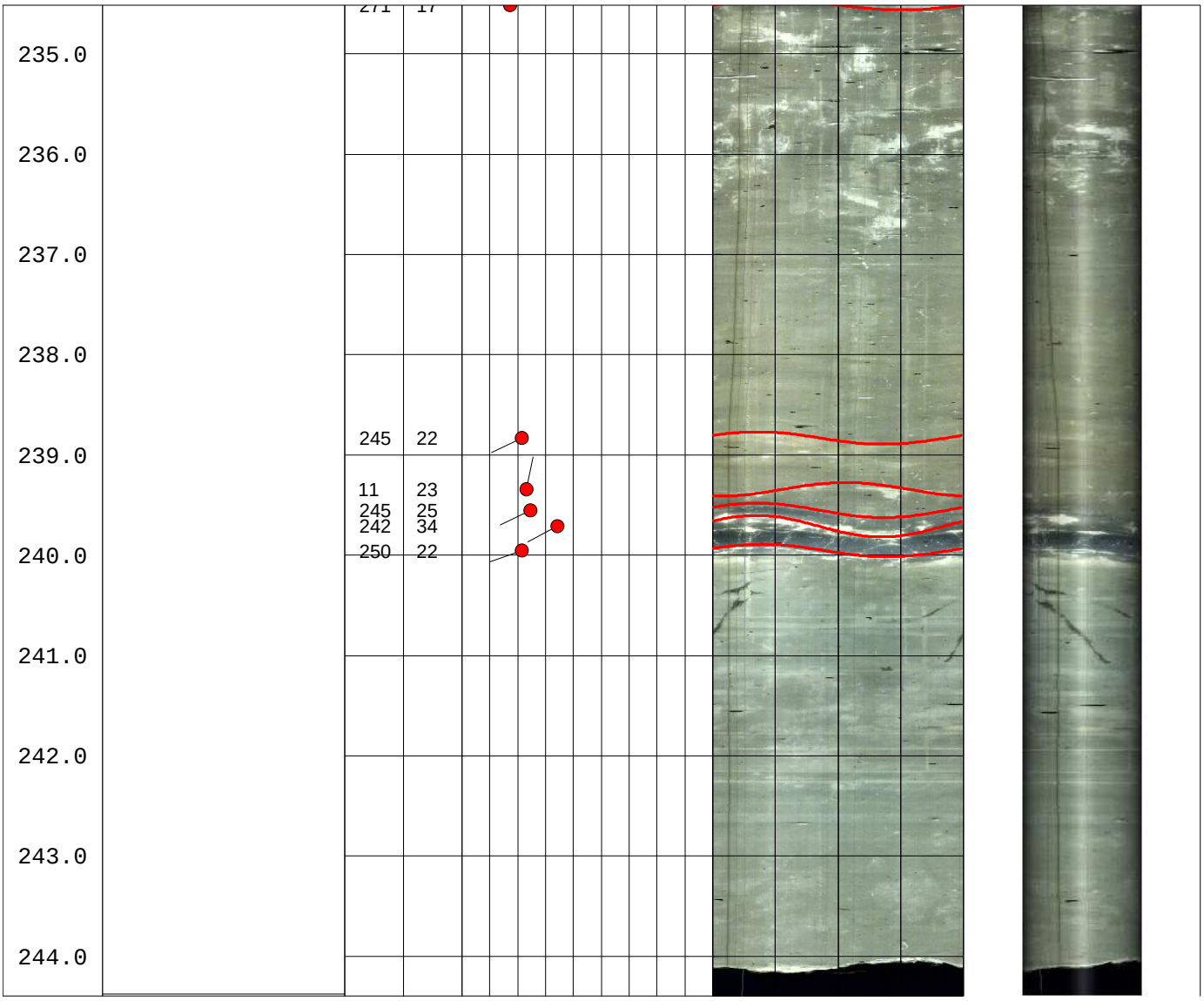
248 22

257 32

234.0

270 21




235.0
236.0
237.0
238.0
239.0
240.0
241.0
242.0
243.0
244.0
271 17
245 22
11 23
245 25
242 34
250 22

H-12-09
CRUX Oriented Borehole Log

Log	Depth	Dip AZ	Dip	Bedding
H-12 obi	83.81	250	28	x
H-12 obi	84.68	347	37	x
H-12 obi	88.65	17	28	B1
H-12 obi	89.68	7	40	B1
H-12 obi	89.89	11	36	B1
H-12 obi	90.54	18	33	B1
H-12 obi	90.91	24	24	B1
H-12 obi	91.04	41	31	B1
H-12 obi	91.23	19	34	B1
H-12 obi	95.70	265	7	x
H-12 obi	95.89	167	32	x
H-12 obi	96.16	144	25	x
H-12 obi	98.32	89	36	x
H-12 obi	98.70	317	19	B1
H-12 obi	99.41	287	50	x
H-12 obi	99.49	295	47	x
H-12 obi	99.95	350	48	x
H-12 obi	100.52	300	28	x
H-12 obi	101.57	127	52	x
H-12 obi	103.04	150	61	x
H-12 obi	105.89	156	63	x
H-12 obi	107.62	211	19	B1
H-12 obi	107.76	209	28	B1
H-12 obi	107.91	182	27	B1
H-12 obi	108.28	180	30	B1
H-12 obi	108.78	200	33	B1
H-12 obi	108.91	185	29	B1
H-12 obi	110.29	178	33	B1
H-12 obi	110.97	50	68	x
H-12 obi	111.86	351	61	x
H-12 obi	114.26	161	29	x
H-12 obi	114.49	158	46	x
H-12 obi	115.73	142	44	x
H-12 obi	120.29	207	49	x
H-12 obi	121.50	217	48	x
H-12 obi	123.60	345	53	x
H-12 obi	125.11	120	59	x
H-12 obi	126.73	94	48	x
H-12 obi	127.36	232	28	x
H-12 obi	128.01	210	47	B1
H-12 obi	128.16	205	49	B1
H-12 obi	128.59	226	42	B1
H-12 obi	128.84	224	43	B1
H-12 obi	129.17	221	38	B1
H-12 obi	129.41	224	46	B1
H-12 obi	129.56	219	42	B1
H-12 obi	130.39	221	44	B1
H-12 obi	130.70	250	43	B1
H-12 obi	131.05	241	45	B1
H-12 obi	131.23	255	40	B1
H-12 obi	131.55	260	31	B1

H-12-09
CRUX Oriented Borehole Log

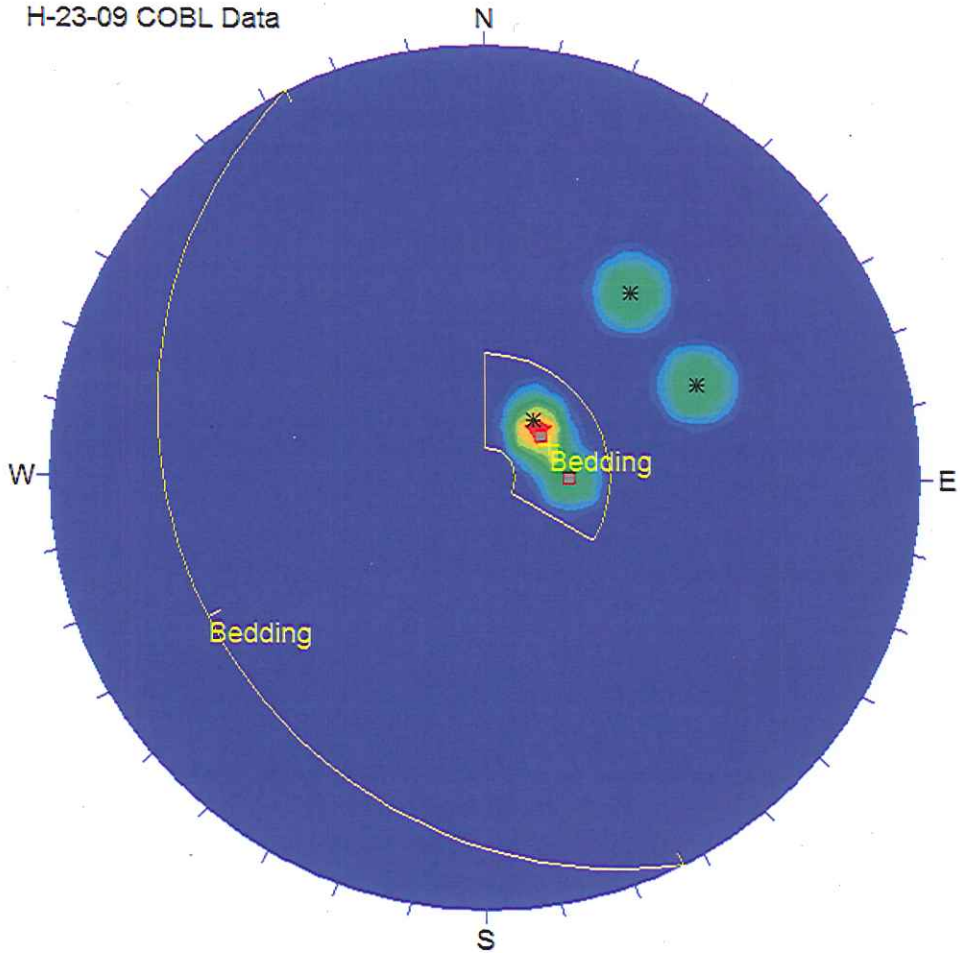
H-12 obi	132.15	245	44	B1
H-12 obi	132.51	174	15	x
H-12 obi	133.06	207	37	B1
H-12 obi	133.50	200	35	B1
H-12 obi	133.72	204	40	B1
H-12 obi	134.07	213	74	x
H-12 obi	134.65	156	44	x
H-12 obi	134.94	162	35	x
H-12 obi	135.40	124	38	x
H-12 obi	135.60	141	35	x
H-12 obi	136.28	174	30	x
H-12 obi	136.48	154	44	x
H-12 obi	138.71	133	54	x
H-12 obi	139.41	144	56	x
H-12 obi	140.41	131	55	x
H-12 obi	141.21	202	40	x
H-12 obi	141.77	23	38	x
H-12 obi	142.02	43	22	x
H-12 obi	142.27	41	14	x
H-12 obi	142.57	38	41	x
H-12 obi	143.84	14	49	x
H-12 obi	143.99	18	48	x
H-12 obi	144.14	1	29	x
H-12 obi	144.59	349	41	x
H-12 obi	147.11	31	44	x
H-12 obi	153.62	91	56	x
H-12 obi	153.84	80	58	x
H-12 obi	154.33	35	57	x
H-12 obi	155.68	56	41	x
H-12 obi	172.48	37	30	x
H-12 obi	174.04	188	27	x
H-12 obi	174.20	221	35	x
H-12 obi	178.38	198	48	x
H-12 obi	188.76	67	56	x
H-12 obi	194.52	129	53	x
H-12 obi	207.18	139	47	x
H-12 obi	207.27	160	30	x
H-12 obi	223.78	56	57	x2
H-12 obi	229.31	13	41	x2
H-12 obi	229.56	346	50	x2
H-12 obi	230.01	16	32	x2
H-12 obi	230.51	292	18	B2
H-12 obi	230.67	277	25	B2
H-12 obi	230.99	301	32	B2
H-12 obi	231.13	298	25	B2
H-12 obi	231.41	288	28	B2
H-12 obi	231.54	285	24	B2
H-12 obi	231.82	292	18	B2
H-12 obi	232.36	288	17	B2
H-12 obi	232.59	312	28	B2
H-12 obi	232.78	292	22	B2
H-12 obi	233.26	238	44	x2

H-12-09
CRUX Oriented Borehole Log

H-12 obi	233.45	248	22	x2
H-12 obi	233.90	257	32	x2
H-12 obi	234.40	270	21	x2
H-12 obi	234.51	271	17	x2
H-12 obi	238.83	245	22	x2
H-12 obi	239.34	11	23	x2
H-12 obi	239.55	245	25	x2
H-12 obi	239.71	242	34	x2
H-12 obi	239.96	250	22	x2

B1 - upper interbed bedding
x - upper interbed and intermediate basalt
B2 - lower interbed bedding
x2 - lower interbed

H-23-09 COBL Data



BEDDING

B [2]

x [3]

BEDDING DIP/DIP DIRECTION

19/243

Equal Angle
Lower Hemisphere
5 Poles
5 Entries

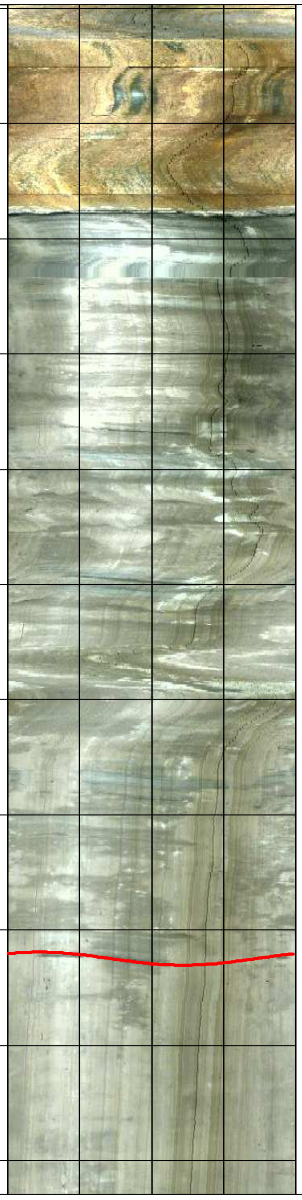
COBL CRUX Oriented Borehole Logging	Company: Washington State Dept. of Transportation
	Location: Yakima, WA
	Project: SR 410 Slide

Date Logged:	January 12, 2010	Borehole ID:	H-23
File Name:	H23.1M.wcl	Logged By:	F G Kruger

Notes:

1) Azimuths reference True North. Magnetic declination of +16degrees applied.
2) 2.5x Horizontal Exaggeration on Televiewer Images.
3) Dip values presented in degrees from horizontal.
4) Dip direction presented in degrees of azimuth.
5) Simulated Core Image is viewed from north, east on left, west on right.

Depth	Comment	Dip AZ (deg)	True Dip (deg)	Tadpole - True Dip (0 – 90)	Tool.Image-NM Optical Trace (0° 90° 180° 270° 0°)	Simulated Core Image
197.0						
198.0						
199.0						
200.0						
201.0						
202.0						
203.0						
204.0						
205.0		220	20			
206.0						
207.0						



208.0

209.0

210.0

211.0

212.0

213.0

214.0

215.0

216.0

217.0

271 22
234 18

218.0

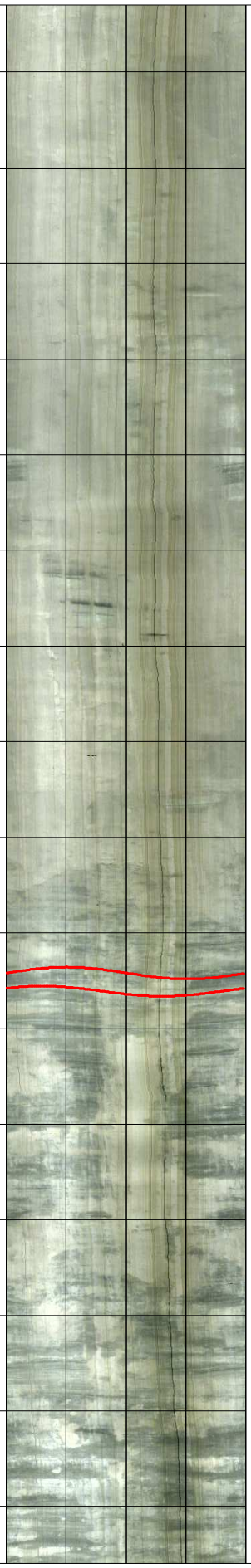
219.0

220.0

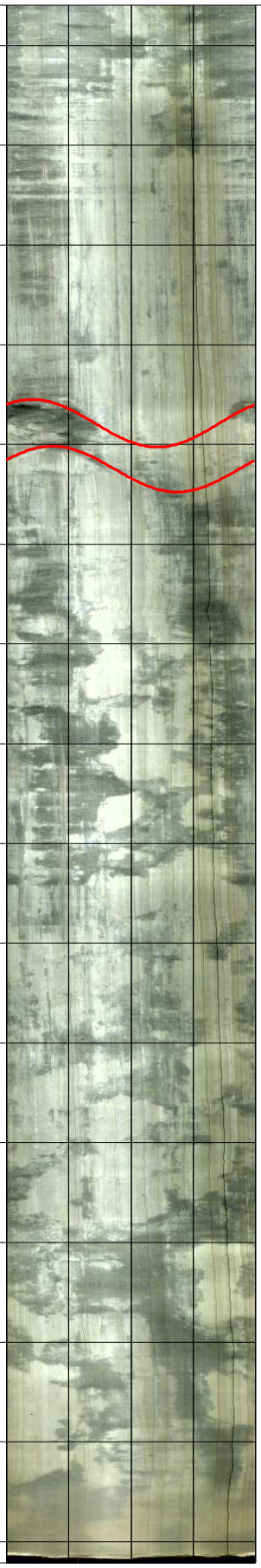
221.0

222.0

223.0



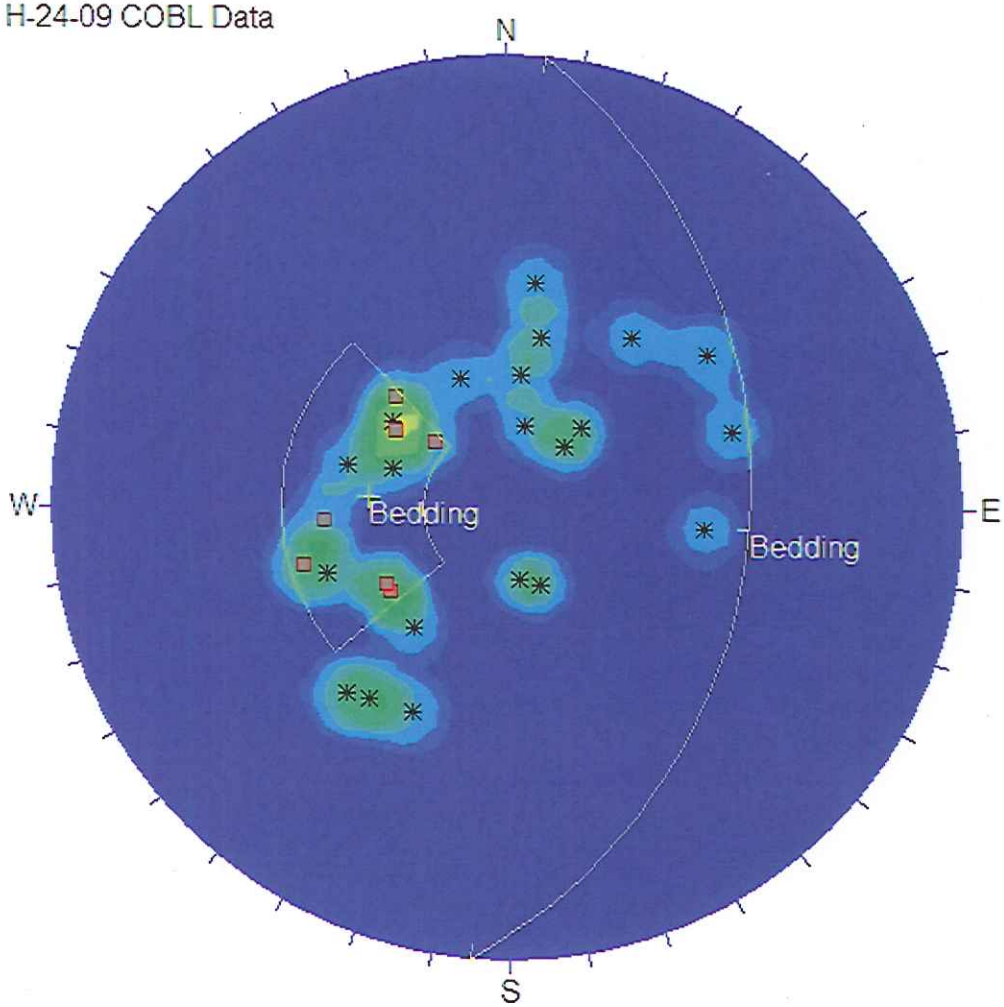
224.0			
225.0			
226.0			
227.0			
228.0	218	57	
	246	56	
229.0			
230.0			
231.0			
232.0			
233.0			
234.0			
235.0			
236.0			
237.0			
238.0			
239.0			



H-23-10
CRUX Oriented Borehole Log

Log	Depth	Dip AZ	Dip	Bedding
H-23 obi	205.25	220	20	x
H-23 obi	217.42	271	22	B
H-23 obi	217.61	234	18	B
H-23 obi	227.79	218	57	x
H-23 obi	228.25	246	56	x

H-24-09 COBL Data



BEDDING

B [7]

x [21]

BEDDING DIP/DIP DIRECTION

34/095

Equal Angle
Lower Hemisphere
28 Poles
28 Entries

COBL CRUX Oriented Borehole Logging	Company: Washington State Dept. of Transportation
	Location: Yakima, WA
	Project: SR 410 Slide

Date Logged:	December 8 & 9, 2009	Borehole ID: H-24
File Name:	H24-1M.wcl	Logged By: F G Kruger

Notes:

1) Azimuths reference True North. Magnetic declination of +16degrees applied.
2) 2.5x Horizontal Exaggeration on Televiewer Images.
3) Dip values presented in degrees from horizontal.
4) Dip direction presented in degrees of azimuth.
5) Simulated Core Image is viewed from north, east on left, west on right.

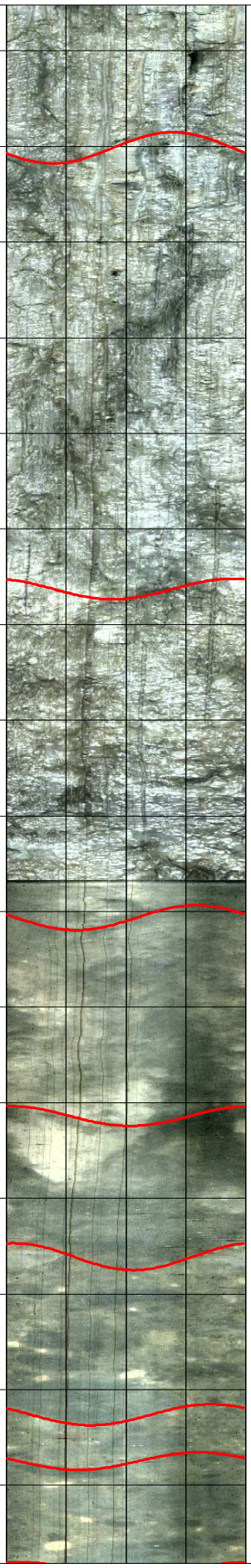
Depth	Comment	Dip AZ (deg)	True Dip (deg)
134.0			
135.0			
136.0			
137.0			
138.0			
139.0			
140.0		36	55
		41	57
141.0			
142.0		25	53
143.0			

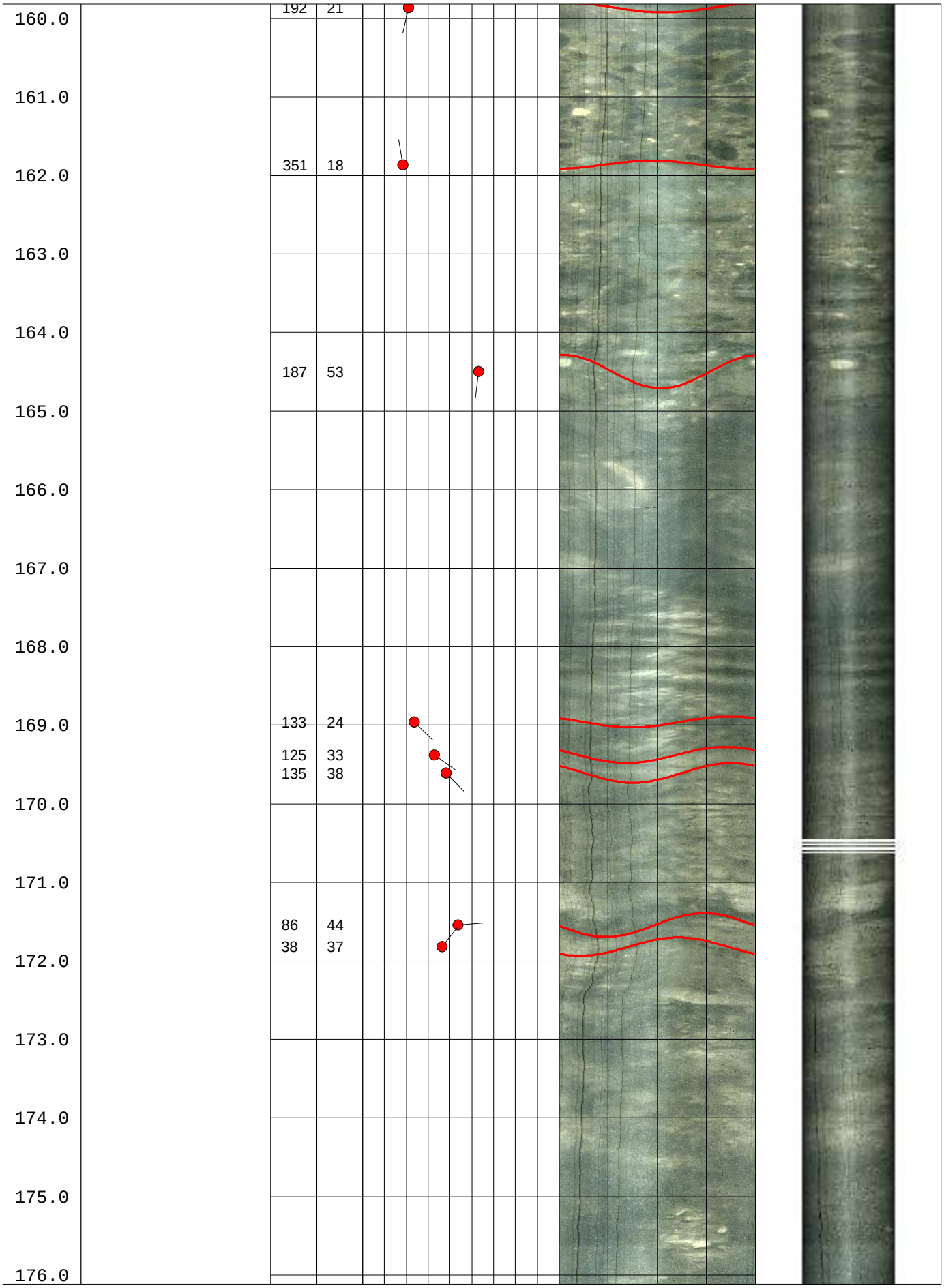
Tadpole - True Dip (0 – 90)

Tool.Image-NM Optical Trace (0° 90° 180° 270° 0°)

Simulated Core Image

144.0			
145.0	70	46	
146.0			
147.0			
148.0			
149.0			
	160	34	
150.0			
151.0			
152.0			
153.0	105	40	
154.0			
155.0	186	33	
156.0			
	191	42	
157.0			
158.0			
	127	35	
	109	30	
159.0			

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161.0
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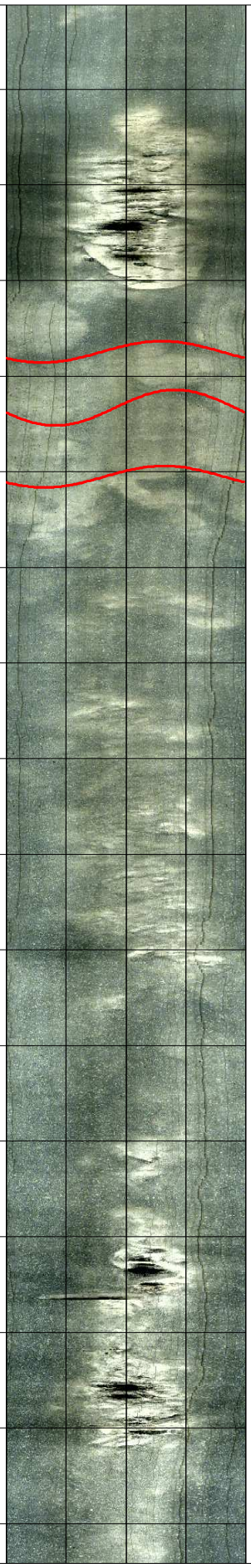
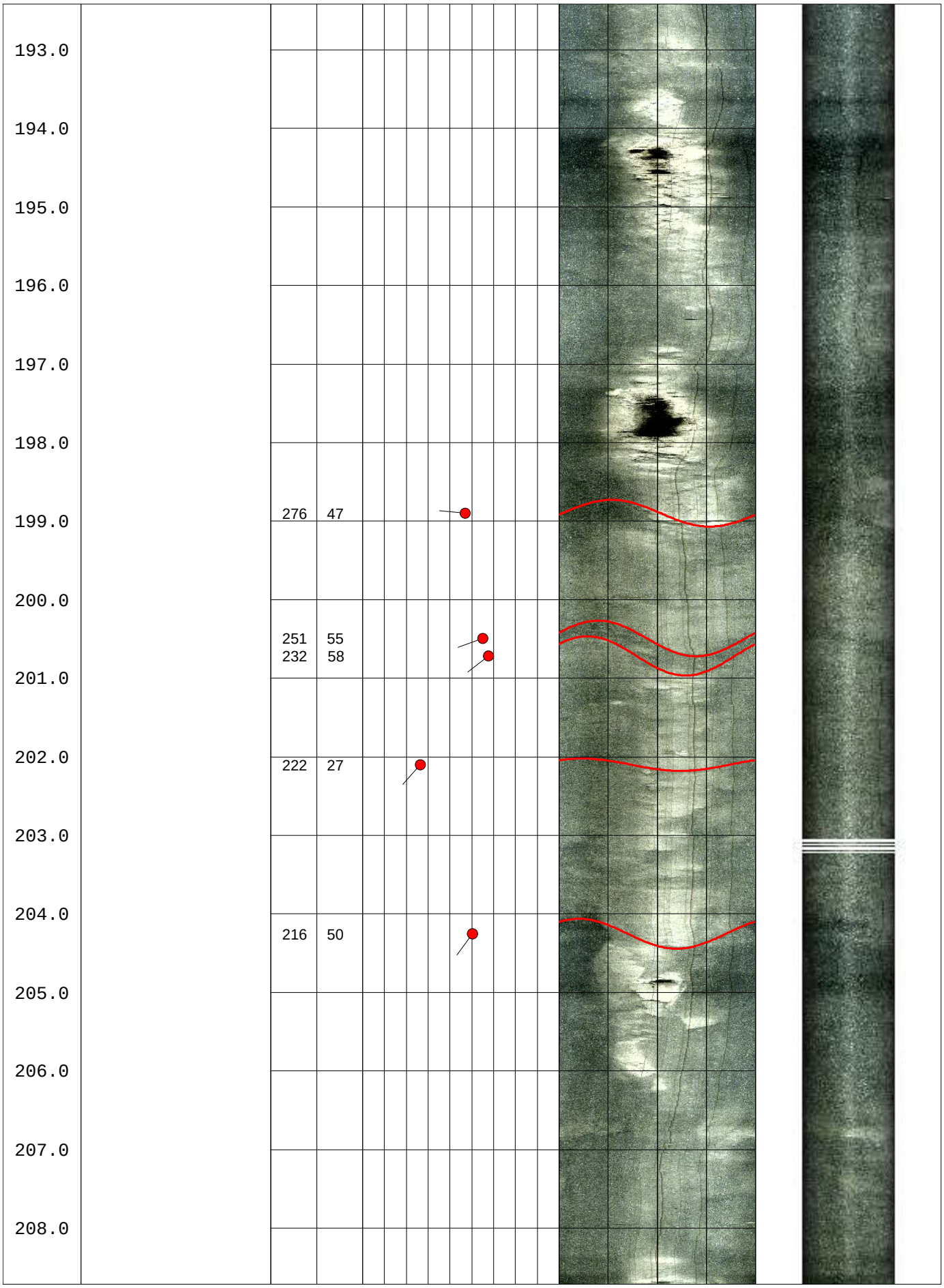
163.0
164.0
165.0
166.0
167.0
168.0
169.0
170.0
171.0
172.0
173.0
174.0
175.0
176.0
192 21
351 18
187 53
133 24
125 33
135 38
86 44
38 37

177.0			
178.0			
179.0			
180.0	54	35	
	74	50	
181.0	57	35	
182.0			
183.0			
184.0			
185.0			
186.0			
187.0			
188.0			
189.0			
190.0			
191.0			
192.0			

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194.0
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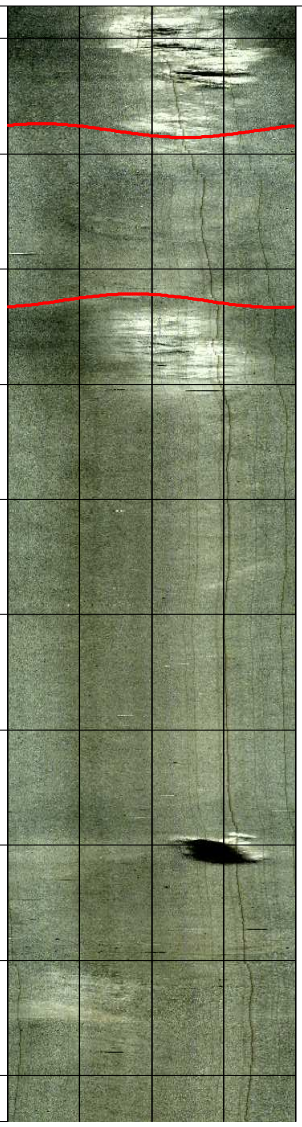
196.0
197.0
198.0
199.0
200.0
201.0
202.0
203.0
204.0
205.0
206.0
207.0
208.0
276 47
251 55
232 58
222 27
216 50

209.0			
		222	21
210.0			
211.0		337	21
212.0			
213.0			
214.0			
215.0			
216.0			
217.0			
218.0			

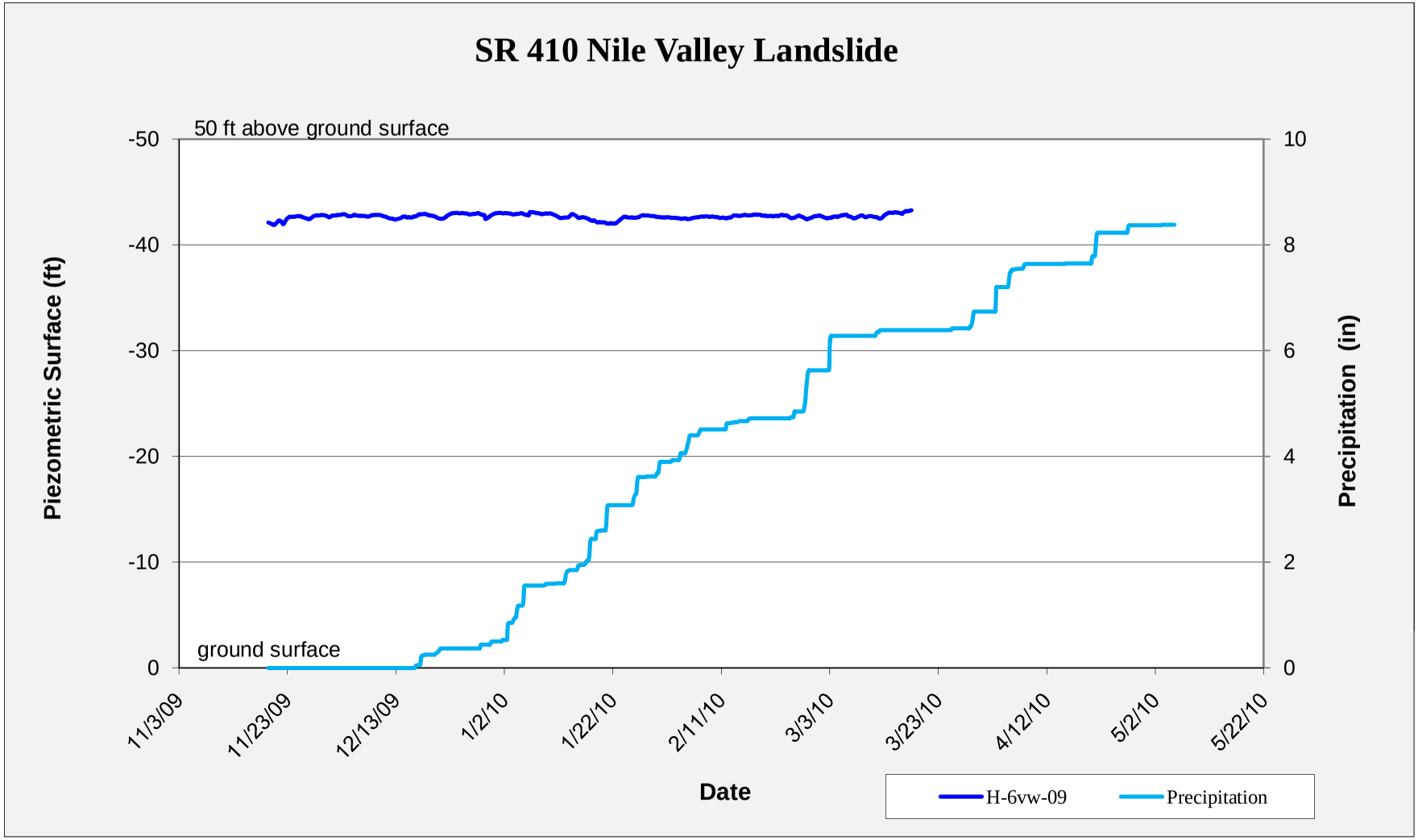


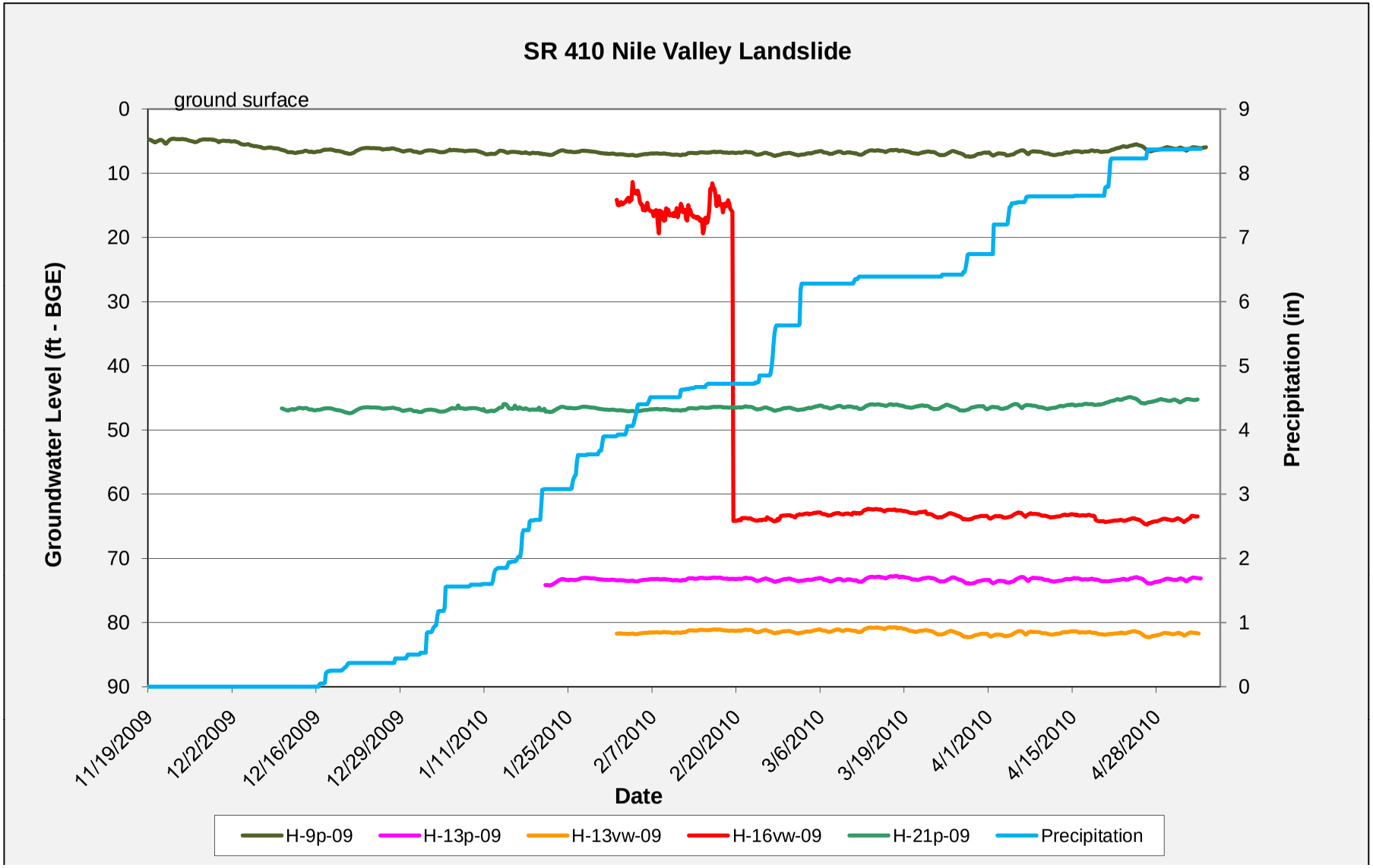
H-24-09
CRUX Oriented Borehole Log

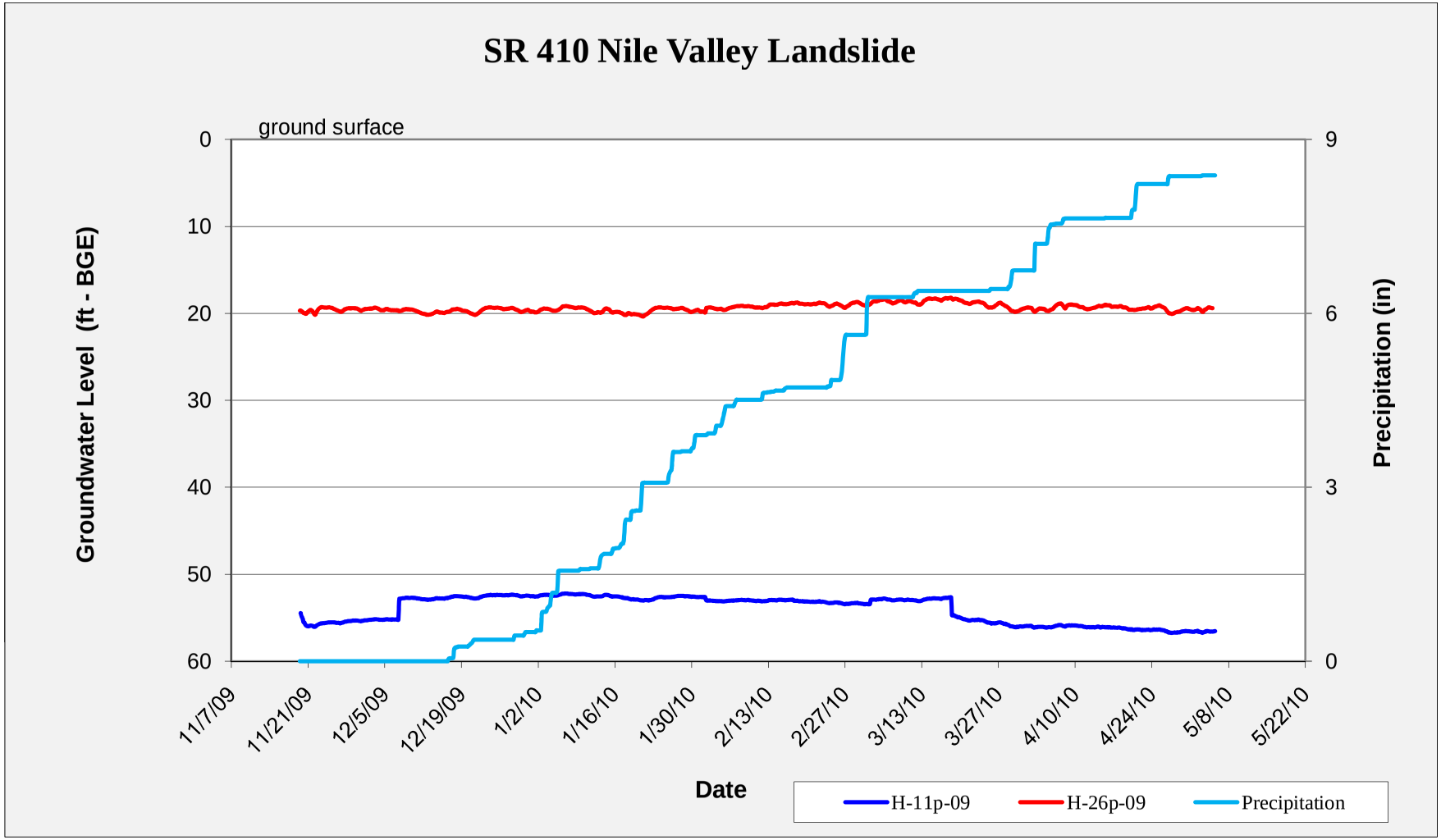
Log	Depth	Dip Direction	Dip	Bedding
H-24 obi	139.50	36	55	x
H-24 obi	139.92	41	57	x
H-24 obi	142.24	25	53	x
H-24 obi	145.01	70	46	x
H-24 obi	149.63	160	34	x
H-24 obi	153.06	105	40	x
H-24 obi	155.14	186	33	x
H-24 obi	156.61	191	42	x
H-24 obi	158.26	127	35	x
H-24 obi	158.75	109	30	x
H-24 obi	159.87	192	21	x
H-24 obi	161.86	351	18	x
H-24 obi	164.50	187	53	x
H-24 obi	168.96	133	24	B
H-24 obi	169.38	125	33	B
H-24 obi	169.61	135	38	B
H-24 obi	171.54	86	44	B
H-24 obi	171.82	38	37	x
H-24 obi	179.75	54	35	B
H-24 obi	180.33	74	50	B
H-24 obi	181.05	57	35	B
H-24 obi	198.90	276	47	x
H-24 obi	200.49	251	55	x
H-24 obi	200.71	232	58	x
H-24 obi	202.10	222	27	x
H-24 obi	204.25	216	50	x
H-24 obi	209.80	222	21	x
H-24 obi	211.27	337	21	x

