Black Canyon Hydroelectric Project
FERC Project No. P-14110
Preliminary Geotechnical Findings Report

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1 EXECUTIVE SUMMARY

Black Canyon Hydro, LLC, (BCH) ultimately plans to file an application for an original license for the Black Canyon Hydroelectric Project (Project), FERC Project Number P-14110, and associated facilities on the North Fork Snoqualmie River (North Fork), approximately 4-miles northeast of North Bend in King County, Washington. The Project has a proposed generating capacity of 25-megawatts (MW) and would be located predominantly on private lands. The combined maximum hydraulic capacity of the four project turbines would be 900 cubic feet per second (cfs). The run-of-river Project would divert water from an approximately 2.7-mile-section of the North Fork.

As required by the Integrated Licensing Process of FERC, BCH conducted several studies to evaluate a wide range of potential impacts associated with the Project. BCH will incorporate the information provided by these studies into ongoing Project design and operations planning. BCH conducted an environmental flows study within the segment of the North Fork that would be affected by the proposed Project. This portion of the river, which extends from approximately river mile (RM) 5.3 to RM 2.6, is referred to as the Project Reach. This document presents the study results as part of the overall program of studies evaluating how flow-dependent resources may be affected by the Project operations and informing how Project goals can be achieved.

The following is a description of Project features that have been updated since the filing of the Revised Study Plan:

PROJECT DESIGN

Intake

The following description of intake features reflects an evolution in Project design since the filing of the Pre-Application Document (PAD) through scoping, stakeholder comment, and study results. As a result of completing relevant studies, two possible design alternatives have been developed for the intake. These Alternatives are called Alternative C and D. Both alternatives involve bulk water screening located at approximately RM 5.3, on the same river bend and point-bar as Alternative A. Alternative C uses a vertical plate screening system, and Alternative D uses a horizontal plate screening system.

Both alternatives would have a (1) control sill to control the normal water surface elevation and maintain a consistent river bed elevation for a side channel bulk-water intake. The control sill would consist of a concrete weir with boulders inset on the surface over top of a sheet pile cutoff wall to capture hyporheic flow. The sill would be at the newly established grade of the river bed and would allow uninterrupted flow through a natural looking re-profiled river as a roughened channel series of step pools, riffles, and boulder weirs. (2) An intake structure with a coarse trashrack, jib crane, and radial gate with sluiceway located on the east bank of the river. Diverted water would be conveyed through; (3) an open channel to a; (4) head gate control structure and into a; (5) fish and debris screening structure. (6) Fish and debris would be screened and bypassed back into the river. Screened water would then flow through a power conduit to the underground powerhouse. (7) Access to the intake site would use an existing logging road and approximately 400 feet of new roadway extending to the intake site.

Powerhouse

The powerhouse location would be located underground beneath the selected intake site. This would include a (1) 450-feet tall, 30-foot diameter vertical shaft to allow space for the power penstock(s), elevator, stairs, ducting, mechanical, and electrical chases. Screened water from the intake screen system would be delivered down a (2) vertical power penstock(s) to the powerhouse. The powerhouse would (3) use four Pelton Turbines each rated at 6.25-MW, as well as appurtenant facilities. The (4) powerhouse substation and (5) elevator building would be located near the intake structure.

Tailrace

The tailrace will be an approximately (1) 8,600 foot long 12 foot diameter tunnel, and is anticipated to be constructed primarily in bedrock. The tailrace water return to the North Fork would be located at approximately the same location as proposed in the PAD at approximately RM 2.6.

Transmission

Transmission would consist of a 34.5-kilovolt (kV) underground transmission line and overhead transmission that transmits project power to the regional grid. The transmission line would be sited predominantly on an existing power line corridor. The transmission line would originate at the powerhouse substation located at the intake site at RM 5.3. Subsurface transmission would follow the vertical shaft to the underground powerhouse, and down the 1.6 mile long tunnel. After exiting the tunnel the transmission would travel underground 1.0 miles on new and existing roads then 4.2 miles as 34.5- kV overhead transmission line predominantly following an existing power line corridor to the point of interconnection. The point of interconnection is located at an existing overhead transmission line near the intersection of 396th Drive SE and SE Reinig Road approximately 0.4 miles from the City of Snoqualmie. A new switch and substation would be added at the point of interconnection to transform voltage from 34.5-kV to 115-kV.

2 INTRODUCTION

This report is the summary of preliminary geotechnical investigation for the Black Canyon Hydroelectric Project. The area of investigation is located in King County, Washington along or near the North Fork Snoqualmie River (North Fork), approximately 4-miles northeast of North Bend in King County, Washington. A vicinity map is shown as Figure 1. The study reach for this investigation is shown on Figure 2 - Study Reach. The study reach range is approximately a five mile section of river, from river mile 1.6 to river mile 6.54. Particular emphasis was spent on the investigation of the 2.7 mile project reach between the powerhouse site and tailrace exit.

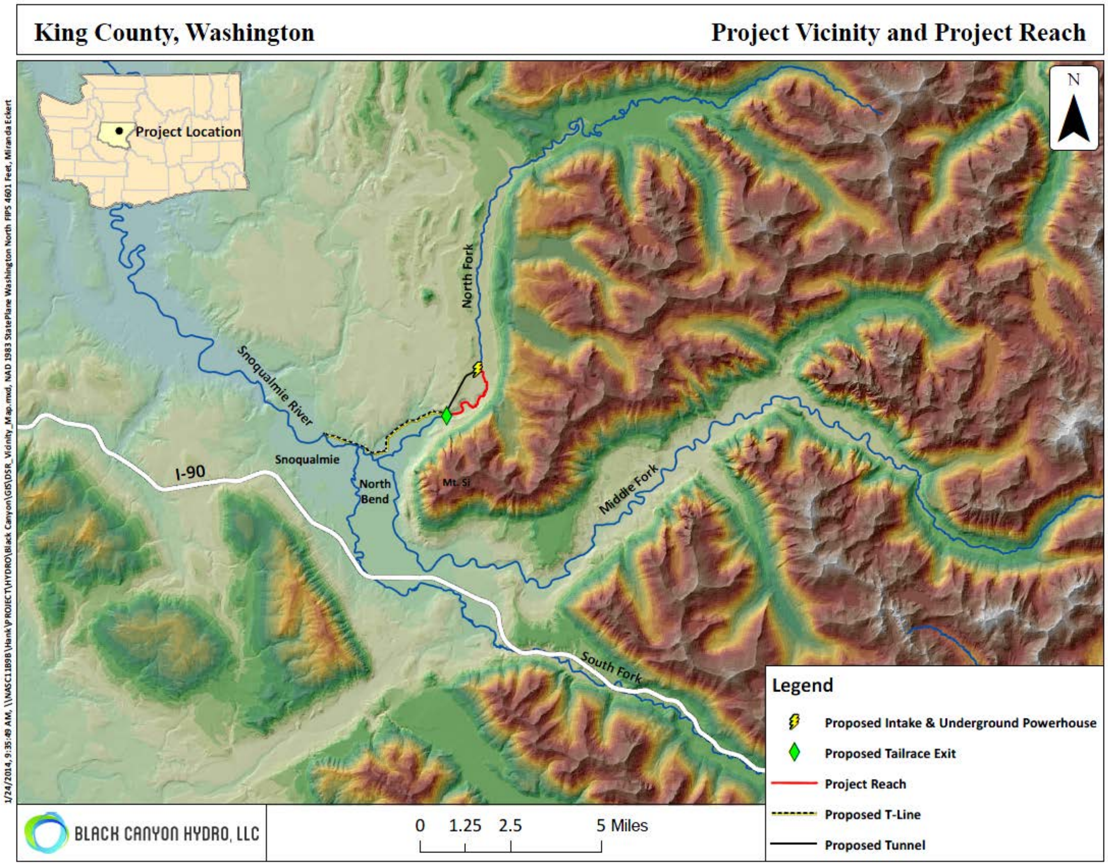


Figure 1 - Vicinity Map

This report contains information from existing investigations and studies that overlap the study reach. These sources are from USGS mapping, Black Creek Hydroelectric Project FERC Project Number P-6221, Weyerhaeuser soil borings, Washington Department of Ecology well logs, City of Snoqualmie 2013 Water System Plan. This report also includes results and conclusions associated with additional field work performed by AMEC Environmental, and BCH engineering stafff. The locations of test pits, drill holes, tunnel, and other major features are shown in Drawing 300 - Tunnel Alignment & Existing Geotechnical Test Sites.

The purpose of this investigation was to define soil types, and understand approximately where the subsurface bedrock is in relationship to the proposed project features. The conclusions and recommendations presented here are based on existing geotechnical studies, well logs, and geologic mapping. Additional field investigations, laboratory testing, and analysis was performed in 2012 and 2013 by engineering staff and their sub consultants. The scope of work was defined by the design needs of BCH staff.

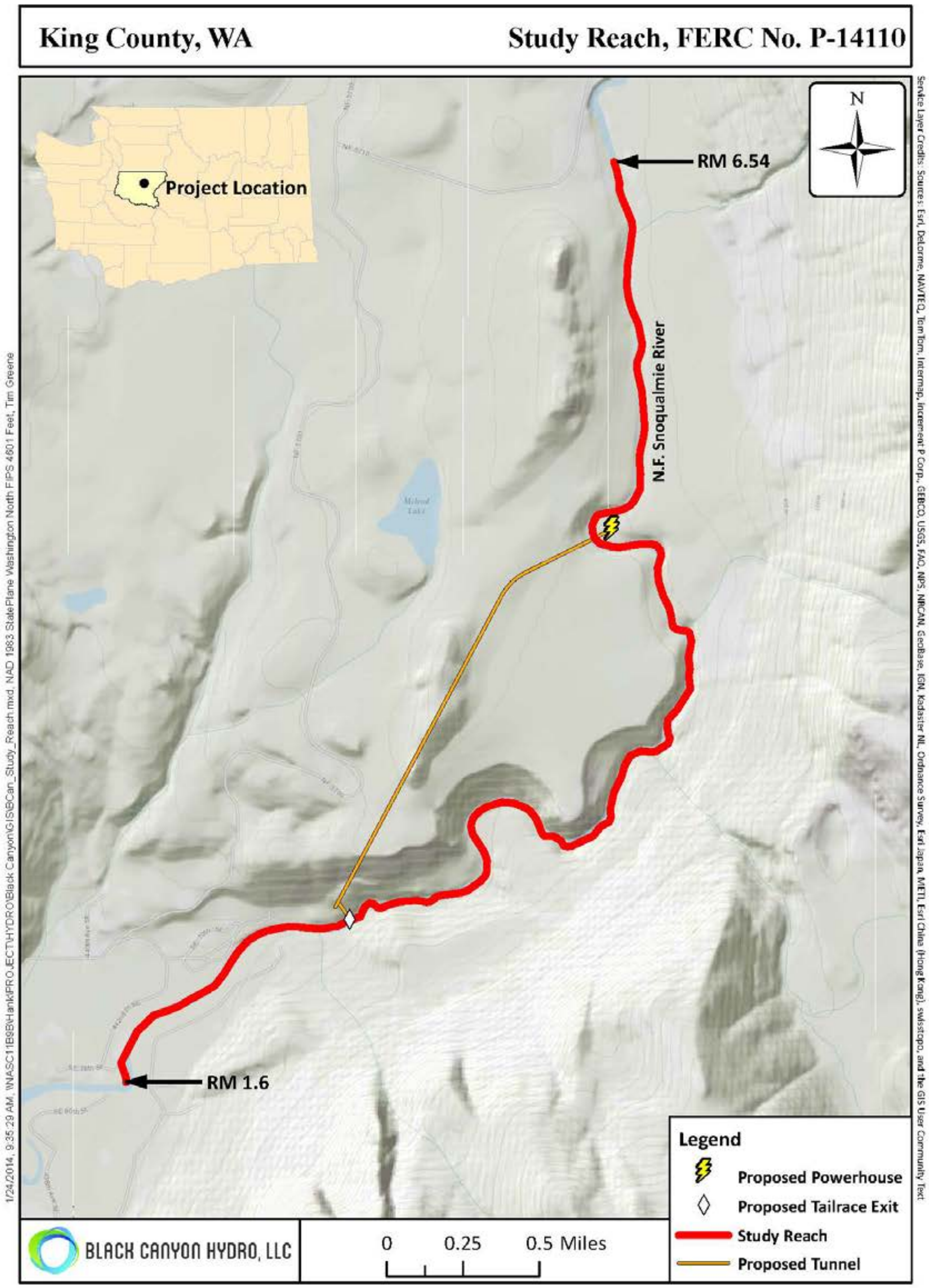


Figure 2 - Study Reach

3 BACKGROUND RESEARCH

Background research for the area is based on information from various sources that provide geologic information within or near the study reach. These sources are documented as follows:

3.1 USGS Geologic Information

USGS Geologic published a map of the Skykomish River Quadrangle. A portion of this map is included in Figure 3 - USGS Mapping, which shows the approximate location of the proposed tunnel. The mapping identifies Recessional outwash (Qvr) overlaying Pre-Tertiary Bedrock (TKwa) and Potassium-feldspar-bearing sandstone (TKwk) adjacent to the TKwa. The depth of the recessional outwash is undefinable from this map. Recessional outwash (Qvr) overlaying Pre-Tertiary Bedrock (TKwa) is shown within the Black Canyon project boundary.

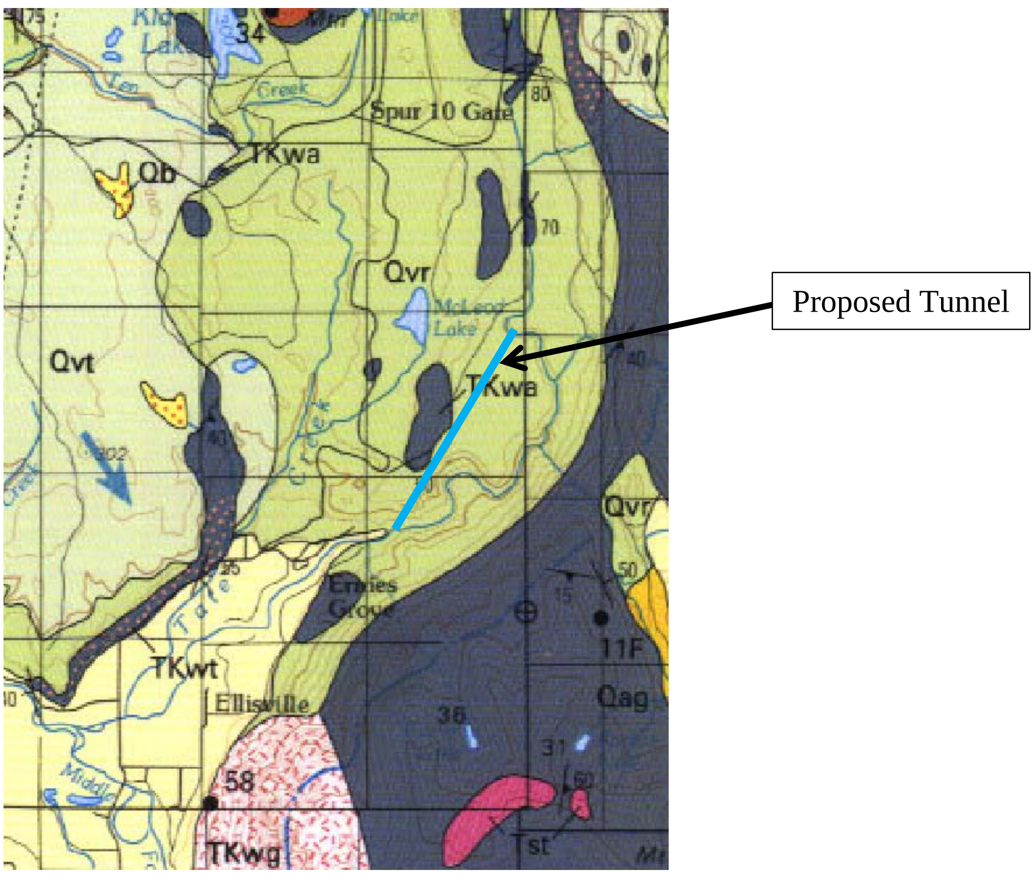


Figure 3 - USGS Mapping

USGS Mapping Definitions
Qvr - Recessional outwash deposits-Stratified sand and gravel, moderately to well sorted, and well-bedded silty sand to silty clay. deposited in proglacial and ice-marginal environments. Largely plane-bedded outwash and foreset deltaic deposits in lowlands, but indudes fine-grained deposits of ice-dammed lakes in major west-draining alpine valleys and at low altitudes along Snoqualmie and Skykomish River valleys. Includes parts of ice-marginal embankments, kame terraces, and glaciolacustrine deltaic deposits.