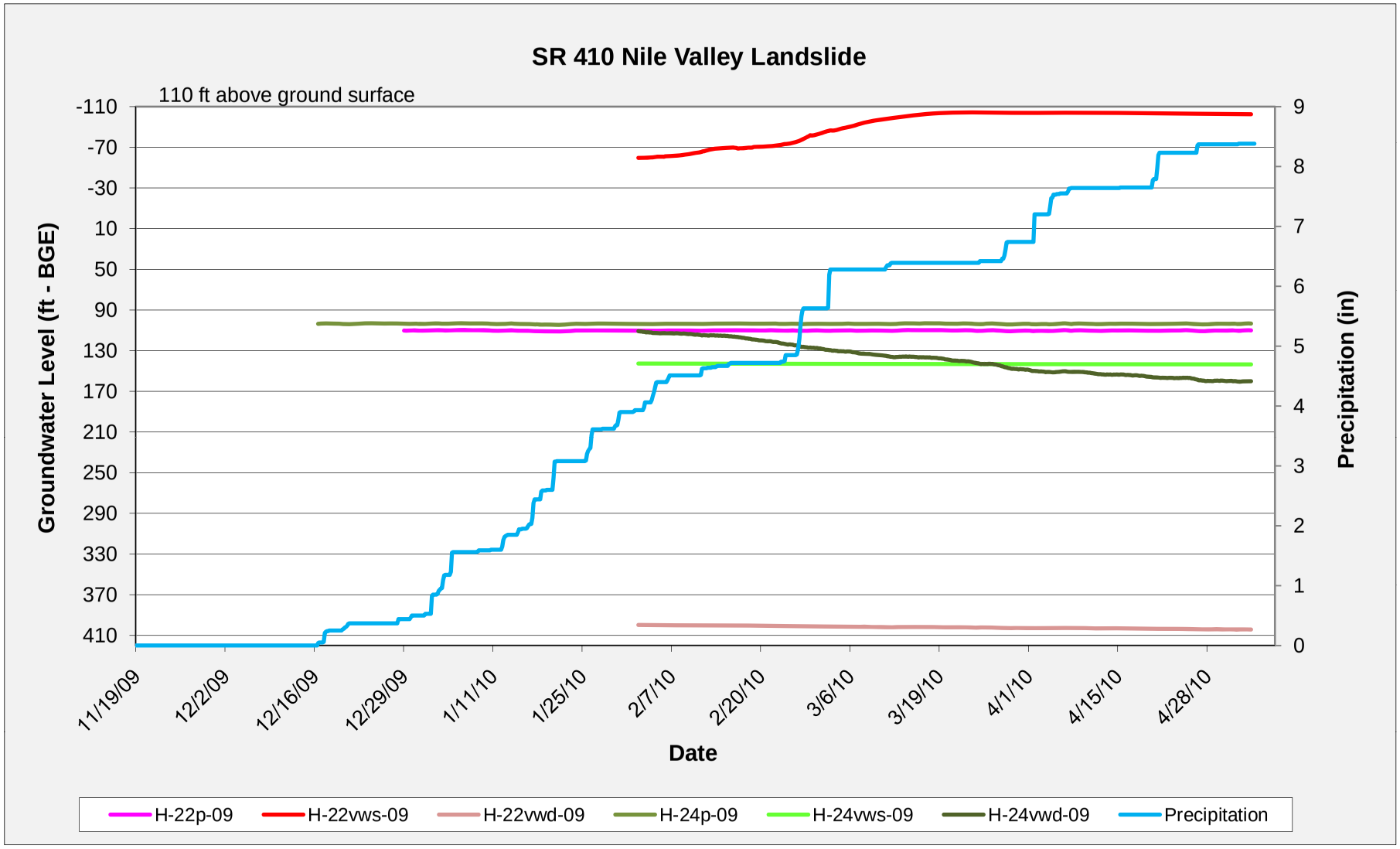
Appendix C

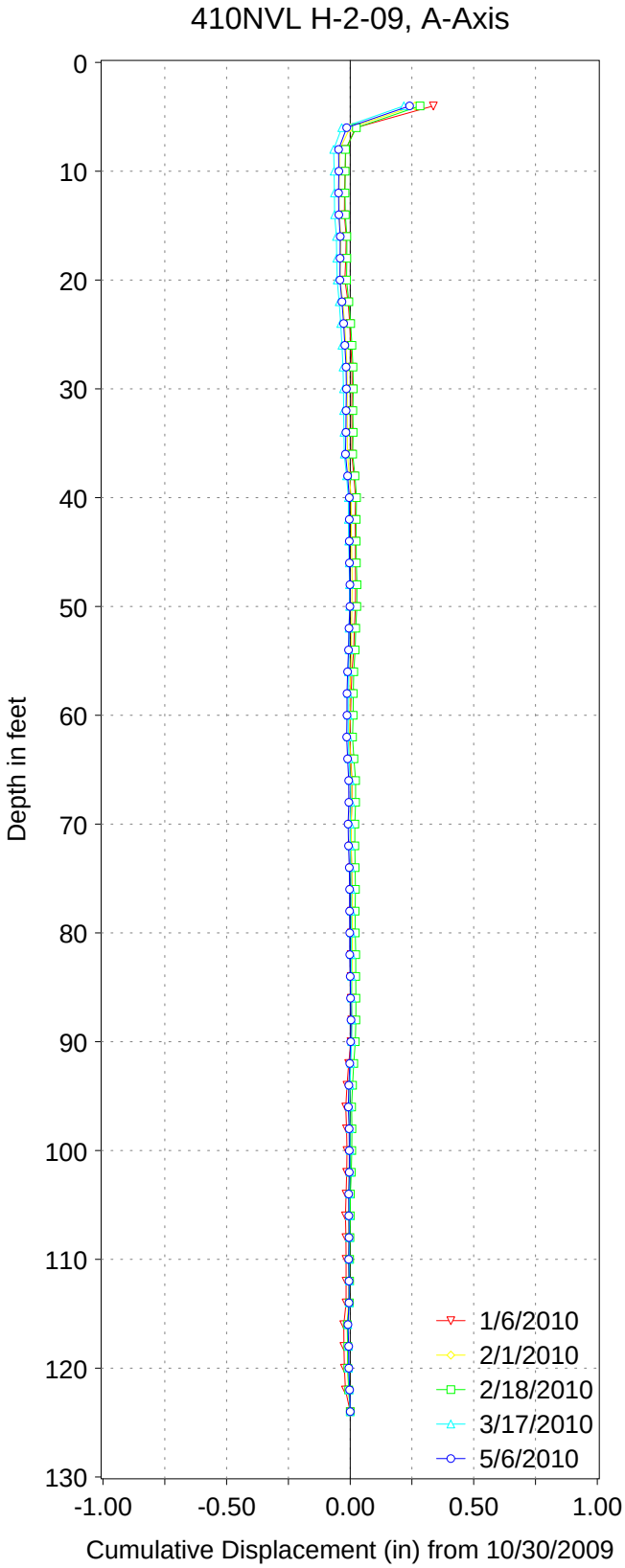
Instrumentation and Survey Monitoring Data

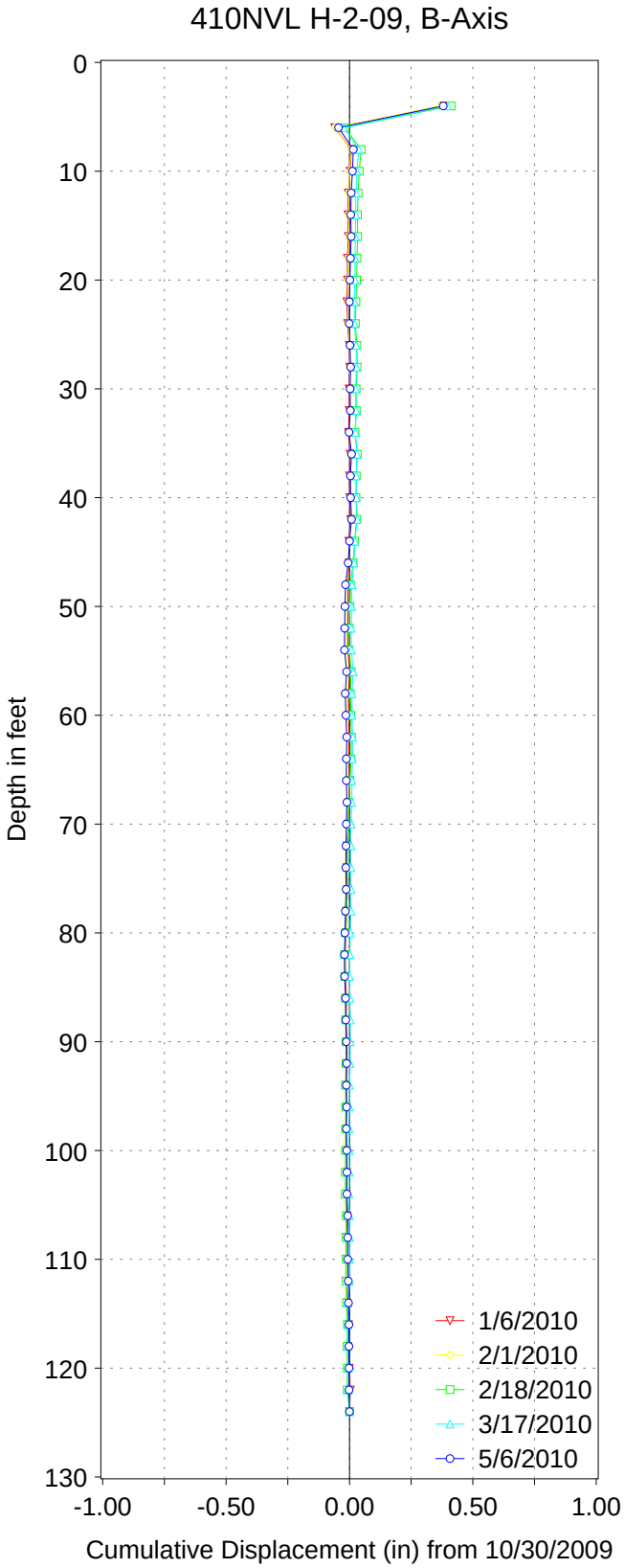

SR 410 Nile Valley Landslide
50 ft above ground surface
ground surface
-50
-40
-30
-20
-10
0
10
8
6
4
2
0
Piezometric Surface (ft)
Precipitation (in)
11/3/09
11/23/09
12/13/09
1/2/10
1/22/10
2/11/10
3/3/10
3/23/10
4/12/10
5/2/10
5/22/10
Date
H-6vw-09
Precipitation


SR 410 Nile Valley Landslide
ground surface
Groundwater Level (ft - BGE)
Precipitation (in)
Date
0
10
20
30
40
50
60
70
80
90
9
8
7
6
5
4
3
2
1
0
11/19/2009
12/2/2009
12/16/2009
12/29/2009
1/11/2010
1/25/2010
2/7/2010
2/20/2010
3/6/2010
3/19/2010
4/1/2010
4/15/2010
4/28/2010
H-9p-09
H-13p-09
H-13vw-09
H-16vw-09
H-21p-09
Precipitation

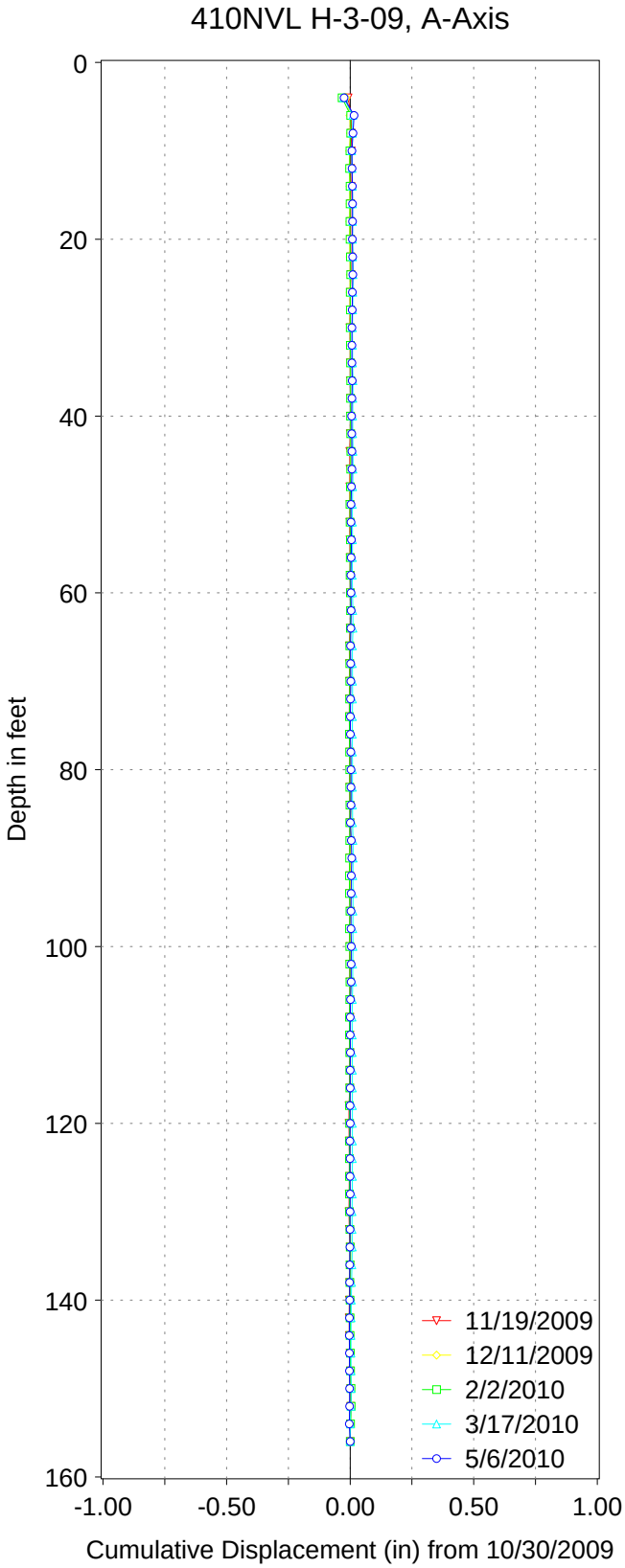

SR 410 Nile Valley Landslide
ground surface
Groundwater Level (ft - BGE)
Precipitation (in)
0
10
20
30
40
50
60
9
6
3
0
11/7/09
11/21/09
12/5/09
12/19/09
1/2/10
1/16/10
1/30/10
2/13/10
2/27/10
3/13/10
3/27/10
4/10/10
4/24/10
5/8/10
5/22/10
Date
H-11p-09
H-26p-09
Precipitation

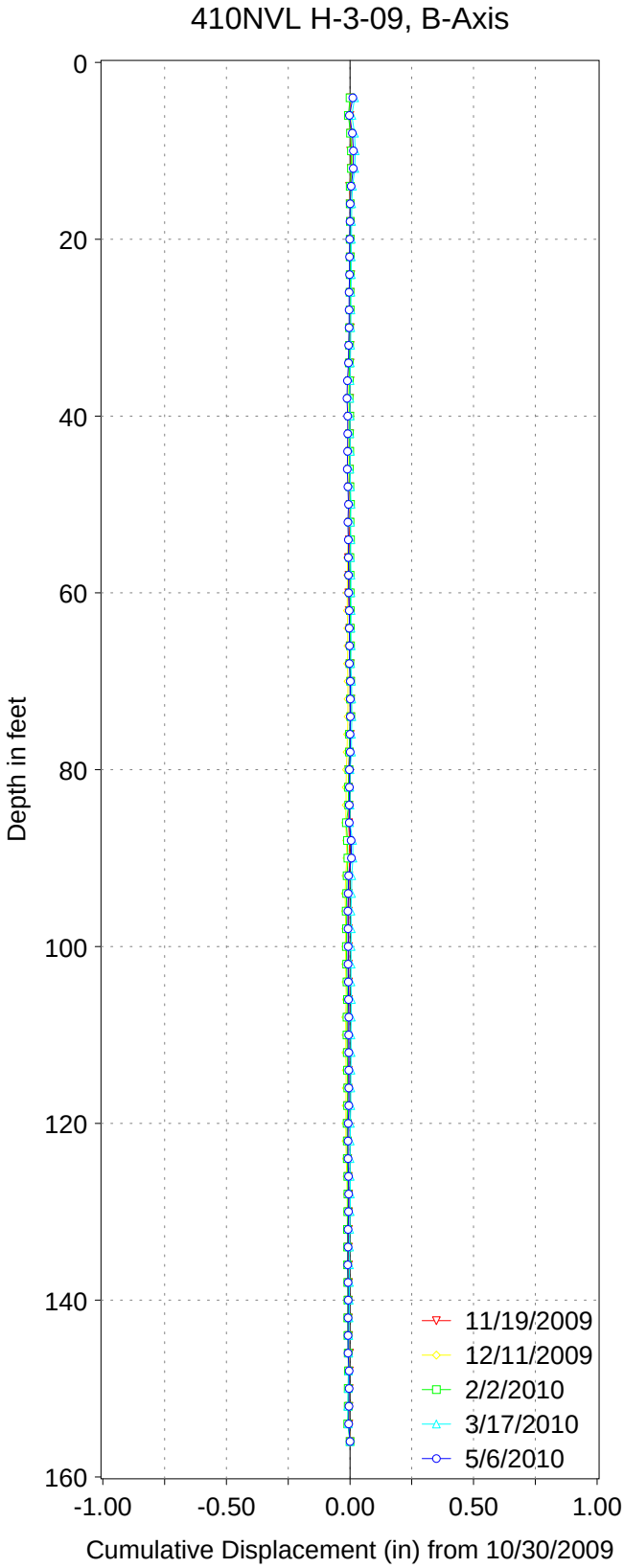

SR 410 Nile Valley Landslide
110 ft above ground surface
Groundwater Level (ft - BGE)
-110
-70
-30
10
50
90
130
170
210
250
290
330
370
410
Precipitation (in)
9
8
7
6
5
4
3
2
1
0
11/19/09
12/2/09
12/16/09
12/29/09
1/11/10
1/25/10
2/7/10
2/20/10
3/6/10
3/19/10
4/1/10
4/15/10
4/28/10
Date
H-22p-09
H-22vws-09
H-22vwd-09
H-24p-09
H-24vws-09
H-24vwd-09
Precipitation



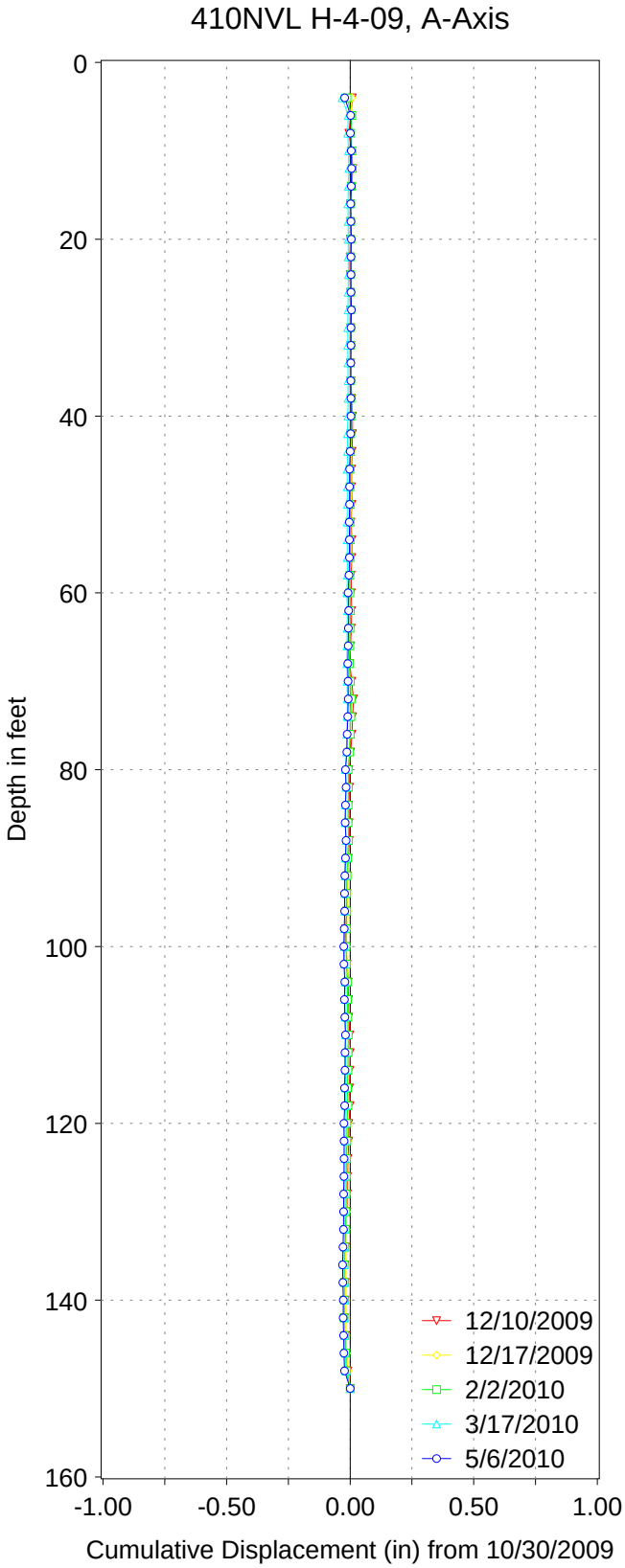


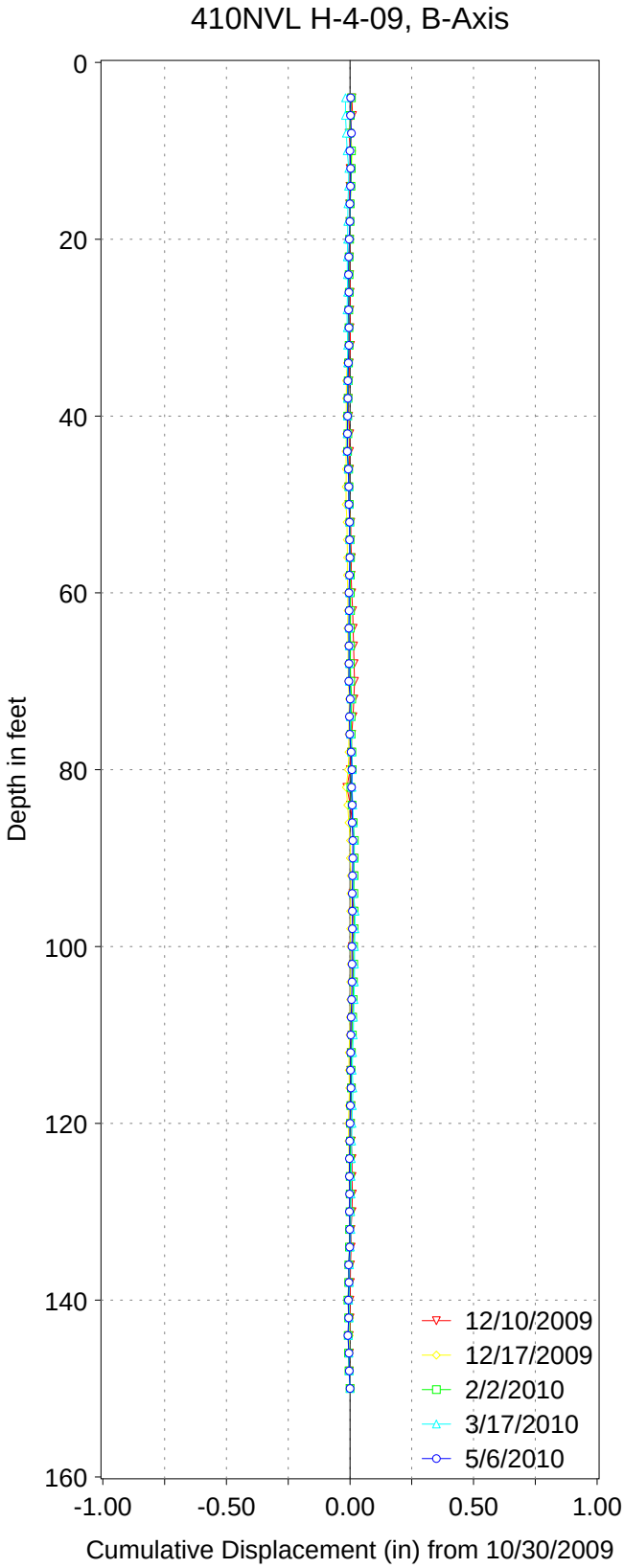
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-2si-09
Olympia, WA	A+ Dir. = N 284 Deg.



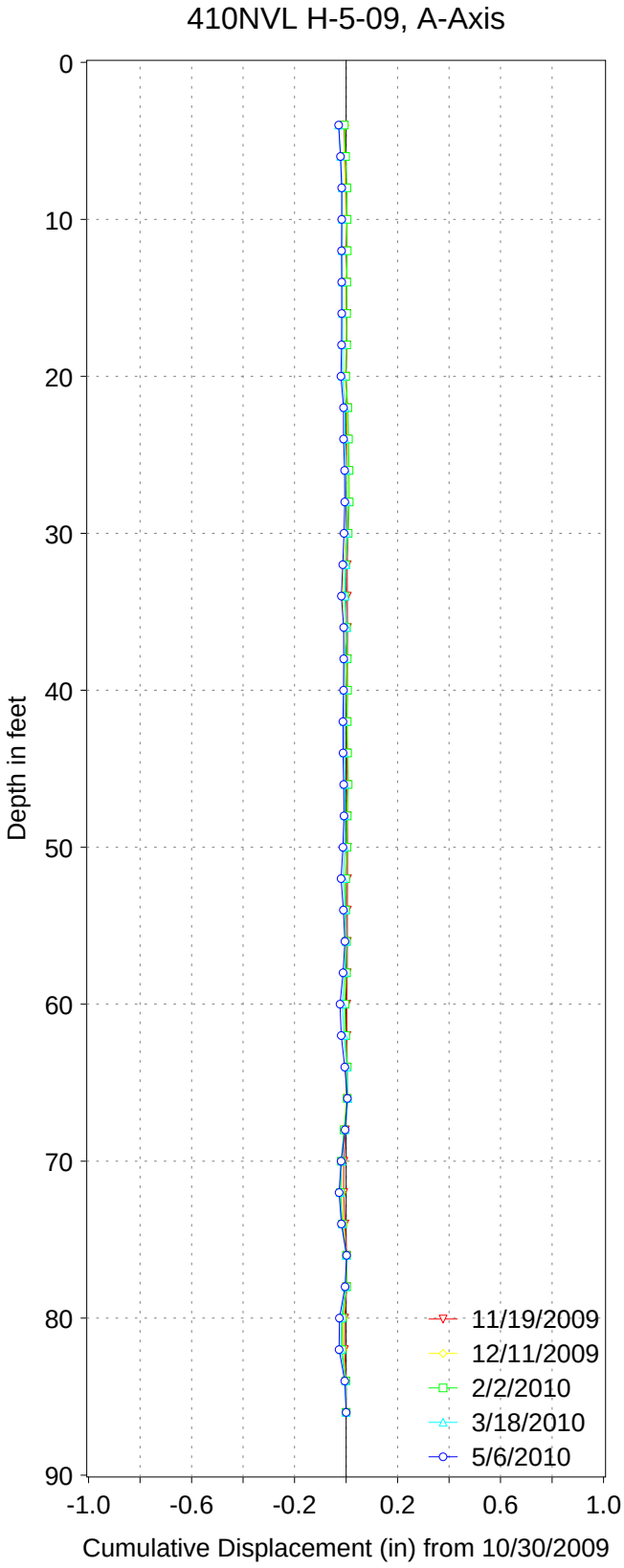


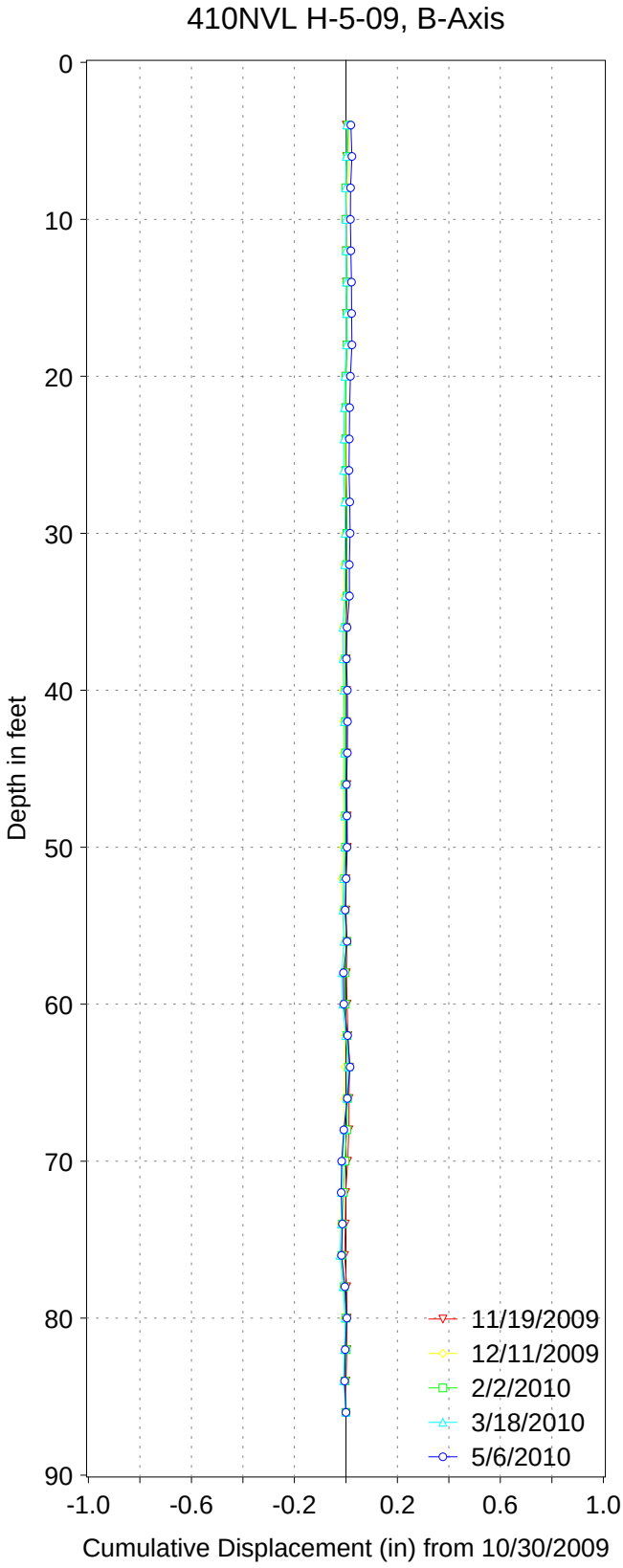
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-3si-09
Olympia, WA	A+ Dir. = N 256 Deg.



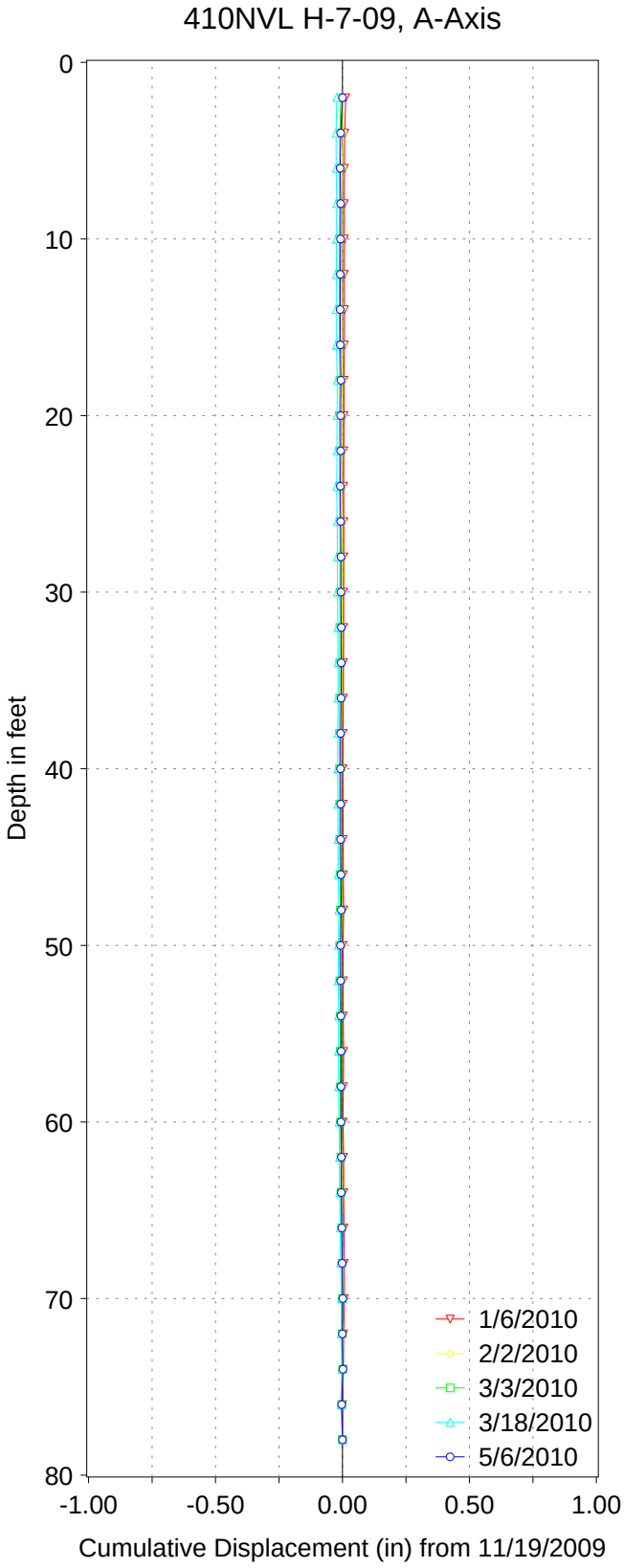


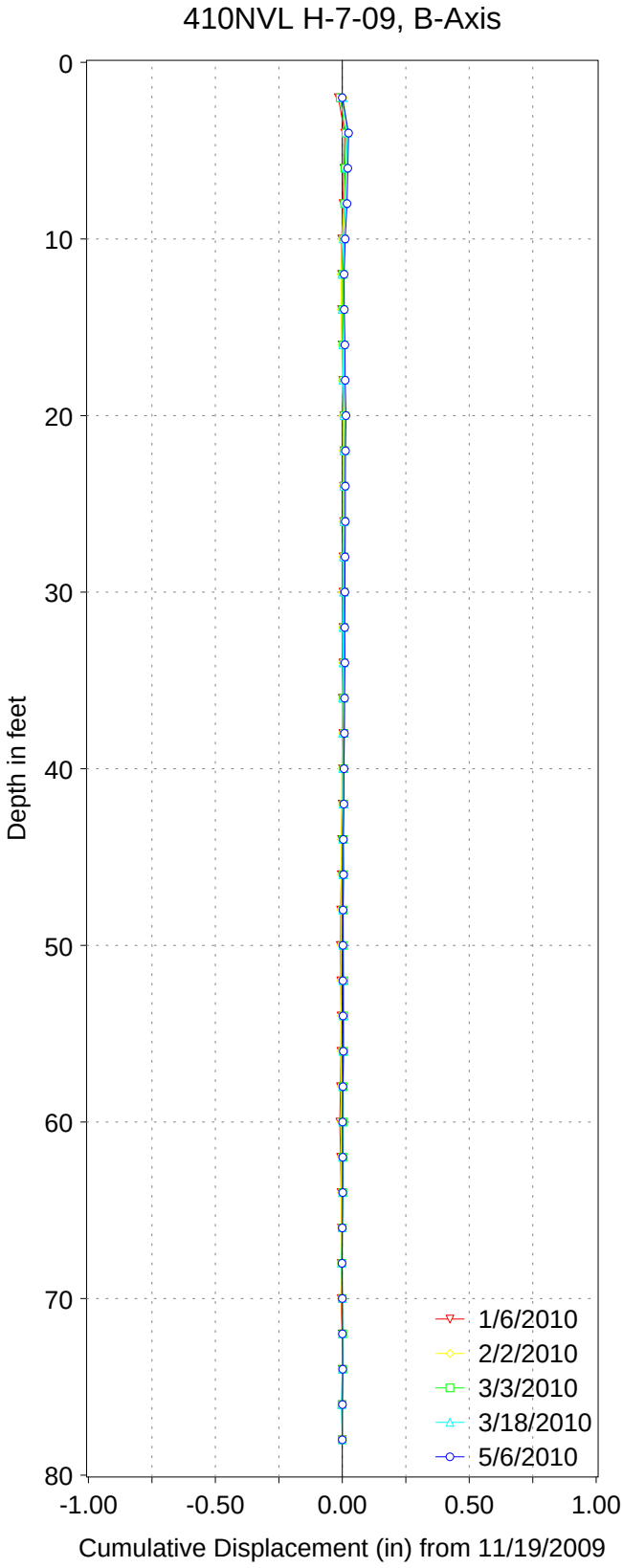
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-4si-09
Olympia, WA	A+ Dir. = N 270 Deg.