TKwa -Argillite and greywacke (Pre-Tertiary Bedrock) -Pervasively sheared, scaley matrix of mostly argillite containing steep-sided, outcrop to mountain-sized phacoids of purplish, reddish, gray, and black, fine to coarse-grained and pebbly, lithofeldspathic, volcanolithic and subquartzose sandstone interbedded with black argillite. Sandstone has clasts mostly of plagioclase, chert, volcanic rocks, and quartz. Also abundant are grains or sandstone, siltstone, phyllite, biotite, muscovite, and epidote. Where more strongly deformed, unstable grains are broken down into anastomosing shear zones or smeared out into indistinct chloritic matrix. Alteration minerals are calcite, chlorite, serlcite, limonite, epidote, and prehnite. Near Tertiary plutons the rocks have become hornfelsic, commonly with conspicuous biotite. Sedimentary features such as graded bedding and load casts are locally well preserved. Unit Includes minor chert, polymictic and quartz pebble conglomerate, and shale-chip breccia: also very minor chert, limestone, metavolcanic rocks, metagabbro, and metatonalite. Locally cut by greenstone (metadiabase) dikes.

TKwk – Potassium-feldspar-bearing sandstone – Lithologically similar to sandstone of unit TKwa but having 2 to 20 percent potassium-feldspar clasts and commonly more plagioclase, muscovite, and biolite.

3.2 Black Creek Hydroelectric Project FERC No. 6221

The Black Creek Hydroelectric project geology is relevant to the Black Canyon Hydroelectric project as the lower study area of the Black Creek hydro project overlaps with the Black Canyon projects study area. The Black Creek hydro project was constructed in 1994 by the Hydro West Group from Bellevue Washington. The Black Creek powerhouse is about a mile downstream of the proposed Black Canyon Intake, Figure 4. The tailrace for the Black Creek project also drains directly into the North Fork of the Snoqualmie River into the Black Canyon Hydroelectric bypass reach located specifically in the North Fork’s “Canyon Reach” study area at approximately river mile (RM) 4.3, Figure 13. The Figure 13 photograph shows the interface of upper weathered rock with the underlying bedrock surface at approximately elevation 790-ft above mean sea level.

Figure 4 - Photo of the Black Creek Hydro Powerhouse

The geology of the Black Creek project area was classified as follows by Ebasco Environmental in The Final Erosion and Sediment Control Plan, prepared for the Black Creek Hydro Project.

"The project area is underlain by pre-Tertiary sedimentary rocks of the Western Melange Belt, primarily argillite with phacoids of sandstone and some chert (Figure 2.3) (Tabor et al., 1982). During the early Tertiary, these pre-Tertiary Belt rocks were uplifted sheared and subsequently eroded. Outcrops examined along the Black Creek penstock route suggest that the Belt rocks in this area were partially metamorphosed (see also Kramer, 1959), as they consist primarily of pervasively sheared phyllite. Bedding and shear planes are oriented predominantly north to northeast, and dip steeply to east, although there are many exceptions to this trend. In addition, Tabor et al (1982) have mapped an outcrop of chert higher up in the Black Creek drainage, although this is outside the project area. The pre-Tertiary rocks are presently exposed in the lower portions of the project, and underlie the powerhouse site. Bedrock observed in exposures is generally hard (dent to crush quality), slightly weathered, and moderately fractured, with three dimensional open planes of separation 6 in to 3 ft apart.

Throughout most of the project area the pre-Tertiary bedrock is mantled by thick deposits of Pleistocene age glacial sediments. Although there were several periods of glaciation during the Pleistocene, it is most likely that the deposits in the study area relate to the most recent Vashon Stade of the Fraser Glaciation, which occurred about 15,000 to 13,000 years ago. During this period an ice sheet expanded in to the Puget Sound region from a source area in British Columbia, and inundated the pre-glacial North Fork Snoqualmie valley up to an elevation of about 2800 ft. (Booth, 1984). As the ice front *moved up in to the lower portions of west flowing drainages (such as Black Creek), it blocked flow down the valleys. This blockage of flow led to the formation of lakes, which were progressively filled with sediments by streams coming down the west flowing drainages and from under the ice sheet (Booth, 1984). Lakes Hancock and Calligan, in west flowing drainages just north of the Black Creek valley, were originally formed by this same process. A similar lake almost certainly existed in the Black Creek drainage, up-valley of the embankment, but drained subsequent to, or during, ice retreat. Fine, layered sediments exposed just west of the diversion site suggest that this lake extended to at least an elevation of 2320 ft., and Tabor at al (1982) indicate that the lake may have extended up to an elevation of 2500 ft. (the extent of Qcs deposits on Figure 2.3).*

The Late Pleistocene deposits in the project area consist primarily of a complex mix of outwash deposits and finer lake sediments. Post-glacial (Holocene) deposits overlie glacial deposits and bedrock in many areas, and consist primarily of colluviaum and recent alluvium. Colluvium (slopewash deposits) generally forms a thin mantle over most of the non-bedrock areas, and consists of a mixture of the upslope and/or underlying deposits that is of lower density than the parent material. These colluvial deposits are generally on the order of a few inches to a few feet thick. In the diversion area there are also recent alluvial deposits associated with Black Creek, which consist of sand and rounded gravel deprived from bedrock and reworking of glacial deposits. The glacial deposits found along most of the project route are described in detail in Table 2.2.1."

In addition to the Ebasco report, a Geotechnical Investigations for Diversion and Penstock was prepared by Bingham Engineering for the Black Creek hydro project. The report documented field explorations in various locations within the project boundary, and documented laboratory testing on soil and rock characteristics within the project boundary. Field explorations were done from May 1990 and completed in January 1992. 16 test pits and 15 drill holes, one hand auger hole, one hand-dug test pit, and 11 seismic refraction lines were performed. The test pits and drill holes at the Black Creek Powerhouse are the closest field explorations available related to the Black Canyon project and have been plotted on Drawing 300 for reference. These are labeled as test pits TP-11, TP-12, TP-13, TP-14, and drill holes DH-7, DH-15. The results of these explorations show contact with bedrock ranging from the surface to approximately 20 feet below surface. The logs for these explorations are attached in Appendix A.

The Bingham Engineering report characterized the bedrock as “light gray to black, medium grained, metagraywacke bedrock,” “The “fresh” rock consisted of white calcite, quartz and pyrite veins cross-cutting white veins of quartz and calcite. The bedrock is relatively massive, hard to very hard with moderate to high strength. Rock Quality Designations (RQD) varied from zero in the upper “weathered” portions to 100 in “fresh” rock. The weathered upper portion was generally on the order of two to three feet and was highly fractured with slight to moderate weathering on the fractured surfaces. The fracturing generally occurred along preferred planes, however, some random fracturing was also present. Some of the fracturing may be attributed to solution of the calcite veins that were present in the “fresh” rock.”

Bingham Engineering also tested five bedrock core samples. Representative samples to the Black Canyon project are drill hole 7 and 15, DH-7, DH-15. Compressive strength of the rock ranged from 6,100 psi to 17,380 psi. The Bingham report Table 2 is attached in Appendix A.

The Bingham reported concluded that “the classifications of the bedrock within the project boundary, as reported in other geological reports were not consistent.” To more accurately describe the bedrock a petrographic analysis was made of a thin section of a representative core sample. Bingham described the bedrock as a medium grained metagraywacke.

3.3 Weyerhaeuser Borings

Weyerhaeuser has provided BCH two borings completed by SubTerra, Inc dated November 19, 2001. Logs and associated maps are attached in Appendix B. SubTerra is a geologic and civil engineering consulting firm located in North Bend Washington. SubTerra at the time was contracted by Weyerhaeuser to explore and estimate existing gravel resources on Weyerhaeuser lands. The approximate locations of drill logs EG-1, and EG-2 have been plotted on attached Drawing No. 300.

The provided borings, EG-1, and EG-2 do not conclusively intersect bedrock. Drill log EG-1 was drilled to a depth of 300-feet below ground surface. EG-1 did not intercept bedrock. EG-2 was drilled to a depth of 273-feet below ground surface. EG-2 went to refusal which could have been either a large boulder or bedrock at the 273-ft mark.

Brandon Hausmann, PE contacted Chris Breeds president of SubTerra, Inc by telephone on July 26, 2012. Mr. Breeds stated the sampling completed for Weyerhaeuser was only with the use of drills. No Geophysical data collection was done. Mr. Breeds stated that SubTerra is not conclusive on the exact depth of bedrock, and emphasized that EG-2 drill log could have been a boulder rather than bedrock.

3.4 Existing Drinking Water Sources

There are two existing residential well logs and an existing City of Snoqualmie well field called Canyon Springs located within the project study area, see Appendix C. Other well logs exist near the study reach in the area downstream of the lower tunnel portal, and on the east side of the river on Moon Valley Road. Those well logs have been left out of this report.

A residential drinking water well was constructed in August 2008 on Tax parcel No. 25-24-08-9002. Well ID Tag # AKF-965. The Washington Department of Ecology well log map web page shows this well on the east side of the North Fork. This location shown on the web page is likely an error. Based on the legal description, land ownership, and discussion with the well driller this well should be located on the west side of the North Fork as approximately shown on attached Drawing 300. The well log describes encountering hard basalt at 175’ below surface and ended hole in hard basalt at 260’ below surface.

A residential drinking water well was constructed in July 2009 on Tax parcel 26-24-08-920102. Well ID Tag # APR-071. The well log describes grey basalt from 100’-150’ below surface and hard basalt from 150’-195’ below the surface. The location of the well shown on drawing No. 300 is approximate and is based on the legal description and the location shown on the Department of Ecology website.

It is unknown how the well drillers classified the bedrock as basalt, and therefore may have classified the rock in error.

Both well logs are in the vicinity of the lower tunnel reach on the upper bench at an approximate elevation above mean sea level of 1000-ft. The proposed tunnel is approximately 500-ft below the ground surface adjacent to the well locations.

City of Snoqualmie – Canyon Springs

The City of Snoqualmie owns a municipal drinking water source located in the southeast quarter section of section 24 located on the west bank of the river, locations shown on drawing No. 300. This drinking water source is known as the "Canyon Springs." A map of the wellhead protection area for Canyon Springs is provided in Figure 5.

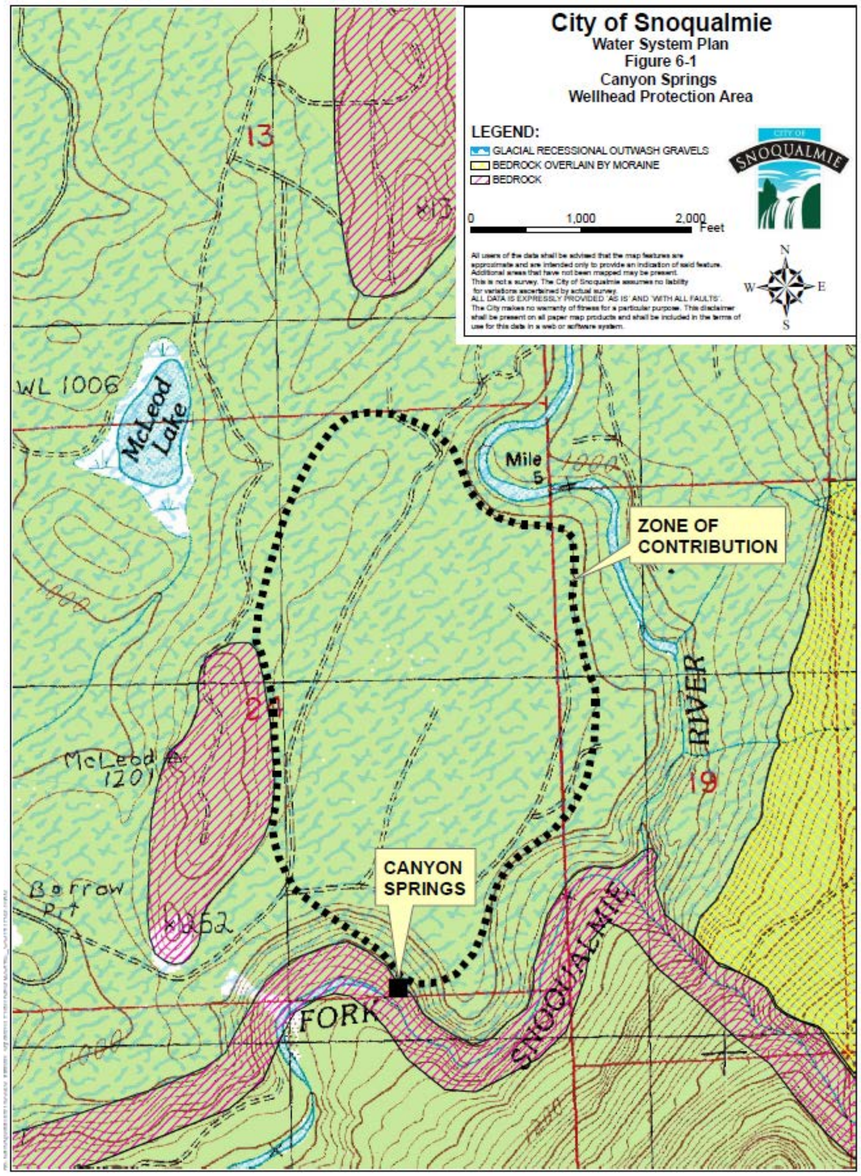
The City of Snoqualmie 2013 Water System Plan by Gray & Osborne, Inc describes the Canyon Springs as follows:

"Canyon Springs is located on a steep hillside above the North Fork of the Snoqualmie River as shown on Figure 6-1. A CFR analysis is not appropriate for this source, as it receives water only from the area to the north. According to geological information, the area upland of the spring is composed of glacial recessional outwash gravels. Underneath this layer is a floor of bedrock. Canyon Springs appears to emerge at roughly the interface between the two layers. The area to the north of the spring is a large, flat plateau that is bounded to the east and north by the North Fork of the Snoqualmie River. Two bedrock knolls suggest a bedrock ridge that would form a westerly boundary of the catchment basin. An approximate boundary of the zone of contribution for the springs is shown on Figure…." See Figure 5 – Canyon Springs Wellhead Protection Area

"The zone of contribution is an approximation of the area that would intercept rainfall. Since the area is flat, it is assumed that any precipitation that is not lost through evapotranspiration recharges the aquifer that feeds the spring. There is no information about the depth of the aquifer, its grade, or its transmissivity. Consequently, an understanding of the travel time through the aquifer and development of 6-month, 1-year, 5-year, and 10-year zones of contribution are not possible. A cursory analysis of total precipitation over the area indicates that the rainfall contribution is only slightly higher than the expected yield. The average precipitation for the area is approximately 90 inches and 36 to 48 inches of evapotranspiration are assumed as average for second-growth conifer forest in western Washington. A net recharge of 40 to 50 inches of precipitation over the 10,000,000 square feet of the zone of contribution would yield approximately 300 million gallons per year, approximately the estimated yield of Canyon Springs.

It is possible that the aquifer receives recharge from the North Fork of the Snoqualmie River in the northern portion of the zone of contribution. At that point, the river is flowing through the outwash gravels and is at a higher elevation than the springs. It is conceivable that some of the flow could, depending upon soil saturation and groundwater levels, flow from the river into the aquifer and emerge at Canyon Spring after passing through the outwash gravels."

Figure 5 - Map of the Canyon Springs Wellhead Protection Area



The spatial relationship of the Canyon Springs water source and the proposed tunnel is shown on plan and cross section, Drawing No's 300 & 303.

4 FIELD INVESTIGATIONS

4.1 AMEC Field Report & Draft Preliminary Geophysical Study

AMEC Environmental staff and BCH engineering staff visited the project site on July 18, 2012, and documented bedrock outcrops along the City of Snoqualmie Canyon Springs access trail near the lower tunnel portal, Figure 9 - Photo of bedrock along the Canyon Springs access trail. See Appendix D for the field report.

AMEC Environmental staff, subcontractor Global Geophysics, and BCH engineering staff conducted seismic refraction and electrical resistivity tomography (ERT) testing at three locations on July 30, and 31 2012. The draft Preliminary Geophysical Study and field report are attached in Appendix D. The test locations were the following:

1. Intake Site Seismic Profile 1
2. Seismic Profile 1 at the lower tunnel access site
3. Seismic Profile 2 at the lower tunnel access site

The seismic profile for lines 1 and 2 located at the lower tunnel site are titled Powerhouse Lines 1 and 2. The powerhouse has been relocated to an underground location under the intake since the time of the draft report. Therefore, seismic profile 1 and 2 at the powerhouse site should now be referenced as the lower tunnel access site. Drawing No. 300 shows the location of the three seismic profile locations.

The AMEC seismic Profile 1 located near the intake location (RM 5.04) was interpreted by AMEC as the following. "The ERT plot is interpreted to show bedrock at 15-20 feet below ground surface near the center of the profile, but sloping steeply away at each end of the profile."

Both seismic profiles along the City of Snoqualmie water main easement near the lower tunnel access site confirm the presence of bedrock near the ground surface.

4.2 Rock Samples

BCH staff also collected two rock samples at the approximate location of the lower tunnel portal at river mile 2.6. The rock sample was found in a pile of broken stone that had recently broken off of the rock face from about 30-ft above. These rock samples were tested for compressive strength. Materials Testing & Consulting (MTC) characterized the rock samples and tested each sample for strength and relative hardness, see Appendix E. Hardness for the samples was placed about 7 on Mohs scale.

<u>Compression Testing Results</u>
Sample # B13-813 compressive strength: 14,840psi
Sample # B13-814 compressive strength: 10,900 psi

MTC characterized the rock samples as follows: "Given the hardness (approximately 7 on Mohs scale) of these samples and the fine crystalline structure, and quartzose veins, we expect that these samples are probably greywacke, basalt or volcanically altered sandstone, or highty altered argillite. Since argillite is typically a massive intermediate of shale and slate, lacking the well defined crystalline structure of these samples, it is less likely."

4.3 Field Observations

The study reach along the North Fork was studied and documented for a variety of required study reports. The approximate five mile study reach is a section of the North Fork from river mile 1.6 to river mile 6.54. Included in the approximate 5 mile study reach is the 2.7 mile project reach. The project reach is defined between the point of diversion and the lower tunnel portal (tailrace exit). The study reach has been broken down into specific aquatic reaches that were classified by the Aquatic Resource Study Report; see Figure 6 - Aquatic Reaches and Drawing 304 – River Profile. These reaches are called Ernie's Grove Reach, Lower Canyon Reach, Snoqualmie Springs Reach, Upper Project Reach, and the Hancock Reach.

Bedrock has been documented by visual observation throughout the project reach. Numerous photographs were taken during field studies throughout the study reach. The study reach was also flown by helicopter and documented with video and photo imagery. Representative photographs of the geology along project reach are included.

Photographs of visible bedrock in the project reach are included in Figures 7 to 15. There are also numerous springs throughout the canyon indicating ground water had encountered bedrock along the project reach at the bedrock-glacial deposit interface.

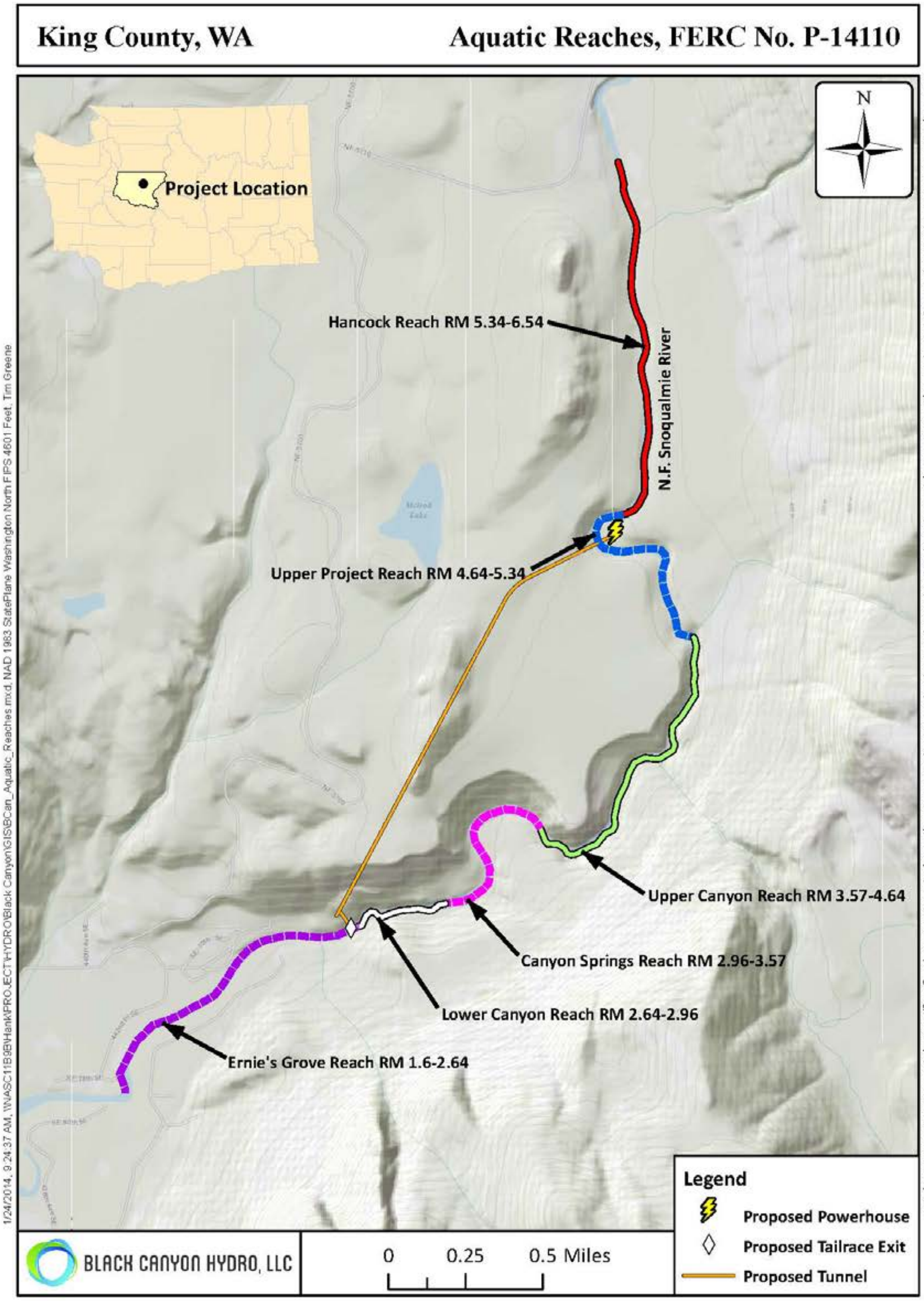


Figure 6 - Aquatic Reaches

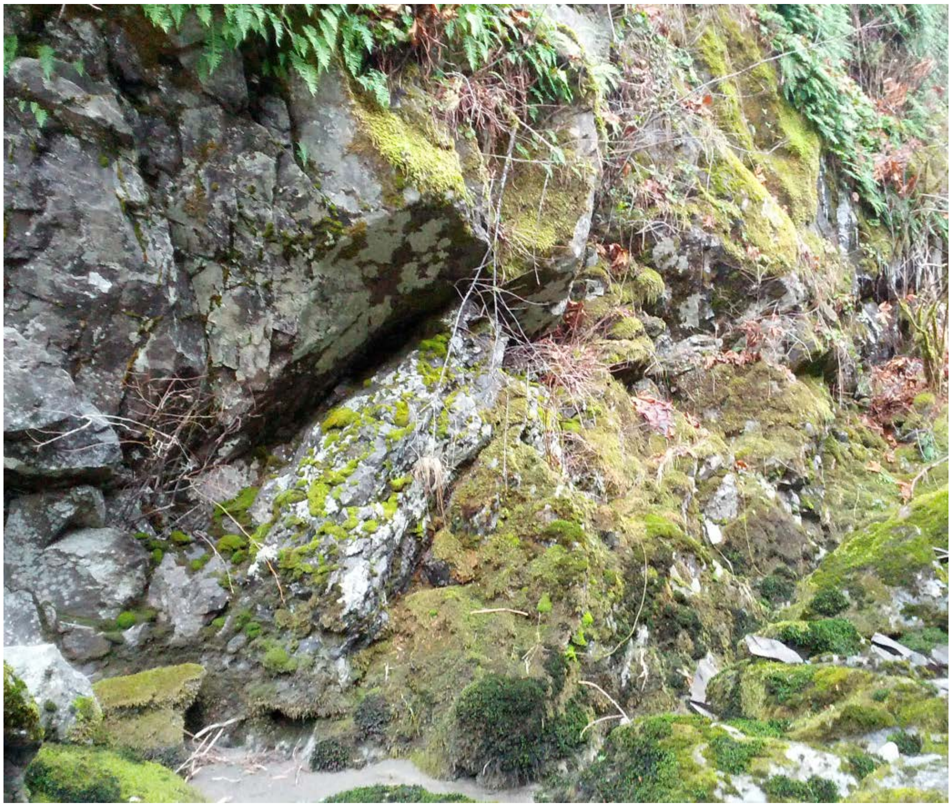


Figure 7 - Photo of west river bank at RM 2.6

Figure 8 - Photo of east river bank at RM 2.6

Figure 9 - Photo of bedrock along the Canyon Springs access trail

Figure 10 - Photo #1, Canyon Reach

Figure 11 - Photo #2, Canyon Reach

Figure 12 - Aerial Photo, Confluence Black Creek & North Fork, RM 4.2

Figure 13 - Aerial Photo, Confluence Black Creek Hydro Tailrace flow & North Fork at RM 4.3, image looking at east bank of North Fork

Figure 14 - Photo confluence of Black Creek Hydro Tailrace and the North Fork at RM 4.3, image looking at west bank of North Fork

Figure 15 - Photo of bedrock on east bank at RM 5.0

Bedrock is not visible at the exact location of the proposed intake Alternatives C and D located at river mile 5.33, See Figure 16. However, there are visible outcrops of bedrock located upstream and downstream of this location at river mile 5.0 and river mile 5.37. There is a protruding outcrop of bedrock or possible large boulder in the river at river mile 5.37, see Figure 17, approximately 300-ft upstream of proposed intake Alternatives C and D location.

Figure 16 - Photo looking toward east bank RM 5.33

Figure 17 - Photo of bedrock outcrop RM 5.37

5 RESULTS

There is sufficient physical and well documented evidence that Pre-Tertiary bedrock exists throughout the project reach. Some of the geophysical investigations, field observations, and reports show a strong correlation between each report and/or data source clearly identifying pre-tertiary bedrock, and typically classifying it as metagraywacke.

The City of Snoqualmie Canyon Springs Water System Plan notes that the Canyon Springs are sited at the bedrock and glacial outwash interface at approximately 685-ft above mean sea level. Weyerhaeuser drill log EG-2 hit refusal at approximately 780-ft above mean sea level. This suggests that the bedrock surface in this location could be approximately 780-ft above mean sea level. The proposed tunnel invert elevation is approximately 500-ft above mean sea level.

The two well logs AKF-965 and APR-071 confirm bedrock is encountered in the vicinity of the lower tunnel alignment with overlying glacial outwash. Bedrock was encountered at approximately between 783-859 feet above mean sea level.

The USGS mapping, well logs, seismic profiles, borings, test pits, and on site observations all document bedrock throughout the project reach. Bedrock has been also visually verified to closely follow the river grade along the project reach. A 3D TIN surface has been created using known elevations of bedrock, surface observations, and interpreted elevations between the known bedrock sites. The exact geometry between these known sites is unknown and can only be approximated with the information available. Drawing No. 300 shows the proposed tunnel alignment and notes two cross sections, Section 7 and Section 8. Both cross sections are seen on Drawing No. 303. The sections show the relationship of the proposed tunnel to the estimated bedrock surface, river, existing boring, and the location of the Canyon Springs. The proposed alignment of the tunnel is sited in bedrock based off of the estimated 3D TIN surface generated.

BCH contracted Element Solutions from Bellingham Washington to review this report. Element Solutions report titled Geologic Considerations for Project Feasibility is included in Appendix F. Element Solutions conclusion supports the findings of this report and concludes by stating the following:

"While actual subsurface lithology could present potential challenges for project design, the preliminary feasibility assessment, given the available information, appears logical and the hypothesis that bedrock is present in the proposed tunnel alignment appears sound. It does not appear given the geomorphic evidence that the large-scale mass wasting deposits occur in the proposed tunnel alignment. No active faults displacing glacial or Holocene deposits were observed in the LiDAR or are shown on the referenced maps. Moving forward with project design and assessment will require a deeper understanding of the bedrock composition, geomorphology, and regional and local faulting."

6 RECOMMENDATIONS

Further geotechnical investigations, and material testing will be necessary to understand the exact bedrock depth, physical properties of the soil, and the physical properties of the bedrock for the final design of all proposed project features. However, it is reasonable to delay this level of investigation and analysis until future phases of design work are warranted. At this time there is adequate information available using the existing project reports, geologic mapping, on site testing, and on site observations to conclude that a large portion of the tunnel alignment and underground powerhouse is likely to be confined within the pre-tertiary metagraywacke bedrock.

7 REFERENCES

Black Creek Hydroelectric Project, Final Erosion and Sediment Control Plan, by Ebasco Environmental, May 1992

Black Creek Hydroelectric Project, Geotechnical Investigations for Diversion and Penstock, By Bingham Engineering, March 1992

Weyerhaeuser logs and mapping, by SubTerra, Inc, November 2001

Geologic Map of The Skykomish River 30-By 60-Minute Quadrangle, Washington
By R.W. Tabor, V.A. Frizzell, Jr., D.B. Booth, R.B. Waitt, J.T. Whetten, and R.E. Zartman
http://pubs.usgs.gov/imap/i1963/skygm.pdf

Washington Department of Ecology website
https://fortress.wa.gov/ecy/

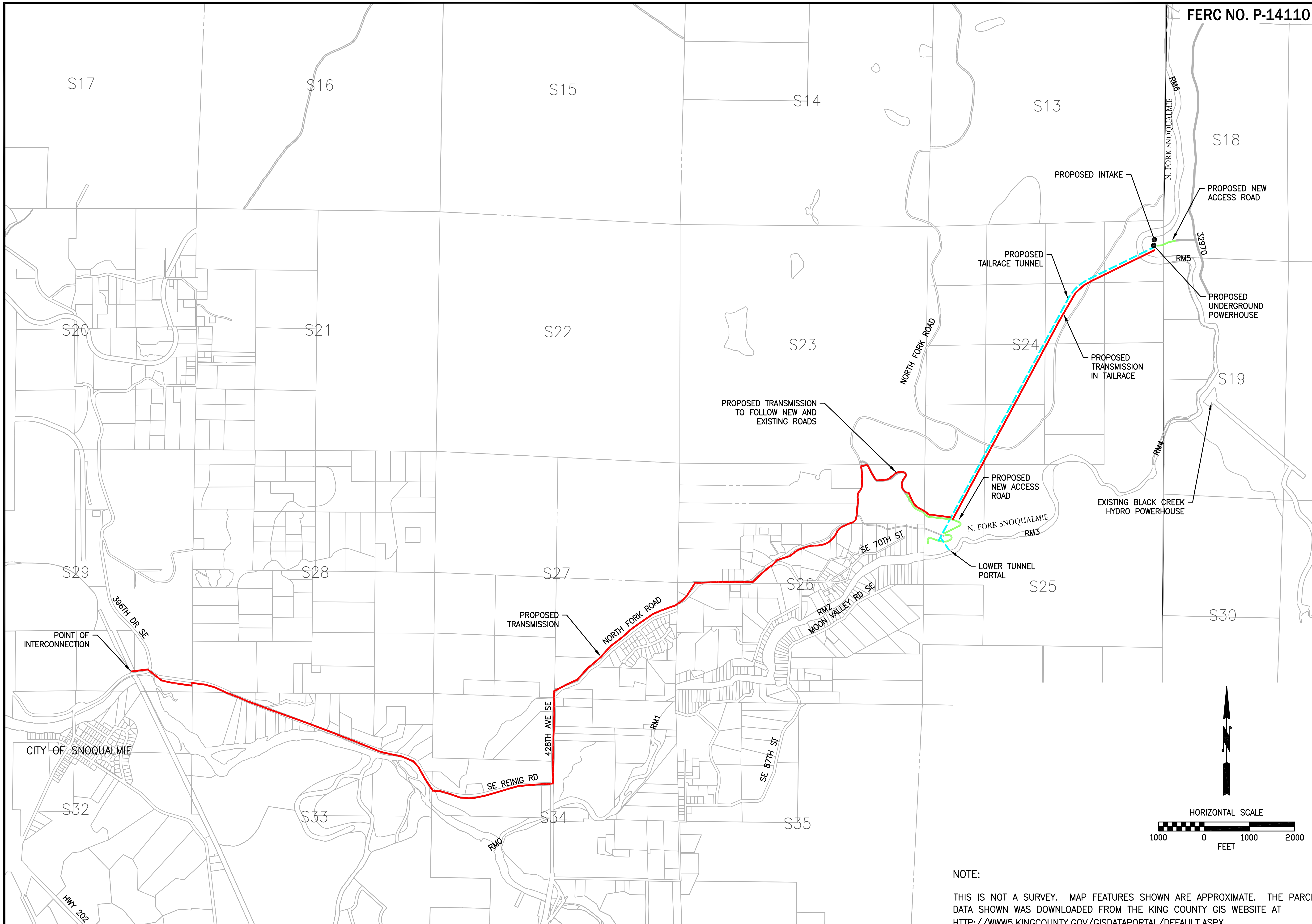
AMEC Environmental & Infrastructure, Inc. Preliminary Geophysical Study, August 17, 2012