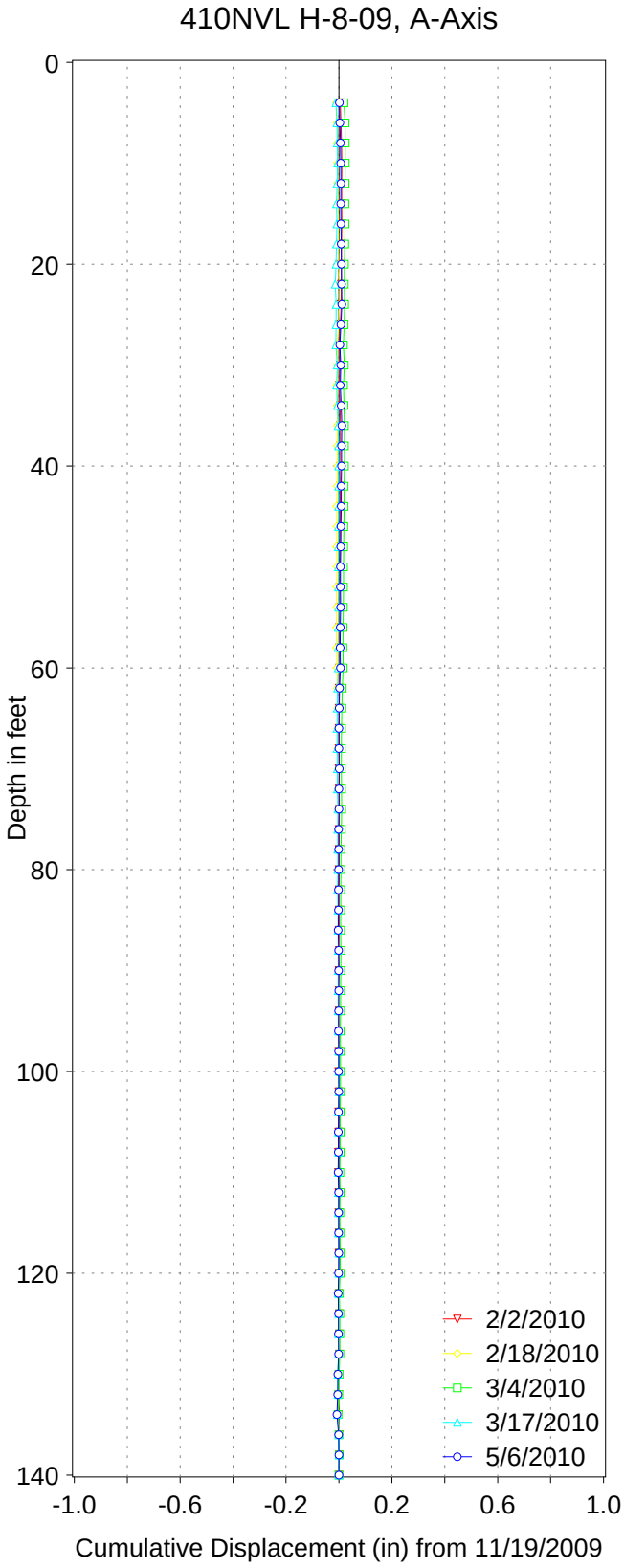


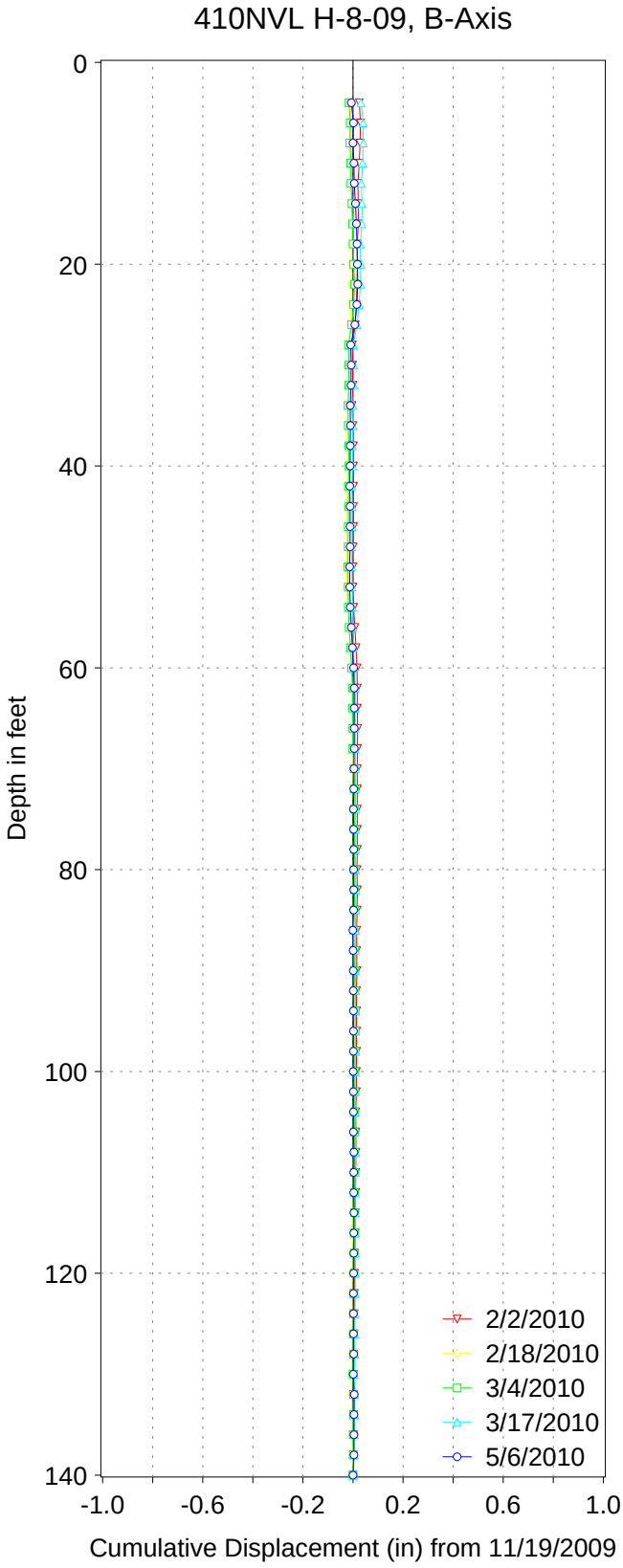
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-5si-09
Olympia, WA	A+ Dir. = N 270 Deg.



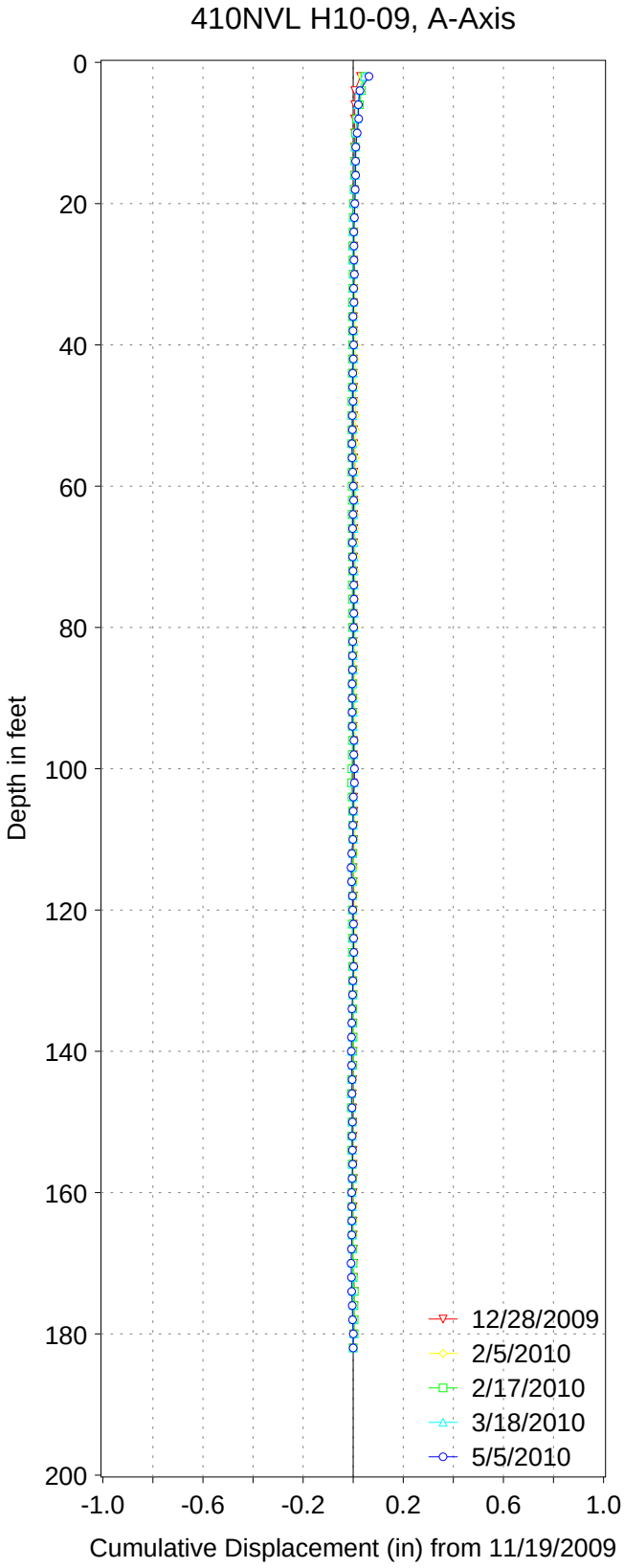


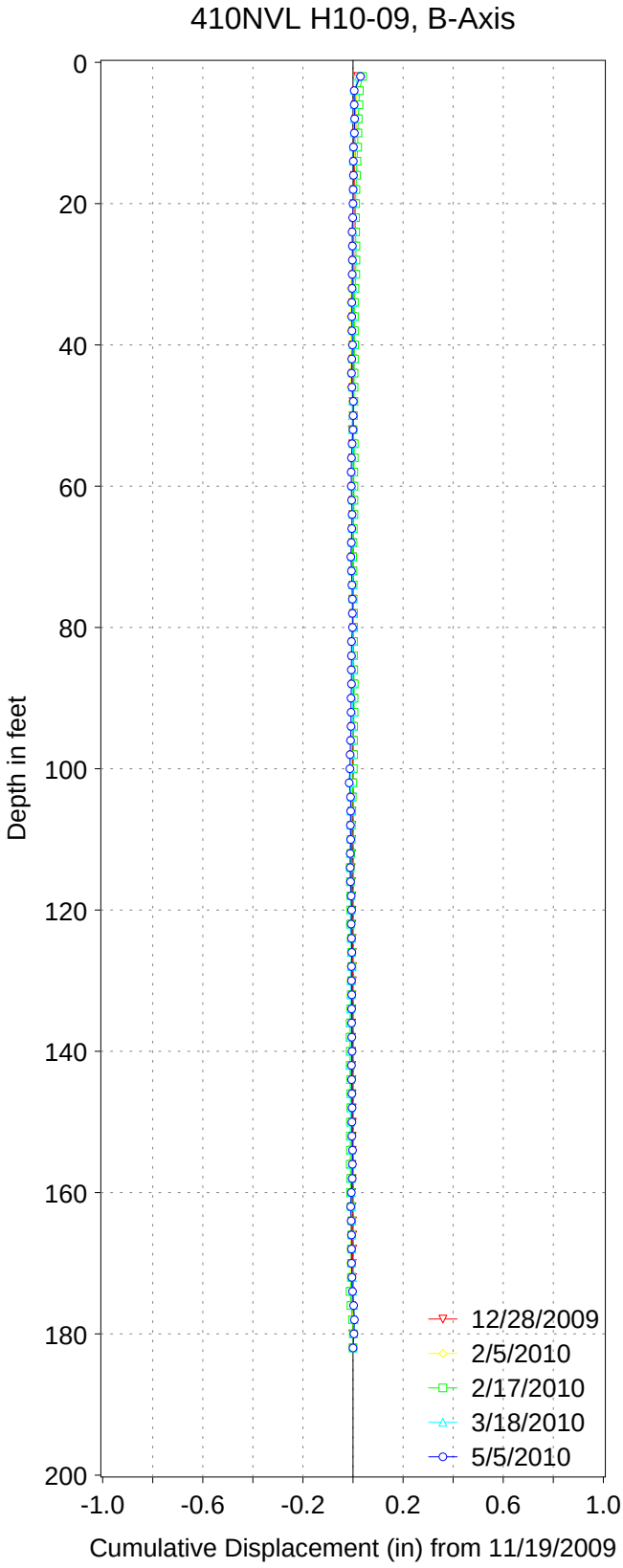
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-7si-09
Olympia, WA	A+ = N228 deg.



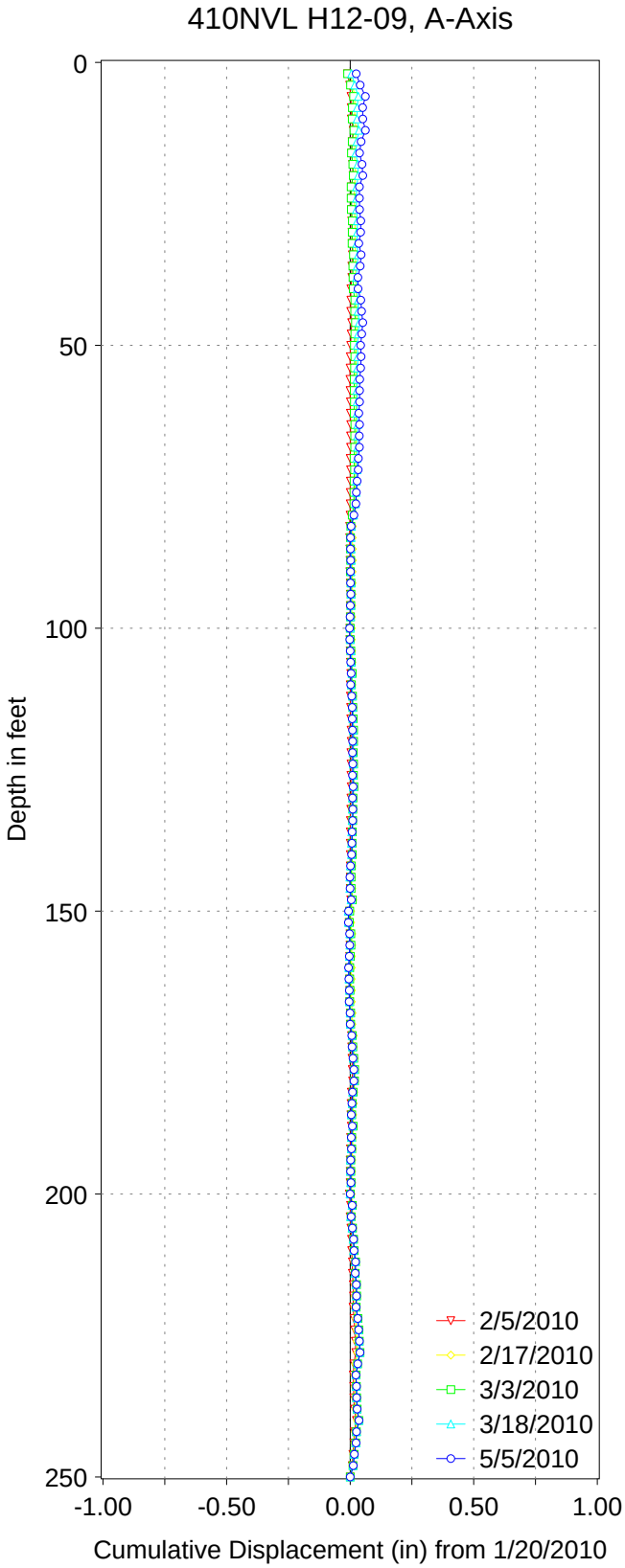


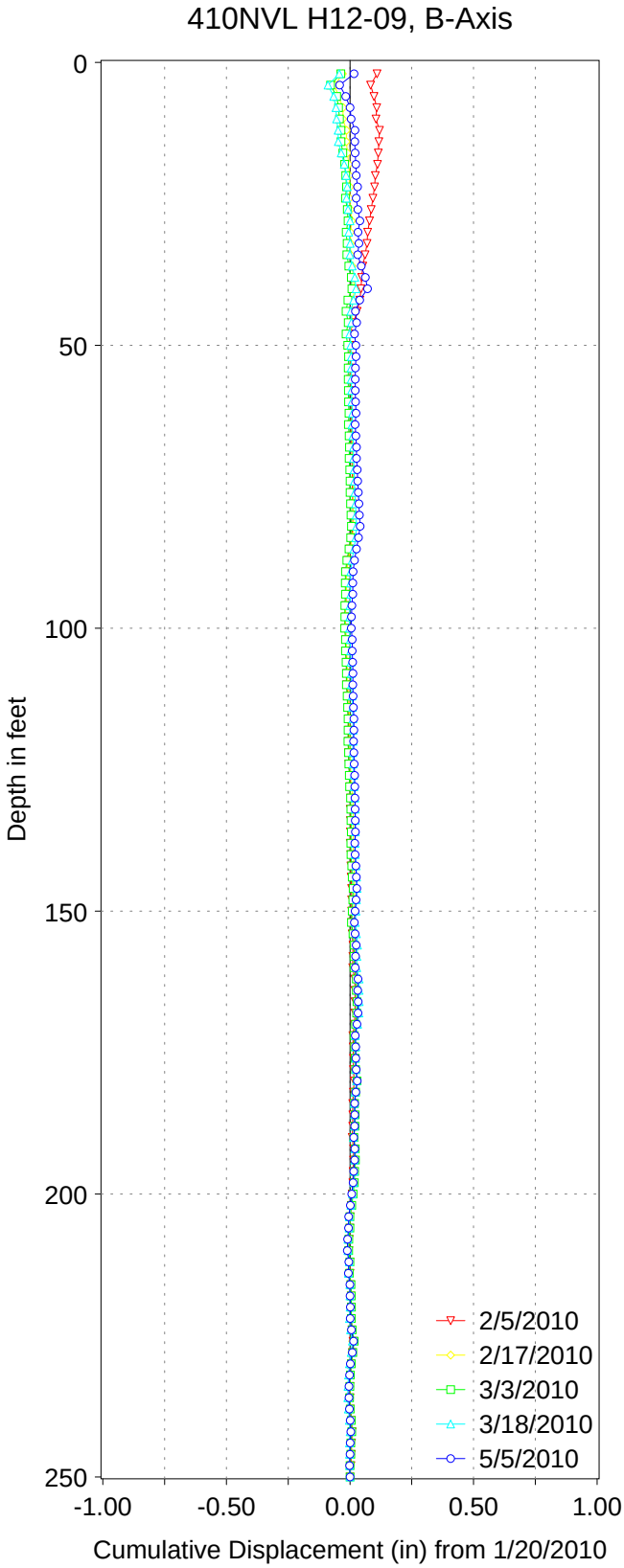
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-8si-09
Olympia, WA	A+ Dir = N210 Deg.



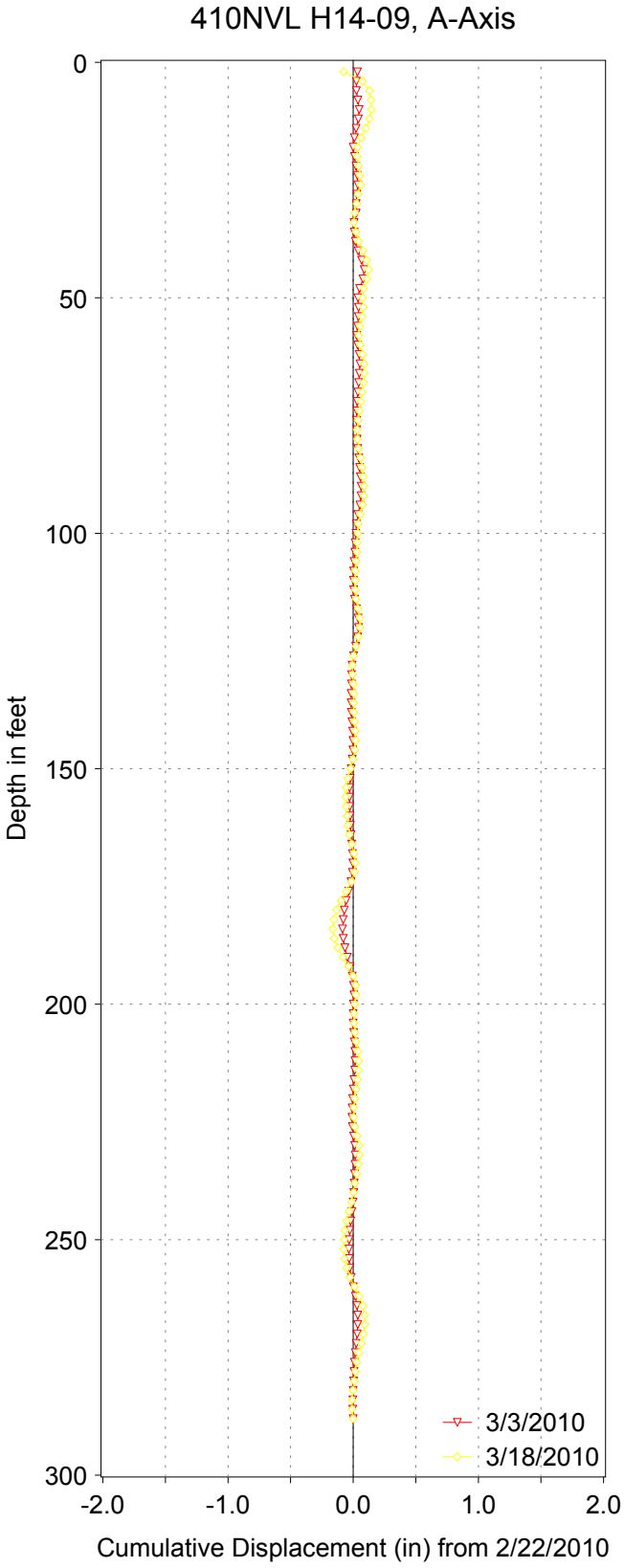


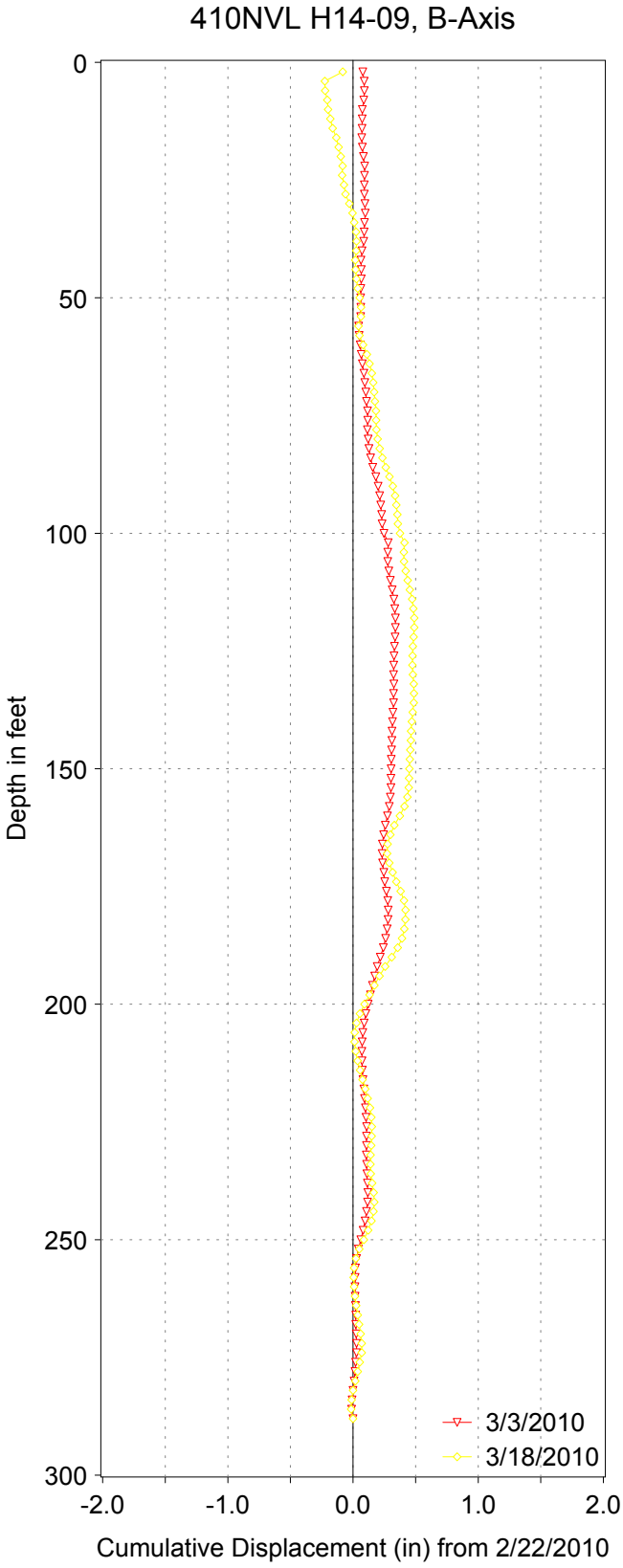
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-10si-09
Olympia, WA	A+ Dir. = N238 Deg.



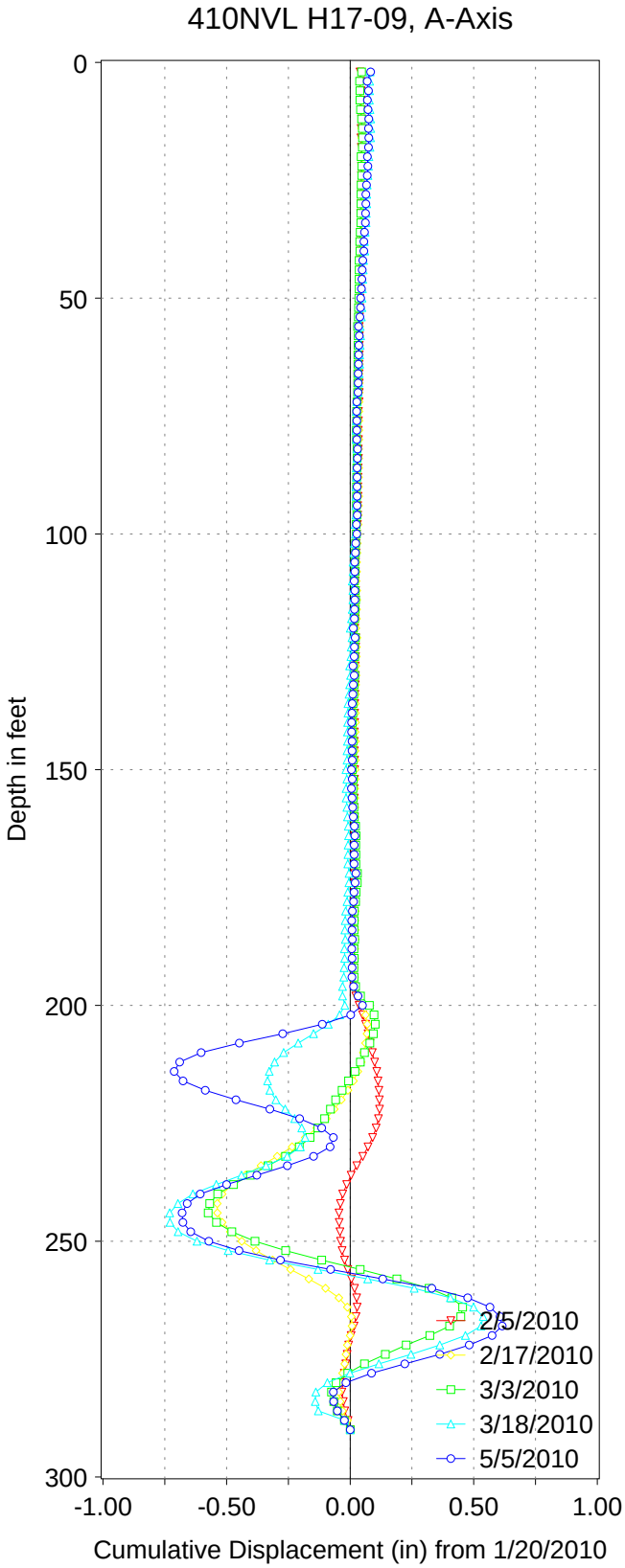


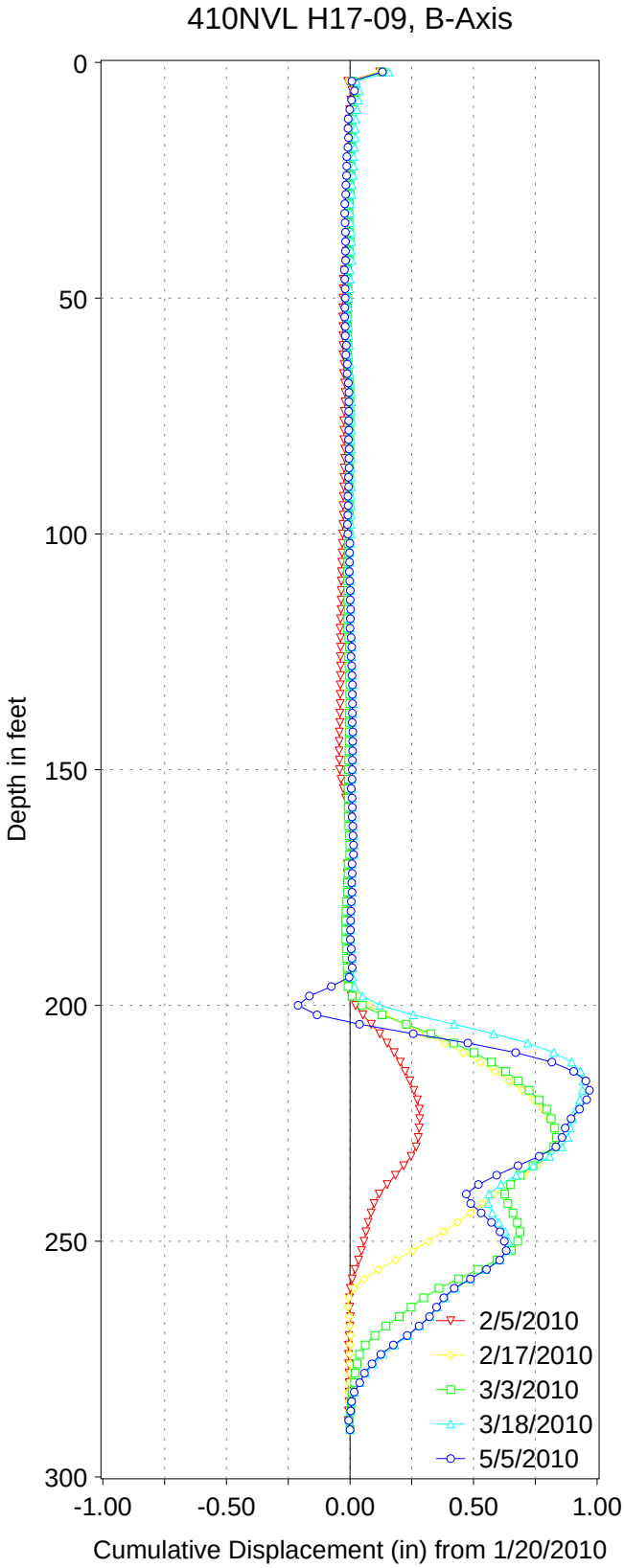
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	X3695
Instrumentation Section	H-12si-09
Olympia, WA	A+ Dir. = N258 Deg.



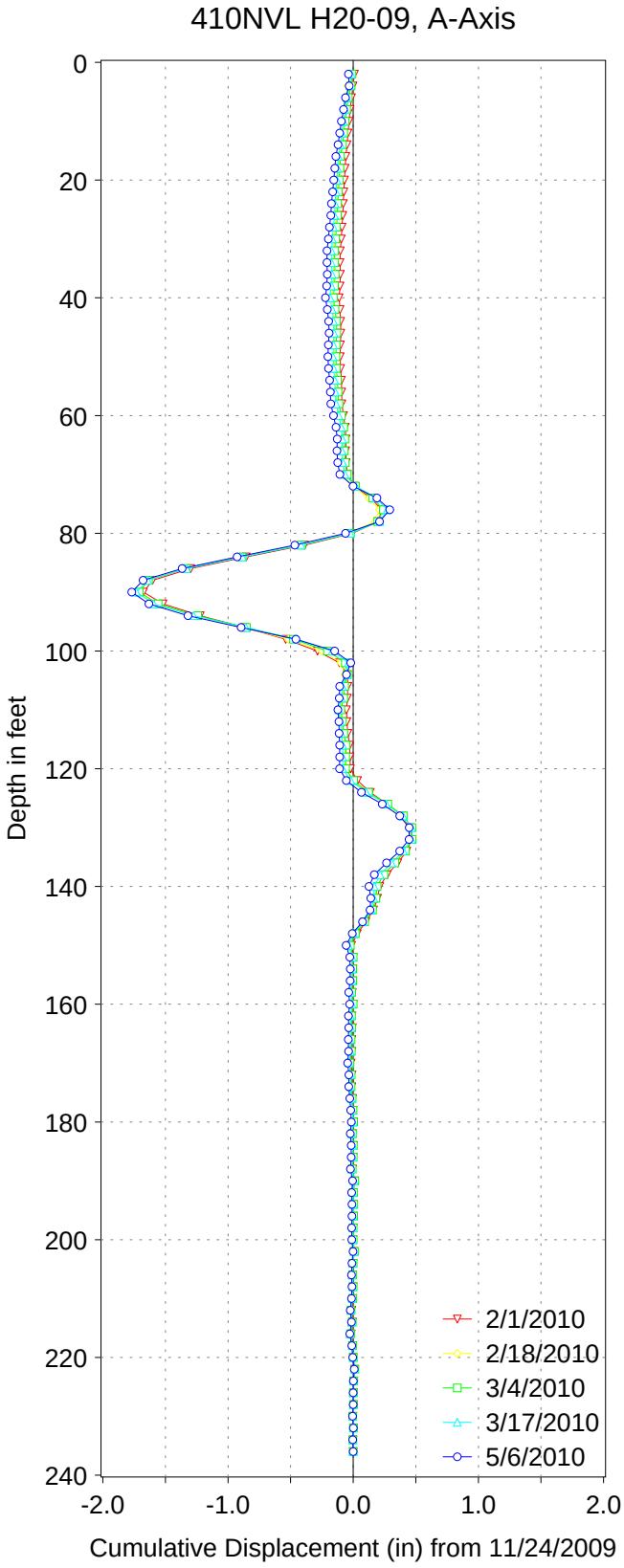


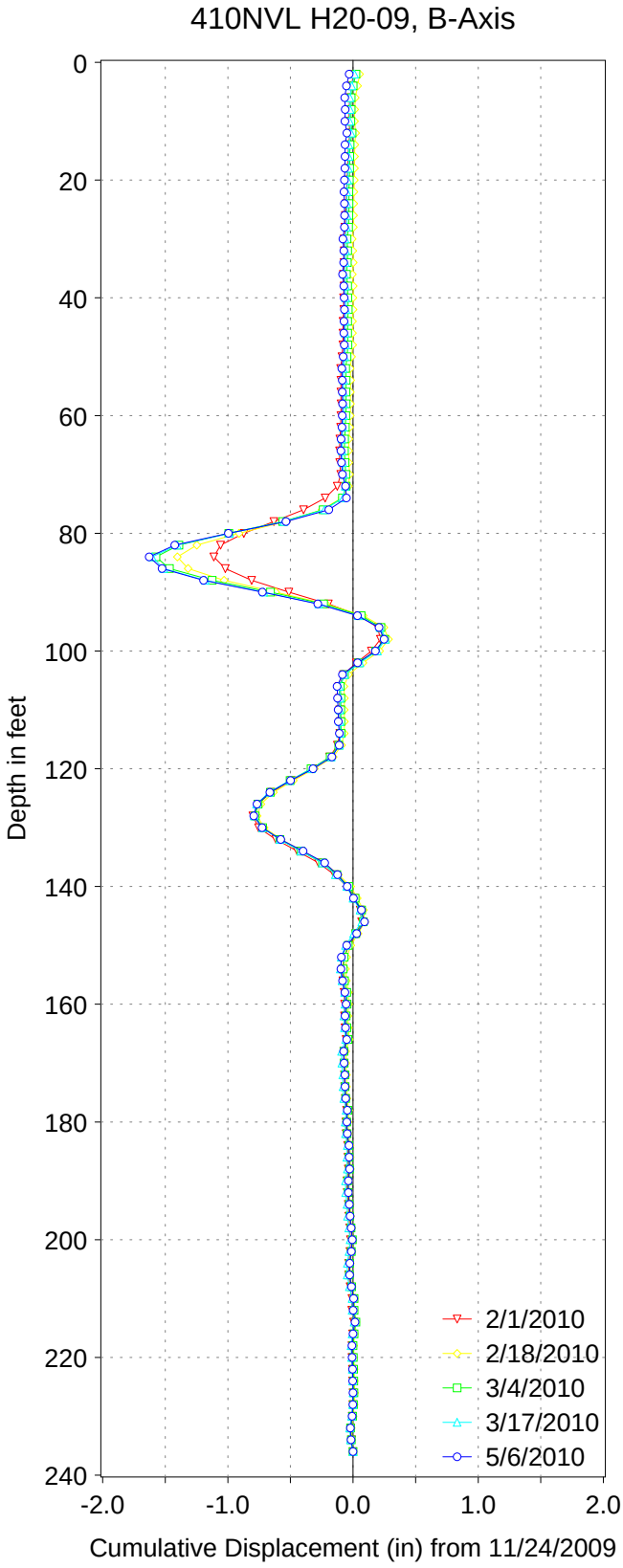
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-14si-09
Olympia, WA	A+ Dir. = N 288 Deg.



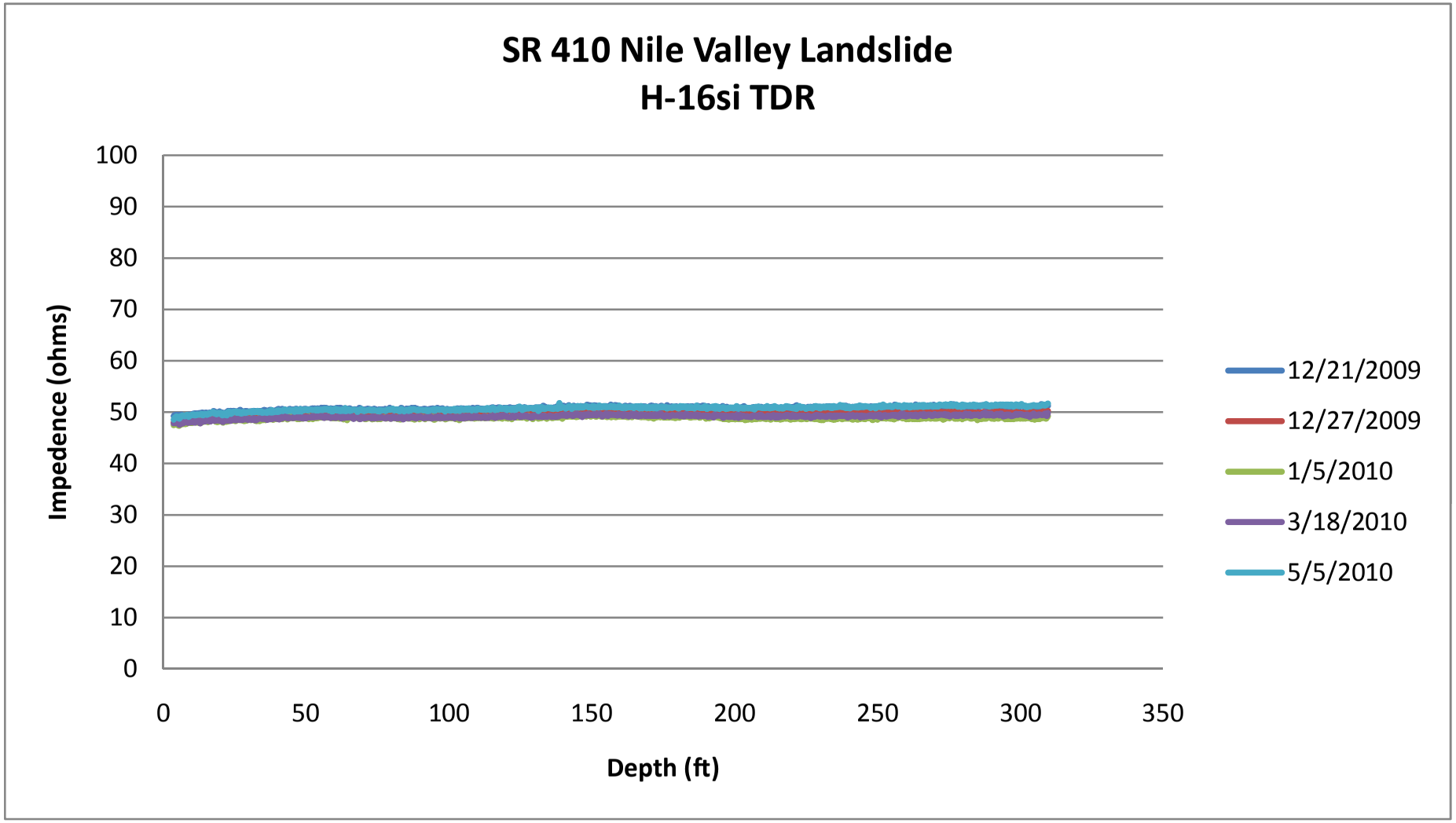


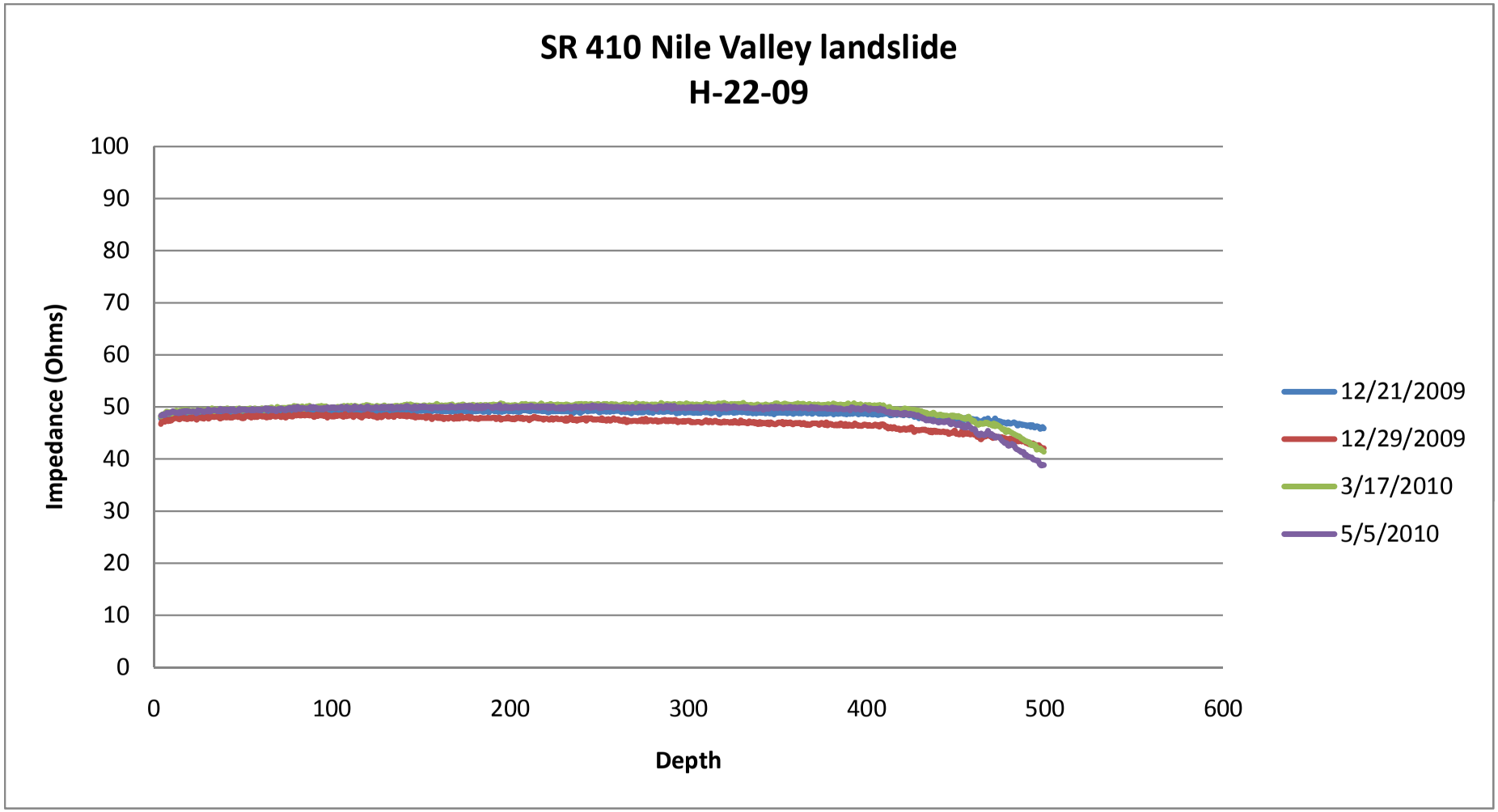
WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-17-09
Olympia, WA	A+ Dir. = N 242 Deg.

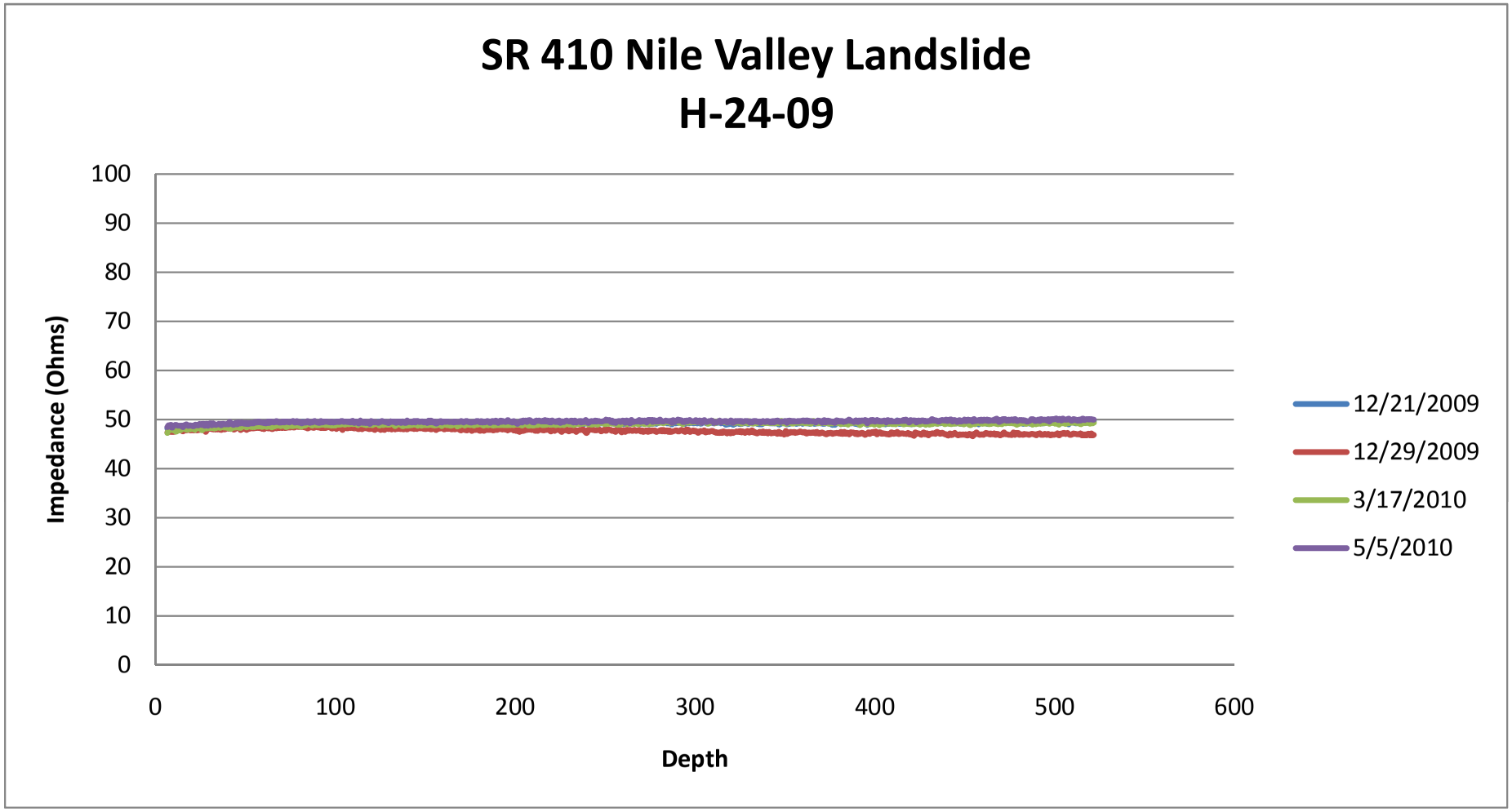




WSDOT	SR 410 Nile Valley Landslide
Geotechnical Division	XL-3695
Instrumentation Section	H-20si-09
Olympia, WA	A+ Dir. = N258 Deg.


SR 410 Nile Valley Landslide
H-16si TDR
Impedence (ohms)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
Depth (ft)
12/21/2009
12/27/2009
1/5/2010
3/18/2010
5/5/2010


SR 410 Nile Valley landslide
H-22-09
Impedance (Ohms)
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
Depth
12/21/2009
12/29/2009
3/17/2010
5/5/2010


SR 410 Nile Valley Landslide
H-24-09
Impedance (Ohms)
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
Depth
12/21/2009
12/29/2009
3/17/2010
5/5/2010

SR-410 Nile Valley Landslide

GPS Positioned Stations - Test Borings

Borehole 12

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	N	N/A
2/26/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Borehole 13

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	N	N/A
2/26/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Borehole 15

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	N	N/A
2/26/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Borehole 16

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	Y	**+0.03N, -0.03E**
2/26/2010	2	N	
3/1/2010	2.5	N	
3/31/2010	2	N	

Borehole 17

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	Y	**+0.03N, -0.07E**
2/26/2010	2	N	
3/1/2010	2.5	N	
3/31/2010	2	N	

Borehole 20

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	N	N/A
2/26/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Borehole 22

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	N	N/A
2/26/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Borehole 23

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	N	N/A
2/26/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

SR-410 Nile Valley Landslide

GPS Positioned Stations - Test Borings

Borehole 24

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
1/6/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2.5	N	N/A
2/26/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

SR-410 Nile Valley Landslide

GPS Control Stations

Station SK

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
11/14/2009	5		NEW STATION
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Station SKA

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
11/14/2009	5		NEW STATION
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A

Station SKB

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/16/2009	5		NEW STATION
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A

Station SKC

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/16/2009	5		NEW STATION
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A

Station SKD

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/16/2009	5		NEW STATION
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A

Station SKE

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
11/14/2009	5		NEW STATION
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A

Station SKF

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
11/14/2009	5		NEW STATION
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A
		N	N/A

Station SKH

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
11/14/2009	5		NEW STATION
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A
		N	N/A

SR-410 Nile Valley Landslide

GPS Control Stations

Station SKJ

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
11/14/2009	5		NEW STATION
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Station SKK

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/16/2009	5		NEW STATION
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Station SKO

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/15/2009	5		NEW STATION
10/16/2008	5	N	N/A
		N	N/A
		N	N/A
		N	N/A
		N	N/A

Station SKR

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/16/2009	5		NEW STATION
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
2/17/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Station SKT

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/15/2009	5		NEW STATION
10/16/2008	5	N	N/A
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

Station SKU

Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/15/2009	5		NEW STATION
10/16/2008	5	N	N/A
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
3/1/2010	2.5	N	N/A

SR-410 Nile Valley Landslide

GPS Control Stations

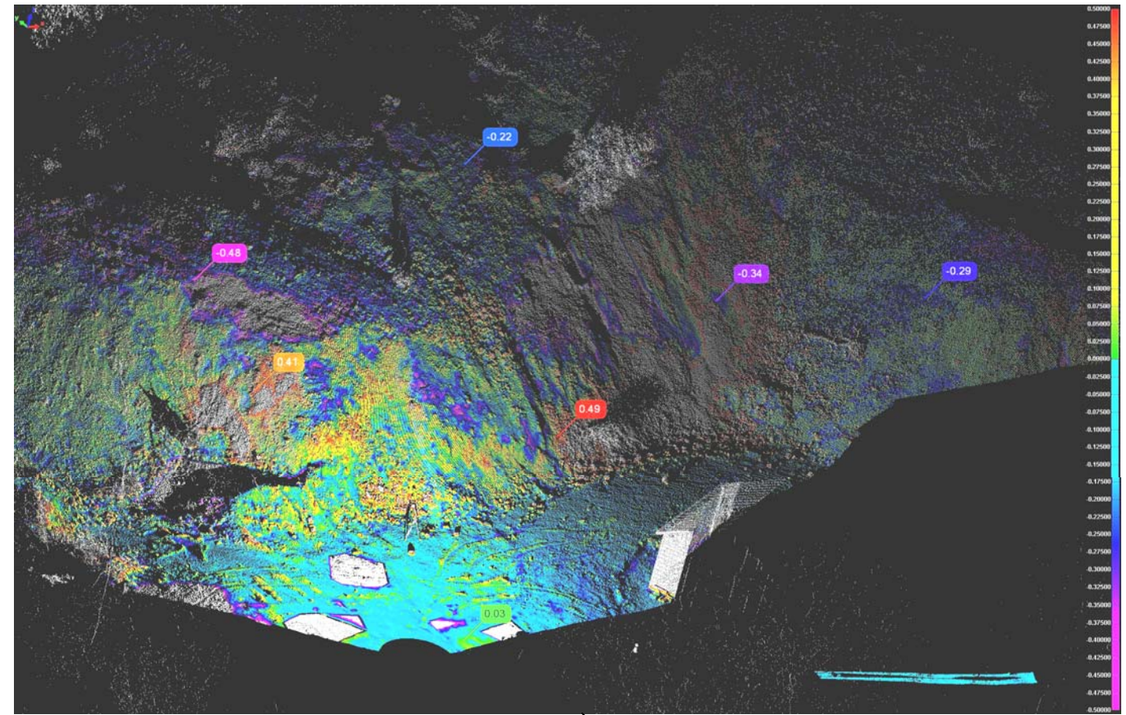
Station	SKV		
Date Measured	Occupation Time in hours	Movement Y/N	If Yes, how much and what direction.
10/15/2009	5		NEW STATION
10/16/2008	5	N	N/A
11/13/2009	5	N	N/A
11/14/2009	5	N	N/A
11/30/2009	2.5	N	N/A
12/17/2009	2.5	N	N/A
1/5/2010	2.5	N	N/A
1/30/2010	2.5	N	N/A
2/17/2010	2	N	N/A
3/1/2010	2.5	N	N/A
3/31/2010	2	N	N/A

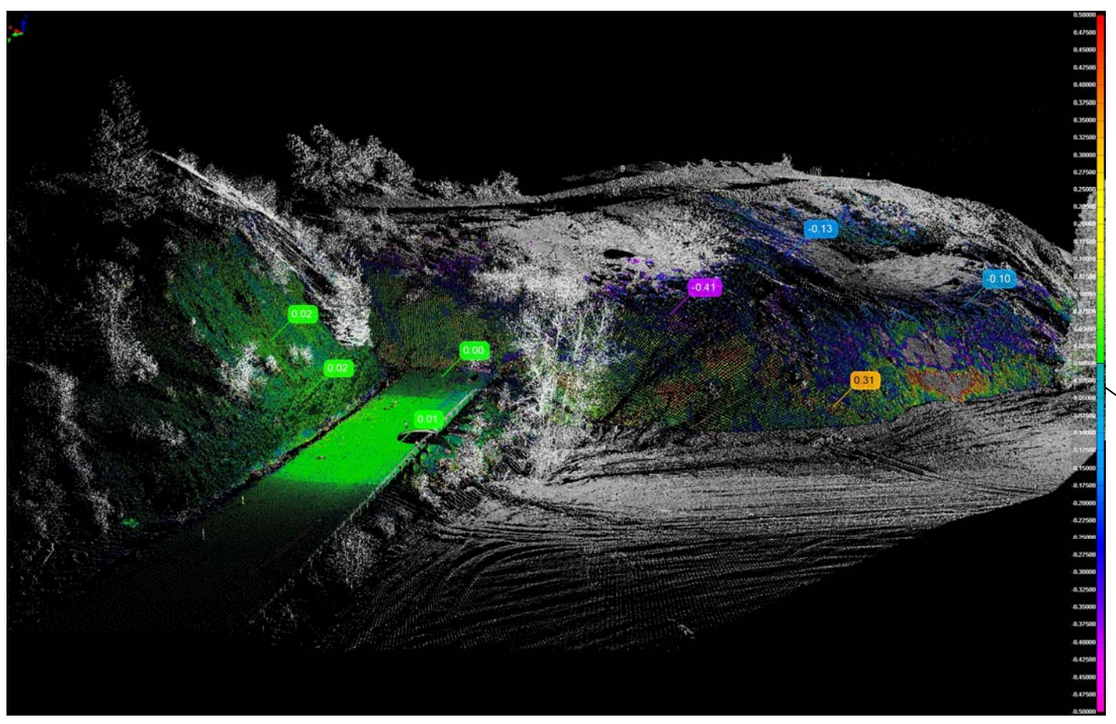
WSDOT Geographic Services - Laser Scanning

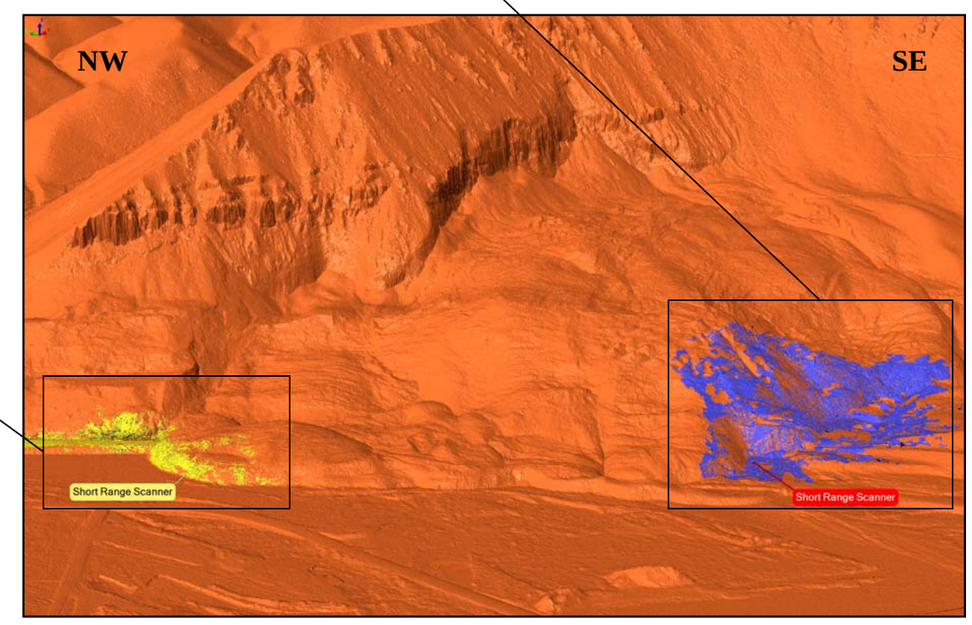
Images depict detected movements for the northwestern and southeastern portions of the landslide toe from initial laser scans on October 15th, 2009 compared with laser scans for February 16th, 2010. Green and light blue colors indicate little to no movement. Yellow-red colors depict movement away from the scanner, and blue to purple colors depict movement toward the scanner. Numerical values are reported in feet.

For the northwestern area, less than a half-foot of movement was detected in a localized area on the upstream edge of the landslide toe immediately adjacent to the river. This movement was detected within the first few weeks following the landslide. No significant movement since occurred.

For the southeastern area adjacent to the Simmons Pit floor, up to a half-foot of movement was detected in the lower portion of the slopes. As interim scans between these dates were not performed, the timing of the movement is not known.







Appendix D

Lab Data and Basalt Chemistry

Job No. **XL3695** Date **April 19, 2010**

Hole No. **Grab Sample** Sheet **1**

Project **SR-410 Nile Valley Landslide**

Laboratory Summary

Washington State Department of Transportation

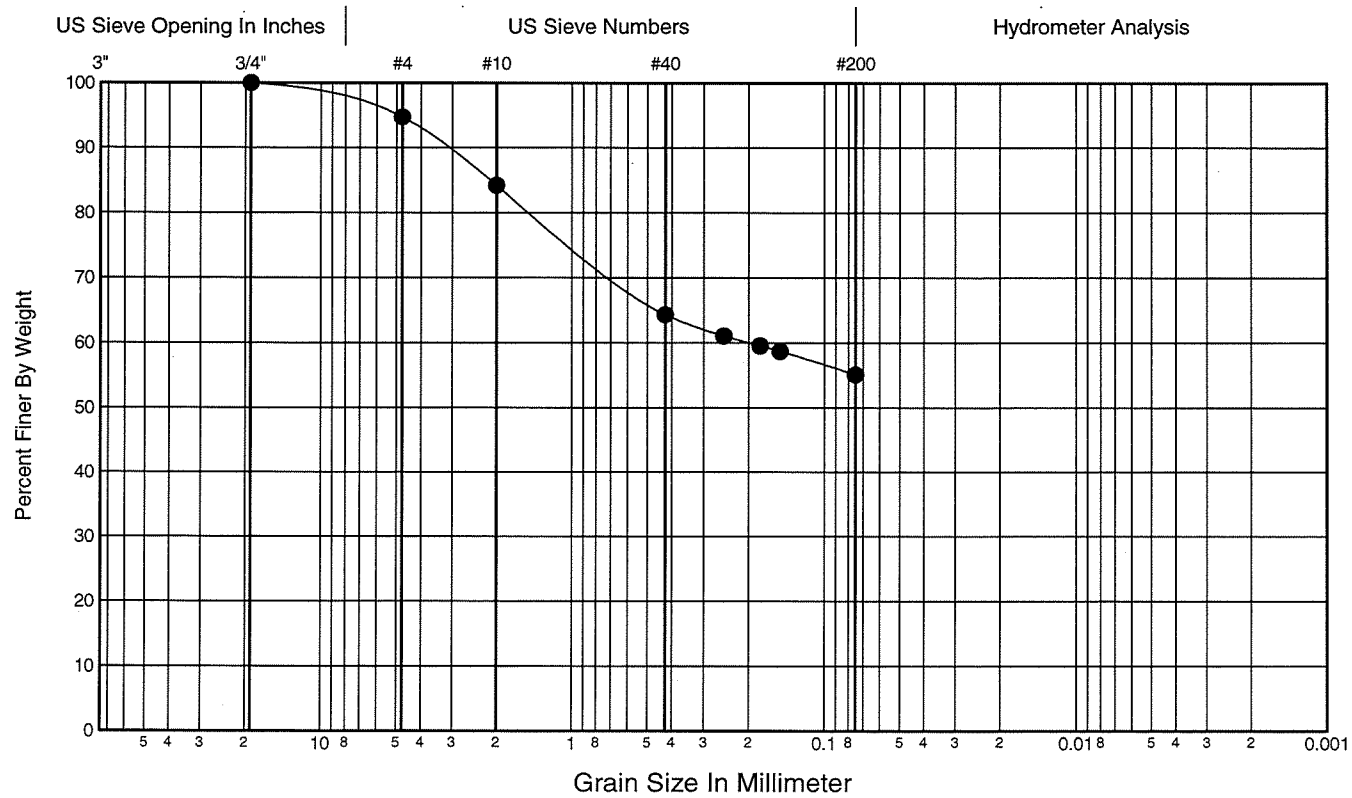
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**1.0**	**0.30**	**GS-1**	**MH**	**See Boring Log**	**SANDY ELASTIC SILT**	**20**	**54**	**30**	**24**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**5.3**	**39.6**	**55.1**		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	**0.199**				



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-06vw-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

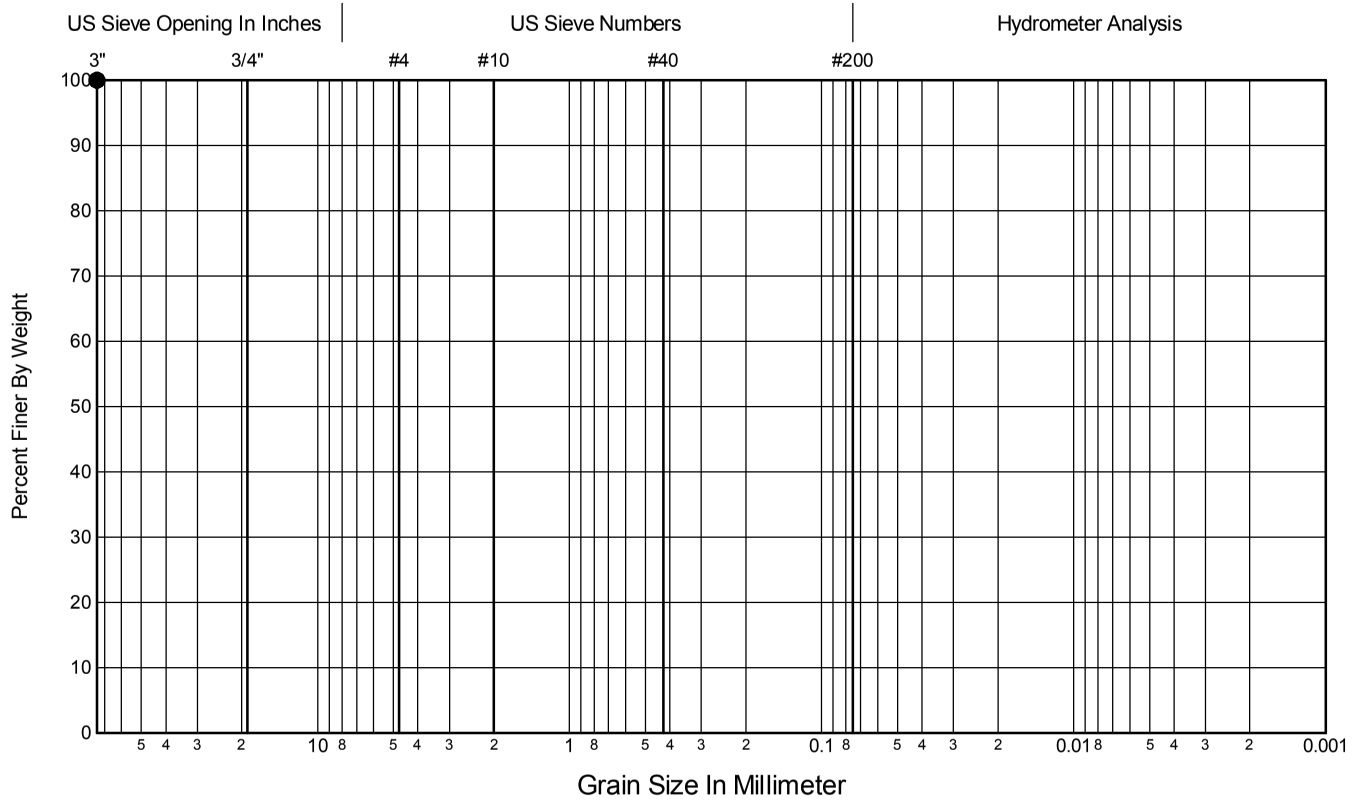
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**140.0**	**42.67**	**D-32**		**See Boring Log**		**28**	**63**	**24**	**39**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●					

GRADATION VALUES

	D60	D50	D30	D20	D10
●					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-07si-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

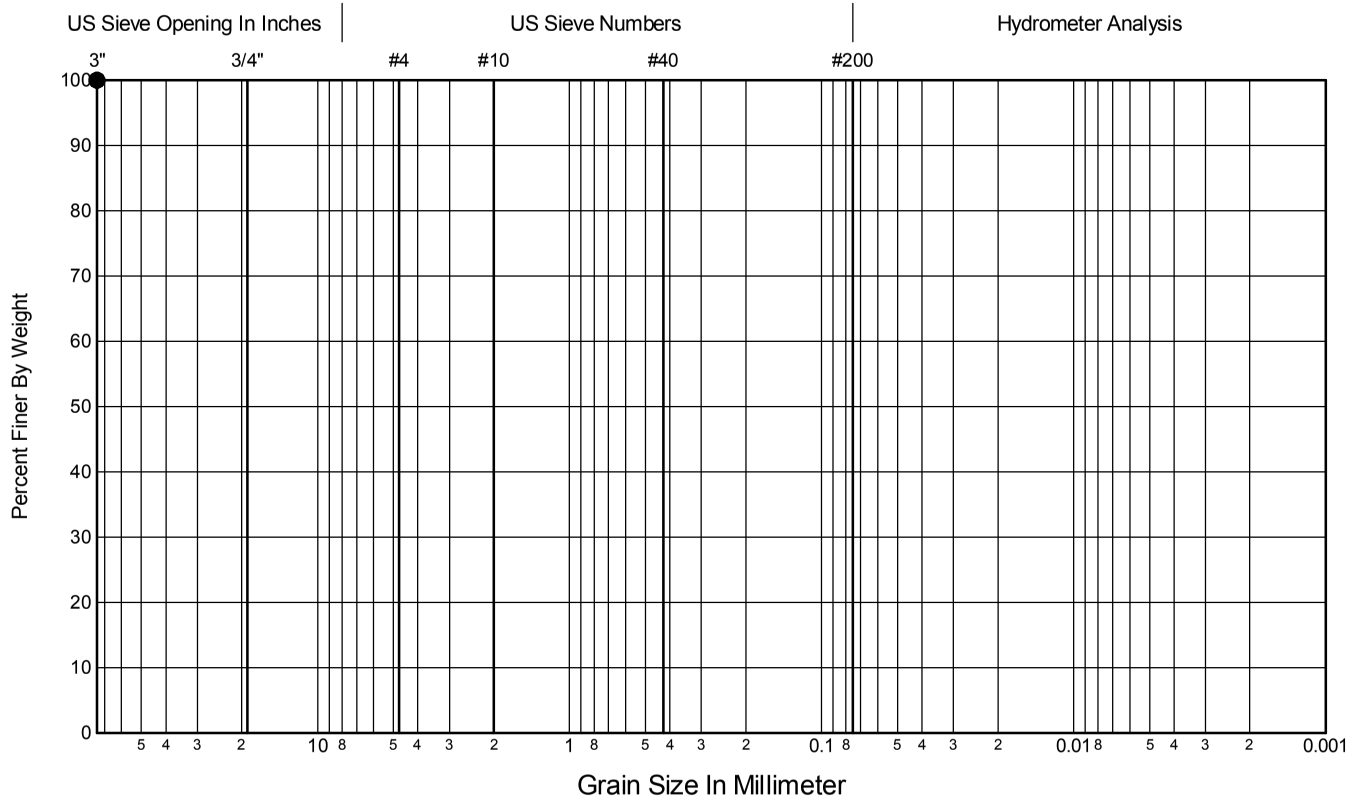
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**65.0**	**19.81**	**C-14**		**See Boring Log**		**23**	**58**	**33**	**25**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●					

GRADATION VALUES

	D60	D50	D30	D20	D10
●					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-08si-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

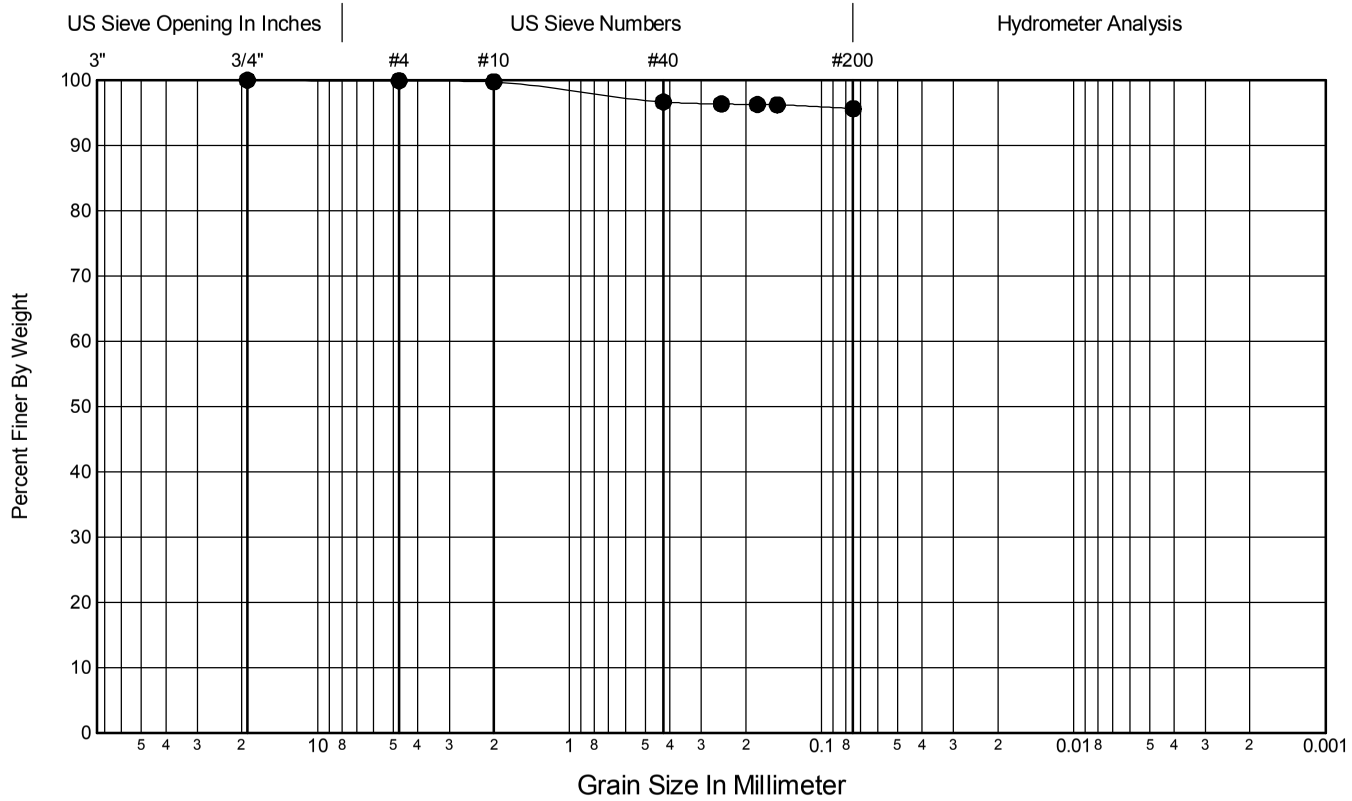
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**21.5**	**6.55**	**C-7**	**MH**	**See Boring Log**	**ELASTIC SILT**	**24**	**55**	**34**	**21**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**0.1**	**4.3**	**95.6**		

GRADATION VALUES

	D60	D50	D30	D20	D10
●					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-09p-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

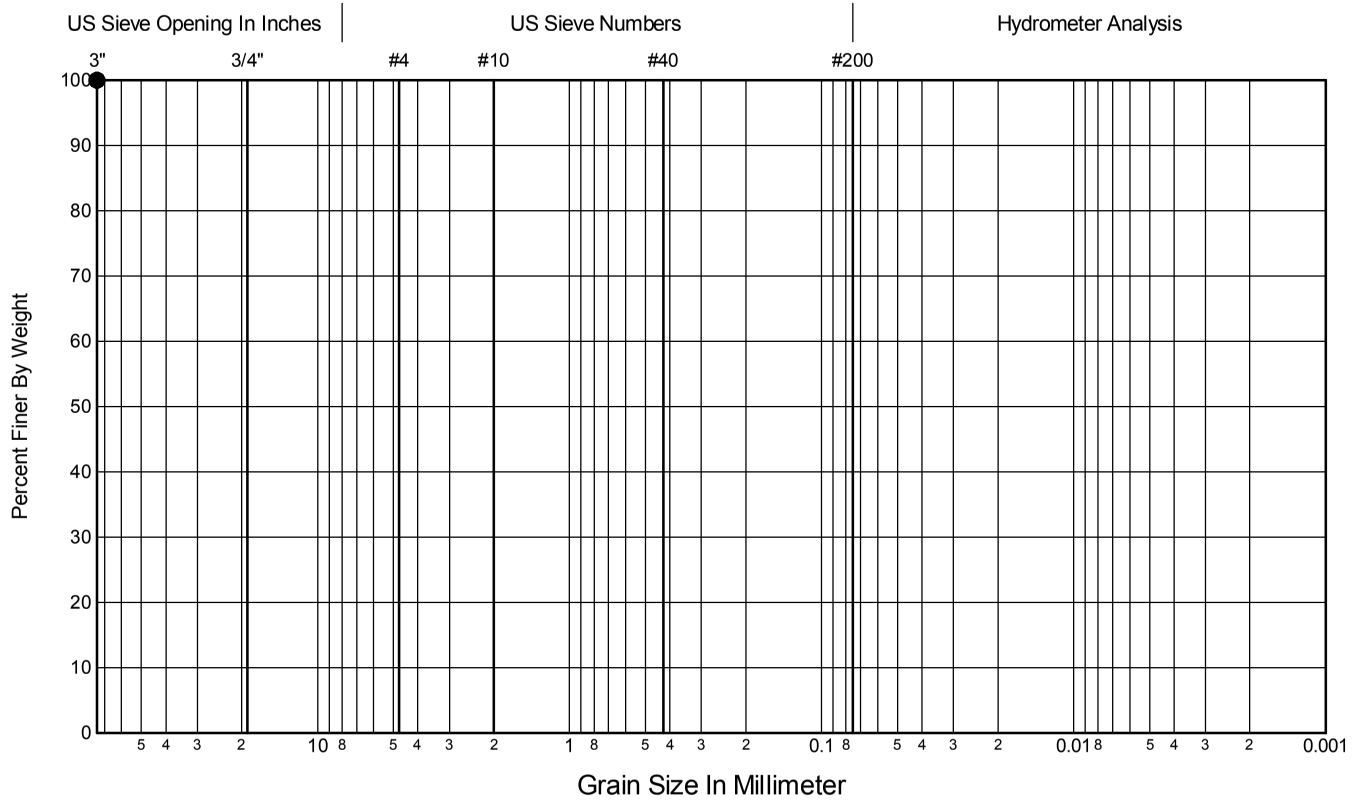
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**25.0**	**7.62**	**C-5**		**See Boring Log**		**28**	**61**	**30**	**31**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●					

GRADATION VALUES

	D60	D50	D30	D20	D10
●					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-10si-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