City of Snoqualmie Water System Plan, by Gray & Osborne, Inc., February 2013

Material Testing & Consulting, Inc., Test results memo December 17, 2013

Element Solutions, Geologic Considerations for Project Feasibility, January 9, 2014

Drawings



NOTE:

THIS IS NOT A SURVEY. MAP FEATURES SHOWN ARE APPROXIMATE. THE PARCEL DATA SHOWN WAS DOWNLOADED FROM THE KING COUNTY GIS WEBSITE AT HTTP://WWW5.KINGCOUNTY.GOV/GISDATAPORTAL/DEFAULT.ASPX

NO.	DATE	REVISION	BY	CK

PRELIMINARY NOT FOR CONSTRUCTION

WHITEWATER engineering corporation
3633 ALDERWOOD AVENUE
BELLINGHAM, WASHINGTON 98225
PH: 360-738-9999 FAX: 360-733-3056

BLACK CANYON HYDROELECTRIC

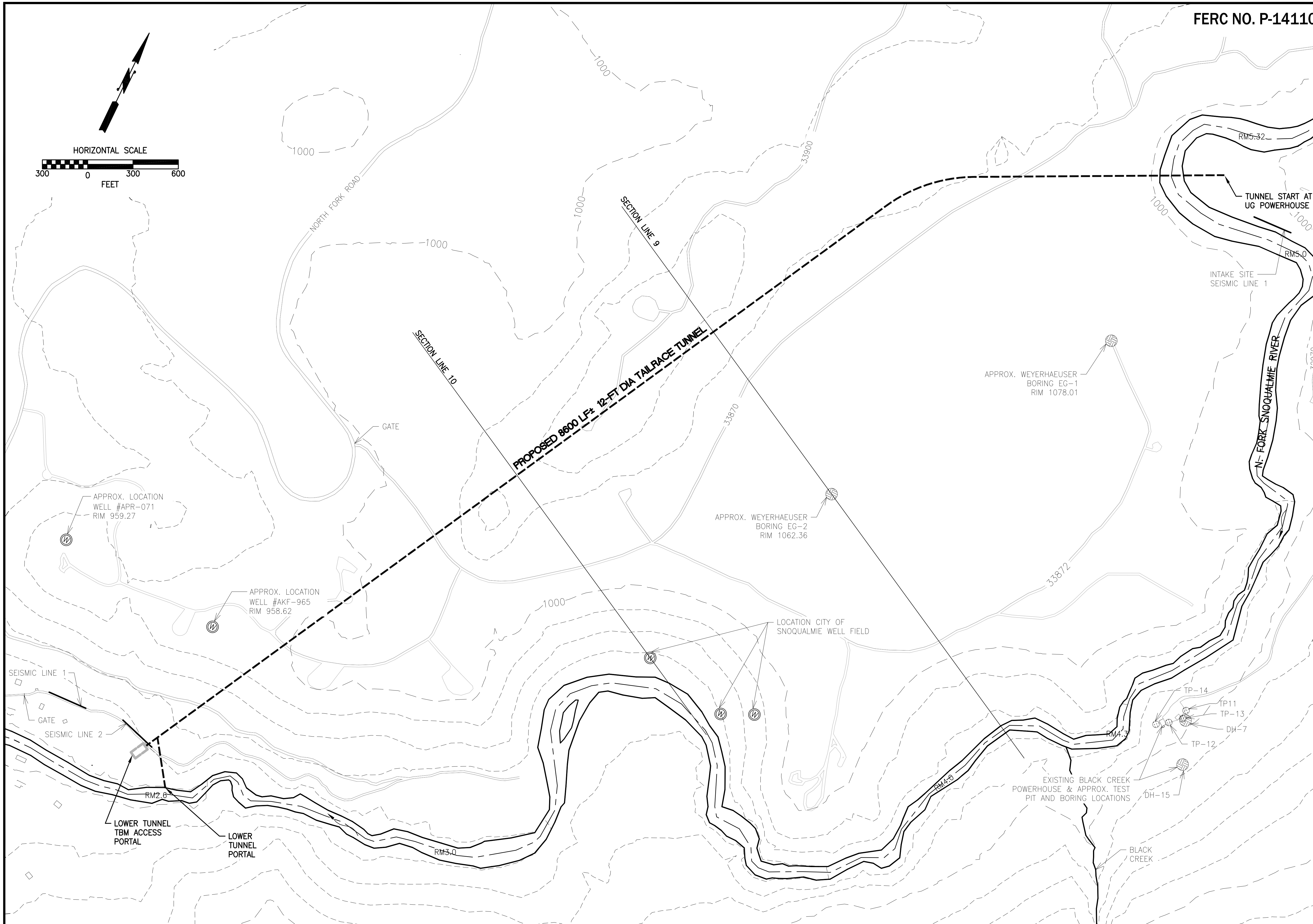
LOCATION MAP

KING COUNTY WASHINGTON

SCALE	AS SHOWN
DESIGN:	B. HAUSMANN
DRAWN:	T. GREENE
CHECKED:	B. HAUSMANN
DATE:	12/12/2013
JOB#:	11030000
SHEET	1 of 1
DRAWING	200

DATE AND TIME PLOTTED
February 3, 2014 04:43
PLOTTED BY
BRANDON

CADD SYSTEM
AutoCAD Rel. 18.2s (LMS Tech)
CADD FILENAME
SITE MAP-OVERALL.dwg



DATE AND TIME PLOTTED February 3, 2014 04:14 PLOTTED BY BRANDON

CADD SYSTEM AutoCAD Rel. 18.2s (LMS Tech) CADD FILENAME TUNNEL.dwg

NO.	DATE	REVISION	BY	CK

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WHITEWATER engineering corporation
3633 ALDERWOOD AVENUE
BELLINGHAM, WASHINGTON 98225
PH: 360-738-9999 FAX: 360-733-3056

BLACK CANYON HYDROELECTRIC

TUNNEL ALIGNMENT & EXISTING GEOTECHNICAL TEST SITES

KING COUNTY WASHINGTON

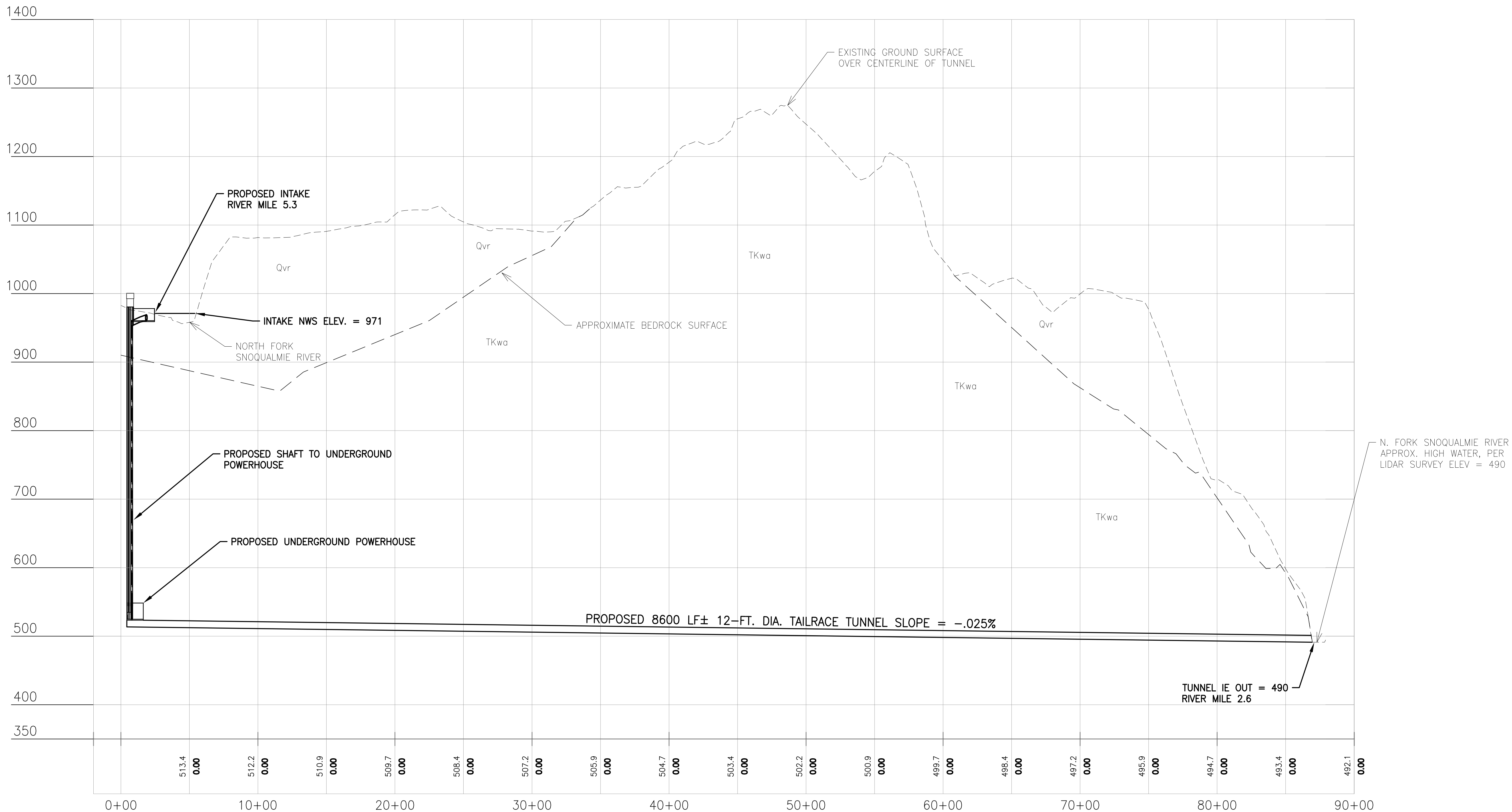
SCALE	AS SHOWN
DESIGN:	B. HAUSMANN
DRAWN:	B. HAUSMANN
CHECKED:	T. FISCHER
DATE:	12/05/2013
JOB#:	11030000
SHEET	1 of 3
DRAWING	300

FERC NO. P-14110

NOTES:
1. TKwa – ARGILLITE AND GREYWACKE (PRE-TERIARY BEDROCK)
2. Qvr – RECESSIONAL OUTWASH DEPOSITS
3. EXISTING GROUND SURFACE FROM LIDAR SURVEY DATA
4. APPROXIMATE BEDROCK SURFACE MODEL DEVELOPED FROM EXISTING DATA USING BORING, WELL, TEST PIT, VISUAL OBSERVATIONS, AND INTERPOLATING BETWEEN OBSERVED BEDROCK LOCATIONS

HORIZONTAL SCALE
400 0 400 800
FEET

VERTICAL SCALE
80 0 80 160
FEET



NO.	DATE	REVISION	BY	CK

PRELIMINARY NOT FOR CONSTRUCTION

WHITEWATER engineering corporation
3633 ALDERWOOD AVENUE
BELLINGHAM, WASHINGTON 98225
PH: 360-738-9999 FAX: 360-733-3056

BLACK CANYON HYDROELECTRIC
TUNNEL PROFILE
KING COUNTY WASHINGTON

SCALE	AS SHOWN
DESIGN:	B. HAUSMANN
DRAWN:	T. GREENE
CHECKED:	T. FISCHER
DATE:	12/05/2013
JOB#:	11030000
SHEET	2 of 3

DRAWING
302

DATE AND TIME PLOTTED February 3, 2014 04:10
PLOTTED BY BRANDON

CADD SYSTEM AutoCAD Rel. 18.2s (LMS Tech)
CADD FILENAME TUNNEL.dwg

FERC NO. P-14110

HORIZONTAL SCALE
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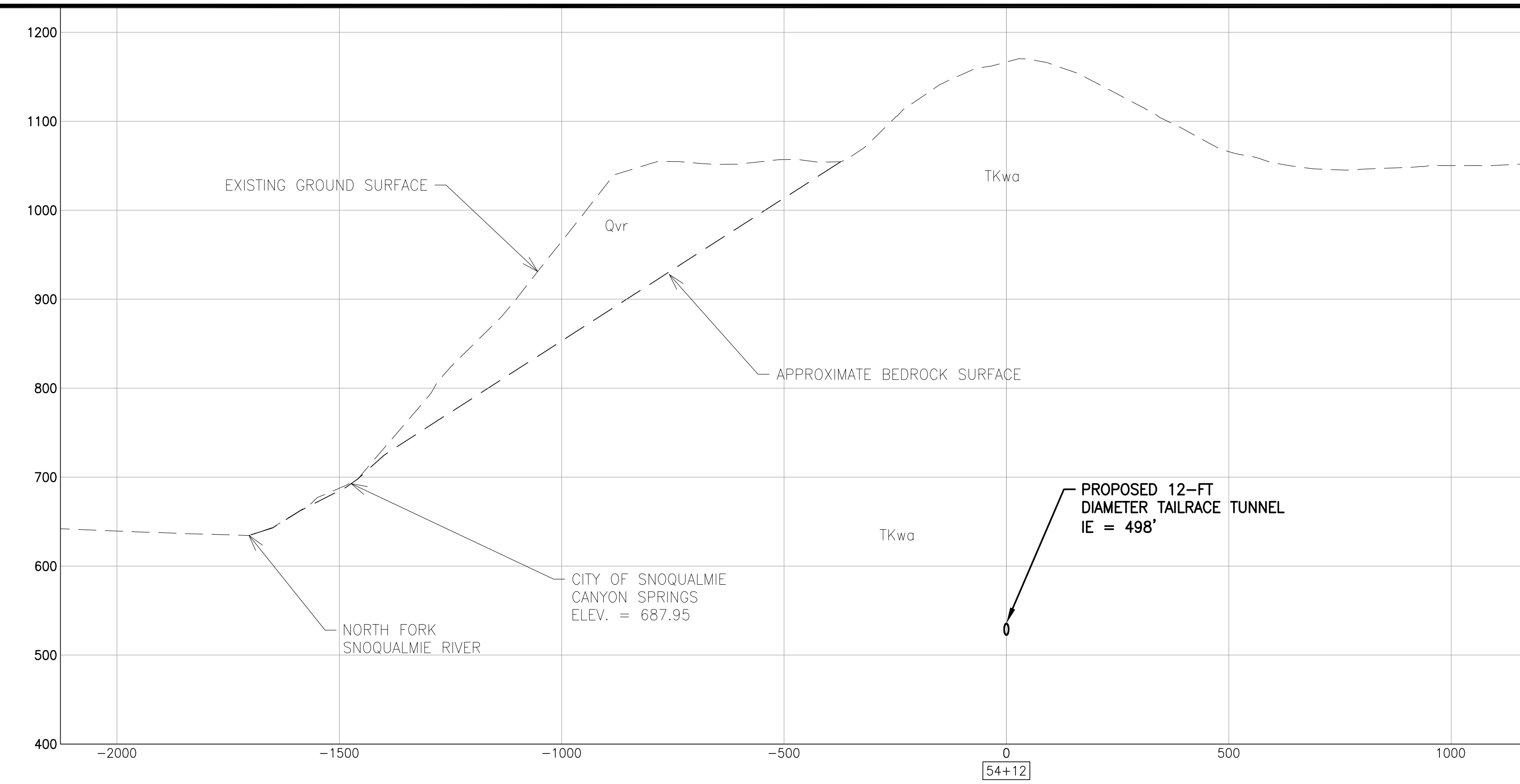
FEET