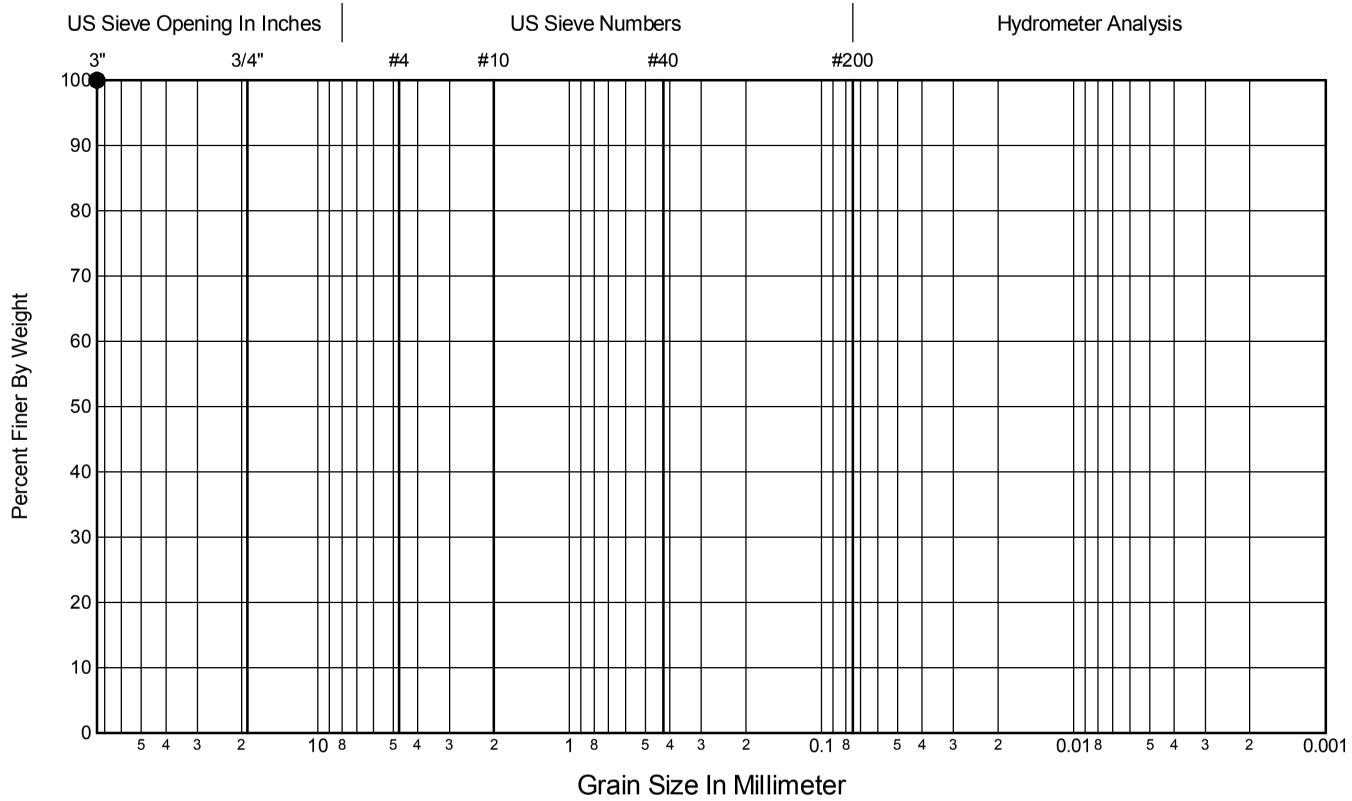
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**91.5**	**27.89**	**C-29**		**See Boring Log**		**38**	**56**	**39**	**17**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●					

GRADATION VALUES

	D60	D50	D30	D20	D10
●					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-12si-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

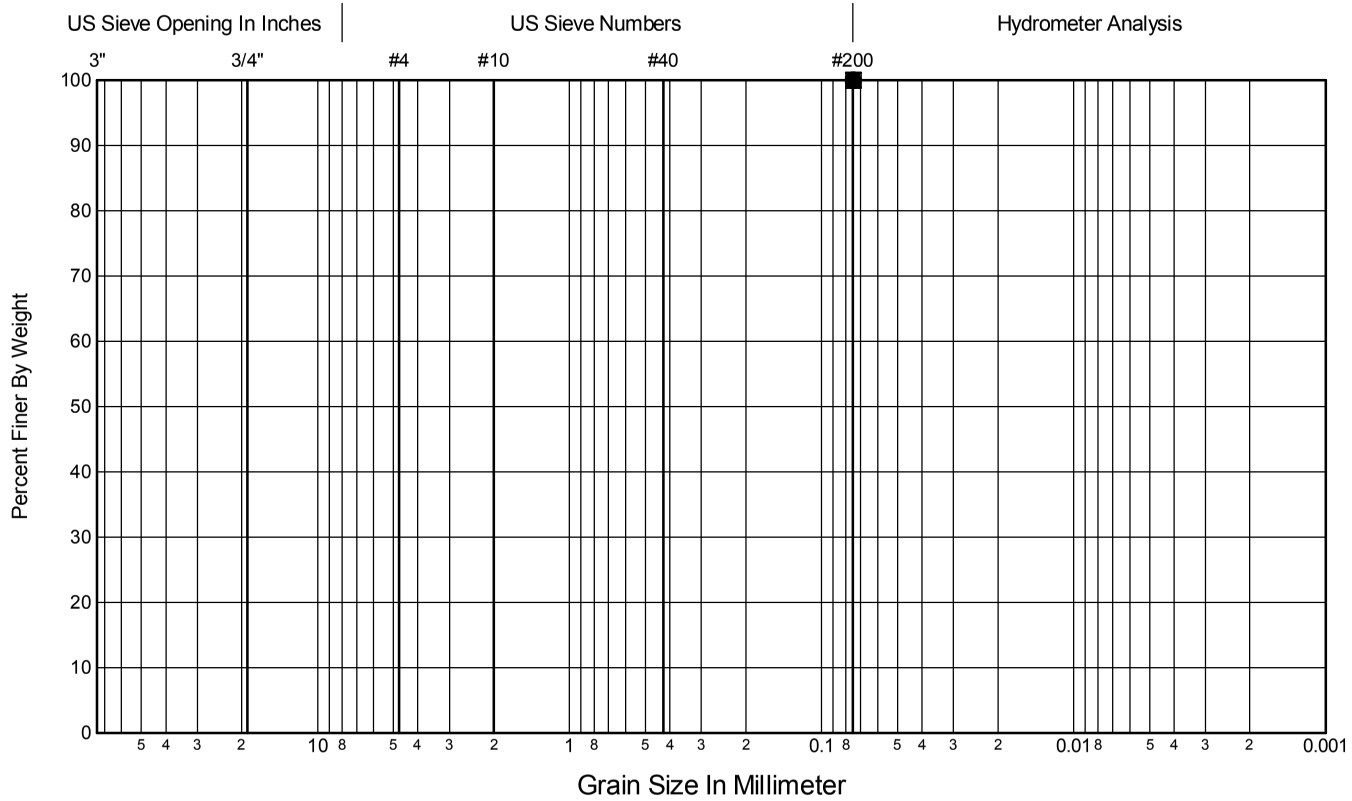
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**76.8**	**23.41**	**C-16**	**MH**	**See Boring Log**	**ELASTIC SILT**	**38**	**83**	**57**	**26**
⧗	**112.1**	**34.17**	**C-24**	**ML**	**See Boring Log**	**SILT**	**26**	**46**	**32**	**14**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**0.0**	**0.0**	**100.0**		
⧗	**0.0**	**0.0**	**100.0**		

GRADATION VALUES

	D60	D50	D30	D20	D10
●					
⧗					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-14si-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

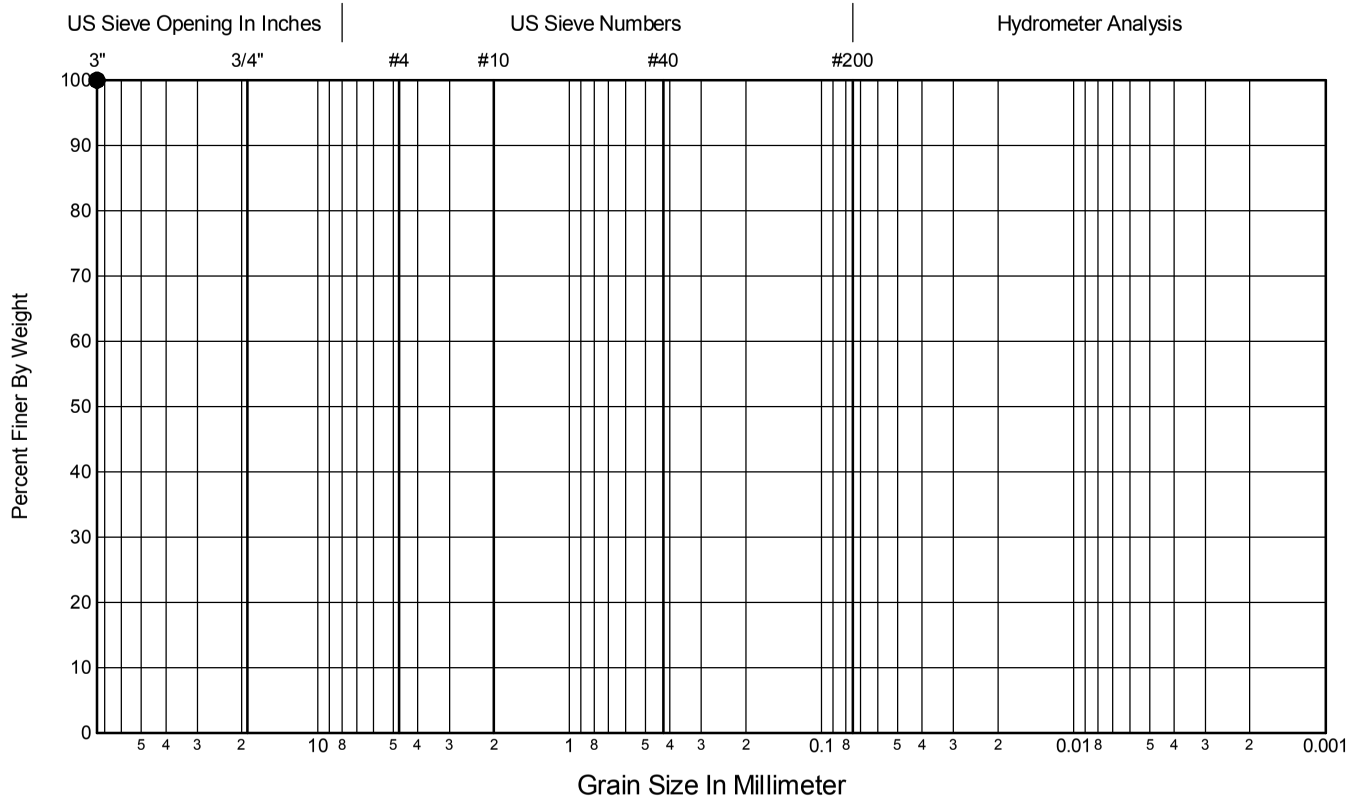
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**220.0**	**67.06**	**C-46**		**See Boring Log**		**44**	**59**	**38**	**21**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●					

GRADATION VALUES

	D60	D50	D30	D20	D10
●					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-22si-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

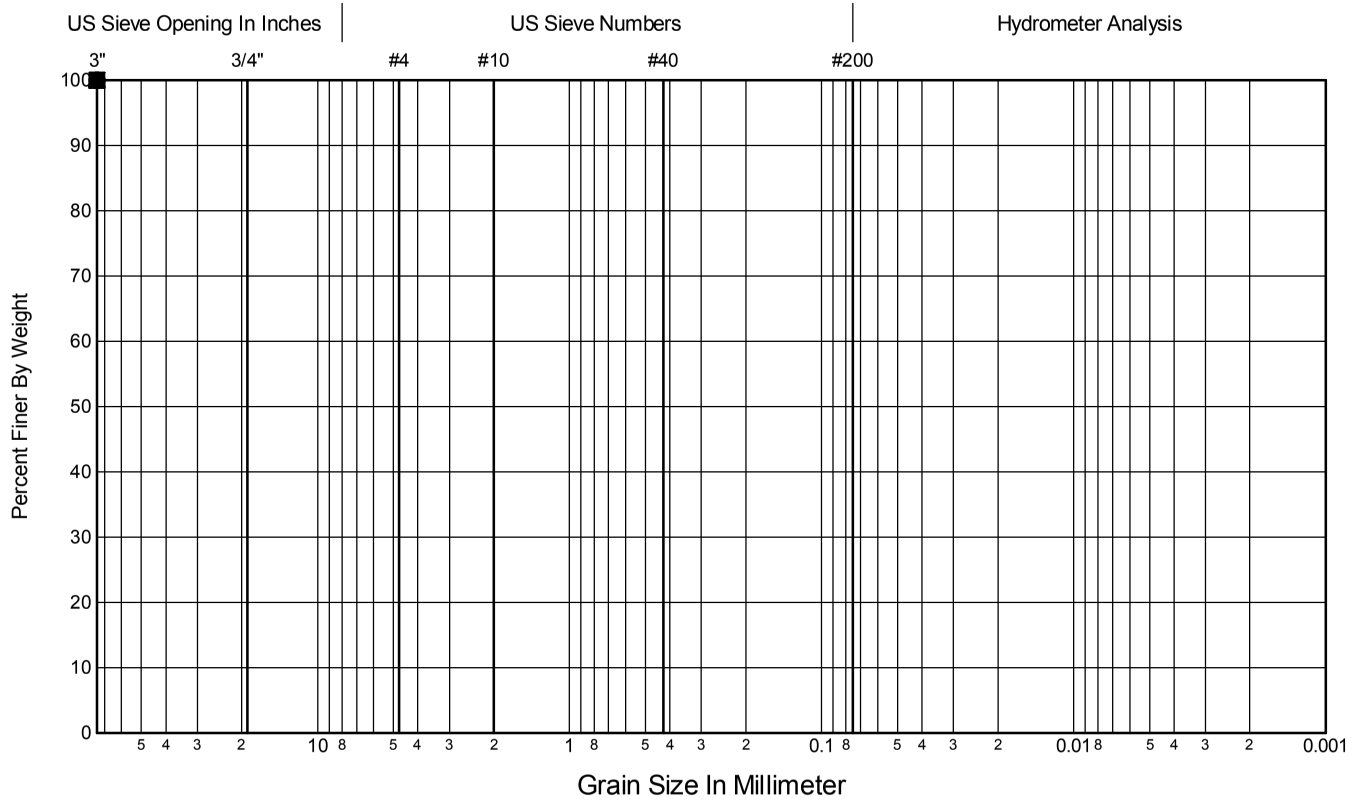
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**111.0**	**33.83**	**C-23**		**See Boring Log**		**42**	**65**	**40**	**25**
⧗	**251.0**	**76.50**	**C-51**		**See Boring Log**		**25**	**63**	**34**	**29**
▲	**271.0**	**82.60**	**C-55**		**See Boring Log**		**37**	**61**	**46**	**15**
★	**276.0**	**84.12**	**D-56**		**See Boring Log**		**47**	**61**	**48**	**13**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●					
⧗					
▲					
★					

GRADATION VALUES

	D60	D50	D30	D20	D10
●					
⧗					
▲					
★					



Job No. **XL3695** Date **May 7, 2010**

Hole No. **H-23-09** Sheet **1**

Project **SR-410 Nile Valley Landslide**

Laboratory Summary

Washington State Department of Transportation

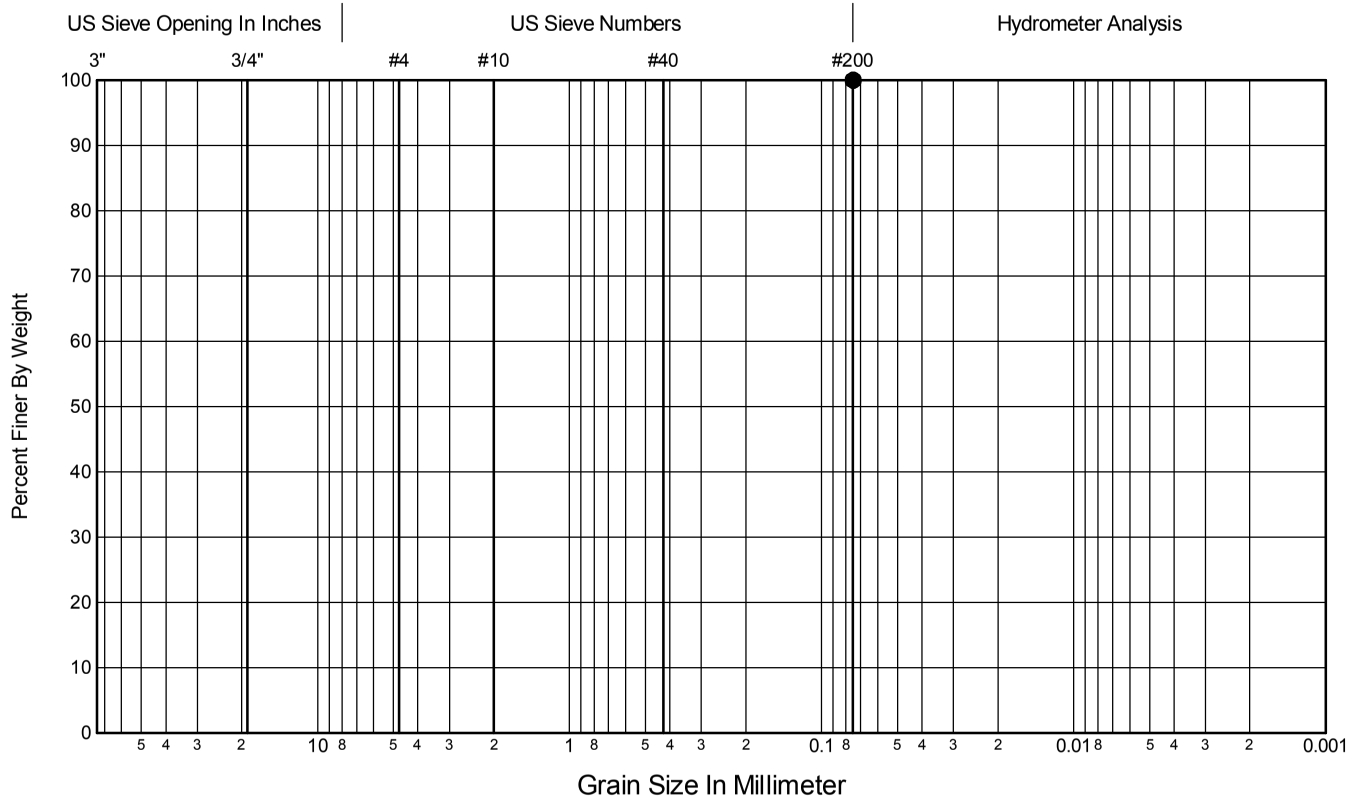
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**270.0**	**82.30**	**C-38**	**MH**	**See Boring Log**	**ELASTIC SILT**	**49**	**82**	**54**	**28**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**0.0**	**0.0**	**100.0**		

GRADATION VALUES

	D60	D50	D30	D20	D10
●					



Job No.	**XL3695**	Date	**May 7, 2010**
Hole No.	**H-24-09**	Sheet	**1**
Project	**SR-410 Nile Valley Landslide**		

Laboratory Summary

Washington State Department of Transportation

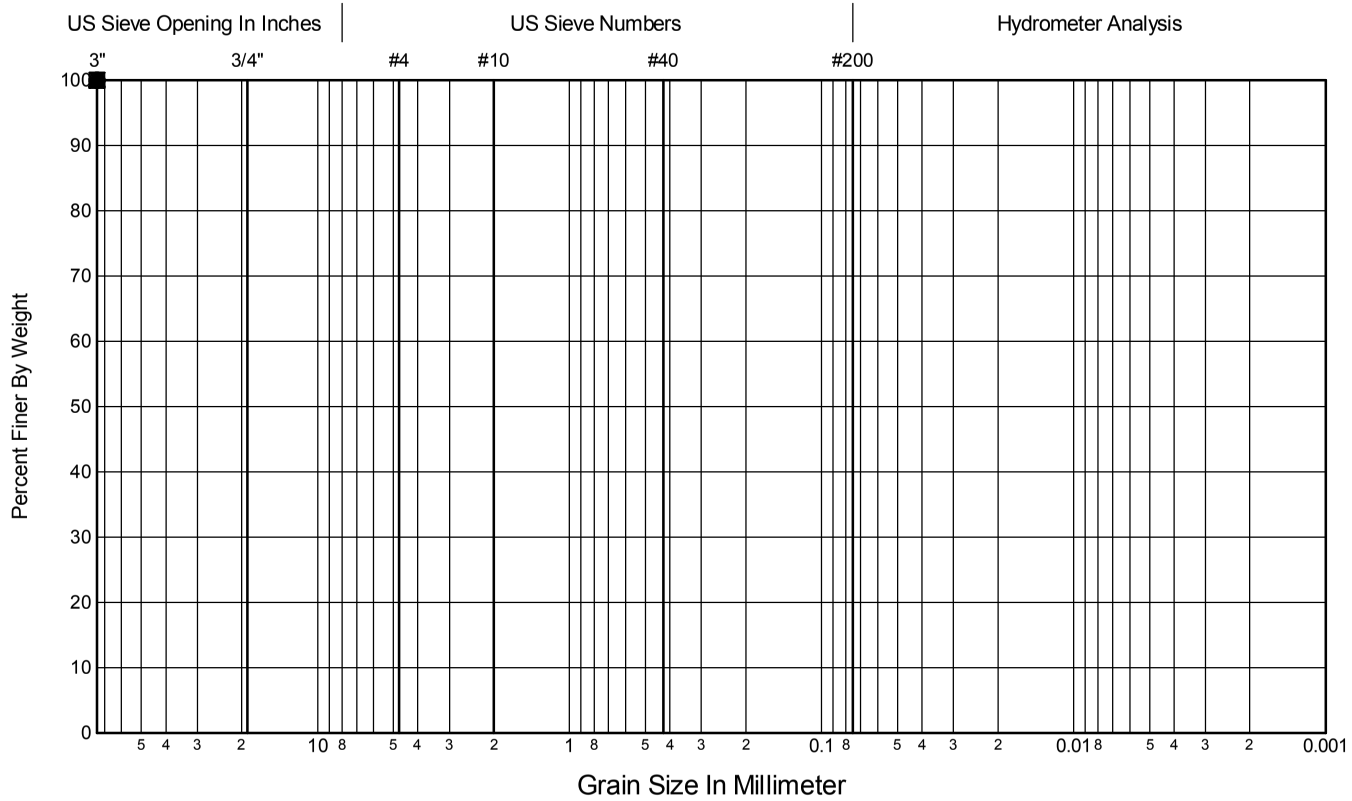
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**112.3**	**34.23**	**C-23**		**See Boring Log**		**9**	**56**	**28**	**28**
⧗	**117.3**	**35.75**	**C-24**		**See Boring Log**		**33**	**50**	**38**	**12**
▲	**227.3**	**69.28**	**C-46**		**See Boring Log**		**44**	**69**	**53**	**16**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●					
⧗					
▲					

GRADATION VALUES

	D60	D50	D30	D20	D10
●					
⧗					
▲					



Gravel	Sand			Silt and Clay
	Coarse	Medium	Fine	

LANDSLIDE TECHNOLOGY
A DIVISION OF CORNFORTH CONSULTANTS
10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1200 Fax 503-452-1528

April 9, 2010 2078

Mr. Thomas Badger
Senior Engineering Geologist
Washington State Department of Transportation
PO Box 47365
Olympia, Washington 98504-7365

Proposal for Geotechnical Services
Naches River Landslide Ring Shear Testing
Naches, Washington

Dear Mr. Badger:

This letter summarizes the results of geotechnical laboratory testing performed for the Naches River Landslide in Nile, Washington.

Background

Laboratory tests on samples from landslide shear zones collected from the Naches River Landslide were requested to develop shear strength parameters for WSDOT. Testing included residual strength and Atterberg limits. A total of six samples from five borings were shipped to our laboratory for testing, representing materials from both an upper and lower shear zone.

Sample Preparation

Boring designation, depths and soil descriptions for each sample tested are summarized in Table 1 below. The soil descriptions are based on a visual classification augmented by the results of the Atterberg limits tests.

Table 1: Sample Information

Boring	Depth (ft)	Soil Description
H-8si-09	23	Brown CLAY
H-12si-09	77	Brown, very silty CLAY
H-24-09	119	Brown, very silty CLAY
H-22si-09	255	Light brown, very silty CLAY
H-22si-09	275	Brown, silty CLAY
H-23-09	272	Light brown, silty CLAY

Samples were received pulverized and air dried, with particle size finer than the #40 sieve. Prior to testing, distilled water was added to the dried sample until a moisture content ranging from 40-70% was obtained. Atterberg limits were performed on the moisture conditioned samples to determine liquid and plastic limits in general accordance with ASTM D 4318.

Ring Shear Procedure

Ring shear testing was completed in general accordance with ASTM D 6467. The prepared sample was placed in the ring shear bottom platen and struck flush with the top surface. Initial unit weight was determined based on the total weight of soil placed in the ring shear and the initial moisture content. The soil was consolidated in stages to the desired normal stress. Samples were inundated with distilled water after achieving a consolidation stress of approximately 6 tons per square foot.

Once fully consolidated, preshear was performed at a rate of 2.2 mm/minute to create a shear surface and to achieve the large displacements required for residual strength in a reasonable time frame. The rate of shear was then decreased to 0.02 mm/min and data was collected until shear stresses were no longer decreasing (residual strength). Once the shear stress reached residual, the normal stress was lowered to approximately 3 tons per square foot and shearing was resumed to obtain a second data set for each sample. The average fit Mohr envelope line was determined based on the two data points and assuming no cohesive intercept for the residual shear condition.

Test Results

Results of the laboratory testing are summarized in Table 2 below.

Table 2: Lab Testing Results

Boring	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Residual Shear Strength Friction Angle
H-8si-09	23	57	27	30	19°
H-12si-09	77	59	36	23	11°
H-24-09	119	89	53	36	8°
H-22si-09	255	72	44	28	7°
H-22si-09	275	56	28	28	15°
H-23-09	272	90	47	43	7°

Mohr plots for each ring shear test sample are attached as well as the plasticity chart depicting Atterberg limit test results.

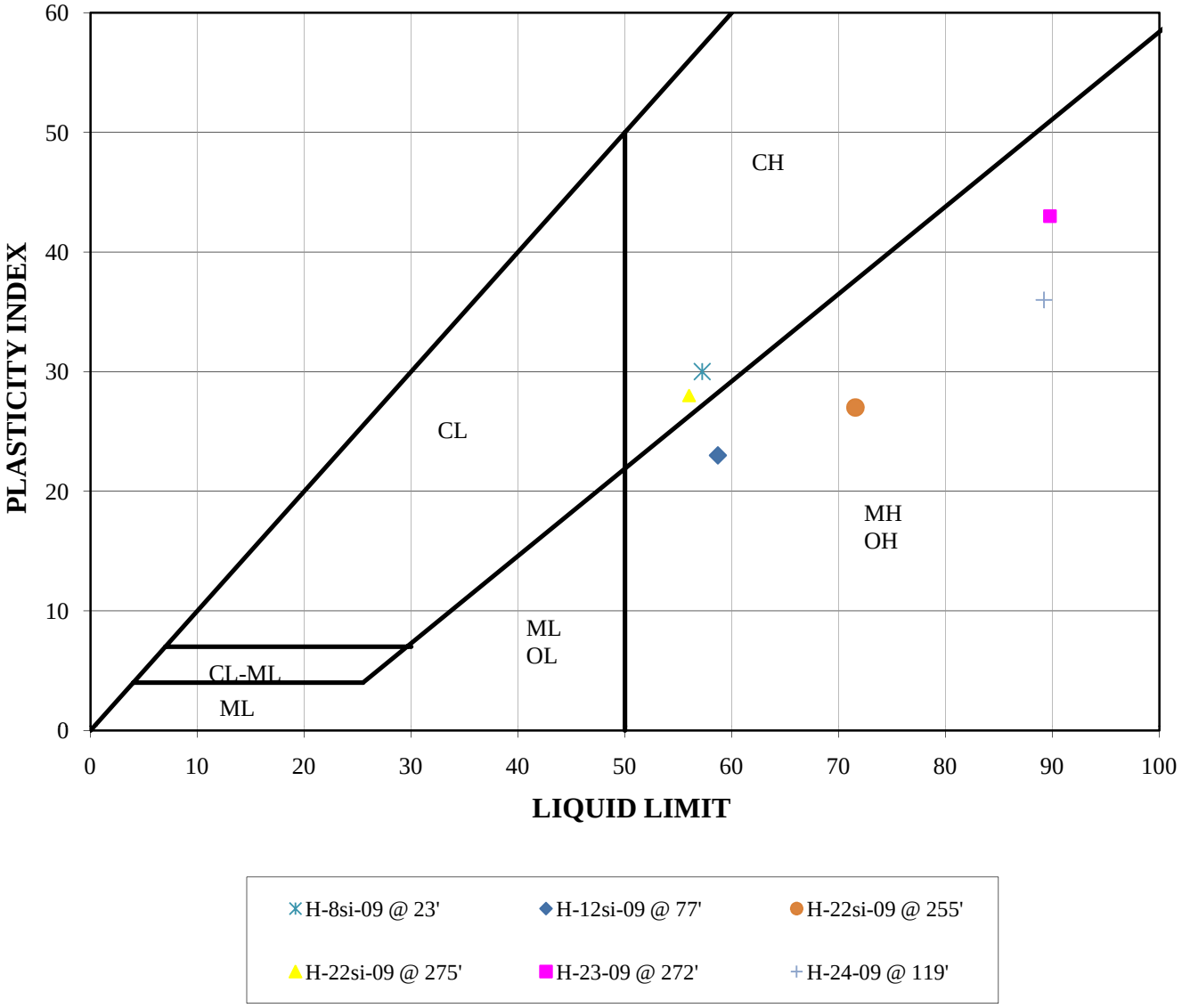
We appreciate the opportunity to be of service on this project. If you have any questions, please contact Chris Carpenter or George Machan at 503-452-1200.

Sincerely,

LANDSLIDE TECHNOLOGY

Chris Carpenter, P.E.
Project Engineer

PLASTICITY CHART

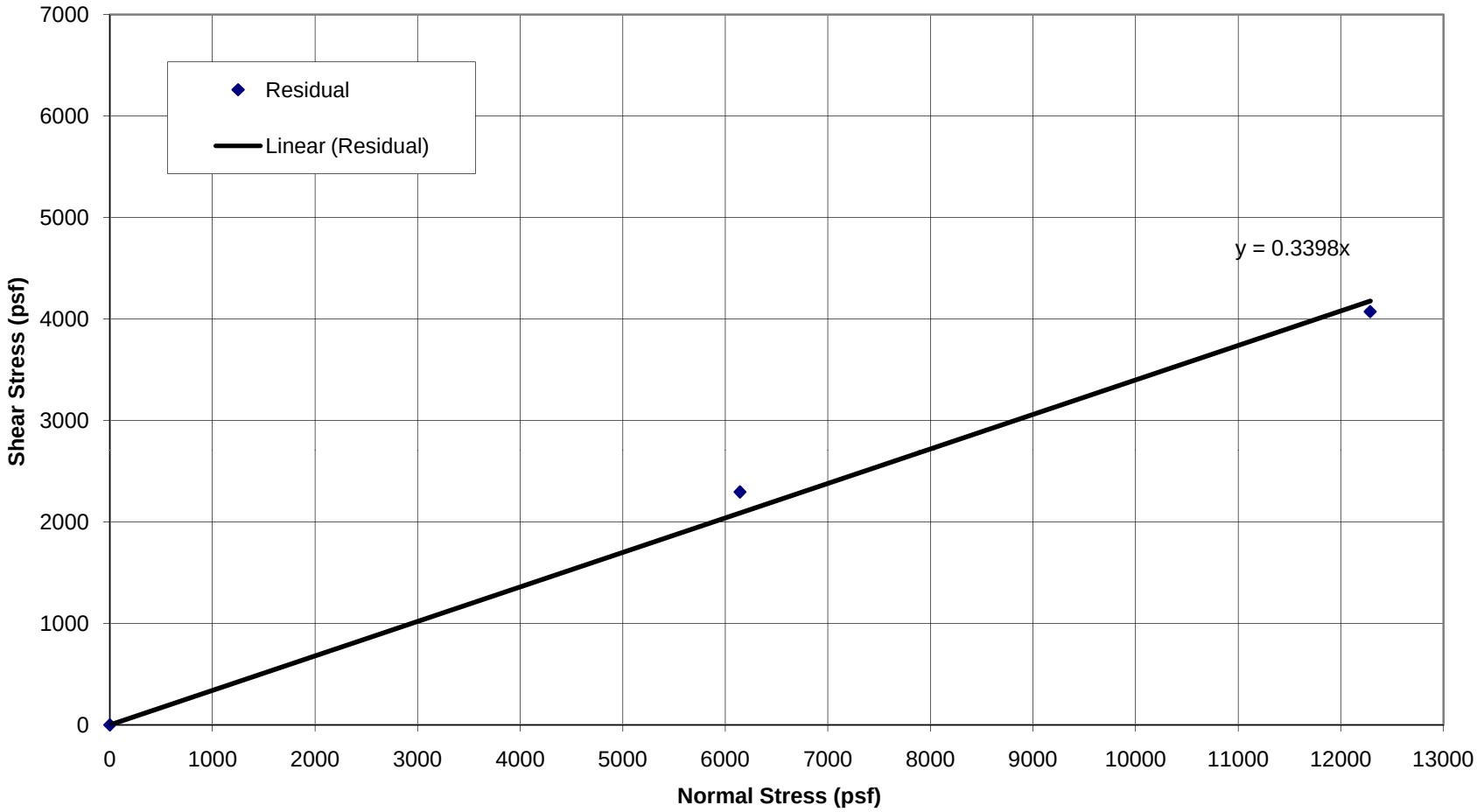


Ring Shear Test Mohr Envelope

Naches River Landslide Laboratory Testing

Boring No. H-8si-09, Depth 23'

ϕ_r= 18.8



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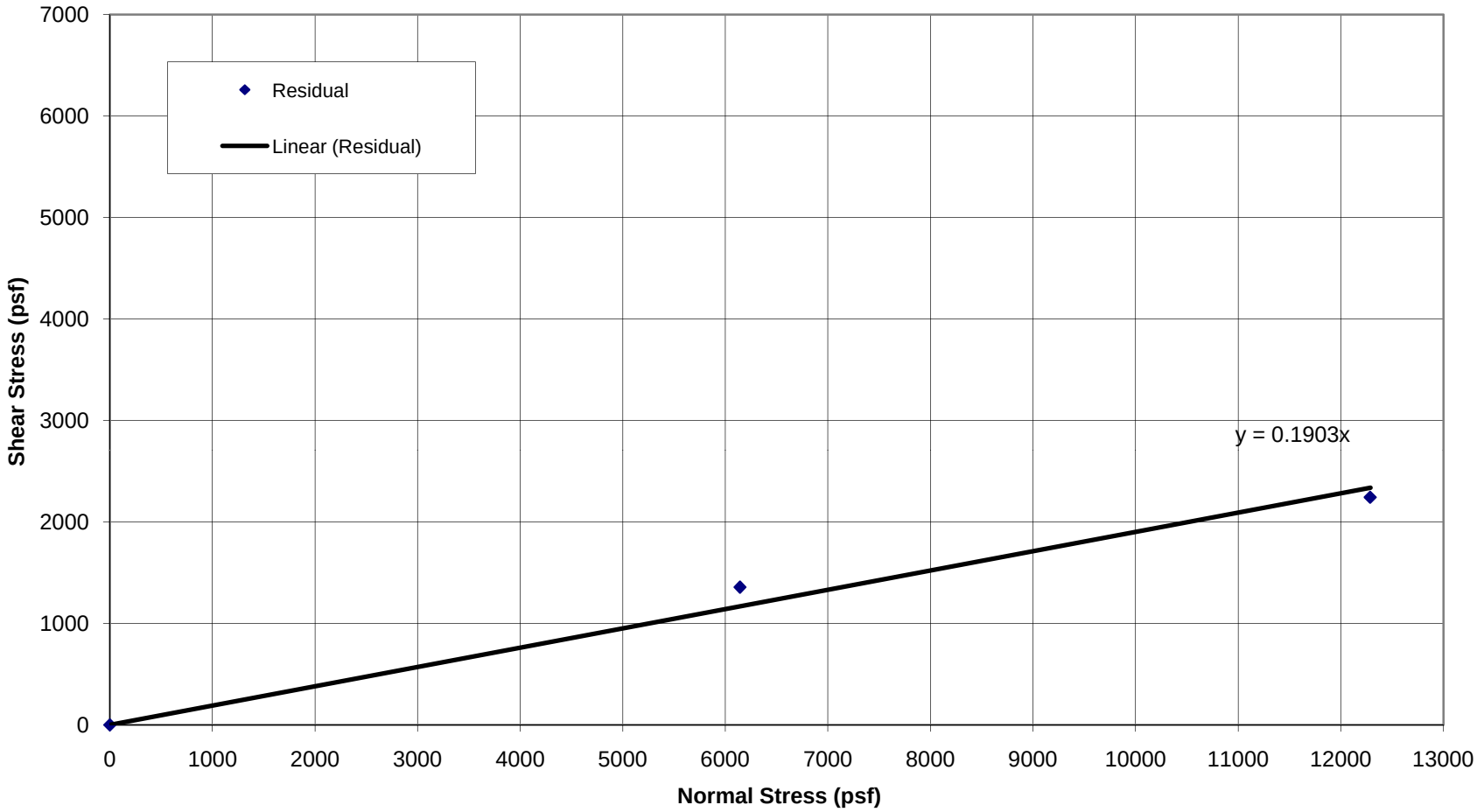
Revision Date: 03/2010

Ring Shear Test Mohr Envelope

Naches River Landslide Laboratory Testing

Boring No. H-12si-09, Depth 77'

ϕ_r= 10.8



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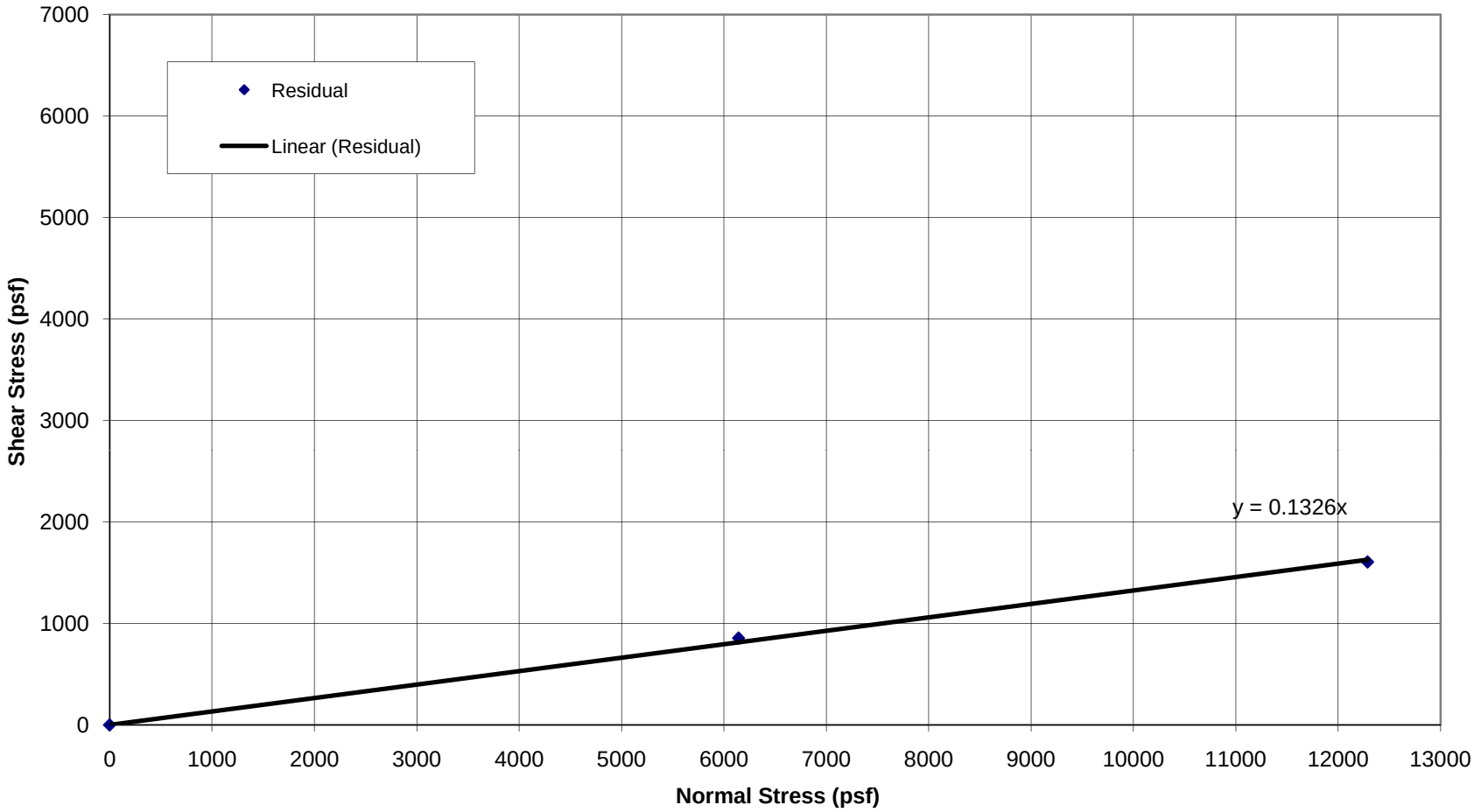
Ring Shear Test Mohr Envelope

Naches River Landslide Laboratory Testing

Boring No. H-24-09, Depth 119'