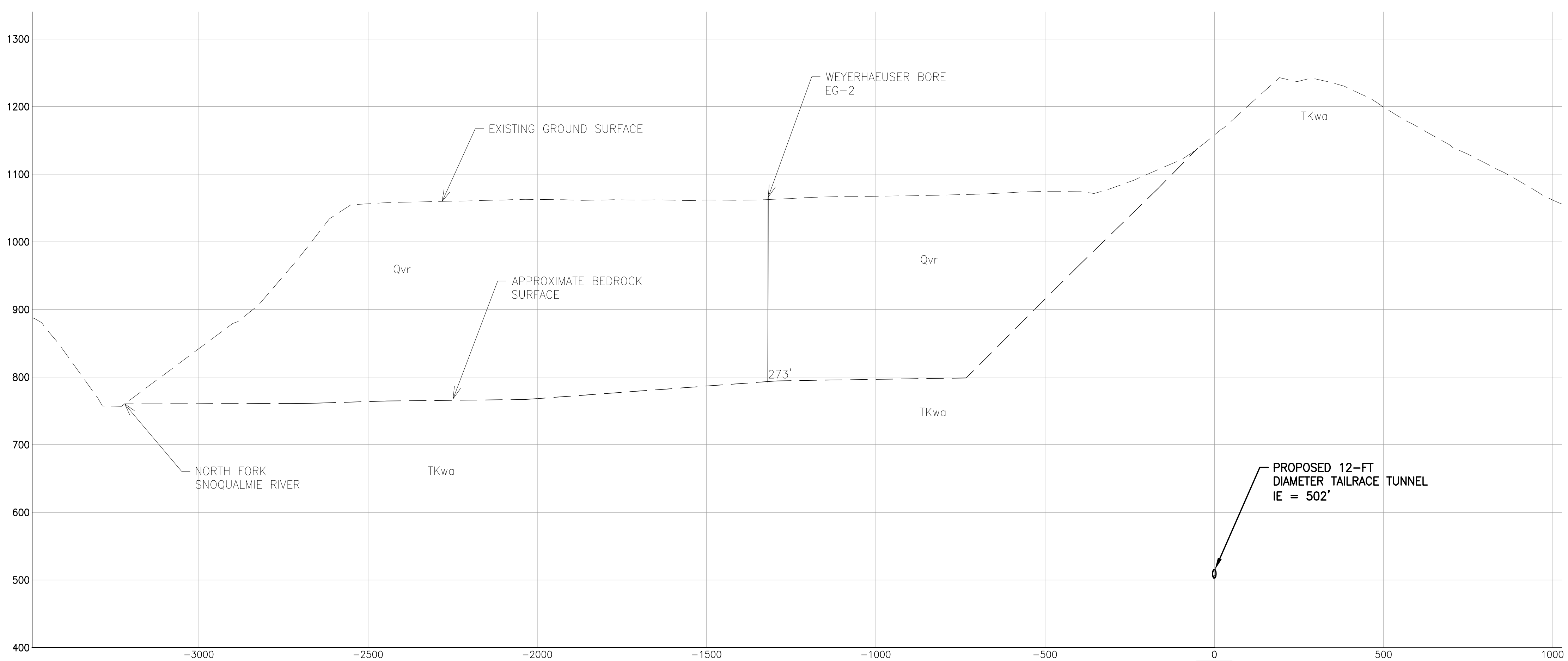
VERTICAL SCALE
100 0 100 200
FEET



SECTION LINE 10 (SL-10) STA 54+12

NOTES:

1. TKwa – ARGILLITE AND GREYWACKE (PRE-TERIARY BEDROCK)
2. Qvr – RECESSIONAL OUTWASH DEPOSITS
3. EXISTING GROUND SURFACE FROM LIDAR SURVEY DATA
4. APPROXIMATE BEDROCK SURFACE MODEL DEVELOPED FROM EXISTING DATA USING BORING, WELL, TEST PIT, VISUAL OBSERVATIONS, AND INTERPOLATING BETWEEN OBSERVED BEDROCK LOCATIONS



SECTION LINE 9 (SL-9) STA 38+03

NO.	DATE	REVISION	BY	CK

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WHITEWATER engineering corporation
3633 ALDERWOOD AVENUE
BELLINGHAM, WASHINGTON 98225
PH: 360-738-9999 FAX: 360-733-3056

BLACK CANYON HYDROELECTRIC

TUNNEL CROSS SECTIONS

KING COUNTY WASHINGTON

SCALE AS SHOWN

DESIGN:	B. HAUSMANN
DRAWN:	T. GREENE
CHECKED:	T. FISCHER
DATE:	12/19/2013
JOB#:	11030000

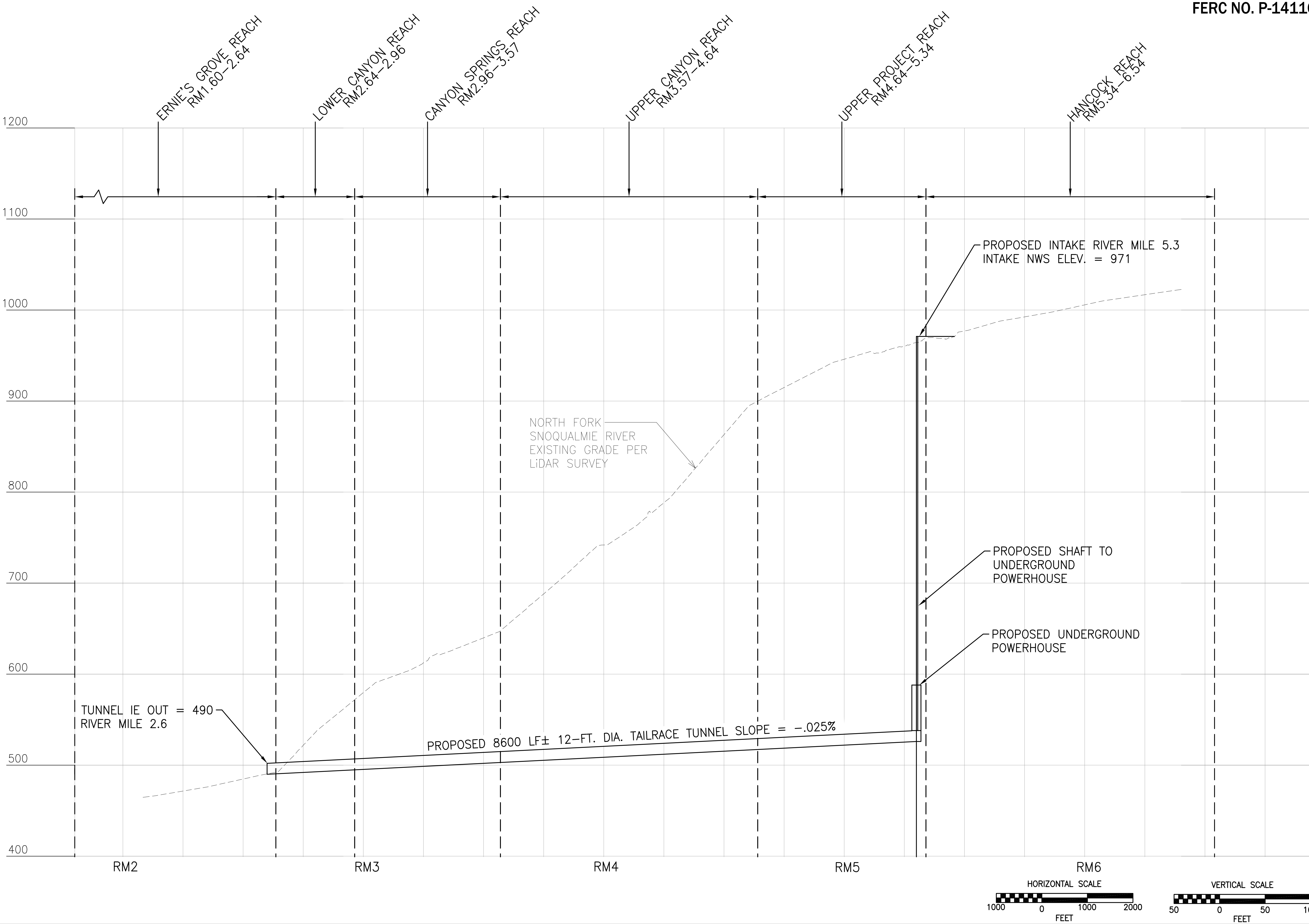
SHEET 3 of 3

DRAWING 303

DATE AND TIME PLOTTED February 3, 2014 04:11 PLOTTED BY BRANDON

CADD SYSTEM AutoCAD Rel. 18.2s (LMS Tech) CADD FILENAME TUNNEL.dwg

FERC NO. P-14110



NO.	DATE	REVISION	BY	CK

PRELIMINARY NOT FOR CONSTRUCTION

WHITEWATER engineering corporation
3633 ALDERWOOD AVENUE
BELLINGHAM, WASHINGTON 98225
PH: 360–738–9999 FAX: 360–733–3056

BLACK CANYON HYDROELECTRIC
RIVER PROFILE
KING COUNTY WASHINGTON

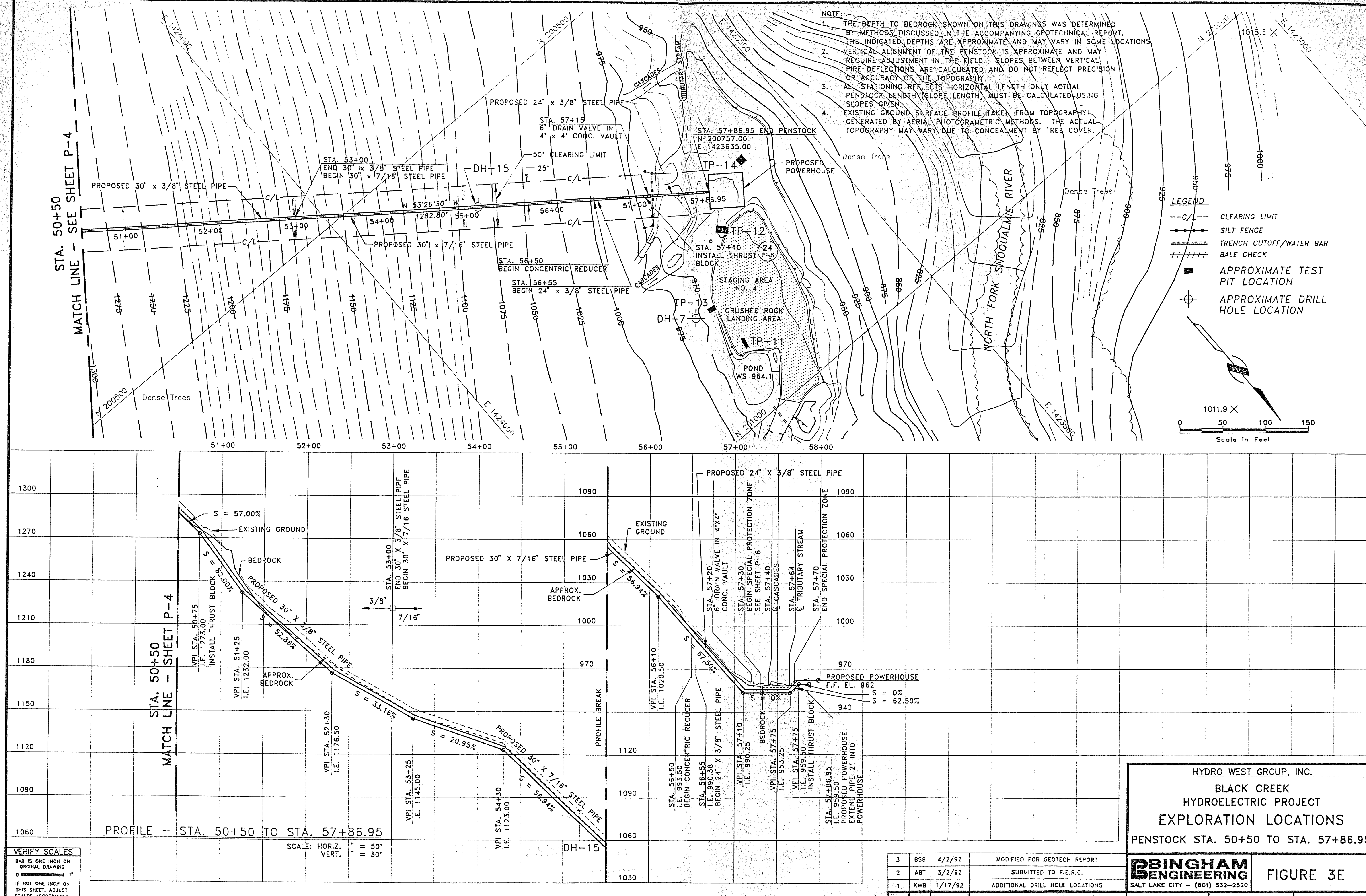
SCALE	AS SHOWN
DESIGN:	B. HAUSMANN
DRAWN:	T. GREENE
CHECKED:	T. FISCHER
DATE:	12/05/2013
JOB#:	11030000
SHEET	5 of 6
DRAWING	304

DATE AND TIME PLOTTED
February 3, 2014 04:08
PLOTTED BY
BRANDON

CADD SYSTEM
AutoCAD Rel. 18.2s (LMS Tech)
CADD FILENAME
TUNNEL.dwg

Appendix A

Black Creek Hydroelectric Project, test logs and data from the Geotechnical Investigations for Diversion and Penstock



NOTE:

1. THE DEPTH TO BEDROCK SHOWN ON THIS DRAWINGS WAS DETERMINED BY METHODS DISCUSSED IN THE ACCOMPANYING GEOTECHNICAL REPORT. THE INDICATED DEPTHS ARE APPROXIMATE AND MAY VARY IN SOME LOCATIONS.
2. VERTICAL ALIGNMENT OF THE PENSTOCK IS APPROXIMATE AND MAY REQUIRE ADJUSTMENT IN THE FIELD. SLOPES BETWEEN VERTICAL PIPE DEFLECTIONS ARE CALCULATED AND DO NOT REFLECT PRECISION OR ACCURACY OF THE TOPOGRAPHY.
3. ALL STATIONING REFLECTS HORIZONTAL LENGTH ONLY ACTUAL PENSTOCK LENGTH (SLOPE LENGTH) MUST BE CALCULATED USING SLOPES GIVEN.
4. EXISTING GROUND SURFACE PROFILE TAKEN FROM TOPOGRAPHY GENERATED BY AERIAL PHOTOGRAMETRIC METHODS. THE ACTUAL TOPOGRAPHY MAY VARY DUE TO CONCEALMENT BY TREE COVER.

LEGEND

- CLEARING LIMIT
- SILT FENCE
- TRENCH CUTOFF/WATER BAR
- BALE CHECK
- APPROXIMATE TEST PIT LOCATION
- APPROXIMATE DRILL HOLE LOCATION

VERIFY SCALES
BAR IS ONE INCH ON ORGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

Rev.	By	Date	Remarks
3	BSB	4/2/92	MODIFIED FOR GEOTECH REPORT
2	ABT	3/2/92	SUBMITTED TO F.E.R.C.
1	KWB	1/17/92	ADDITIONAL DRILL HOLE LOCATIONS

HYDRO WEST GROUP, INC.

BLACK CREEK HYDROELECTRIC PROJECT

EXPLORATION LOCATIONS

PENSTOCK STA. 50+50 TO STA. 57+86.95

BINGHAM ENGINEERING
SALT LAKE CITY - (801) 532-2520

FIGURE 3E

Date MARCH 1992 | Proj. # 1315-006 | GEODATAS

TABLE 2

BINGHAM ENGINEERING MATERIALS LABORATORY
COMPRESSIVE STRENGTH TEST RESULTS

CLIENT: *HYDROWEST*
PROJECT: *BLACK CREEK HYDRO* PROJECT NO.: 1315-011
FEATURE: *Bedrock cores along lower penstock alignment*

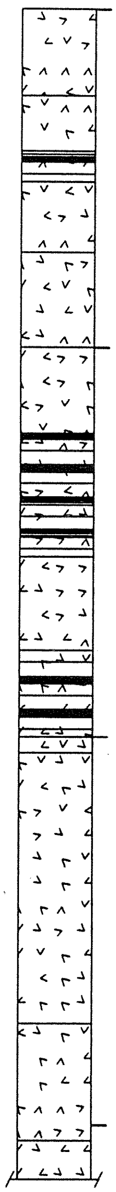
SPECIMEN NO.	SPECIMEN LOCATION	DATE CORED	DATE TESTED	AGE (DAYS)	DIA. (IN)	HEIGHT (IN)	TOTAL LOAD (LBS)	H/D CORRECT. FACTOR	COMPRESSIVE STRENGTH (PSI)	TESTED BY	REMARKS
1315-5	DH-7, 0.4'	01-31-91	02-05-91		1.87	3.7	32,000	1.000	11,650	DA	Specific Gravity = 2.699
1315-1	DH-12, 9.5'	01-09-92	01-24-92		1.72	3.4	40,381	1.000	17,380	DA/GC	Specific Gravity = 2.689
1315-2	DH-12, 10.8'	01-09-92	01-24-92		1.73	3.4	36,624	1.000	15,670	DA/GC	Specific Gravity = 2.701
1315-3	DH-14, 13.5'	01-11-92	01-24-92		1.75	3.4	25,609	1.000	10,700	DA/GC	Specific Gravity = 2.720
1315-4	DH-15, 12.5'	01-13-92	01-24-92		1.75	3.4	14,614	1.000	6,100	DA/GC	Specific Gravity = 2.699

CORE HOLE LOG

CORE HOLE NO.: DH-7

PROJECT: Black Creek Hydroelectric Project
CLIENT/OWNER: Hydro West Group
HOLE LOCATION: Above Powerhouse Pad
DRILLER: Soil Sampling Service
DRILL RIG: Mobile Muskox, NQ Wireline
ANGLE FROM HOR.: 63-degrees BEARING: : S80E

PROJECT NO.: 1315-004
DATE: 1/31/91
DEPTH TO WATER: Not Enco
GS ELEV.: 975 Approx.
LOGGED BY: KWB
HOLE NO.: DH-7

ELEVATION / DEPTH	ROCK SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	Sample Interval	% Core Recov.	RQD	URCS	Core Time
975 — 0		BEDROCK CONTACT: Light gray, medium grained, metagraywacke. 6" to 10" of weatherd bedrock was removed during preparation of drill pad.	0-4.3'	99	93		39
		60 deg. coring fracture.					
972.5 — 2.5		weathered zone, stained brown with some crystallation on one surface, one 60 deg break.					
		coring break, 25 deg.					
		1/4" thick white vein at 65 deg.	4.3'-9.3'	100	52		26
970 — 5							
		weathered zone with fractures being 85 deg, weathered surfaces are oxidation stained some containing calcite deposits.					
967.5 — 7.5							
		weathered zone, black veining starts.					
			9.3'-14.3'	100	64		25
965 — 10		...grades to black with mottled gray zones.					
962.5 — 12.5							
		at 13' and 13.6' slightly weathered fractures.					
		5 deg break.	14.3'-19.3'	100	90		22
960 — 15	Boring Continues						

Completed to 28.2'. Bedrock contact at surface. NQ Wireline used from 0 to 28.2'. Backfilled with bentonite.