ϕ_r= 7.6



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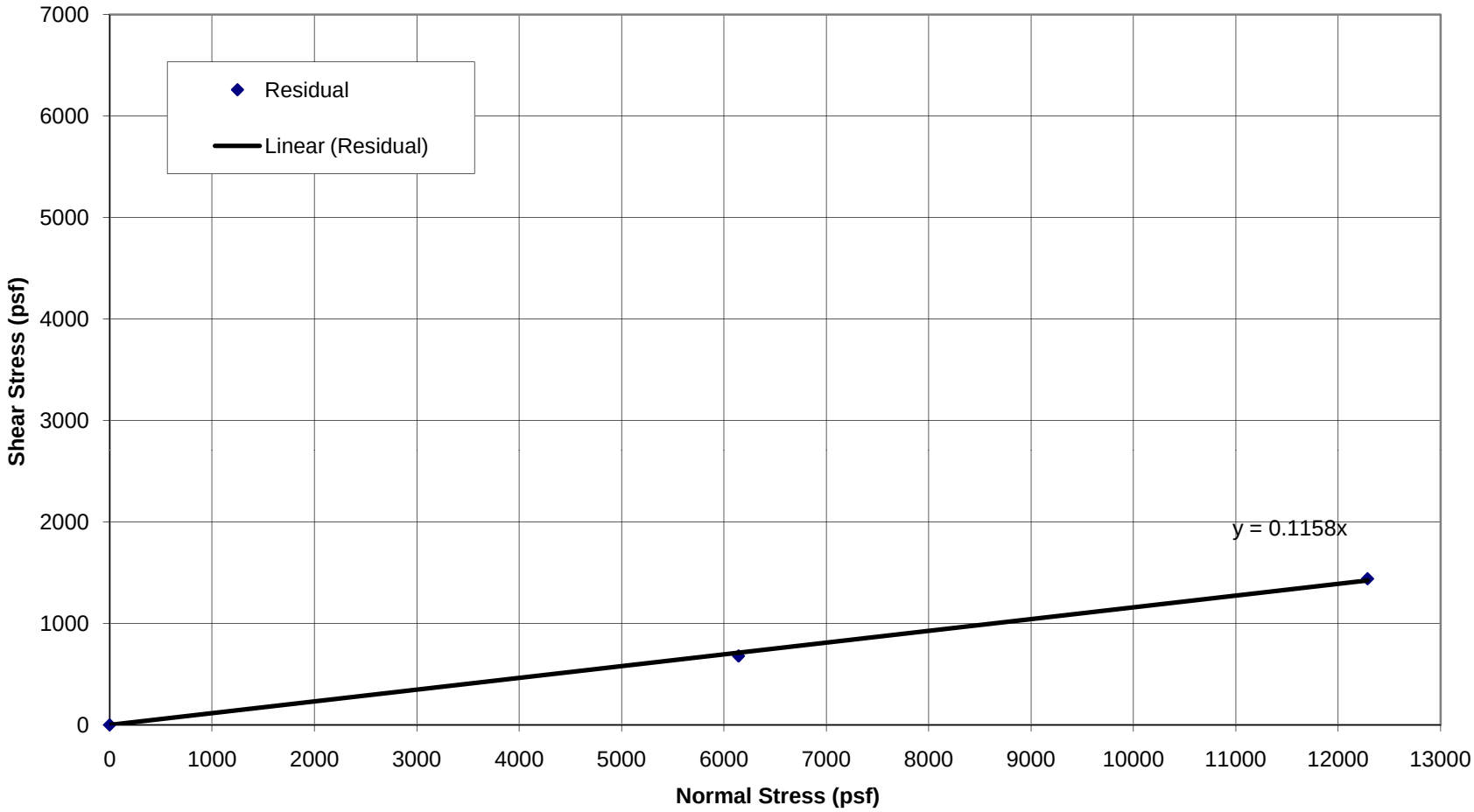
Revision Date: 03/2010

Ring Shear Test Mohr Envelope

Naches River Landslide Laboratory Testing

Boring No. H-22si-09, Depth 255'

ϕ_r= 6.6



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Portland, OR 97223

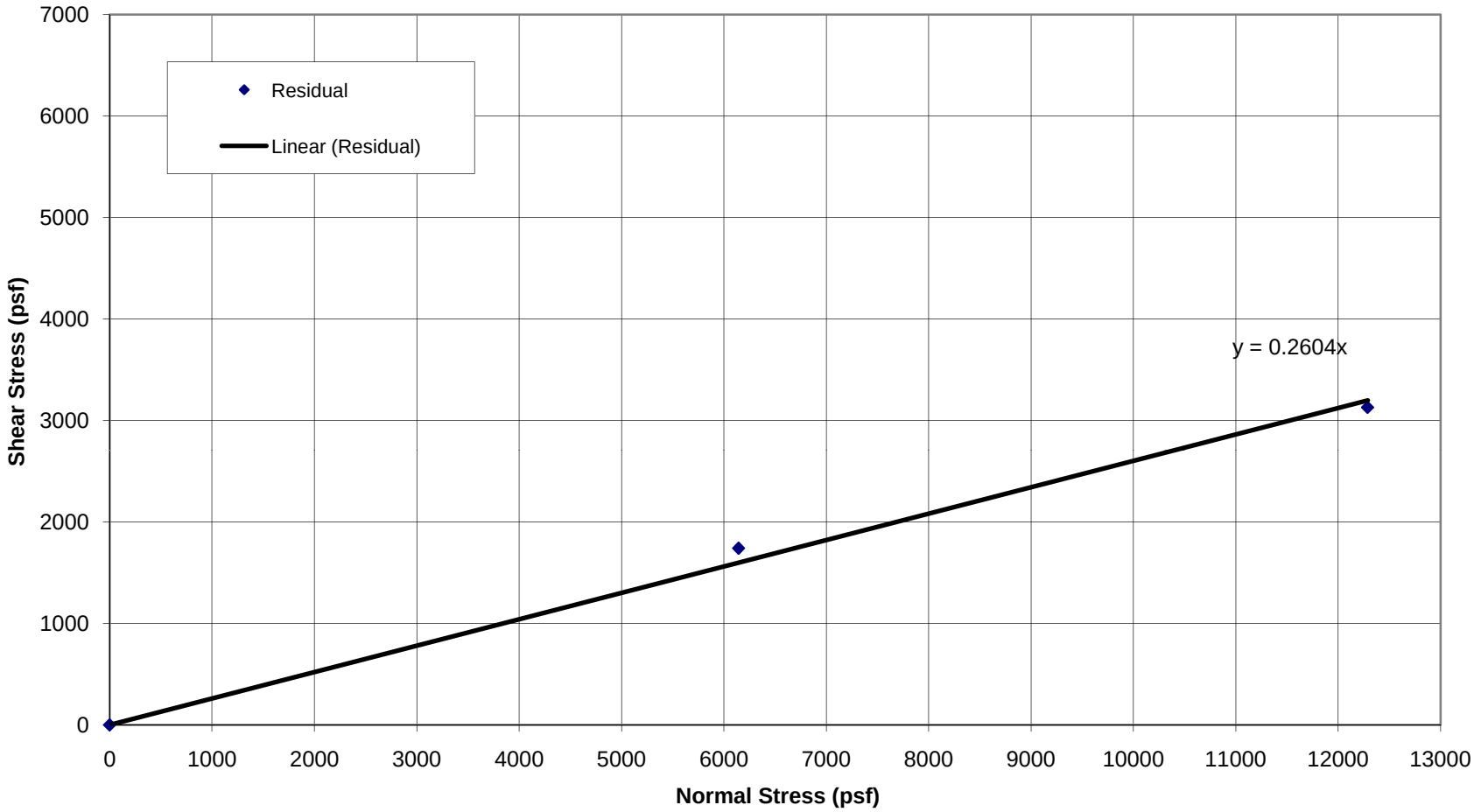
Revision Date: 03/2010

Ring Shear Test Mohr Envelope

Naches River Landslide Laboratory Testing

Boring No. H-22si-09, Depth 275'

ϕ_r= 14.6



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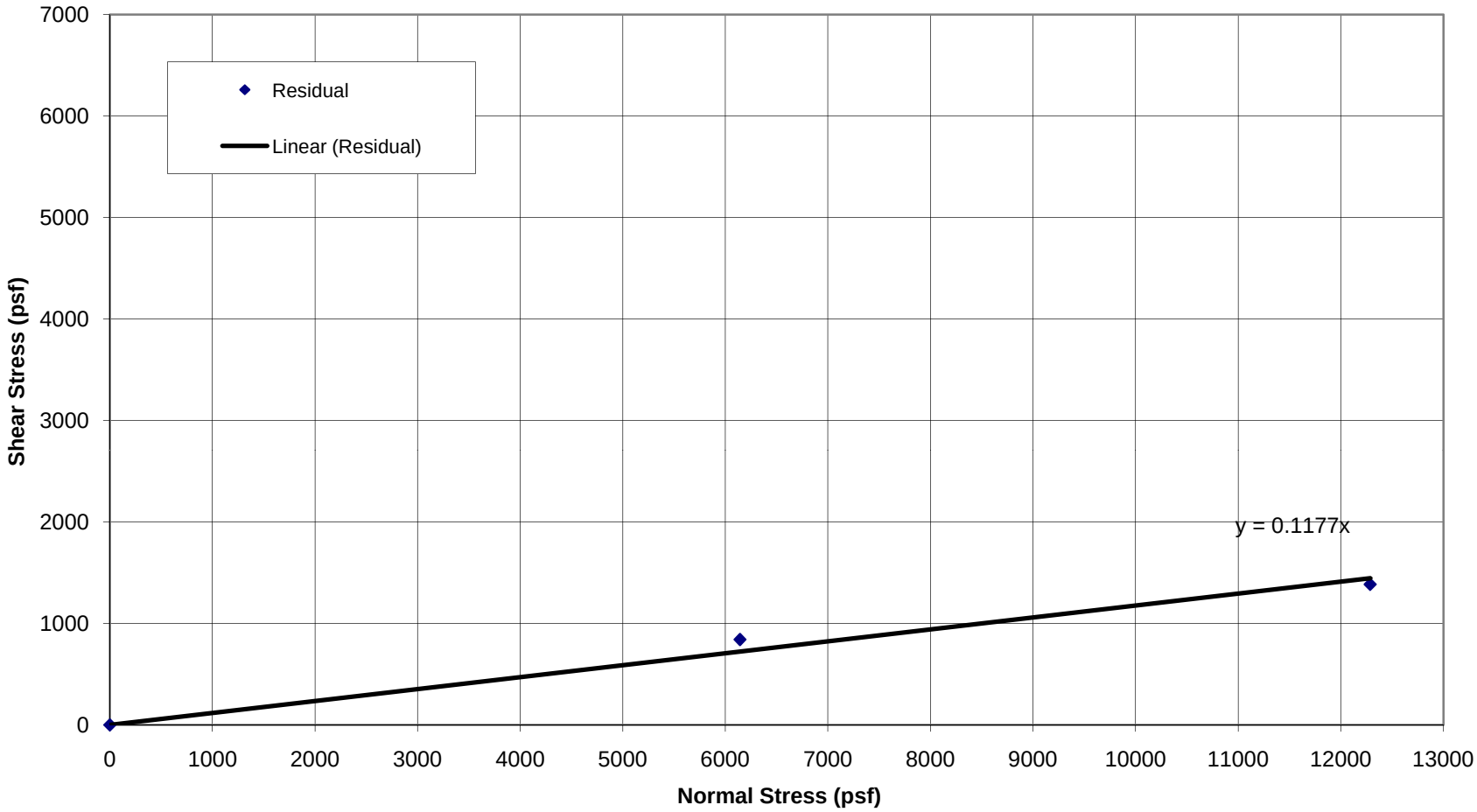
Ring Shear Test Mohr Envelope

Naches River Landslide Laboratory Testing

Boring No. H-23-09, Depth 272'

ϕ_r= 6.7



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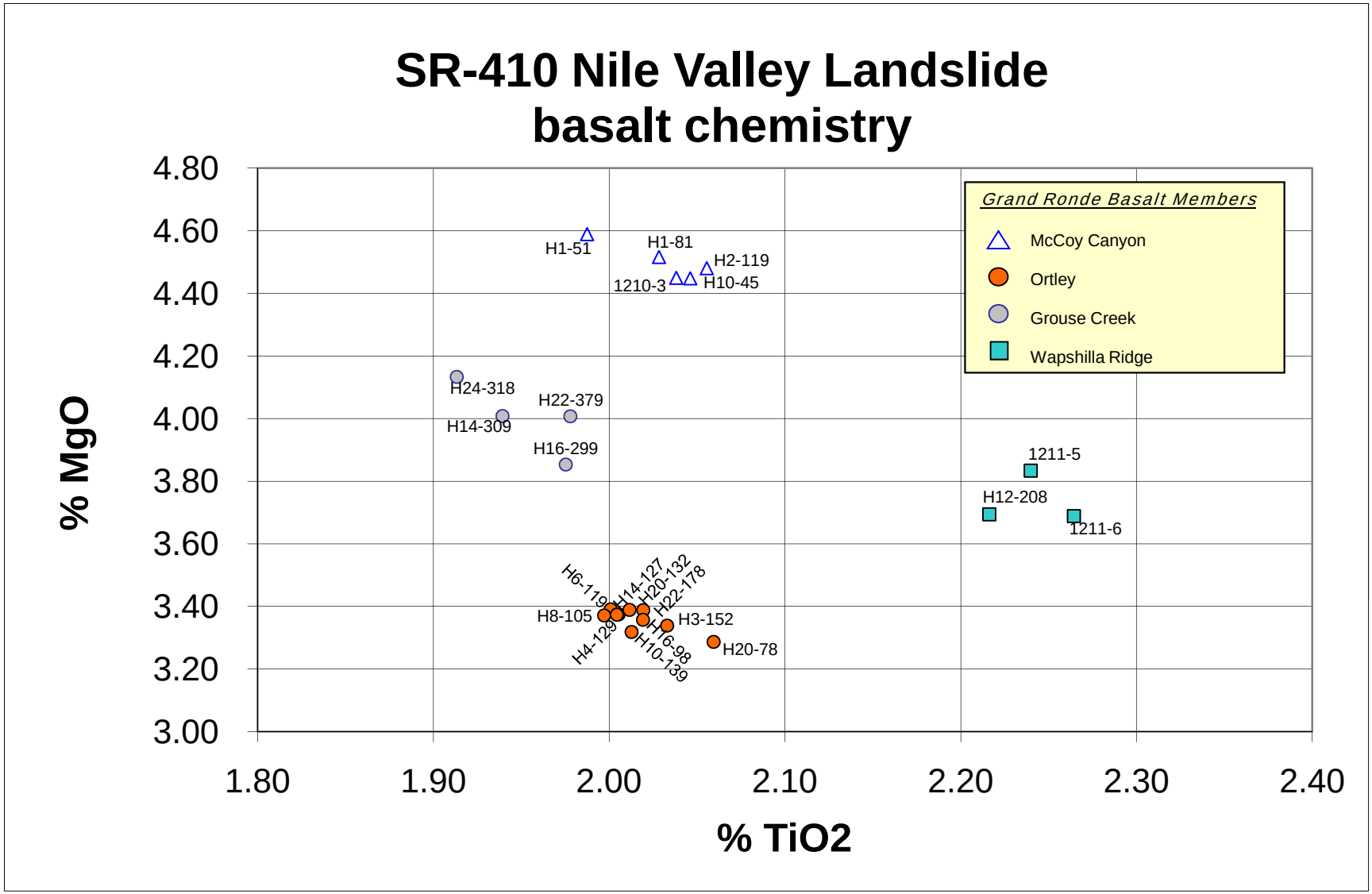
Revision Date: 03/2010


SR-410 Nile Valley Landslide
basalt chemistry
% MgO
% TiO2
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
1.80
1.90
2.00
2.10
2.20
2.30
2.40
Grand Ronde Basalt Members
McCoy Canyon
Ortley
Grouse Creek
Wapshilla Ridge
H1-51
H1-81
H2-119
1210-3
H10-45
H24-318
H22-379
H14-309
H16-299
1211-5
H12-208
1211-6
H6-119
H14-127
H20-132
H22-178
H8-105
H3-152
H4-129
H16-98
H10-139
H20-78

Run 0109, Tom Badger, WSDOT

	BAD121 0093	BAD121 1095	BAD121 1096	BADH14 09309	BADH14 09127	BADH22 09178	BADH22 09379	BADH24 09318	BAD H1 0951	BAD H1 0981
Date	6-Jan-10	6-Jan-10	6-Jan-10	6-Jan-10	6-Jan-10	6-Jan-10	6-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10
	1210-3	**1211-5**	**1211-6**	**H14-309**	**H14-127**	**H22-178**	**H22-379**	**H24-318**	**H1-51**	**H1-81**
	Unnormalized Major Elements (Weight %):									
SiO2	53.78	54.25	53.90	54.69	55.60	56.15	54.65	54.72	53.65	53.94
TiO2	2.025	2.218	2.226	1.901	1.975	1.995	1.955	1.891	1.971	2.019
Al2O3	13.64	13.62	13.48	13.75	13.60	13.64	13.69	13.75	13.74	13.73
FeO*	12.55	12.43	12.34	11.24	11.60	11.22	11.82	11.58	12.22	12.31
MnO	0.210	0.196	0.196	0.176	0.189	0.189	0.190	0.186	0.221	0.217
MgO	4.42	3.80	3.63	3.93	3.32	3.35	3.96	4.08	4.55	4.49
CaO	8.19	7.40	7.34	7.34	6.92	6.94	7.62	7.65	8.36	8.26
Na2O	2.88	3.09	3.01	3.20	3.16	3.12	3.07	3.11	2.88	2.92
K2O	1.33	1.62	1.78	1.51	1.75	1.83	1.58	1.53	1.27	1.28
P2O5	0.336	0.406	0.394	0.313	0.379	0.370	0.320	0.311	0.317	0.341
Sum	99.36	99.02	98.30	98.05	98.49	98.81	98.87	98.81	99.18	99.51
	Normalized Major Elements (Weight %):									
SiO2	54.12	54.78	54.84	55.78	56.45	56.83	55.28	55.38	54.09	54.21
TiO2	2.038	2.240	2.264	1.939	2.005	2.019	1.978	1.913	1.987	2.028
Al2O3	13.73	13.76	13.72	14.02	13.81	13.81	13.85	13.92	13.85	13.79
FeO*	12.63	12.55	12.55	11.46	11.77	11.36	11.95	11.72	12.32	12.37
MnO	0.211	0.198	0.199	0.180	0.191	0.191	0.192	0.188	0.223	0.218
MgO	4.45	3.83	3.69	4.01	3.37	3.39	4.01	4.13	4.59	4.52
CaO	8.24	7.47	7.47	7.49	7.02	7.03	7.71	7.75	8.43	8.30
Na2O	2.90	3.12	3.06	3.27	3.21	3.16	3.11	3.14	2.91	2.94
K2O	1.34	1.64	1.81	1.54	1.78	1.85	1.60	1.55	1.28	1.29
P2O5	0.338	0.410	0.401	0.319	0.385	0.375	0.324	0.315	0.320	0.342
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Unnormalized Trace Elements (ppm):									
Ni	12	18	16	15	6	6	15	17	13	10
Cr	18	12	11	13	4	5	12	14	17	18
Sc	35	34	34	32	31	30	33	33	37	37
V	345	395	391	337	300	302	348	336	341	348
Ba	497	667	660	625	711	712	616	621	491	514
Rb	33	45	48	43	52	52	44	42	32	34
Sr	318	335	333	315	330	330	319	320	320	324
Zr	163	183	184	167	194	193	170	168	162	164
Y	34	38	38	34	36	38	35	34	34	36
Nb	12.3	13.0	13.0	11.6	14.1	14.4	12.0	11.9	12.0	12.0
Ga	20	22	21	19	21	22	20	20	20	22
Cu	23	38	38	30	15	15	31	30	25	25
Zn	122	128	127	117	125	123	120	116	124	122
Pb	5	8	8	9	8	9	7	8	6	6
La	23	27	25	22	28	29	21	24	20	23
Ce	47	55	54	50	57	59	50	46	44	44
Th	4	5	6	6	8	7	5	6	5	4
Nd	26	29	33	25	31	31	22	26	24	25
U	2	2	3	3	2	2	1	1	3	1
sum tr.	1739	2052	2042	1872	1972	1977	1879	1872	1730	1767
in %	0.17	0.21	0.20	0.19	0.20	0.20	0.19	0.19	0.17	0.18
sum m+tr	99.53	99.23	98.50	98.24	98.69	99.01	99.06	99.00	99.35	99.69
M+Toxides	99.58	99.28	98.55	98.28	98.73	99.05	99.10	99.05	99.40	99.74

Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
"R" denotes a duplicate bead made from the same rock powder.

Run 0109, Tom Badger, WSDOT

	BAD H2	BAD H4	BADH20	BADH20	BAD H6	BAD H8	BADH16	BADH16	BADH10	BADH10
	09119	09129	0978	09132	09119	09105	09299	0998	09139	0945
Date	7-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10	7-Jan-10
	H2-119	H4-129	H20-78	H20-132	H6-119	H8-105	H16-299	H16-98	H10-139	H10-45
Unnormalized Major Elements (Weight %):										
SiO2	53.78	55.85	55.71	55.89	55.47	55.67	54.57	55.87	55.82	53.48
TiO2	2.043	1.978	2.023	1.987	1.968	1.960	1.932	1.985	1.983	2.020
Al2O3	13.77	13.59	13.58	13.56	13.55	13.54	13.66	13.62	13.59	13.59
FeO*	12.30	11.57	11.34	11.56	11.67	11.34	11.35	11.14	11.42	12.35
MnO	0.214	0.187	0.201	0.194	0.205	0.205	0.185	0.185	0.197	0.214
MgO	4.45	3.33	3.23	3.35	3.34	3.31	3.77	3.30	3.27	4.39
CaO	8.20	6.91	6.82	6.95	6.93	6.90	7.30	6.90	6.92	8.21
Na2O	2.92	3.17	3.10	3.14	3.06	3.00	3.17	3.02	3.03	2.86
K2O	1.35	1.73	1.88	1.81	1.82	1.83	1.51	1.92	1.92	1.29
P2O5	0.333	0.370	0.367	0.358	0.365	0.368	0.346	0.355	0.360	0.332
Sum	99.37	98.69	98.25	98.79	98.36	98.13	97.79	98.29	98.53	98.74
Normalized Major Elements (Weight %):										
SiO2	54.12	56.59	56.70	56.57	56.39	56.73	55.80	56.84	56.66	54.16
TiO2	2.056	2.004	2.059	2.012	2.001	1.997	1.975	2.019	2.013	2.046
Al2O3	13.86	13.78	13.82	13.72	13.77	13.80	13.97	13.85	13.80	13.77
FeO*	12.38	11.72	11.55	11.70	11.86	11.56	11.60	11.33	11.59	12.51
MnO	0.216	0.190	0.205	0.197	0.209	0.208	0.189	0.189	0.200	0.217
MgO	4.48	3.37	3.29	3.39	3.39	3.37	3.85	3.36	3.32	4.45
CaO	8.25	7.00	6.95	7.03	7.05	7.03	7.47	7.02	7.03	8.31
Na2O	2.94	3.21	3.16	3.18	3.11	3.06	3.24	3.08	3.08	2.90
K2O	1.36	1.76	1.91	1.84	1.85	1.87	1.54	1.95	1.95	1.31
P2O5	0.335	0.375	0.373	0.362	0.371	0.375	0.354	0.361	0.365	0.337
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Unnormalized Trace Elements (ppm):										
Ni	12	8	6	8	8	7	16	7	9	12
Cr	18	3	4	4	4	3	10	3	2	17
Sc	35	31	30	31	31	31	33	31	31	36
V	348	303	296	299	297	296	348	298	300	346
Ba	504	726	725	704	700	726	618	712	730	495
Rb	35	51	54	53	53	54	43	52	54	34
Sr	324	329	332	329	329	335	314	332	331	321
Zr	163	193	194	194	192	195	169	193	193	163
Y	36	37	38	38	37	37	35	37	38	35
Nb	12.5	13.6	14.1	14.0	13.8	14.4	12.1	14.0	13.9	12.7
Ga	21	21	20	22	22	21	21	21	21	20
Cu	25	14	13	14	14	13	31	13	13	25
Zn	122	124	125	124	123	122	118	126	125	121
Pb	5	7	9	9	9	10	7	9	9	7
La	22	28	27	28	30	24	25	26	27	19
Ce	47	57	58	58	56	58	50	59	59	48
Th	5	7	6	8	7	6	5	7	7	4
Nd	26	30	29	31	27	31	26	29	31	25
U	3	1	3	2	2	2	3	2	2	2
sum tr.	1763	1981	1981	1968	1956	1984	1884	1973	1995	1742
in %	0.18	0.20	0.20	0.20	0.20	0.20	0.19	0.20	0.20	0.17
sum m+tr	99.55	98.89	98.45	98.98	98.56	98.33	97.98	98.49	98.73	98.92
M+Toxides	99.60	98.93	98.50	99.03	98.60	98.38	98.02	98.54	98.77	98.96

Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
"R" denotes a duplicate bead made from the same rock powder.

Run 0109, Tom Badger, WSDOT

	BADH3 09152	BADH12 09208	BAD121 1095	BAD121 1095 R
Date	7-Jan-10	7-Jan-10	6-Jan-10	7-Jan-10
	H3-152	**H12-208**		
	Unnormalized Major Elements (Weight %):			
SiO2	55.69	50.94	54.25	53.88
TiO2	1.999	2.062	2.218	2.210
Al2O3	13.58	12.58	13.62	13.52
FeO*	11.43	12.57	12.43	12.54
MnO	0.205	0.181	0.196	0.194
MgO	3.28	3.44	3.80	3.71
CaO	6.88	7.12	7.40	7.35
Na2O	3.05	2.61	3.09	3.03
K2O	1.87	1.19	1.62	1.61
P2O5	0.365	0.350	0.406	0.402
Sum	98.35	93.04	99.02	98.44
	Normalized Major Elements (Weight %):			
SiO2	56.62	54.75	54.78	54.73
TiO2	2.033	2.216	2.240	2.245
Al2O3	13.81	13.52	13.76	13.73
FeO*	11.62	13.52	12.55	12.74
MnO	0.208	0.194	0.198	0.197
MgO	3.34	3.69	3.83	3.77
CaO	7.00	7.65	7.47	7.46
Na2O	3.10	2.81	3.12	3.08
K2O	1.91	1.28	1.64	1.63
P2O5	0.371	0.376	0.410	0.408
Total	100.00	100.00	100.00	100.00
	Unnormalized Trace Elements (ppm):			
Ni	8	18	18	19
Cr	2	9	12	10
Sc	30	32	34	34
V	301	370	395	391
Ba	707	573	667	669
Rb	54	35	45	45
Sr	334	324	335	334
Zr	194	170	183	183
Y	37	34	38	38
Nb	14.6	13.2	13.0	13.4
Ga	22	21	22	19
Cu	13	37	38	37
Zn	124	116	128	130
Pb	8	7	8	8
La	30	24	27	28
Ce	60	48	55	51
Th	6	5	5	6
Nd	31	26	29	28
U	2	1	2	2
sum tr.	1979	1864	2052	2045
in %	0.20	0.19	0.21	0.20
sum m+tr	98.55	93.22	99.23	98.65
M+Toxides	98.60	93.27	99.28	98.70

Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
"R" denotes a duplicate bead made from the same rock powder.

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512

ROCK CORES

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No : 410
Project Engineer : Tom Badger
Org Code : 452201

Sample ID : 00000106591 H-6VW-09, 138.ft. siltstone
Lab Number : C0100028
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

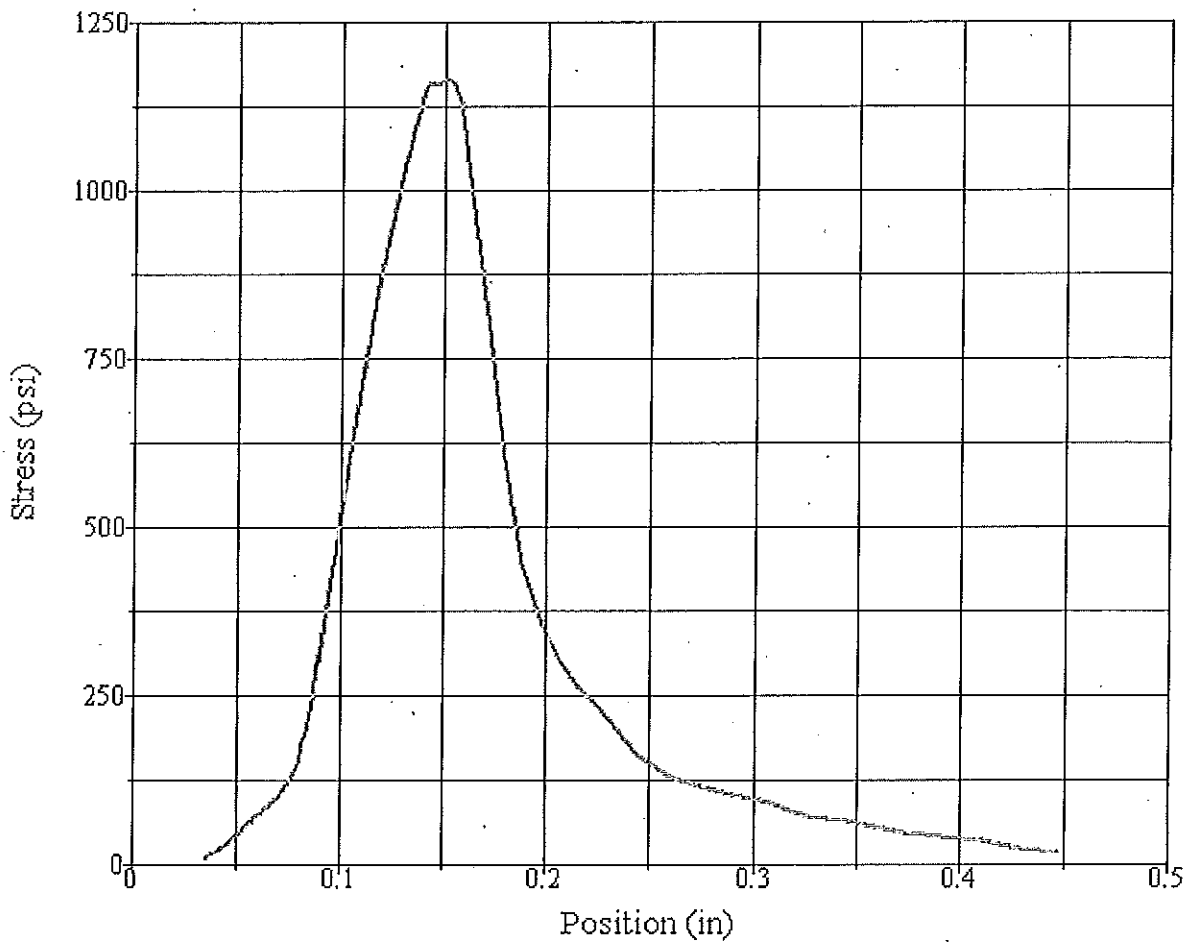
Cylinder No:	A-1
Avg. Diameter(in):	2.40
Cross Section Area (sq.in):	4.50
Original Height(in):	5.46
Original Weight(lbs):	1.72
Density (lbs/cf.):	120.97
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.28
Correction Factor:	1.00
Maximum Load (lbs):	5,265
Compressive Strength (psi) :	1,170
Fracture Type:	Cone and Shear

Average Compressive Strength : 1,170 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	0
Elapsed Time:	00:00:40
Cube Number:	A-1
Contract Number:	XL3695
Lab ID Number:	000000106591
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	9:16:23 AM
End Date:	3/4/2010
End Time:	9:17:03 AM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.4000 in
Area:	4.5239 in²
Peak Stress:	1164 psi
Peak Load:	5265 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No :
Project Engineer :
Org Code : 452201

Sample ID : 000001065af 11-14-09, 238ft. Siltstone
Lab Number : C0100031
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

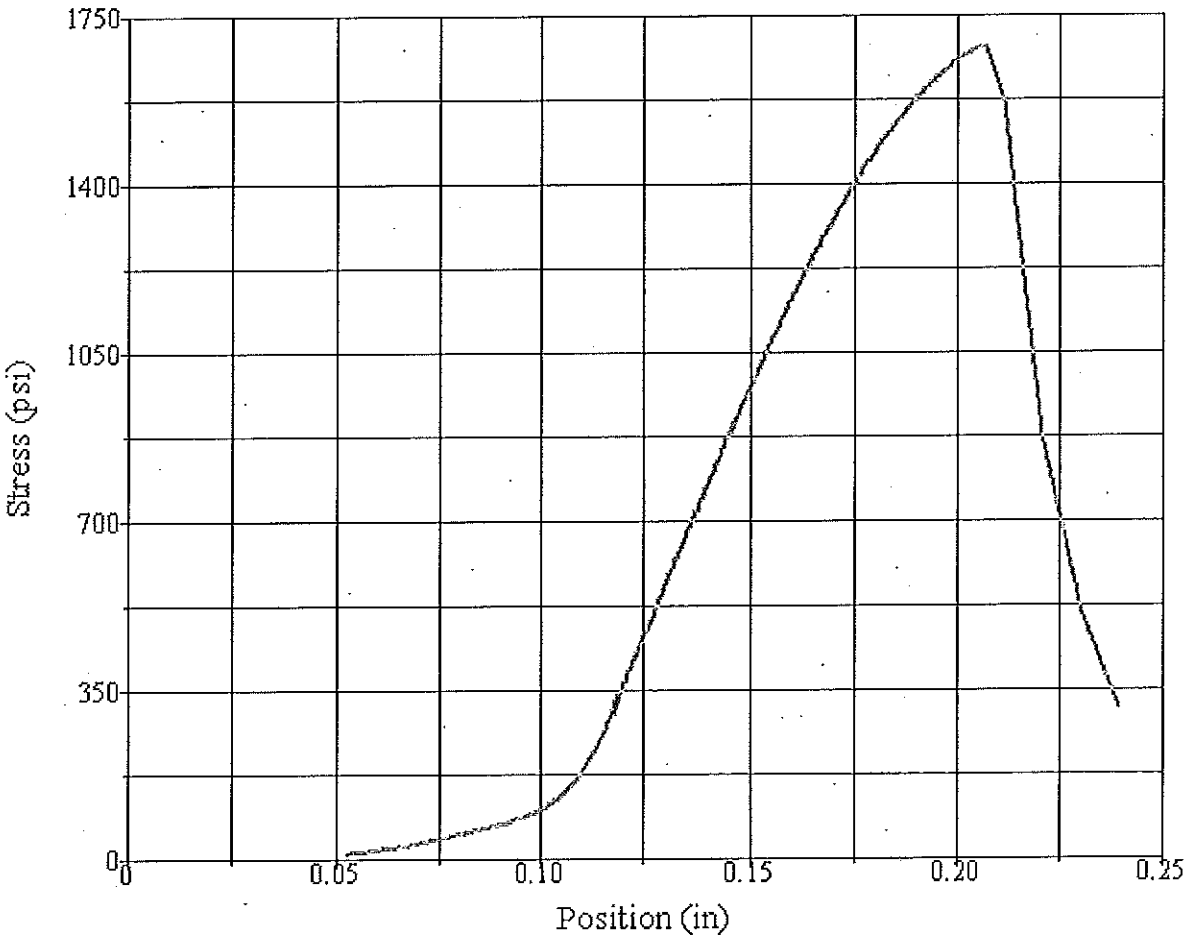
Cylinder No:	C-2
Avg. Diameter(in):	2.39
Cross Section Area (sq.in):	4.49
Original Height(in):	5.65
Original Weight(lbs):	1.76
Density (lbs/cf.):	119.88
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.36
Correction Factor:	1.00
Maximum Load (lbs):	7,552
Compressive Strength (psi) :	1,680
Fracture Type:	Shear

Average Compressive Strength : 1,680 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	947
Elapsed Time:	00:00:52
Cube Number:	C-2
Contract Number:	XL3695
Lab ID Number:	000001065AF
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	11:34:35 AM
End Date:	3/4/2010
End Time:	11:35:27 AM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3900 in
Area:	4.4863 in²
Peak Stress:	1683 psi
Peak Load:	7552 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No :
Project Engineer :
Org Code : 452201

Sample ID : 000001065b7 H-20-09, 91 ft. siltstone
Lab Number : C0100037
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

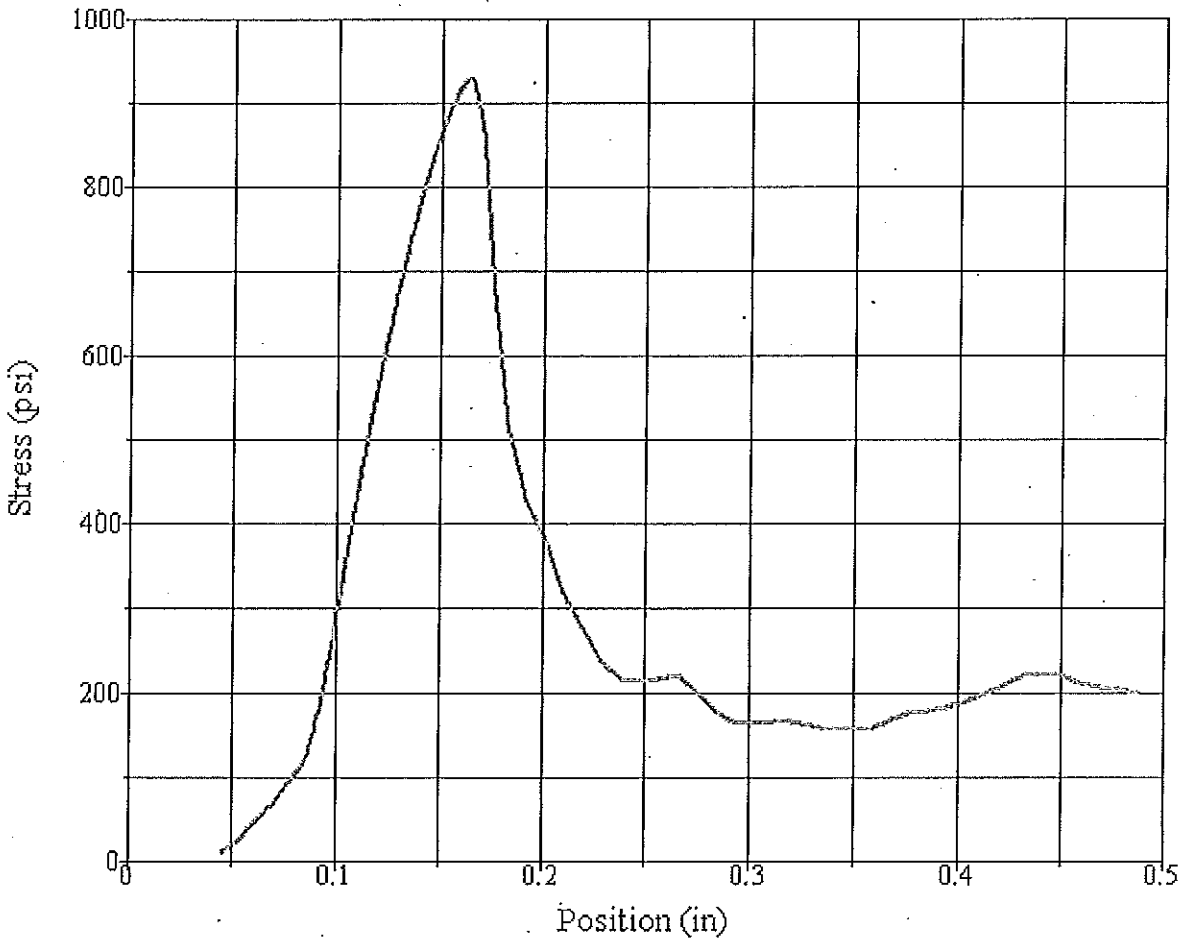
Cylinder No:	E-1
Avg. Diameter(in):	2.35
Cross Section Area (sq.in):	4.34
Original Height(in):	5.43
Original Weight(lbs):	1.58
Density (lbs/cf.):	115.85
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.31
Correction Factor:	1.00
Maximum Load (lbs):	4,031
Compressive Strength (psi) :	930
Fracture Type:	Columnar

Average Compressive Strength : 930 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	0
Elapsed Time:	00:00:33
Cube Number:	E-1
Contract Number:	XL3695
Lab ID Number:	000001065B7
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	2:22:36 PM
End Date:	3/4/2010
End Time:	2:23:09 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3500 in
Area:	4.3374 in²
Peak Stress:	929 psi
Peak Load:	4031 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512

ROCK CORES

H-24-09, ~~47.6~~ ft (181 ft ?)
siltstone

Work Order :	XL3695	**Sample ID :**	000001065bd
Section :	SR410/NILE VALLEY LANDSLIDE		
State Route No :		**Lab Number :**	C0100040
Project Engineer :		**Bid Item No :**	
Org Code :	452201	**Date Received :**	2/25/2010
		Local Agency No :	

Mix Design Number :		**Material :**	Rock Cores
Fine Agg Pit Number :		**Used For Production Testing :**	
Coarse Agg Pit Number :		**Used For Qualification :**	
Paving Date :		**Date Made :**	2/24/2010
Operator Name :		**Date Tested :**	3/4/2010
Coring Date :		**Test Age :**	1 Days

Cylinder No:	G-1
Avg. Diameter(in):	2.31
Cross Section Area (sq.in):	4.17
Original Height(in):	5.46
Original Weight(lbs):	1.66
Density (lbs/cf.):	125.99
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.36
Correction Factor:	1.00
Maximum Load (lbs):	5,452
Compressive Strength (psi) :	1,310
Fracture Type:	Shear

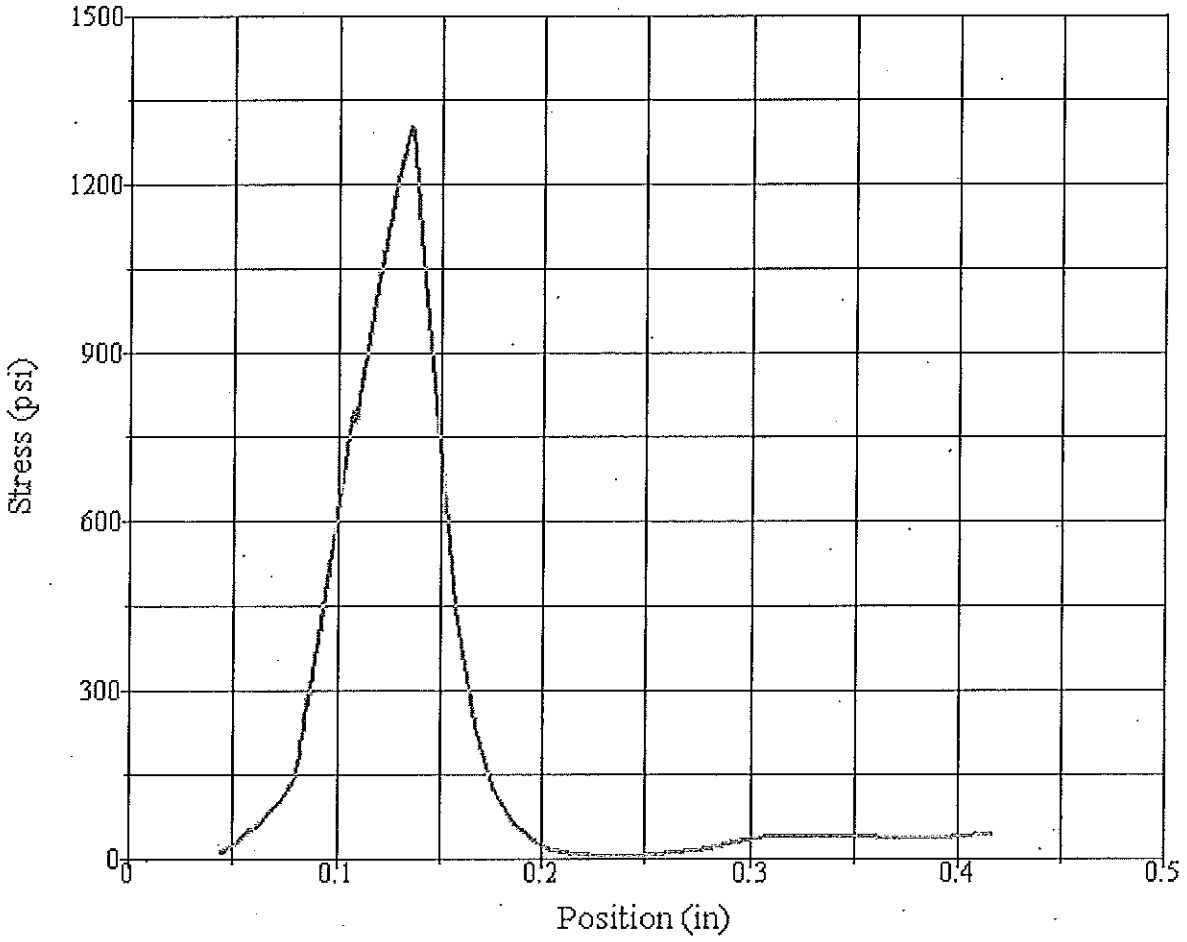
Average Compressive Strength : 1,310 PSI

Result Code: Informational

Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By: _____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 2



Test Summary

Counter:	0
Elapsed Time:	00:00:42
Cube Number:	G-1
Contract Number:	XL3695
Lab ID Number:	000001065BD
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	3:37:47 PM
End Date:	3/4/2010
End Time:	3:38:29 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3100 in
Area:	4.1910 in²
Peak Stress:	1301 psi
Peak Load:	5452 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

Work Order : XL3695
Sample ID : 000001065b3
Section : SR410/NILE VALLEY LANDSLIDE PHASE 2 EST INTERIM DETOUR
State Route No :
Lab Number : C0100033
Project Engineer :
Bid Item No :
Org Code : 452201
Date Received : 2/25/2010
Local Agency No :

H-16-09, 222 ft.
siltstone

Mix Design Number :
Material : Rock Cores
Fine Agg Pit Number :
Used For Production Testing :
Coarse Agg Pit Number :
Used For Qualification :
Paving Date :
Date Made : 2/24/2010
Operator Name :
Date Tested : 3/4/2010
Coring Date :
Test Age : 1 Days

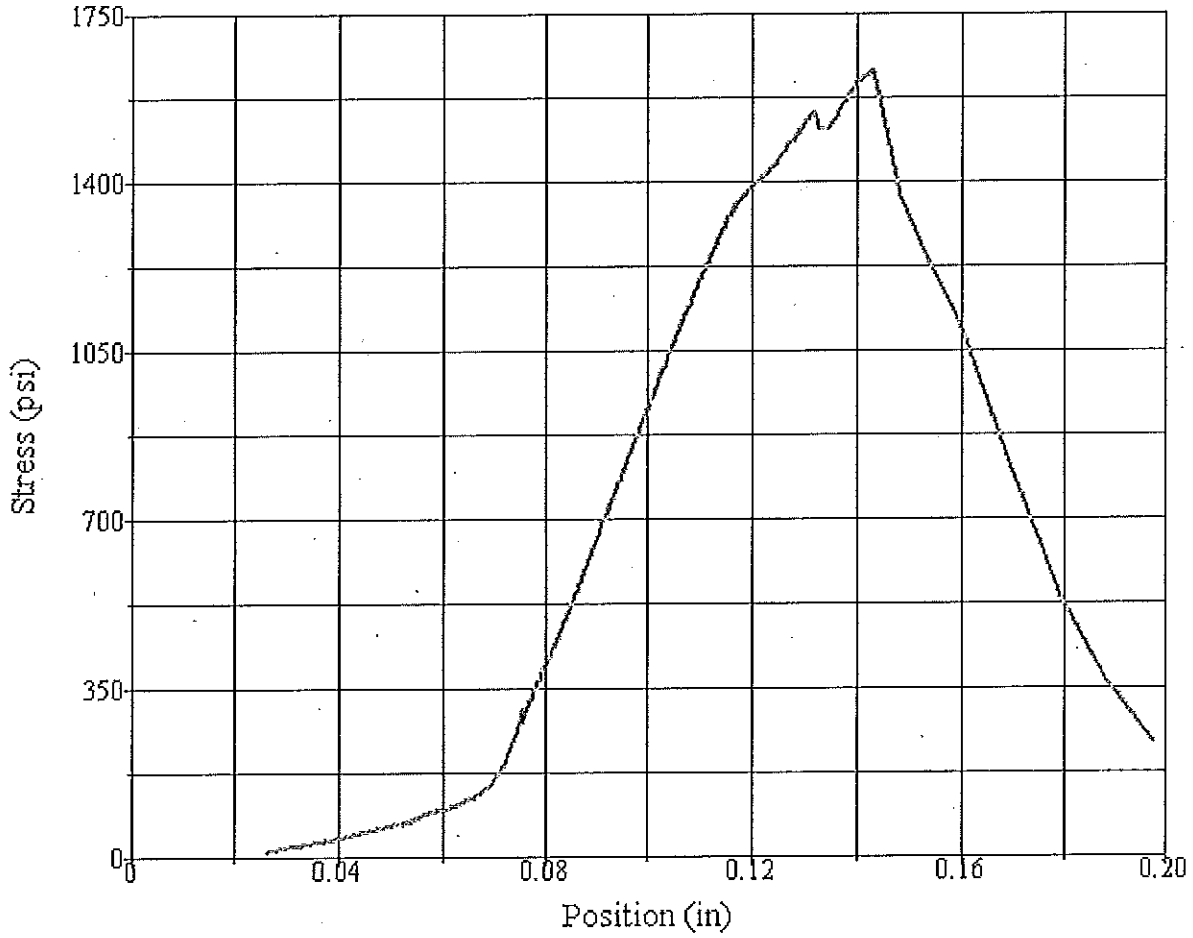
Cylinder No:	D-1
Avg. Diameter(in):	2.39
Cross Section Area (sq.in):	4.49
Original Height(in):	5.55
Original Weight(lbs):	1.86
Density (lbs/cf.):	128.98
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.32
Correction Factor:	1.00
Maximum Load (lbs):	7,320
Compressive Strength (psi) :	1,630
Fracture Type:	Shear

Average Compressive Strength : 1,630 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	949
Elapsed Time:	00:00:50
Cube Number:	D-1
Contract Number:	XL3695
Lab ID Number:	000001065B3
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	12:42:23 PM
End Date:	3/4/2010
End Time:	12:43:13 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3900 in
Area:	4.4863 in²
Peak Stress:	1632 psi
Peak Load:	7320 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

H-22-09, 234 ft. siltstone

Work Order : XL3695
Sample ID : 000001065ba
Section : SR410/NILE VALLEY LANDSLIDE PHASE 2 EST INTERIM DETOUR
State Route No :
Lab Number : C0100038
Project Engineer :
Bid Item No :
Org Code : 452201
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Material : Rock Cores
Fine Agg Pit Number :
Used For Production Testing :
Coarse Agg Pit Number :
Used For Qualification :
Paving Date :
Date Made : 2/24/2010
Operator Name :
Date Tested : 3/4/2010
Coring Date :
Test Age : 1 Days

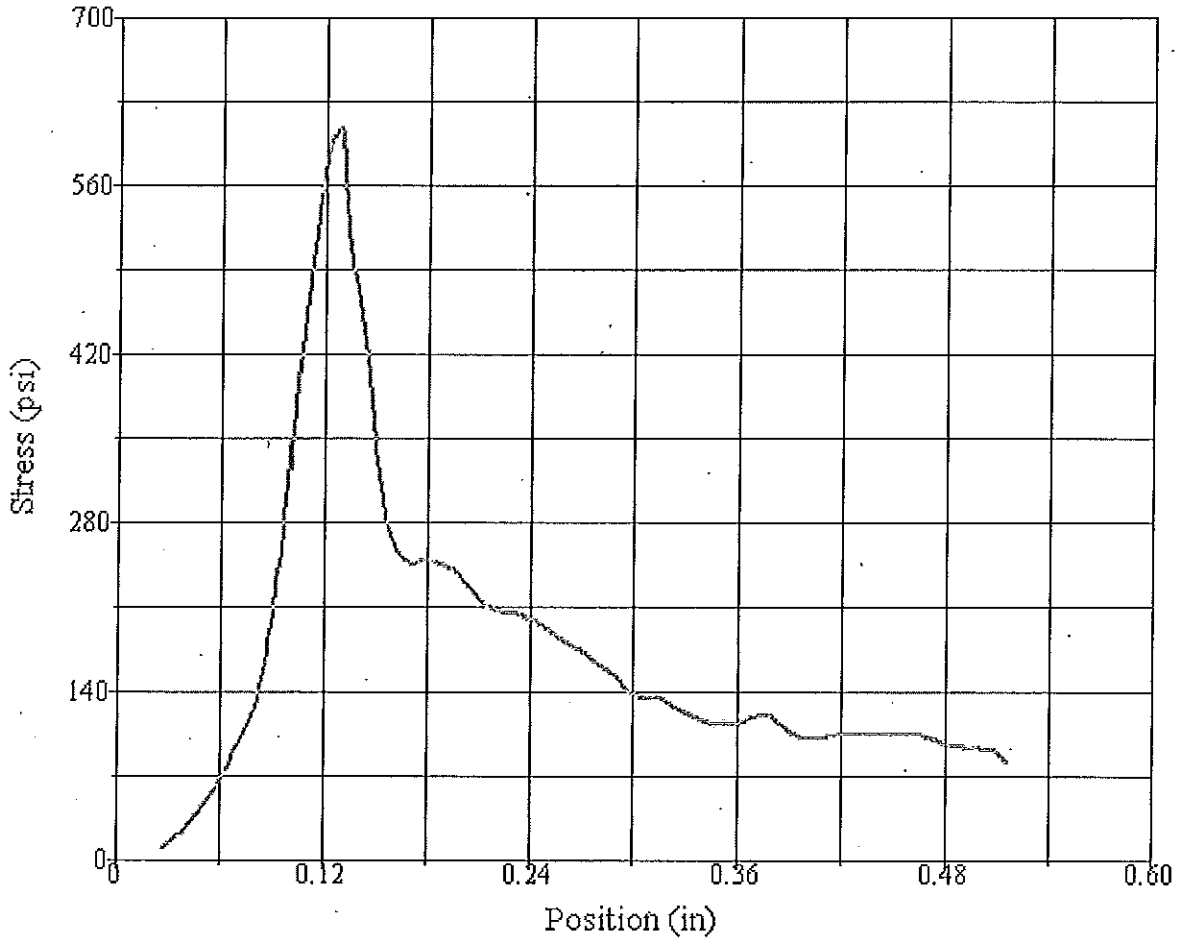
Cylinder No:	F-1
Avg. Diameter(in):	2.35
Cross Section Area (sq.in):	4.34
Original Height(in):	5.55
Original Weight(lbs):	1.64
Density (lbs/cf.):	117.65
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.36
Correction Factor:	1.00
Maximum Load (lbs):	2,630
Compressive Strength (psi) :	610
Fracture Type:	Shear

Average Compressive Strength : 610 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary	
Counter:	0
Elapsed Time:	00:00:24
Cube Number:	F-1
Contract Number:	XL3695
Lab ID Number:	000001065BA
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	2:34:42 PM
End Date:	3/4/2010
End Time:	2:35:06 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results	
Diameter:	2.3500 in
Area:	4.3374 in²
Peak Stress:	606 psi
Peak Load:	2630 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

H-16-09, 240ft. altered siltstone.

Work Order :	XL3695	**Sample ID :**	000001065b4
Section :	SR410/NILE VALLEY LANDSLIDE		
State Route No :		**Lab Number :**	C0100034
Project Engineer :		**Bid Item No :**	
Org Code :	452201	**Date Received :**	2/25/2010
		Local Agency No :	

Mix Design Number :		**Material :**	Rock Cores
Fine Agg Pit Number :		**Used For Production Testing :**	
Coarse Agg Pit Number :		**Used For Qualification :**	
Paving Date :		**Date Made :**	2/24/2010
Operator Name :		**Date Tested :**	3/4/2010
Coring Date :		**Test Age :**	1 Days

Cylinder No:	D-2
Avg. Diameter(in):	2.35
Cross Section Area (sq.in):	4.32
Original Height(in):	5.48
Original Weight(lbs):	1.62
Density (lbs/cf.):	118.25
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.33
Correction Factor:	1.00
Maximum Load (lbs):	2,102
Compressive Strength (psi) :	490
Fracture Type:	Shear

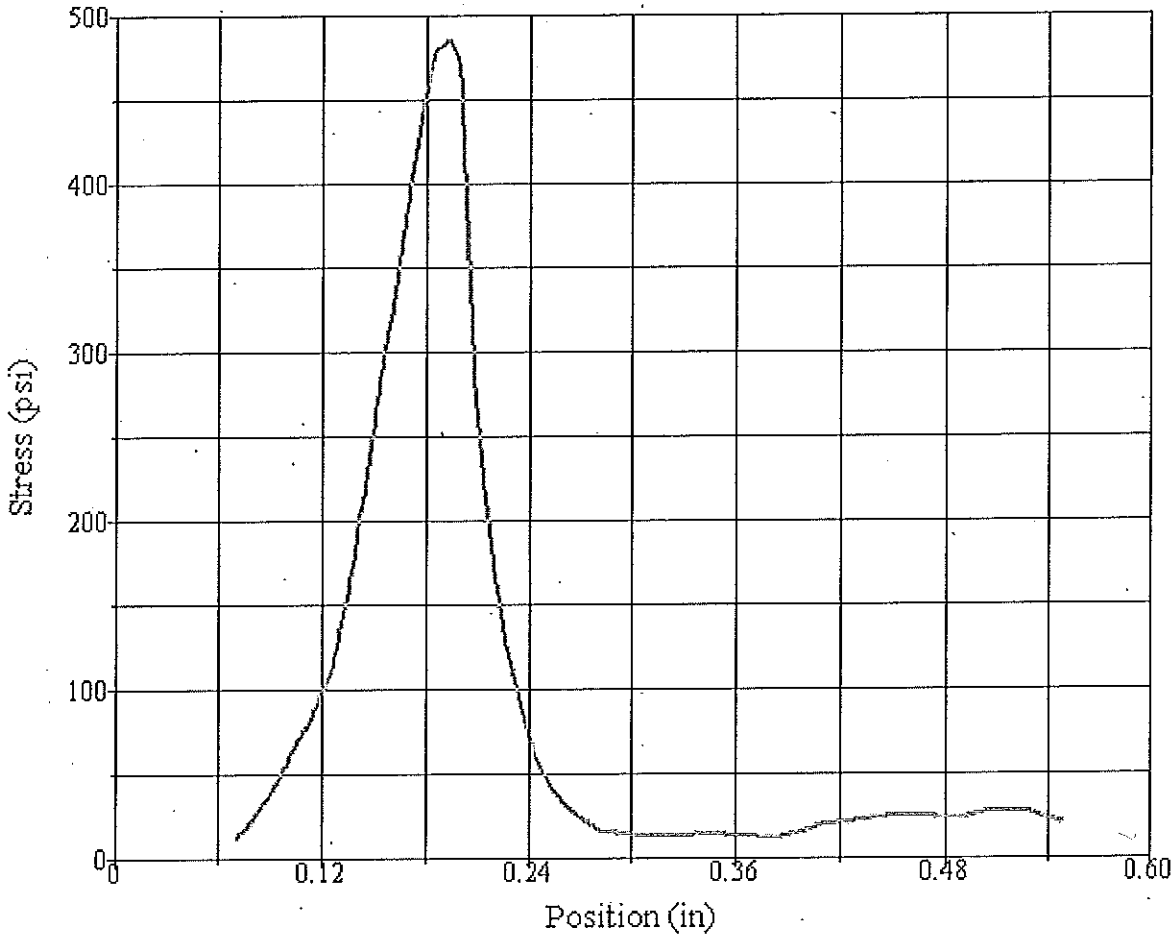
Average Compressive Strength : 490 PSI

Result Code: Informational

Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	0
Elapsed Time:	00:00:20
Cube Number:	D-2
Contract Number:	XL3695
Lab ID Number:	000001065B4
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	12:53:28 PM
End Date:	3/4/2010
End Time:	12:53:48 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3500 in
Area:	4.3374 in²
Peak Stress:	485 psi
Peak Load:	2102 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No :
Project Engineer :
Org Code : 452201

Sample ID : 000001065b5 H-16-09 242 ft. altered siltstone
Lab Number : C0100035
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

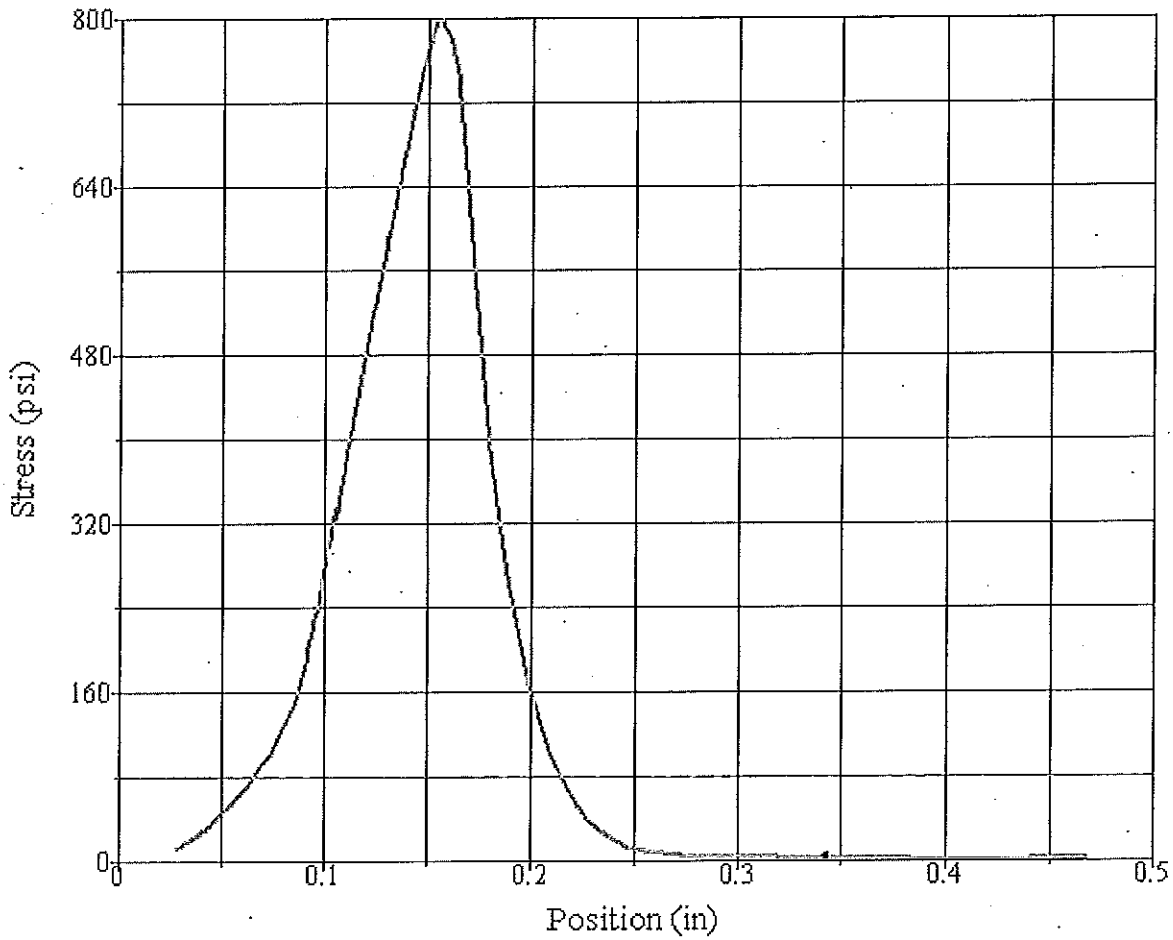
Cylinder No:	D-3
Avg. Diameter(in):	2.39
Cross Section Area (sq.in):	4.47
Original Height(in):	5.49
Original Weight(lbs):	1.72
Density (lbs/cf.):	121.11
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.30
Correction Factor:	1.00
Maximum Load (lbs):	3,579
Compressive Strength (psi) :	800
Fracture Type:	Shear

Average Compressive Strength : 800 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	0
Elapsed Time:	00:00:29
Cube Number:	D-3
Contract Number:	XL3695
Lab ID Number:	000001065B5
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	1:04:29 PM
End Date:	3/4/2010
End Time:	1:04:58 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3900 in
Area:	4.4863 in²
Peak Stress:	798 psi
Peak Load:	3579 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

H-16-09, 244 ft.
altered siltstone

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No :
Project Engineer :
Org Code : 452201

Sample ID : 000001065b6
Lab Number : C0100036
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

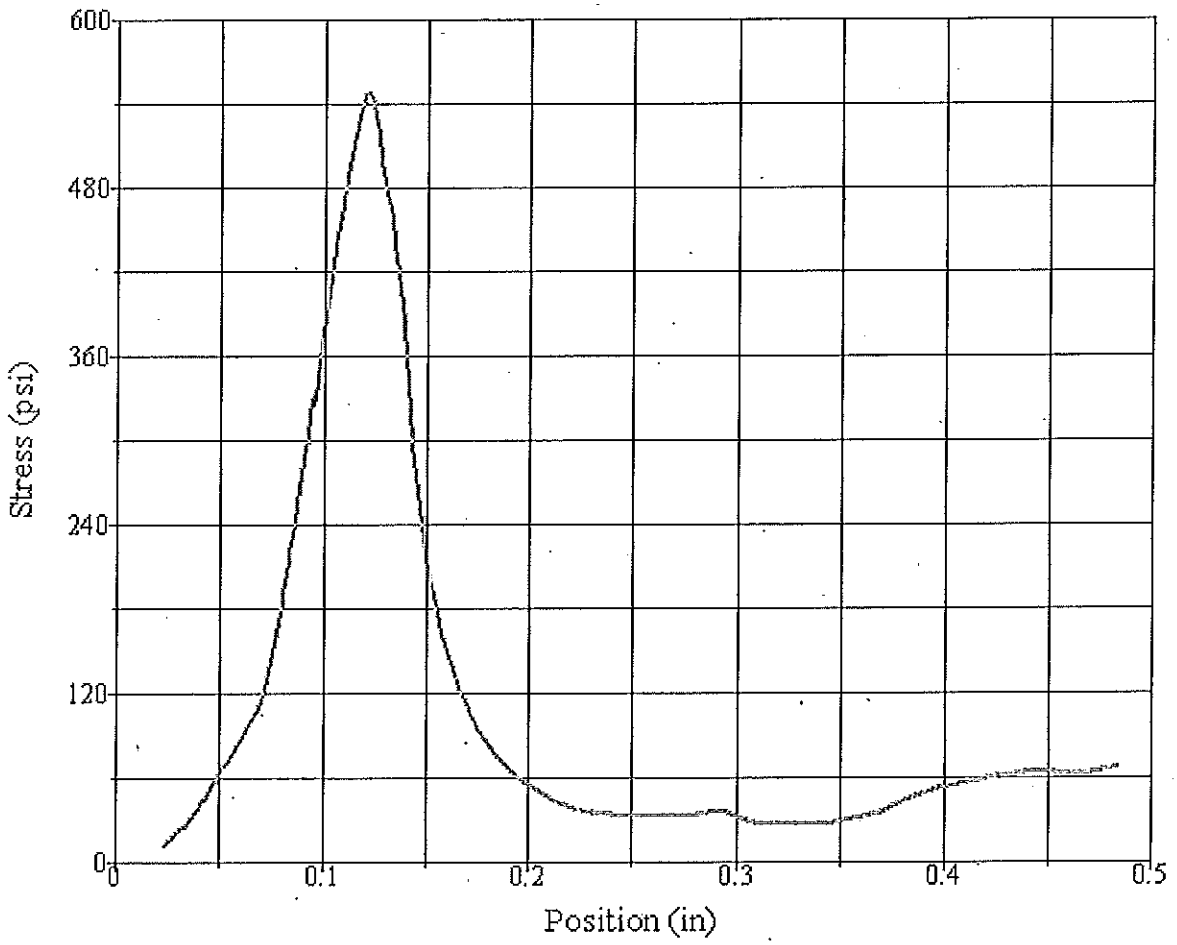
Cylinder No:	D-4
Avg. Diameter(in):	2.35
Cross Section Area (sq.in):	4.34
Original Height(in):	5.51
Original Weight(lbs):	1.68
Density (lbs/cf.):	121.40
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.34
Correction Factor:	1.00
Maximum Load (lbs):	2,376
Compressive Strength (psi) :	550
Fracture Type:	Shear

Average Compressive Strength : 550 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	0
Elapsed Time:	00:00:22
Cube Number:	D-4
Contract Number:	XL3695
Lab ID Number:	000001065B6
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	1:26:30 PM
End Date:	3/4/2010
End Time:	1:26:52 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3500 in
Area:	4.3374 in²
Peak Stress:	548 psi
Peak Load:	2376 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

H-14-09, 240ft. altered siltstone

Work Order : XL3695
Sample ID : 000001065ab
Section : SR410/NILE VALLEY LANDSLIDE PHASE 2 EST INTERIM DETOUR
State Route No :
Lab Number : C0100029
Project Engineer :
Bid Item No :
Org Code : 452201
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Material : Rock Cores
Fine Agg Pit Number :
Used For Production Testing :
Coarse Agg Pit Number :
Used For Qualification :
Paving Date :
Date Made : 2/24/2010
Operator Name :
Date Tested : 3/4/2010
Coring Date :
Test Age : 1 Days

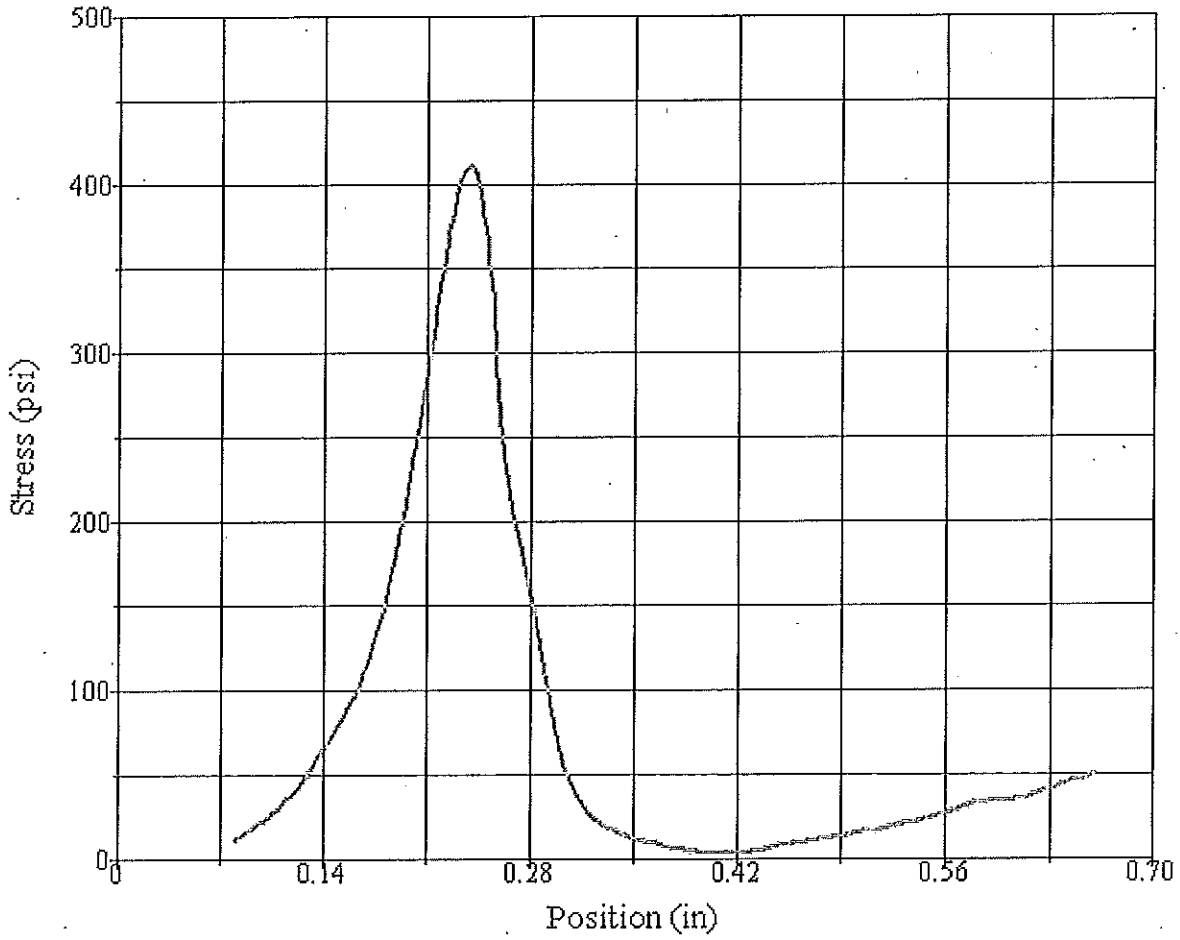
Cylinder No:	B-1
Avg. Diameter(in):	2.35
Cross Section Area (sq.in):	4.32
Original Height(in):	5.34
Original Weight(lbs):	1.58
Density (lbs/cf.):	118.35
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.27
Correction Factor:	1.00
Maximum Load (lbs):	1,780
Compressive Strength (psi) :	410
Fracture Type:	Shear

Average Compressive Strength : 410 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	0
Elapsed Time:	00:00:15
Cube Number:	B-1
Contract Number:	XL3695
Lab ID Number:	0000001065AB
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	9:27:58 AM
End Date:	3/4/2010
End Time:	9:28:13 AM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.3500 in
Area:	4.3374 in²
Peak Stress:	410 psi
Peak Load:	1780 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No :
Project Engineer :
Org Code : 452201

Sample ID : 000001065ac 11-14-09, 158ft Ortley Basalt
Lab Number : C0100030
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

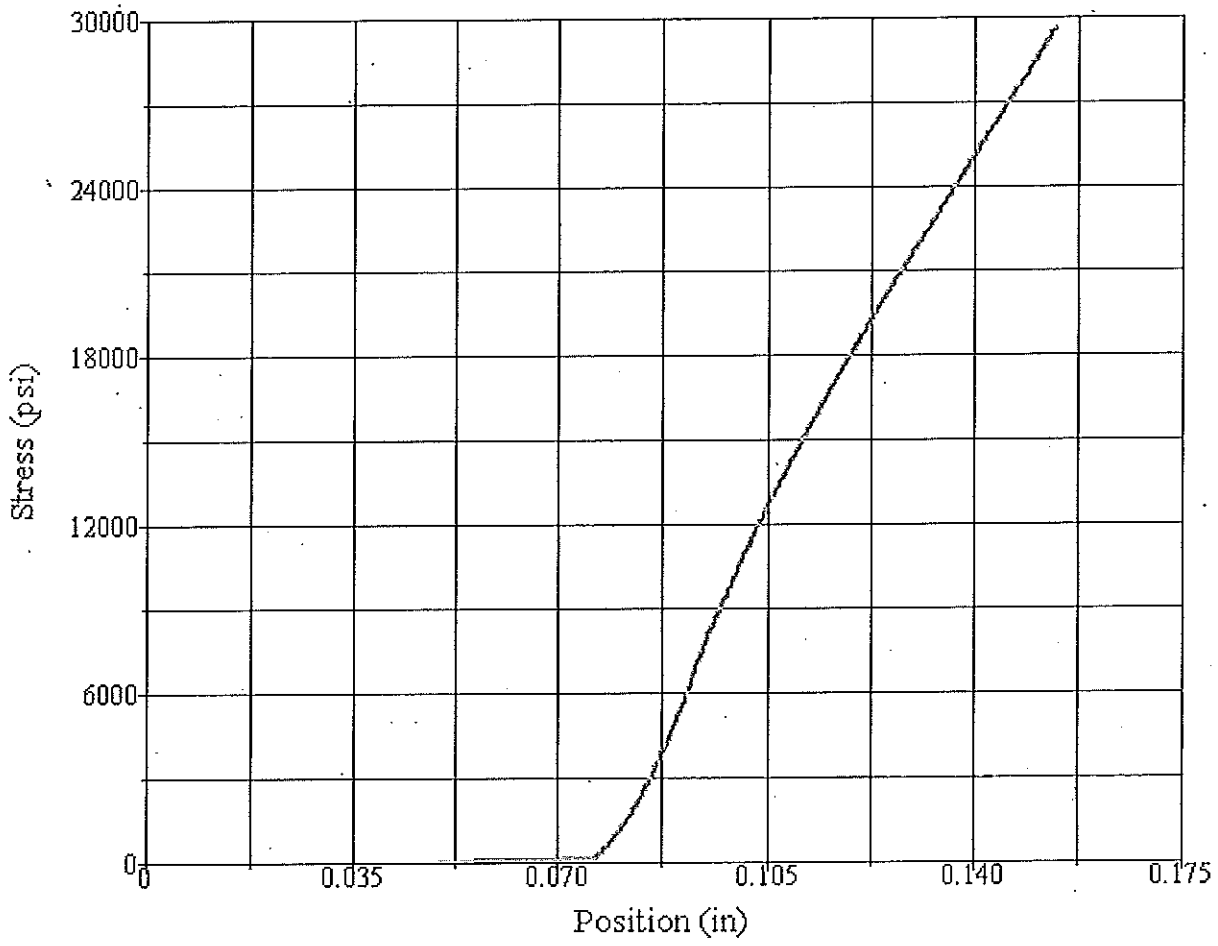
Cylinder No:	C-1
Avg. Diameter(in):	2.41
Cross Section Area (sq.in):	4.56
Original Height(in):	5.81
Original Weight(lbs):	2.64
Density (lbs/cf.):	172.19
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.41
Correction Factor:	1.00
Maximum Load (lbs):	134,920
Compressive Strength (psi) :	29,590
Fracture Type:	

Average Compressive Strength : 29,590 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	941
Elapsed Time:	00:14:48
Cube Number:	C-1
Contract Number:	XL3695
Lab ID Number:	0000001065AC
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	9:38:59 AM
End Date:	3/4/2010
End Time:	9:53:47 AM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.4100 in
Area:	4.5617 in²
Peak Stress:	29577 psi
Peak Load:	134920 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

H-14-09, 301 ft.
Grouse Ck Basalt

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No :
Project Engineer :
Org Code : 452201

Sample ID : 000001065b1
Lab Number : C0100032
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

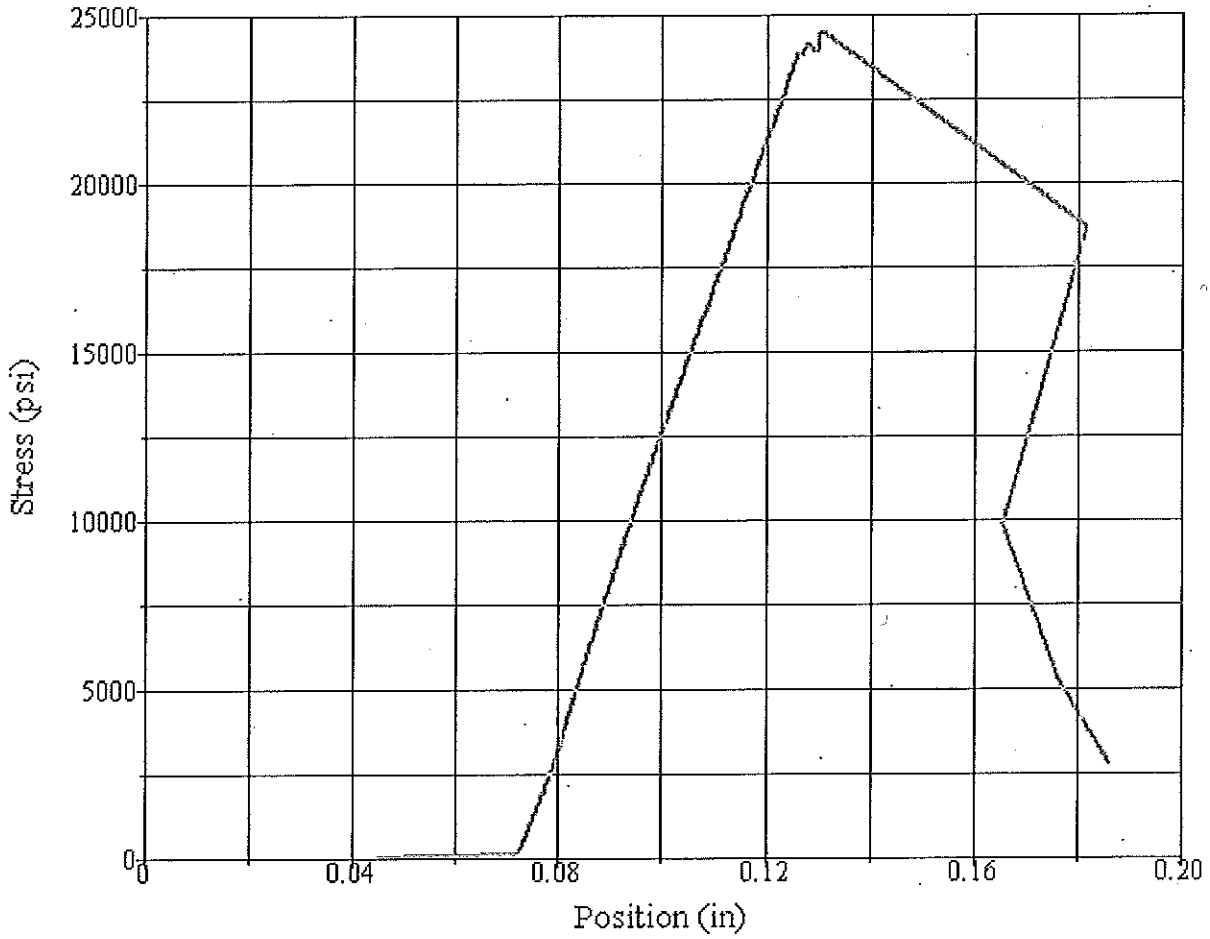
Cylinder No:	C-3
Avg. Diameter(in):	2.41
Cross Section Area (sq.in):	4.56
Original Height(in):	5.75
Original Weight(lbs):	2.58
Density (lbs/cf.):	170.03
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.39
Correction Factor:	1.00
Maximum Load (lbs):	111,870
Compressive Strength (psi) :	24,530
Fracture Type:	Columnar