Figure No. 37

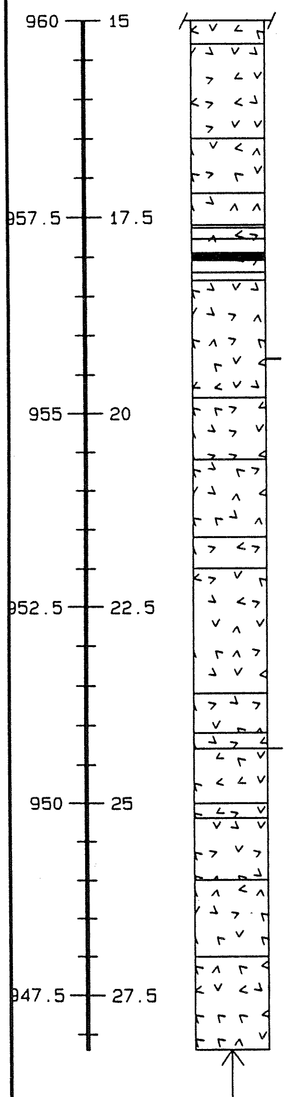
CORE HOLE LOG

CORE HOLE NO.: DH-7

PROJECT: Black Creek Hydroelectric Project
CLIENT/OWNER: Hydro West Group
HOLE LOCATION: Above Powerhouse Pad
DRILLER: Soil Sampling Service
DRILL RIG: Mobile Muskox, NQ Wireline
ANGLE FROM HOR.: 63-degrees BEARING: : S80E

PROJECT NO.: 1315-004
DATE: 1/31/91
DEPTH TO WATER: Not Enco
GS ELEV.: 975 Approx.
LOGGED BY: KWB
HOLE NO.: DH-7

ELEVATION / DEPTH	ROCK SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	Sample Interval	% Core Recov.	RQD	URCS	Core Time



10 deg coring break.

zone of 45 deg breaks.

...grades light gray, 0.4' thick

zone of random fracturing, some have slight amount of oxidation staining.

70 deg fracture.

10 deg fracture at 20.6', 45 deg at 20.8 deg.

...grades with brittle zone for 0.4'.

...grades gray zone for 0.6'.

slightly oxidized fracture.

fracture zone, slightly brittle, possibly coring fractures.

...grades with slight more white veins

75 deg. coring break.

brittle zone with some oxidation staining on fracture zone.

80 deg. fracture, slight trace of oxidation staining.

45 deg. fractures at 27' and 27.7'.

Sample Interval	% Core Recov.	RQD	URCS	Core Time
19.3'-24.3'	100	86		24
24.3'-28.2'	100	92		16

Completed to 28.2'. Bedrock contact at surface. NQ Wireline used from 0 to 28.2'. Backfilled with bentonite.

Figure No. 38

Bingham Engineering

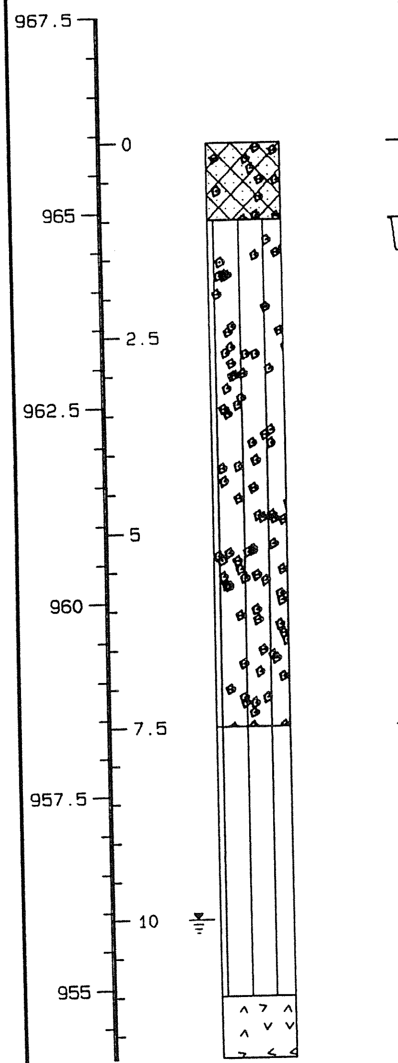
TEST PIT LOG

TEST PIT NO.: TP-11

PROJECT: Black Creek Hydroelectric Project
CLIENT/OWNER: Hydro West Group
DATE LOGGED: 1/22/91
EQUIPMENT: Komatsu PC220LC
DEPTH TO WATER: 10', seepage
TEST PIT LOCATION: NE Corner of Powerhouse Pad

PROJECT NO.: 1315-004
SURF ELEV: 965.9+/-
LOGGED BY: KWB
PIT LENGTH: 12'
PIT WIDTH: 4'
TEST PIT NO.: TP-11

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample Number	Depth
		GW	Surface: CRUSHED ROCK: Crushed rock to 12", most 1/2" to 2", w/some rock fines.		
			GEOTEXTILE FABRIC		
		ML/ GM	GRAVELLY SILT: Reddish brown, gravelly silt (gravel to 2") with some fine to medium sand, some roots & root hairs, loose to medium dense - wet. ... grades to grayish brown with more sand and fine gravel, cobbles and boulders to 24", contact varies from 3.5' on north to 2.4' on south.		
		ML	SILT: Dark brown to black, silt with abundant woody remnants, appears to be compressible soft - wet.		
		Bx	BEDROCK CONTACT: Depth of contact varies, 11' deep 3' south of north end, 9' deep 7' south, 7' deep 11' south. - - - - - NOTE: Moderately heavy seepage on west side of TP @ 10', appears to be located at or near Bx contact.		



Excavated to 11'. Bedrock or very large boulder at 11'. Backfilled with excavated material. Possible compressible layer 7.5 to 11'.

Figure No. 16

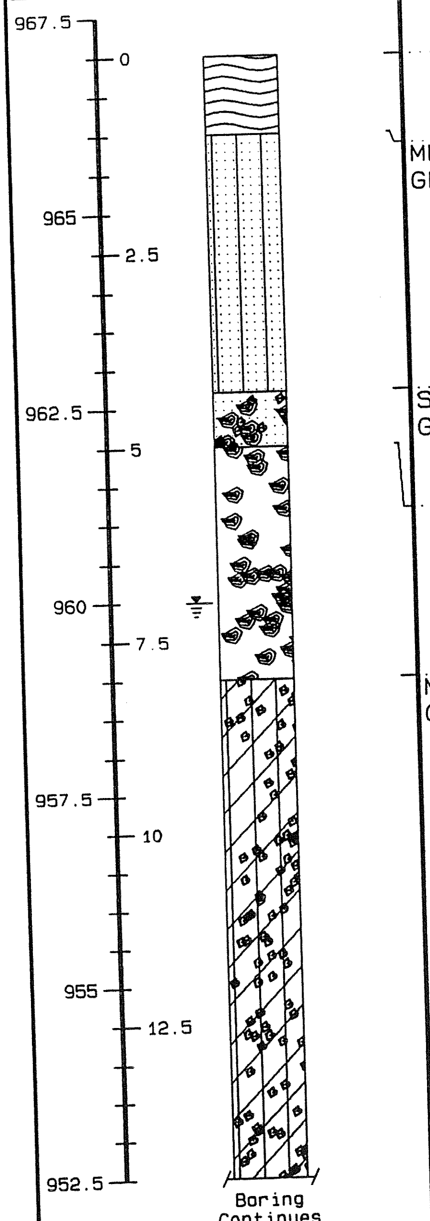
TEST PIT LOG

TEST PIT NO.: TP-12

PROJECT: Black Creek Hydroelectric Project
CLIENT/OWNER: Hydro West Group
DATE LOGGED: 1/22/91
EQUIPMENT: Komatsu PC220LC
DEPTH TO WATER: 7' and 20', seepage
TEST PIT LOCATION: 40'N of SE Corner of Pad

PROJECT NO.: 1315-004
SURF ELEV: 967+/-
LOGGED BY: KWB
PIT LENGTH: 14'
PIT WIDTH: 8'
TEST PIT NO.: TP-12

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample Number	Depth
			MULCH: Dark brown to black mulch consisting of bark, needles, leaves, etc. depth varies for 0.75 to 1.5'.		
		ML/ GM	SANDY SILT: Reddish brown with gravel and cobbles, heavy oxidation staining, medium dense - moist, depth is variable.		
		SW/ GW	SAND W/GRAVEL and COBBLES: Light greenish gray, trace of silt, gravel and cobbles are subangular, most, 1" to 6", largest 18", medium dense - moist.		
			BOULDER: Very large boulder, 3' x 5'.		
		ML/ GM	CLAYEY SILT WITH GRAVEL: Dark silver to dark gray, clayey silt with some sub-angular gravel, and fine to medium sand, medium dense - wet.		



Excavated to 20'. Bedrock contact at 20'. Backfilled with excavated material. Possible compressible layer 19' to 20'.

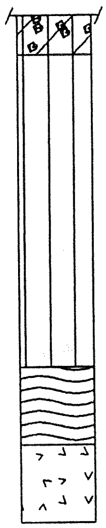
Figure No. 17

TEST PIT LOG

TEST PIT NO.: TP-12

PROJECT: Black Creek Hydroelectric Project
CLIENT/OWNER: Hydro West Group
DATE LOGGED: 1/22/91
EQUIPMENT: Komatsu PC220LC
DEPTH TO WATER: 7' and 20', seepage
TEST PIT LOCATION: 40'N of SE Corner of Pad

PROJECT NO.: 1315-004
SURF ELEV: 967+/-
LOGGED BY: KWB
PIT LENGTH: 14'
PIT WIDTH: 8'
TEST PIT NO.: TP-12

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample Number	Depth
952.5 / 15		ML	SILT: Reddish brown silt with abundant woody remnants and logs, appears to be compressible, soft - moist.		
950 / 17.5					
947.5		PT	PEAT: Dark brown to black, peat, horizontally layered soft - wet.		
20		Bx	BEDROCK CONTACT: Anticipated but TP was not entered to observe. - - - - - - NOTE: Seepage @ 7' SE corner, heavy seepage at Bx contact.		

Excavated to 20'. Bedrock contact at 20'. Backfilled with excavated material. Possible compressible layer 19' to 20'.

Figure No. 18

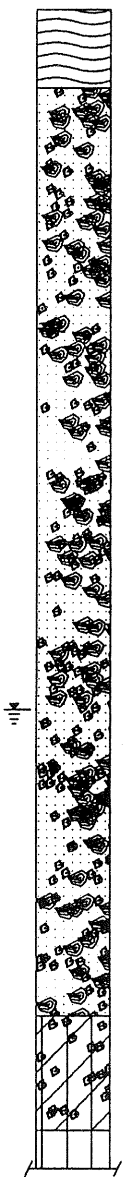
TEST PIT LOG

TEST PIT NO.: TP-13

PROJECT: Black Creek Hydroelectric Project
CLIENT/OWNER: Hydro West Group
DATE LOGGED: 1/22/91
EQUIPMENT: Komatsu PC220LC
DEPTH TO WATER: 9', seepage
TEST PIT LOCATION: 60' S of NE corner of pad

PROJECT NO.: 1315-004
SURF ELEV: 970+/-
LOGGED BY: KWB
PIT LENGTH: 9'
PIT WIDTH: 5.5'
TEST PIT NO.: TP-13

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample Number	Depth
970 — 0			MULCH: Dark brown to black mulch consisting of bark, needles, leaves, etc.		
			GRAVELLY SAND WITH COBBLES & BOULDERS: Reddish brown with heavy oxidation staining and some silt and boulders to 15", medium dense - moist.		
967.5 — 2.5					
			... grades light greenish gray with some boulders to 2'.		
965 — 5					
962.5 — 7.5					
			... grades with more cobbles.		
960 — 10					
957.5 — 12.5					
		ML	CLAYEY SILT W/GRAVEL: Dark silver to dark gray, clayey silt with some subangular gravel, and fine to medium sand, medium dense - wet.		
		ML	SILT: Reddish brown silt with abundant woody remnants and logs, appears to be compressible, soft - moist.		
955 — 15	Boring Continues				



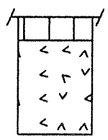
Excavated to 15.5'. Bedrock contact at 15.5'. Backfilled with excavated material. Possible commpressible layer 13' to 15.5'.

Figure No. 19

TEST PIT LOG

TEST PIT NO.: TP-13

PROJECT: Black Creek Hydroelectric Project — PROJECT NO.: 1315-004
CLIENT/OWNER: Hydro West Group — SURF ELEV: 970+/-
DATE LOGGED: 1/22/91 — LOGGED BY: KWB
EQUIPMENT: Komatsu PC220LC — PIT LENGTH: 9'
DEPTH TO WATER: 9', seepage — PIT WIDTH: 5.5'
TEST PIT LOCATION: 60' S of NE corner of pad — TEST PIT NO.: TP-13

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample Number	Depth
955 — 15			... grades with some woody remnants (logs) possibly peat layer. BEDROCK CONTACT: - - - - - NOTE: Moderate seepage at 9'.		

Excavated to 15.5'. Bedrock contact at 15.5'. Backfilled with excavated material. Possible commpressible layer 13' to 15.5'.

Figure No. 20

Bingham Engineering

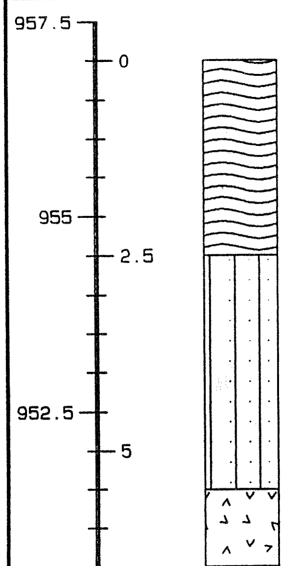
TEST PIT LOG

TEST PIT NO.: TP-14

PROJECT: Black Creek Hydroelectric Project
CLIENT/OWNER: Hydro West Group
DATE LOGGED: 1/22/91
EQUIPMENT: Komatsu PC220LC
DEPTH TO WATER: Not Encounterd
TEST PIT LOCATION: 50' S of SE Corner of Pad

PROJECT NO.: 1315-004
SURF ELEV: 957+/-
LOGGED BY: KWB
PIT LENGTH: 9'
PIT WIDTH: 9'
TEST PIT NO.: TP-14

ELEVATION / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample Number	Depth



USCS	Description	Sample Number	Depth
	FOREST FLOOR: Organic layer 6" to 8" thick.		
	SILTY SAND: Light reddish brown, silty fine to coarse sand with some subangular gravel and cobbles, medium dense - moist.		
Bx	BEDROCK CONTACT: Apparent surface dip 20 - 25 degrees, S 20 degrees E.		

Excavated to 5.5'. Bedrock contact at 5.5'. Backfilled with excavated material.

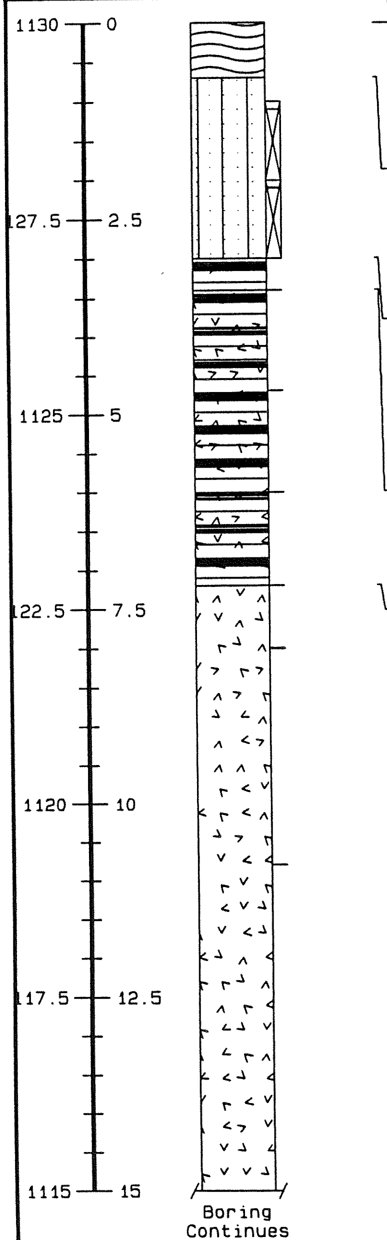
CORE HOLE LOG

CORE HOLE NO.: DH-15

PROJECT: Black Creek Hydroelectric
CLIENT/OWNER: Hydro West Group Inc.
HOLE LOCATION: Station 54+25
DRILLER: McFerron and Marcus
DRILL RIG: Winkie NX Core
ANGLE FROM HOR.: 90-degrees BEARING: : NA

PROJECT NO.: 1315-011
DATE: 1/13/92
DEPTH TO WATER: NA
GS ELEV.: 1130 +/-
LOGGED BY: KWB
HOLE NO.: DH-15

ELEVATION / DEPTH — ROCK SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA



Description	Sample Interval	% Core Recov.	RQD	URCS	Core Time
ORGANIC MATTER: Brown to black mulch, dead fall, and roots, loose - moist. Varies w/ location in vicinity of hole. ... grades with trace to some silt and fine to medium sand.	1.0'-2.0' B-15-1	-200 = B. Bag	28.6		NP
SILTY GRAVEL: Reddish brown, silty fine gravel with some fine to coarse sand, occasional coarse gravel	2.0'-3.0' B-15-2	B. Bag			
and 4" cobble.	3.0'-3.4'	50			
... grades with more gravel.	3.4'-4.7'	100	0	CBDA	15
WEATHERED BEDROCK: Gray to black, metagraywacke, heavy oxidation staining and weathering along joints, joints/fractures along preferred planes, generally at 30+/- deg. and nearly vertical.	4.7'-6.0'	92	0	CBDA	13
... grades to highly fractured and weathered, jointing at 30-degrees from vertical, fracturing is parallel to	6.0'-7.2'	100	0	CBDA	
jointing with longest piece 0.3' long.	7.2'-8.0'	100	44	BBCA	
BEDROCK: Dark gray to black metagraywacke, some white cross-cutting veins and mottling, from 8 to 20' appears to faulting/shearing zone, some oxidation staining and weathering on joints.	8.0'-10.8'	96	25	BBCA	16
	10.8'-15.0'	100	95	BBCA	15

Completed to 20'. Bedrock contact at 3'. Backfilled hole with bentonite chips. Soil samples were retrieved by coring without water.

Figure No. 52

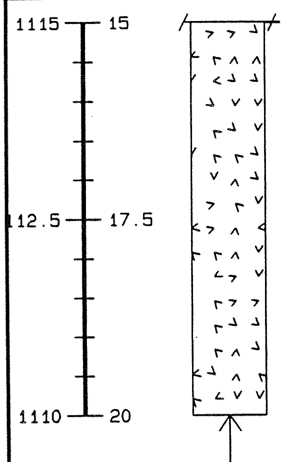
CORE HOLE LOG

CORE HOLE NO.: DH-15

PROJECT: Black Creek Hydroelectric
CLIENT/OWNER: Hydro West Group Inc.
HOLE LOCATION: Station 54+25
DRILLER: McFerron and Marcus
DRILL RIG: Winkie NX Core
ANGLE FROM HOR.: 90-degrees BEARING: : NA

PROJECT NO.: 1315-011
DATE: 1/13/92
DEPTH TO WATER: NA
GS ELEV.: 1130 +/-
LOGGED BY: KWB
HOLE NO.: DH-15

ELEVATION / DEPTH	ROCK SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	Sample Interval	% Core Recov.	RQD	URCS	C T
1115 – 15			15.0'-20.0'	100	80	BBCA	

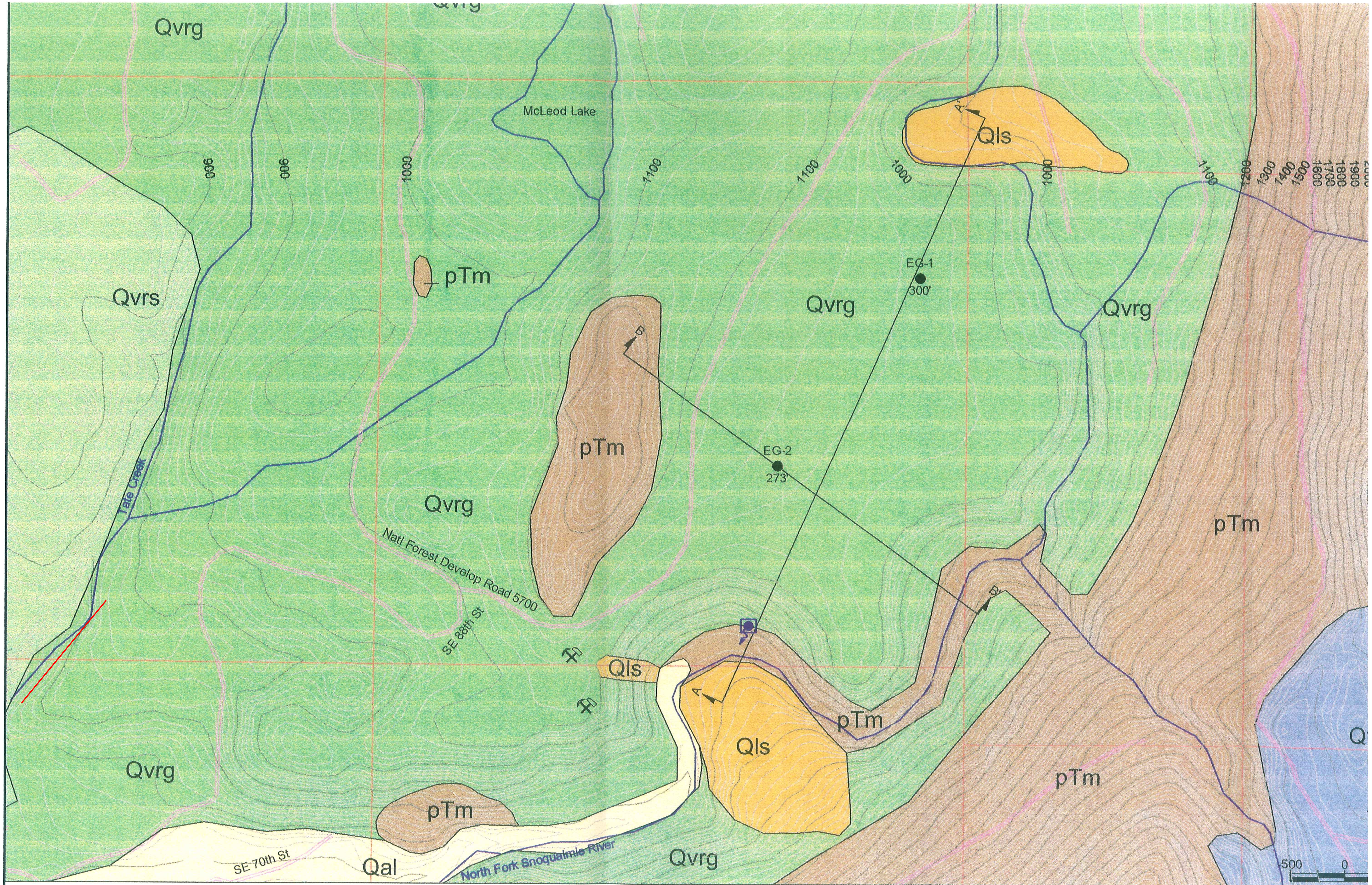


Completed to 20'. Bedrock contact at 3'. Backfilled hole with bentonite chips. Soil samples were retrieved by coring without water.

Figure No. 53

Appendix B

Weyerhaeuser soil logs

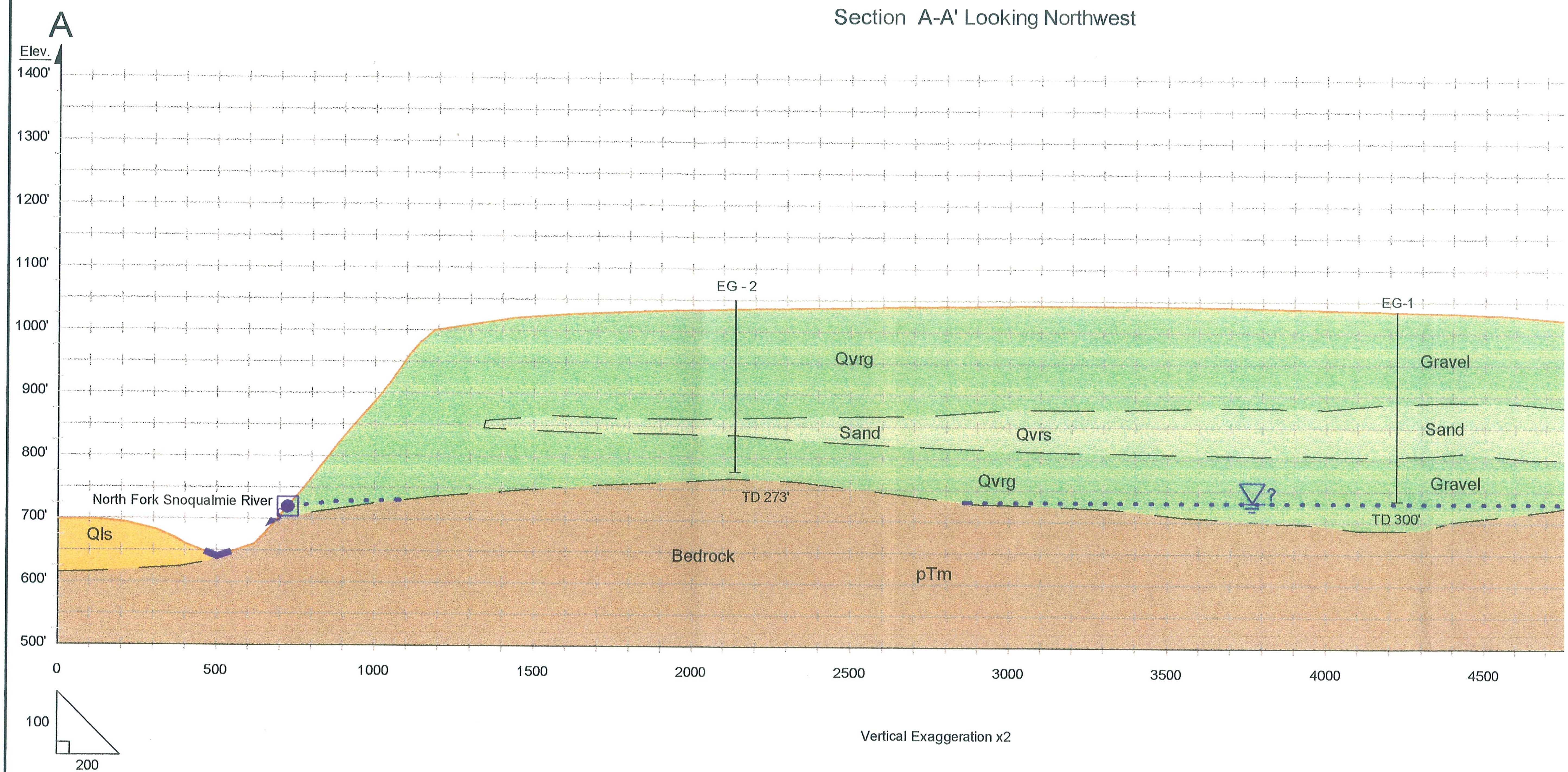


SOURCE- SYLVAN ASCENT, INC. FEATURE NAMES FROM USGS GEOGRAPHICAL NAMES INFORMATION SYSTEM (GNIS) TRANSPORTATION AND HYDROGRAPHY SOURCE DATA FROM U.S. CENSUS BUREAU TIGER 1997 FILES AND/OR USGS 100k AND 24K DLG

Qls = Landslide Deposits
Qal = Recent Alluvium
pTm = PreTertiary Bedrock
= Quarry

HORIZONTAL SCALE
1"=1000'

SubTerra, Inc.



SOURCE - SYLVAN ASCENT, INC FEATURE NAMES FROM USGS GEOGRAPHICAL NAMES INFORMATION SYSTEM (GNIS), TRANSPORTATION AND HYDROGRAPHY SOURCE DATA FROM U.S. CENSUS BUREAU TIGER 1997 FILES AND/OR USGS 100K AND 24K DLG

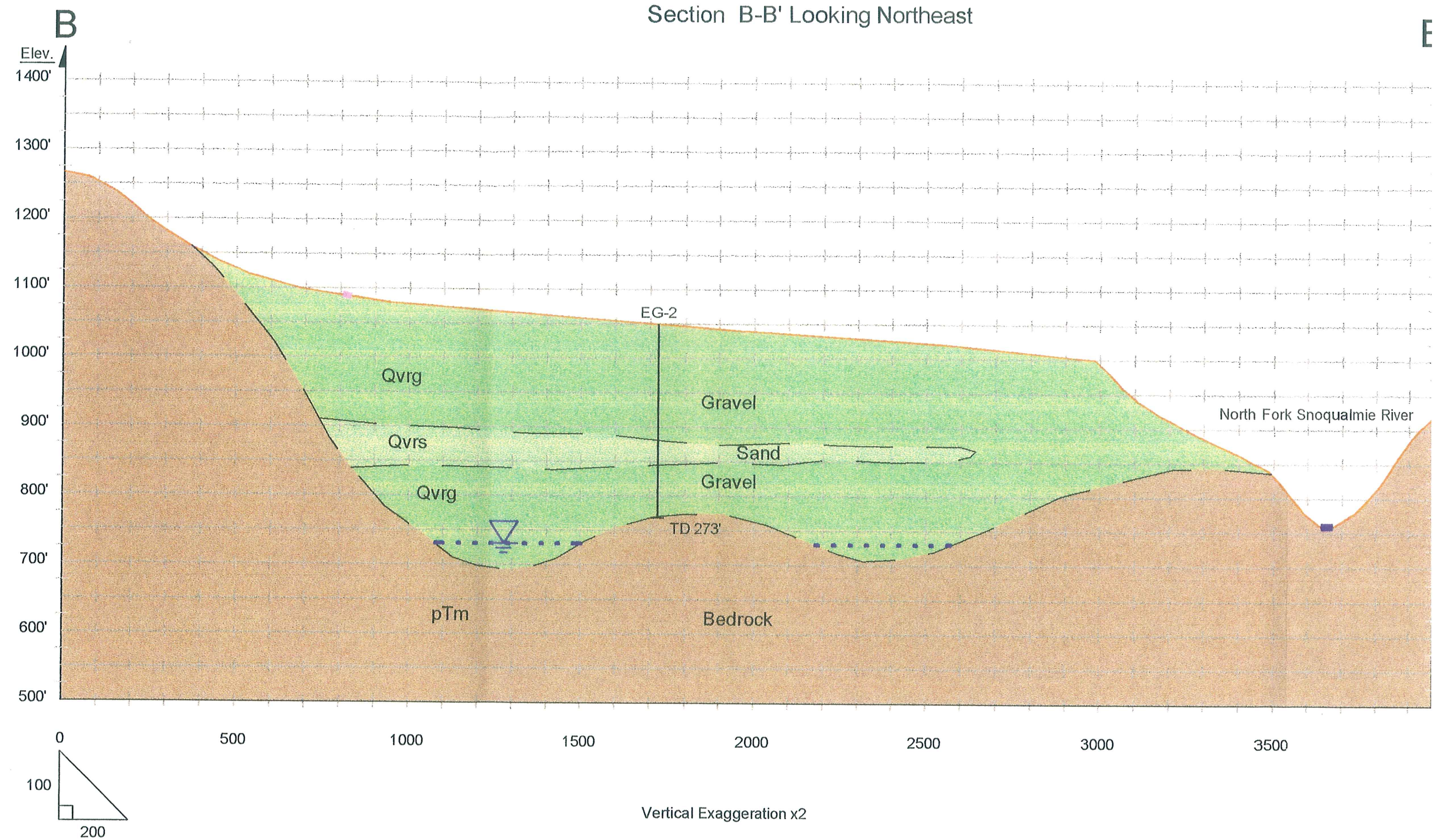
Qls = Landslide Deposits
Qal = Recent Alluvium

pTm = PreTertiary Bedrock
EG-1 = Drill Hole

HORIZONTAL SCALE
1"=400'

SubTerra, Inc.