Average Compressive Strength : 24,530 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	948
Elapsed Time:	00:12:16
Cube Number:	C-3
Contract Number:	XL3695
Lab ID Number:	000001065B1
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	11:44:05 AM
End Date:	3/4/2010
End Time:	11:56:21 AM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.4100 in
Area:	4.5617 in²
Peak Stress:	24524 psi
Peak Load:	111870 lbf

Washington State Department of Transportation
Materials Laboratory
PO Box 47365 Olympia WA 98504 / 1655 S. 2nd Ave Tumwater WA 98512
ROCK CORES

H-22-09, 408 ft.
Browse Ck Basalt

Work Order : XL3695
Section : SR410/NILE VALLEY LANDSLIDE
State Route No :
Project Engineer :
Org Code : 452201

Sample ID : 000001065bb
Lab Number : C0100039
Bid Item No :
Date Received : 2/25/2010
Local Agency No :

Mix Design Number :
Fine Agg Pit Number :
Coarse Agg Pit Number :
Paving Date :
Operator Name :
Coring Date :

Material : Rock Cores
Used For Production Testing :
Used For Qualification :
Date Made : 2/24/2010
Date Tested : 3/4/2010
Test Age : 1 Days

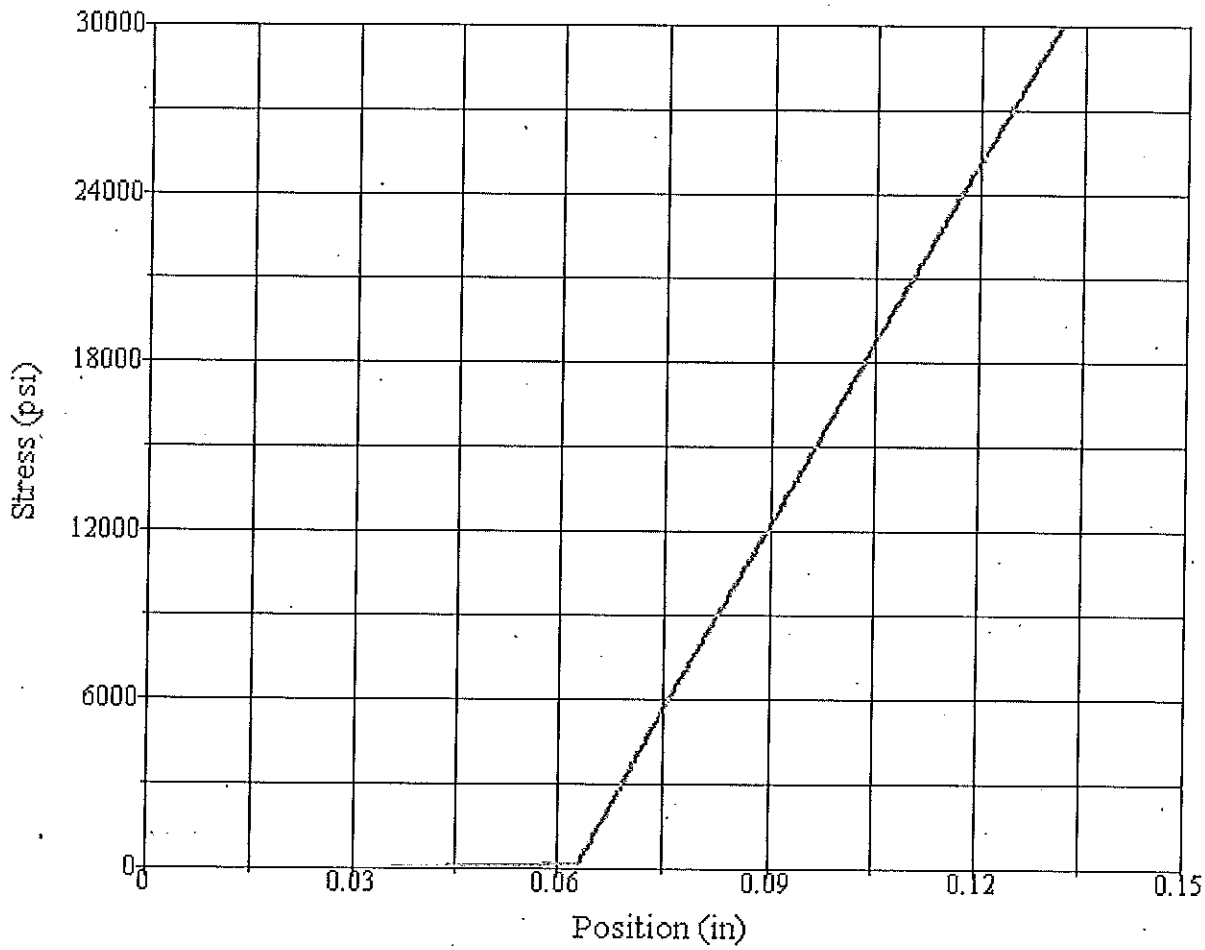
Cylinder No:	F-2
Avg. Diameter(in):	2.40
Cross Section Area (sq.in):	4.52
Original Height(in):	5.79
Original Weight(lbs):	2.66
Density (lbs/cf.):	175.63
Trimmed Length(in) :	
Length/ Diameter Ratio:	2.41
Correction Factor:	1.00
Maximum Load (lbs):	134,920
Compressive Strength (psi) :	29,850
Fracture Type:	

Average Compressive Strength : 29,850 PSI

Result Code: Informational
Remarks :

Thomas E. Baker, P.E.
State Materials Engineer
Michael Polodna, P.E. By:_____
Structural Material Testing Engineer
Date : 3/5/2010
Phone : (360) 709-5446

Billing Code
T46E - 1



Test Summary

Counter:	955
Elapsed Time:	00:14:57
Cube Number:	F-2
Contract Number:	XL3695
Lab ID Number:	000001065BB
Procedure Name:	1.75 Dia. Cores
Start Date:	3/4/2010
Start Time:	3:10:59 PM
End Date:	3/4/2010
End Time:	3:25:56 PM
Workstation:	MLA2563033
Tested By:	CoopeGr

Test Results

Diameter:	2.4000 in
Area:	4.5239 in²
Peak Stress:	29824 psi
Peak Load:	134920 lbf

Appendix E

Eyewitness Spreadsheet and PNSN Seismic Plots

Contact List

Contact	Other Information
Mary and Steve Smith	first house destroyed; west of gravel pit access road
Roger and Denise Martin	house on east knob that was destroyed
Don Dexter	neighbor to the east of Ron and Mary Beth Simmons (house destroyed)
Seth Berghoff (WSP)	1 of 2 WSP officers
Patrick Lunning (WSP)	1 of 2 WSP officers
Chuck Laidler (WSDOT)	Rimrock Maintenance Supervisor
Ron and Mary Beth Simmons	own houses east of access road to the gravel pit (Elizabeth lives in one closest to the pit road; Mary and Steve Smith live on the west side of the access road; they live in brick house east of the access road) Elizabeth and Mary are daughters to Ron and Mary Beth Simmons (house destroyed)
Gerald and Francis Simmons	lives down valley from landslide; older brother to Ron and worked with Ernie in family pit business with Ron
Boyd and Shirley Brown	left a number of messages for Frank Koch and Brown's to call me back for two weeks
Frank Koch (Brown's hand)	claims pit area has made sounds for the last several weeks in Yakima Herald article
Jason Smith (SCR Enviro)	first responder from DOT with Don Whitehouse, Craig Broadhead, and Scott Anfinson
Denny Sveen	local resident that saw the middle and eastern portion failing
Davey Walker	local resident that was on the ridge above the Brown's farm and watched the landslide from 7:45am to 3:30pm Sunday; got there before Denny Sveen
Scott Lockert	fly fisherman that frequents the Nachez River reach in Nile Valley
Keelan McPhee	Briefly watched west landslide from Nile Loop Road and witnessed buckling of Nile Loop Road
Ernie and Robbin Simmons	Owners of Simmon's Pit and cousin to Ron and Gerald Simmons; were in the pit moving equipment prior to evacuation after the western landslide occurred.

Saturday 10-10-2009

Event	Time	Source
Big seismic pop	10:20	seismic record
multiple rocks sliding down the hill around our house; could hear sounds from the hill above, like a rumbling thunder sound, but faint	11:00	Steve and Mary Smith
landslide first noticed just west of pit floor; driveway was narrowing; emptied garden shed and moved vehicles from the residence down to highway area	12:00	Steve and Mary Smith
garden shed destroyed in less than one hour; thunder-like sounds heard under the ground; open tension crack approximately 100 to 200 feet upslope that you could fit a couple cars in	13:00	Steve and Mary Smith
contacted Nile Fire, WSP, Yakima County Sheriffs Dept., and DOT, as I didn't know if the slide would stop before entering the highway.	14:00	Steve and Mary Smith
landslide occurring just west of pit floor opening; moving toward highway; beginning to push garden shed toward the Smith residence; Steve Smith indicates a tension crack was observed on the first bench above the pit floor	14:30	Chuck Laidler
landslide first noticed by next door neighbor; no landslide activity in pit floor or walls, but noticed Ernie and Robbin Simmons moving equipment from the west to the east side of the pit	14:30	Ron and Mary Beth Simmons
landslide activity was localized to area just west of the pit and hillside movement was blocking approximately 20 feet of the driveway to the Smith's Residence	16:00	Patrick Lunning
More than 50 feet from highway and 12 feet from the house; seemed like the landslide had stopped, no rumbling sounds any longer; DOT and WSP left site	16:30	Steve and Mary Smith, Chuck Laidler, and Patrick Lunning
made dinner in the house, watched the Huskies game, and retired to the 5th wheel down by the highway for the evening	22:00	Steve and Mary Smith

Sunday 10-11-2009

Event	Time	Source
heard rocks hitting garden shed remains and house	2:30	Steve and Mary Smith
Denise Martin got up to check on her daughter and noticed that half of their house had lost power, similar to a year earlier from low voltage problems; no creaking in house; could hear rockfall throughout the evening on slopes above Simmons Pit	3:30	Roger and Denise Martin
small seismic rumbles	4:12	seismic record
awoken by rocks hitting the Smith's home; went outside to investigate	4:12	Ron Simmons
I heard the mountain moving again; our carport was in the process of being destroyed	4:12	Steve and Mary Smith
stood in pit floor and watched the landslide push the garden shed into Smith's residence; ground below pit floor sounded like the moaning and groaning of a glacier moving on a hot day; small rock slides could be heard in the pit	4:30	Ron Simmons
small seismic rumbles	4:41	seismic record
landslide was entering the highway and Smith residence was now being pushed from its foundation; notified Nile Fire, WSP, and DOT	4:45	Steve and Mary Smith
small seismic rumbles	4:48	seismic record
WSP notified of landslide movement and the need for possible closure of SR 410	5:00	Patrick Lunning
Arrived at the pit and checked on parents (Alfred and Roberta Simmons)	5:30	Ernie and Robbin Simmons
1st WSP officer to arrive on-site and found that Steve Smith and the Nile Fire Department had effectively closed the highway in both directions; Smith's house was being pushed off its foundation	5:30	Patrick Lunning
from the east road block notices approximately 200 feet west of the Smith Residence that the ditch is closing as the hillside begins to move toward the highway; subtle movement with no obvious tension cracks upslope; constant rock falling	5:45	Patrick Lunning
5 second seismic pops	5:48	seismic record
TMC radios to Rimrock Maintenance "Mountain in Road"	5:50	Chuck Laidler
Sgt. Seth Berghoff arrives; hears rocks falling over much of the slope area / can't see where because it is dark; shoulder and WB lane are being impacted by a small lobe of the landslide directly below the Smith's house; about 20 ft. wide and 20 feet high	6:00	Seth Berghoff and Patrick Lunning
Steve and Mary Smith had blocked the highway when the lobe of the landslide at the Smith's residence entered the highway; no movement detected in the pit high wall or floor at this time	6:45	Ernie and Robbin Simmons
landslide just west of the pit floor has pushed the garden shed and carport into Smith's home and has reached the WB lane of the highway; lobe in road is 30 to 40 ft wide and moves forward like lava; WSP has blocked the road on east side of SR 410	6:45	Chuck Laidler

Sunday 10-11-2009

Mr. Dexter comes out of his house to see the road partially blocked by the landslide in front of the Smith's	7:00	Don Dexter
Roger and Denise Martin can hear Steve Smith on a loud speaker down by his house talking about the landslide in the highway.	7:00	Roger and Denise Martin
lobe of landslide creeping across roadway at 3 feet in 15 minutes (avg. 1 ft every 5 minutes); Nile Fire is set up at the road block on west end of landslide area	7:00	Chuck Laidler
WB lane is covered to centerline	7:00	Patrick Lunning
Went into pit to move Sealand and their equipment to east part of the pit floor; it was 20 degrees and the equipment hadn't been started for two week, so only some equipment would start	7:00	Ernie and Robbin Simmons
noticed constant rockfall on west highwall and booming, cracking, and thunder sounds were coming from upslope of the west highwall	7:05	Ernie and Robbin Simmons
Firefighter notifies the Martin's of the landslide on the highway	7:10	Roger and Denise Martin
Sunrise	7:12	Weather Underground
a 60 ft by 60 ft area at the base of the west highwall started uplifting; a D-8 cat was in the middle of the uplifted floor	7:15	Ernie and Robbin Simmons
firefighter walks up to the west edge of the active landslide lobe on SR 410 and indicates on the radio that the road is moving under his feet and he runs back to the west road block area; road being uplifted	7:30	Chuck Laidler
Smith's house is being overwhelmed; sees movement about 1/3 the height of the mountain slope above the Smith's house; movement observed in the gravel pit; sounds under the ground getting louder	7:30	Seth Berghoff
big seismic burst	7:38	seismic record
western landslide area covers the highway and Steve Smith is yelling in his blow horn that "its moving" while blowing the siren in his fire vehicle; evacuation starts	7:38	Ron and Mary Beth Simmons
just after daylight, saw the western landslide occur from the pit	7:38	Ernie and Robbin Simmons
Dexter watches the west landslide come down as he stands at the WSP east road block; it moved slowly into the river	7:38	Don Dexter
from west road closure, witnessed the western landslide area initially fail over about 1 minute; roadway punched straight up approx. 35 feet and then moved into the river; filled half of river before road surface slid to the toe of the landslide	7:38	Chuck Laidler
west of the Smith house landslide; hillside begins cracking and rumbling; the slope near the west road block failed like a ton of bricks pushing the roadway up and the hillside moved into the river	7:38	Patrick Lunning
Snaps a sequence of photographs from the east road block as the western landslide area fails; these photos were used to approximate the area of the western failure	7:38	Sherry Gillespie
After the western landslide area failed, the sounds below the ground in the eastern portion of the landslide got noisier	7:45	Mary Smith

Sunday 10-11-2009

D-8 was now 10 vertical feet above the original pit floor elevation; about 10 feet of uplift in 30 minutes; constant rock falling and the wall seemed to be crawling/rolling toward the crusher; left pit at the urging of Steve Smith and WSP	7:45	Ernie and Robbin Simmons
Firefighter returns to notify Martin's that they need to evacuate from their home; Denise goes to Woodshed Restaurant at SR 410 jct. Nile Loop Road; Roger stays behind to gather some personal items	7:45	Roger and Denise Martin
From WSP's east road block, watched the eastern landslide continue to crawl across the pit floor eastward; the described the movement as, "the big slide goes down in the upper mountain area and comes back up at the pit"	8:00	Ernie and Robbin Simmons
along the west edge of the recent landslide, the earth cracked just below the rock bluffs above	8:00	Chuck Laidler
moved WSP road block eastward and firefighters road block westward	8:00	Chuck Laidler, Patrick Lunning, and Don Dexter
Incident Command Center set up at Eagle Rock (just down valley (eastward) of the landslide)	8:00	Chuck Laidler
steady seismic popping starts (8:08 to 9:43) - building up to loudest seismic burst	8:08	seismic record
Roger Martin leaves the house; no problems with the house and did not notice any displacement of the property	8:30	Roger Martin
Nile Loop Road was identified as the emergency detour	8:30	Chuck Laidler
arrived at a vantage above the Brown's farm to watch the landslide; west landslide had pushed up the highway and was crossing the Naches River; the eastern landslide was moving in the pit and in the upslope area	8:45	Davey Walker
sounds underground got much louder; sounded like standing next to a waterfall	9:00	Seth Berghoff
standing outside the Eagle Rock command center he noticed a tension crack near the top of the ridge that lined up with the western landslide area	9:00	Chuck Laidler
The Martin's watched the eastern landslide toe area moving toward their house from the Woodshed Restaurant at SR 410 jct. Nile Loop Road; no cracks noticed in the upper slope area above their house	9:00	Roger and Denise Martin
Eastern Landslide area is described as fairly slow and seems like it is falling into a hole in the upper portion of the mountain below the headscarp; no distinct location of movement, just moved everywhere east of the west landslide	9:00	Davey Walker
WSP begins to evacuate more residents from their homes east of the Smith's residence because landslide had moved 40 feet east toward Simmons and Martin's homes across the pit floor	9:00	Patrick Lunning

Sunday 10-11-2009

Leave the Eagle Rock ICC and movement has only occurred in the pit thus far, no movement down at the highway or at the houses east of the Smith's	9:30	Ernie and Robbin Simmons
loudest seismic burst - lasts 12 minutes (9:43 to 9:55)	9:43	seismic record
from the Eagle Rock ICC watched the east landslide fail across the slope from west to east	9:43	Don Dexter
observed eastern failure occur as driving up the Nile Valley from the east; occurred rapidly in 10 to 20 secs; valley filled with dust; Don Whitehouse, Craig Broadhead, and Scott Anfinson were in the car	9:43	Jason Smith
observed eastern failure occur standing at east road block; lasted about 10 to 20 seconds and was very rapid; everything quickly shifted horizontally toward the river	9:43	Seth Berghoff and Patrick Lunning
Drives west on Nile Loop Road and notices that it is uplifting across from the west landslide near the log cabin; in 15 minutes the road begins to buckle, uplifting 1 to 1.5 feet so he notifies DOT at east end of Nile Loop Rd	9:45	Roger Martin
stopped at Nile Loop Road across from the west landslide; sounded like constant waterfall/rockfall sound as the west landslide pushes across the river into the south bank; noticed a crack across Nile Loop Road	9:45	Keelan McPhee
from Eagle Rock incident command center saw a large cloud of dust in the upper portion of the slope above the pit; after 10 minutes the dust cleared and the headscarp was fully exposed near the top of the ridge above the pit	9:53	Chuck Laidler
Steve Smith drives Ron Simmons up to their house to grab some supplies; no movement of the Simmon's house and the rock crusher had not been overwhelmed by the landslide yet.	10:00	Ron Simmons
Nile Loop Road buckles at the location of the crack and uplifted 1 to 1.5 feet as a truck and horsetrailer crossed it; movement was constant, not episodic; everything was constantly changing	10:00	Keelan McPhee
Watched Nile Loop Road and the cabin deform as the west landslide blocked the river channel and pushed up the opposing bank; Don Whitehouse, Craig Broadhead, and Scott Anfinson were at the site also	10:15	Jason Smith
from opposing valley ridge observed east landslide toe thrusting up in front of Simmons and Dexter residences and deforming the Martin's house; watched equipment in pit floor being overturned	10:15	Denny Sveen
Smith's house and rock crusher in the Simmon's Pit is being overwhelmed by landslide movement (pushing sideways)	10:45	Davey Walker
Nile Loop Road was uplifting and the log cabin was destroyed	11:00	Don Dexter

Sunday 10-11-2009

heavy equipment in the pit was overturned and SR 410 is uplifting near the Simmon's residence; could see the Martin's driveway in front of the house deforming and slope moving toward Dexter's house below the Martin's	12:00	Davey Walker
Naches River flowing around the toe of the west landslide was blocked by the Nile Loop Road uplift	12:00	Davey Walker
Watched Naches River start to overtop the Nile Loop Road and flow into the Brown's pasture	12:00	Don Dexter
Naches River was flowing around the uplifted Nile Loop Road in the Brown's field and found its way back to the channel to the east	13:00	Davey Walker
Dust had settled in the upper landslide area and movement had slowed significantly; observes deformation occurring in SR 410 near the Simmon's residences	13:00	Davey Walker
Randy Leonard and Steve Smith went up to check on the Simmon's homes; highway and driveway was buckled, but no huge thrust of the Simmon's home had occurred yet	14:00	Ron Simmons
leaves the vantage on opposing valley ridge after watching landslide movement for the last 6 to 7 hours; when he left, it appeared that the landslide movement had stopped on Nile Valley Loop Road and on the north side of the valley (SR 410)	15:30	Davey Walker
back half of house was pushed off the foundation; no uplift of the house detected; slope in backyard pushed against the house	16:00	Don Dexter
Simmon's house started to uplift	16:00	Ron Simmons
returned to house and saw damage for the first time; it was eerily quiet and no one was around	16:20	Roger and Denise Martin

Monday 10-12-2009

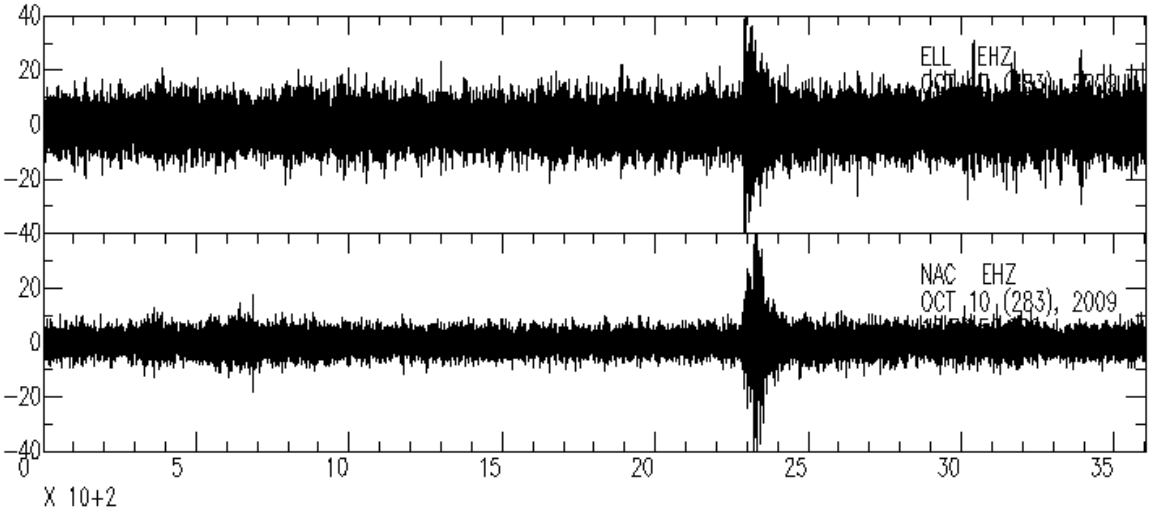
Event	Time	Source
house had moved approximately 10 feet vertically and 7 to 12 feet horizontally to the south; not a dish fell from the kitchen cabinets	8:00	Ron Simmons
western landslide areas uplift appears to finally stop on Nile Loop Road section	15:00	Jason Smith

Landslide seismic signals – From John Vidale, 10/13/09

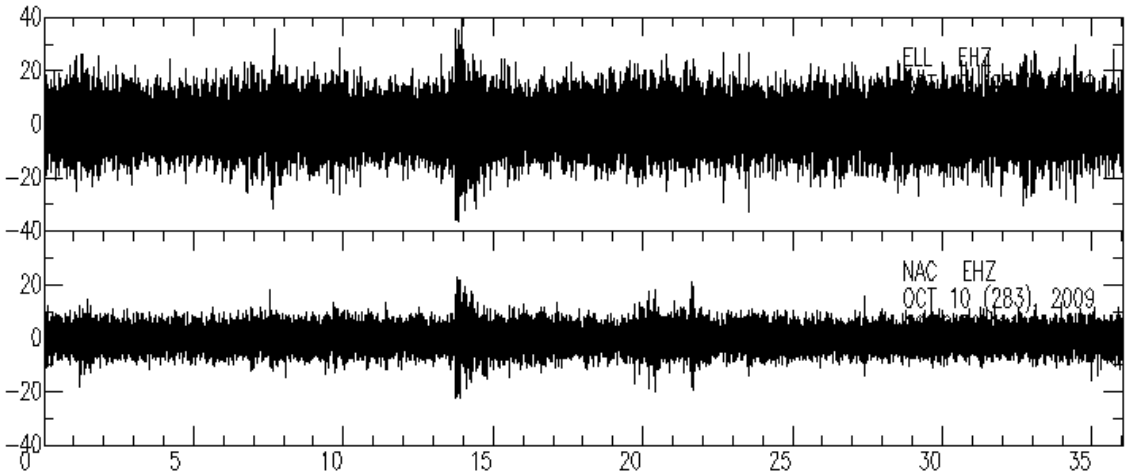
Hours examined – **10/10 5:00 – 10/11 17:00 PDT**,
I compared two nearby sensitive short-period stations NAC & ELL in the passband 1-4Hz, and interpreted as landsliding the common features.

Coherent spindle-shaped 1-2Hz energy on both NAC and ELL,
Each plot is an hour long, starting on the hour.

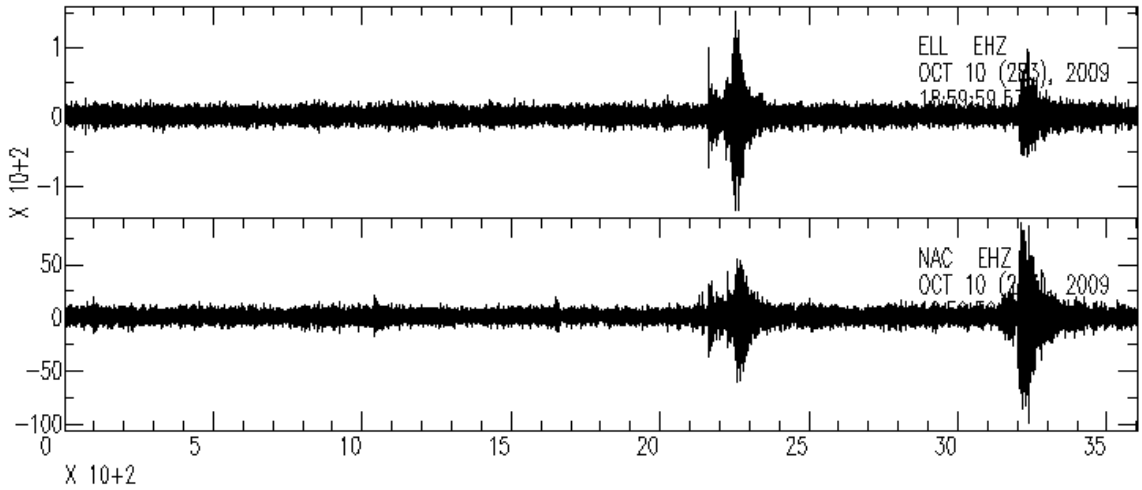
Saturday 10/10
7:37 PDT



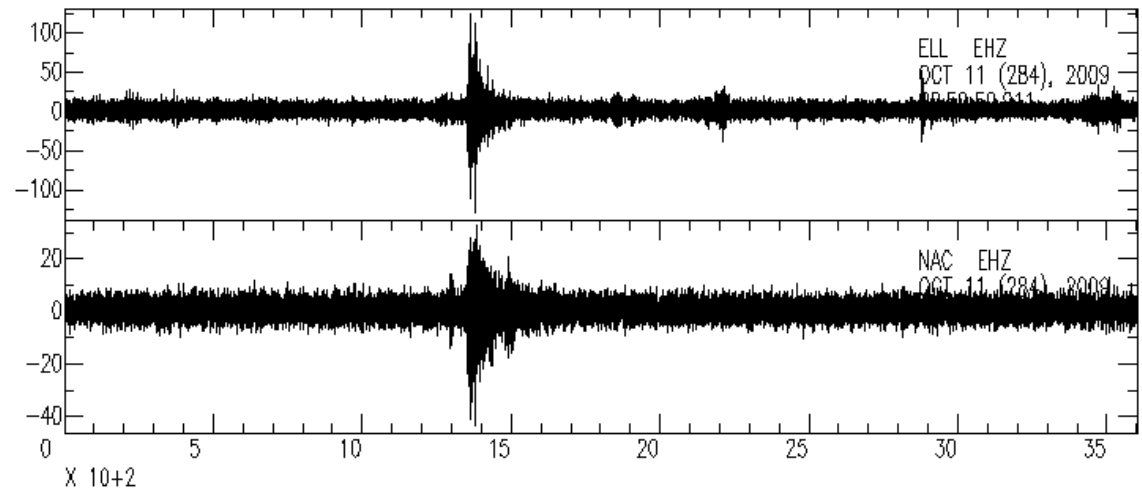
10:22 PDT



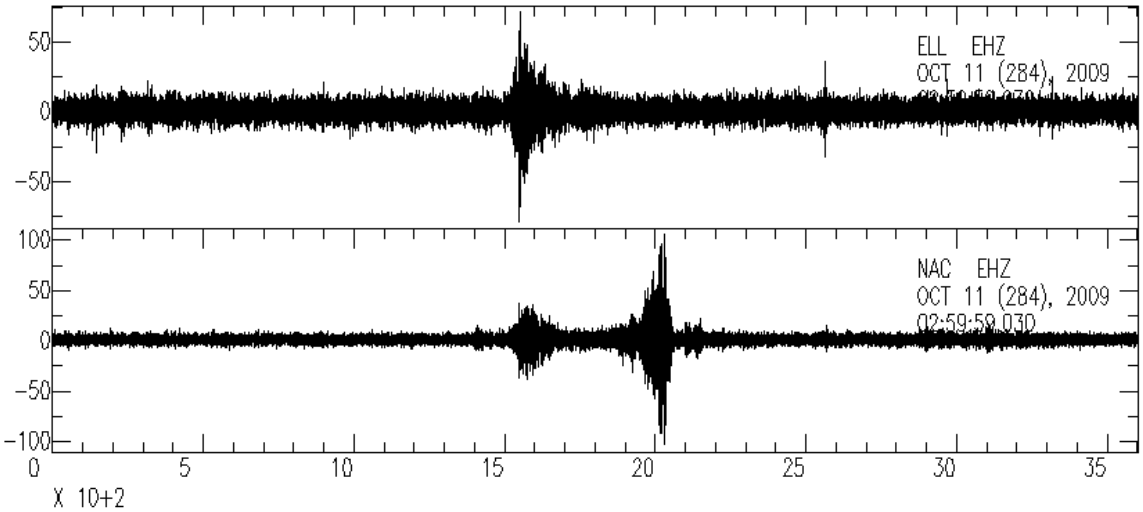
12:36, 12:53 PDT (note increased amplitude)



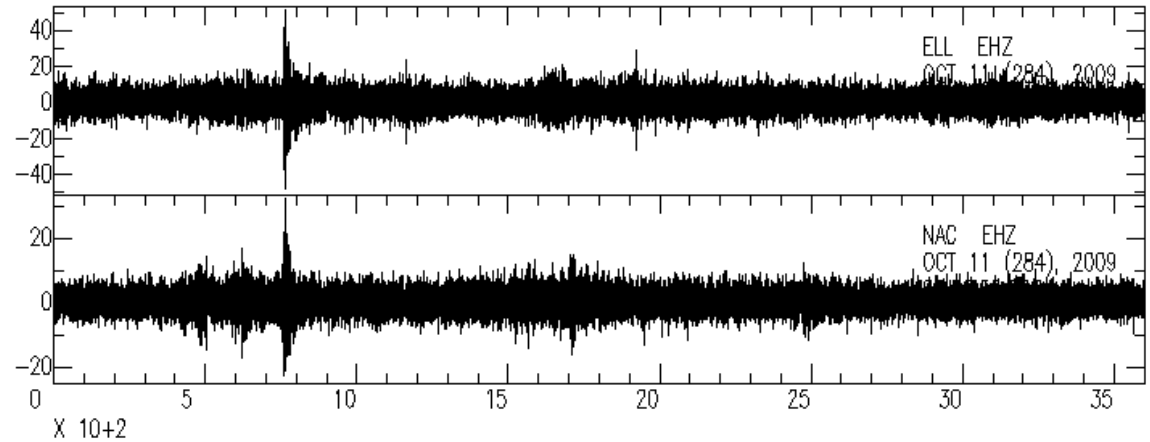
18:22 PDT



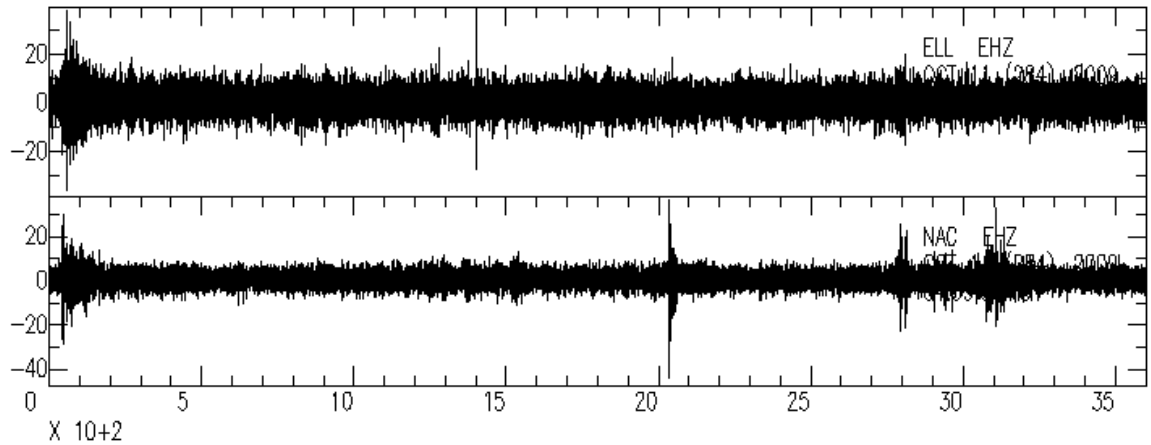
20:22 PDT, (note second bump is only on one station hence probably local noise)



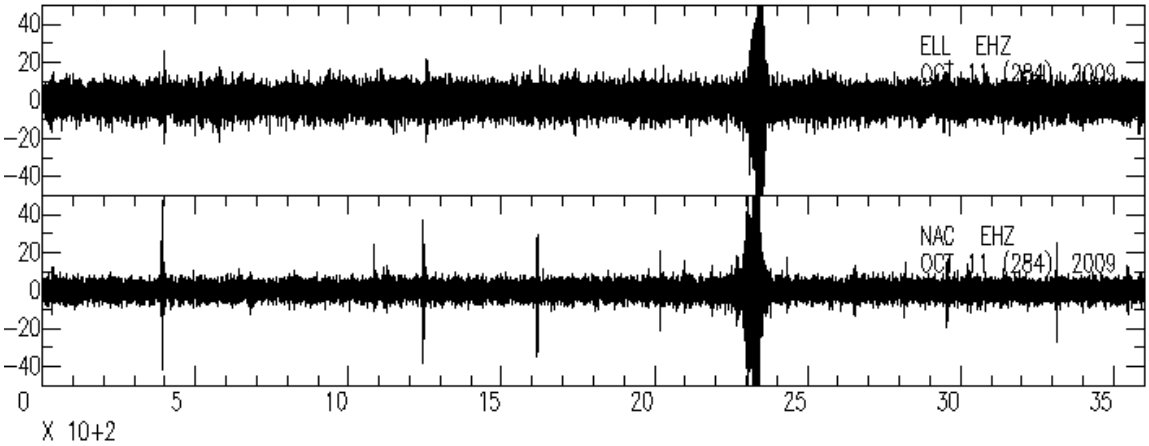
21:12 PDT



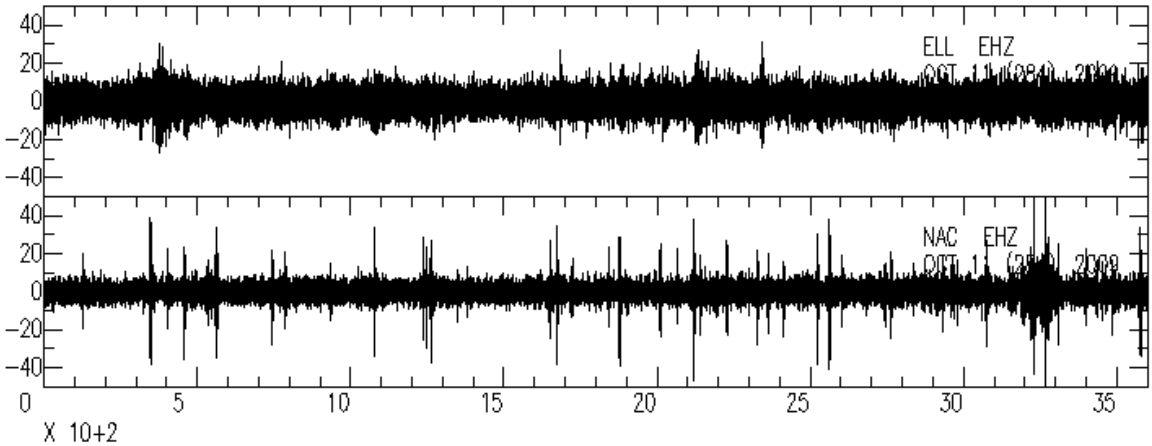
22:00 PDT

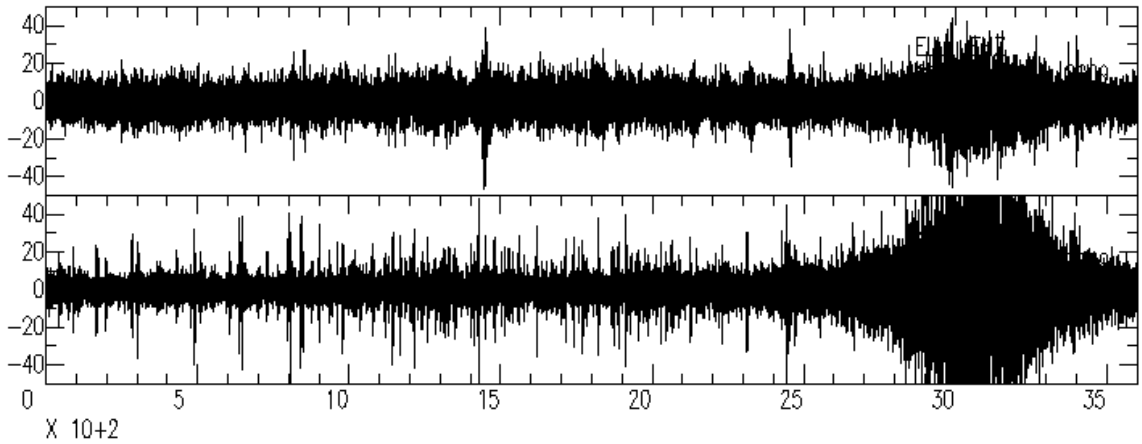
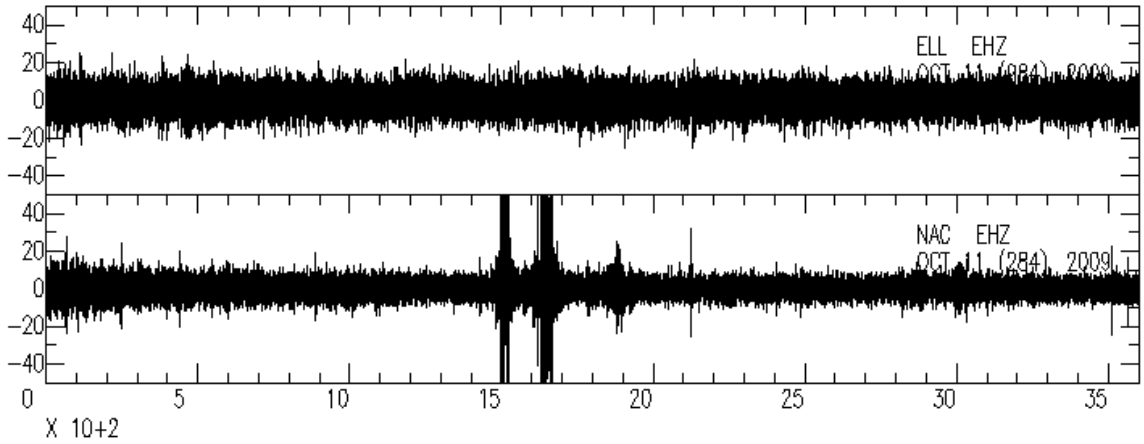


Sunday 10/11
5s pops **4:48 and 5:48 PDT** (not shown)
pops plus big burst **7:38 PDT**



steady set of pops **8:00-10:00 PDT**, loudest burst **9:43-9:55 PDT**





then nothing obvious more, the next hour **10:00-11:00 PDT** is shown (pulses, just appearing on one of the stations, are again probably local noise)