Section B-B' Looking Northeast



SOURCE-- SYLVAN ASCENT, INC FEATURE NAMES FROM USGS GEOGRAPHICAL NAMES INFORMATION SYSTEM (GNIS) TRANSPORTATION AND HYDROGRAPHY SOURCE DATA FROM U S CENSUS BUREAU TIGER 1997 FILES AND/OR USGS 100K AND 24K DLG

Qls = Landslide Deposits
Qal = Recent Alluvium

pTm = PreTertiary Bedrock
EG-1 = Drill Hole

HORIZONTAL SCALE
1"=400'

SubTerra, Inc.

DRILL HOLE LOG

Project:	North Fork Gravel; Ernie's Grove	**Elevation:**	1,040 ft.
Contractor:	Layne Environmental	**Depth:**	300 ft.
Drill Method:	Reverse Circulation	**Diameter:**	6 in.
Sampling:	Cyclone	**Azimuth/Dip:**	-90

HOLE ID: EG-1
DATE: 11/19/01

Depth (ft)	Symbol	Description
2		road prism
5		
10		wet, brown, gravelly **SAND**, trace cobbles
15		trace to some cobbles
20	SAND	
25		boulder(s)
30		
35		moist to wet, grayish brown, cobbly **GRAVEL**, trace to some boulders
40		
45		wet, sandy **GRAVEL**, trace cobbles, silty coating
50		
55	GRAVEL	
60		
65		
70		
75		wet, grayish brown, sandy **GRAVEL**, trace cobbles

Depth (ft)	Symbol	Description
		wet, grayish brown, sandy **GRAVEL**, trace cobbles
80	GRAVEL	
85		trace to some cobbles
90		
95		wet, grayish brown, gravelly **SAND**, trace silt
100		
105	SAND	
110		
115		
120		
125		
130	GRAVEL	wet, grayish brown, sandy **GRAVEL**, trace cobbles
135		some cobbles
140		
144		
150	SAND	wet, grayish brown, gravelly coarse **SAND**

DRILL HOLE LOG

Project:	North Fork Gravel; Ernie's Grove	**Elevation:**	1,040 ft.
Contractor:	Layne Environmental	**Depth:**	300 ft.
Drill Method:	Reverse Circulation	**Diameter:**	6 in.
Sampling:	Cyclone	**Azimuth/Dip:**	-90

HOLE ID: EG-1
DATE: 11/19/01

Depth (ft)	Symbol	Description
	SAND	wet, grayish brown, gravelly coarse **SAND**
155		
160		some cobbles
165		medium to coarse **SAND**, some gravel
170		
175		gravelly **SAND**
180		
185		medium to coarse SAND, trace to some gravel
190		
195		trace gravel
200		
205		
210		
215		gravelly **SAND**
220		
225		trace cobbles

Depth (ft)	Symbol	Description
		trace cobbles
230		
	GRAVEL	wet, grayish brown, sandy **GRAVEL**, some cobbles
235		
240		
245		sandy cobbly **GRAVEL**
250		
255		trace boulder(s)
260		
	COBBLES	moist to wet, grayish brown, gravelly **COBBLES**, some sand, trace boulder(s)
265		
270		
	GRAVEL	wet, grayish brown, sandy cobbly **GRAVEL**, trace to some boulder(s)
275		
280		
285		wet, grayish brown, sandy cobbly **GRAVEL**
290		
295		
300		BOH @ 300'

DRILL HOLE LOG

Project:	North Fork Gravel; Ernie's Grove	**Elevation:**	1,045 ft.
Contractor:	Layne Environmental	**Depth:**	273 ft.
Drill Method:	Reverse Circulation	**Diameter:**	6 in.
Sampling:	Cyclone	**Azimuth/Dip:**	-90

HOLE ID: EG-2
DATE: 11/20/01

Depth (ft)	Symbol	Description
2		road prism
5		
10		moist, grayish brown, sandy **GRAVEL**, trace to some cobbles
15		some cobbles
20		
25		moist, grayish brown, sandy **GRAVEL**, trace to some cobbles
30		
35	GRAVEL	
40		
45		sandy **GRAVEL**, some cobbles
50		
55		trace cobbles
60		
65		
70		
75		wet, grayish brown, sandy cobbly **GRAVEL**, trace boulder(s)

Depth (ft)	Symbol	Description
80		wet, grayish brown, sandy cobbly **GRAVEL**, trace boulder(s)
85		
90		
95		
100	GRAVEL	
105		
110		
115		
120		
125		
130		
135	BOULDERS	moist, grayish brown, cobbly gravelly **BOULDER(S)**; (most "sand" in sample is pulverized rock fragments)
140		
145	GRAVEL	moist to wet, grayish brown, cobbly **GRAVEL**, trace boulder(s), trace sand (could be gravelly cobbles)
150		

DRILL HOLE LOG

Project:	North Fork Gravel; Ernie's Grove	**Elevation:**	1,045 ft.
Contractor:	Layne Environmental	**Depth:**	273 ft.
Drill Method:	Reverse Circulation	**Diameter:**	6 in.
Sampling:	Cyclone	**Azimuth/Dip:**	-90

HOLE ID: EG-2
DATE: 11/20/01

Depth (ft)	Symbol	Description
155	GRAVEL	moist to wet, grayish brown, cobbly **GRAVEL**, trace boulder(s), trace sand
160		
165		
170		
175		
180		
185		wet, brownish gray, sandy **GRAVEL**, trace cobbles
190		
195		
200		
205		wet, brownish gray, sandy **GRAVEL**, trace cobbles
210		
215		
220		
225		

Depth (ft)	Symbol	Description
230	GRAVEL	wet, brownish gray, sandy **GRAVEL**, trace cobbles
235		
240		
245		
250		
255		
260		
265		
270		wet, brownish gray, medium to coarse **SAND** (270' - 271')
273		dry to damp, **BEDROCK/BOULDER**
		BOH @273'

Appendix C

Washington Dept. of Ecology Well Logs

349625

24-8e-26A

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission ("x" in circle)
☒ Construction
○ Decommission ORIGINAL INSTALLATION Notice of Intent Number ______

CURRENT
Notice of Intent No. WE 10124
Unique Ecology Well ID Tag No. APR ~~050~~ 071
Water Right Permit No. N/A
Property Owner Name DIC, LLC
Well Street Address ______
City ______ County ______
Location NE 1/4-1/4 NE 1/4 Sec 26 Twn 24 R 8 EWM or WWM (circle one)
Lat/Long (s, t, r Still REQUIRED) Lat Deg ______ Lat Min/Sec ______
Long Deg ______ Long Min/Sec ______
Tax Parcel No. 2624089201O2

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned ☐ Deepened
Method: ☐ Dug ☐ Bored ☐ Driven ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 295 ft.
Depth of completed well 295 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6" Diam. from 0' ft. to 100 ft.
☒ Liner installed 4.5" Diam. from 0' ft. to 295 ft.
☐ Threaded ______ Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 125 ft. below top of well Date 7/21/2009
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 2 gal./min. with stem set at 294 ft. for 2 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
BROWN H.P. W/COBBLES	0'	100'
GREY BASALT	100'	150'
HARD GREY BASALT	150'	195'

RECEIVED
JUL 24 2009
Dept of Ecology
WR-NWRO

Start Date 7/2/2009 Completed Date 7/21/2009

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) LARRY JOHNSON
Driller/Engineer/Trainee Signature Larry R Johnson
Driller or trainee License No. 0226

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company STATEWIDE DRILLING CO.
Address 19417 131st Ave SW
City, State, Zip VASHON, WA 98070
Contractor's Registration No. STATEDC136RG Date 7/22/2009

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

310567

24-8E-25E

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

ECOLOGY

Construction/Decommission *("x" in circle)*
☒ Construction
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

CURRENT
Notice of Intent No. W212830
Unique Ecology Well ID Tag No. AKF-965
Water Right Permit No. ______
Property Owner Name David Zarett
Well Street Address C8C8 North Fork RDSE
City Snoqualmie County King
Location SW 1/4-1/4 NW 1/4 Sec 25 Twn 24 R 8 (EWM) or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 25-24-08-9002

PROPOSED USE: ☐ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☒ Irrigation ☐ Test Well ☐ Other
(5,000 gpd / 1/2 Acre or less)

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 200 ft.
Depth of completed well 175 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6" Diam. from 0 ft. to 175 ft.
☐ Liner installed ______" Diam. from ______ ft. to ______ ft.
☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 18 ft.
Material used in seal bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 220 ft. below top of well Date 8-25-08
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)
Time | Water Level | Time | Water Level | Time | Water Level

Date of test well makes 20 gallons per Day
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest ______ gal./~~min. with stem set at~~ ______ ft. for ______ hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Surface	0	3
Sand-gravel brown	3	11
Hardpacked gravel-brown	11	37
Sand-gravel-brown	37	160
Hardpan-brown	160	175
Basalt-hard	175	200

RECEIVED
SEP 08 2008
Dept of Ecology
WR-NWRO

Start Date 8-11-08 Completed Date 8-25-08

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Brad Johnson
Driller/Engineer/Trainee Signature [signature]
Driller or trainee License No. 0233

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company Johnson Drilling Co., LLC
Address 19415 108th Ave SE
City, State, Zip Renton, WA 98055
Contractor's Registration No. JOHNSDC207QM Date 8-25-08

Ecology is an Equal Opportunity Employer.

The Department of Ecology does NOT warranty the Data and/or Information on this Well Report.

Appendix D

AMEC Draft Preliminary Geophysical Study and field report

AMEC Environment & Infrastructure, Inc.
11810 North Creek Parkway N Tel (425) 368-1000
Bothell, WA 98011 Fax (425) 368-1001

DAILY FIELD REPORT

PROJECT NAME		PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Plant		12PROPENGY.RP00.0002	1
ADDRESS: Extension of SE 70th Street & Raptor Camp Grounds Road		DATE: July 18, 2012	PAGE: 1 OF 7
CITY OR COUNTY: Snoqualmie, WA	PERMIT NO.	ARRIVAL TIME: 9:10 PM	DEPARTURE TIME: 3:15 PM
CLIENT Cell (360 920-5444: Whitewater Engrg. Corp./ Brandon Hausmann, P.E.	AMEC PROJECT MANAGER/PHONE NO.: Jim Dransfield, P.E. / (425)368-1000		
GENERAL CONTRACTOR	AMEC FIELD REPRESENTATIVE/ MOBILE NO.: Henry Brenniman / 425-864-0165		
SUBCONTRACTOR: None	WEATHER: Mostly cloudy with sun breaks; 50-70°F		
TYPE OF WORK PERFORMED: Site Reconnaissance			
EQUIPMENT USED: None			

COMMENTS

AMEC arrived at the Snoqualmie Lodge East Parking Lot at ~9:10 am on behalf of Whitewater Engineering Corporation to participate in a site visit of the proposed hydroelectric project (Figure 1). Upon arrival we had a group meeting with the following: Whitewater Engineering Corporation - Brandon Hausmann, Brian Smith and Alex Grant;

National Park Service - Susan Rosebrough;
APS - Scott Edwards; and
AMEC – Henry Brenniman

The group first visited the Proposed Powerhouse Plant site, but access was restricted to the City of Snoqualmie waterline easement to their water source approximately one mile from the locked gate at the end of SE 70th Street (see Photograph# 1). The proposed plant site is located in the meadow adjacent to the last residence on the south side of SE 70th Street, and south of the City of Snoqualmie easement (see Photographs #'s 2 and 3). The area of the meadow appears to be either older terrace gravels or more recent alluvial sediments carried down the North Fork of the Snoqualmie River and deposited as an alluvial fan as the river exits the Black Canyon rapids. A seismic line has been proposed on the alluvial sediments to determine the depth to bedrock (Figure 2). Approximately one-quarter mile from the locked gate we observed a bedrock outcrop that appeared to have slickensides with surface drainage cutting through this area with small waterfall (see Photograph# 4). This outcrop suggests that there has been movement in the bedrock from either folding or faulting or both, with groundwater in the fractures and could cause problems in driving a tunnel through fractured rock if it is present along the alignment. Several members of the group proceeded down the easement to springs where water is collected for the City of Snoqualmie before returning to the site.

After leaving the proposed Powerhouse Site, time was taken to drive up to the existing Black River generating station where we were given a tour of the facility (Photograph# 5). There was a scenic lookout over the North Fork of the Snoqualmie River where bedrock is visible on both sides of the river (Photograph #6).

☒ The contents of this field report were discussed with the contractor's on-site representative.

☐ A preliminary copy of this field report was left on site. All recommendations contained herein are subject to change pending review by the AMEC project manager.

Henry W Brenniman
AMEC FIELD REPRESENTATIVE

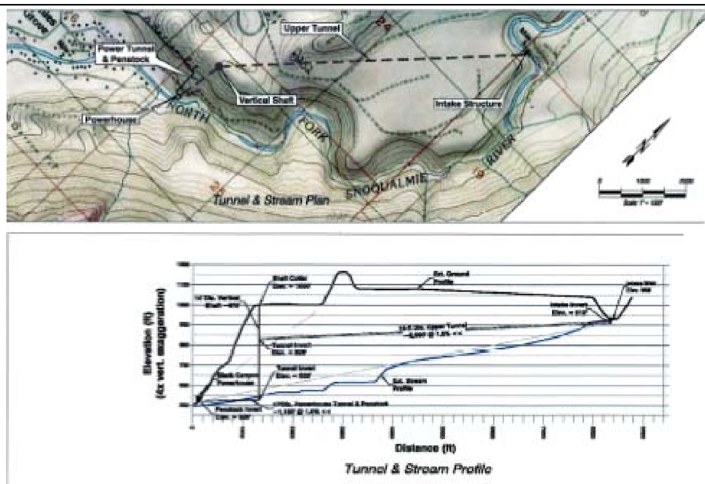
James S Dransfield
AMEC PROJECT MANAGER

AMEC Environment & Infrastructure, Inc.
11810 North Creek Parkway N Tel (425) 368-1000
Bothell, WA 98011 Fax (425) 368-1001

DAILY FIELD REPORT

	PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Project	12PROPENGY.RP00.0002	1
ADDRESS Snoqualmie, King County, Washington	DATE July 18, 2012	PAGE 2 OF 7

COMMENTS

	
Proposed Black Canyon Hydroelectric Project (Figure 1)	Locked gate at the end of SE 70th Street looking southeast towards the Powerhouse site (Photograph #1).
	
View of the Powerhouse Site looking to southeast (Photograph #2).	Another view of the Powerhouse Site looking to the southeast (Photograph #3).

AMEC FIELD REPRESENTATIVE

AMEC PROJECT MANAGER

AMEC Environment & Infrastructure, Inc.
11810 North Creek Parkway N   Tel (425) 368-1000
Bothell, WA 98011   Fax (425) 368-1001

DAILY FIELD REPORT

Black Canyon Hydroelectric Project	PROJECT NO. 12PROPENGY.RP00.0002	FIELD REPORT NO. 1
ADDRESS Snoqualmie, King County, Washington	DATE July 18, 2012	PAGE 3 OF 7

COMMENTS

Approximate location of proposed seismic line for the Powerhouse Site (Figure 2).

View of fractured bedrock with slickensides along the City of Snoqualmie easement with small waterfall (Photograph #4).

View of Black River Powerhouse (Photograph #5).

View of North Fork of Snoqualmie River near the mouth of the Black River (Photograph #6).

Time was then taken to visit the intake structure to the Black River Powerhouse, but the gate to it was locked. On

AMEC FIELD REPRESENTATIVE   AMEC PROJECT MANAGER

AMEC Environment & Infrastructure, Inc.
11810 North Creek Parkway N   Tel (425) 368-1000
Bothell, WA 98011   Fax (425) 368-1001

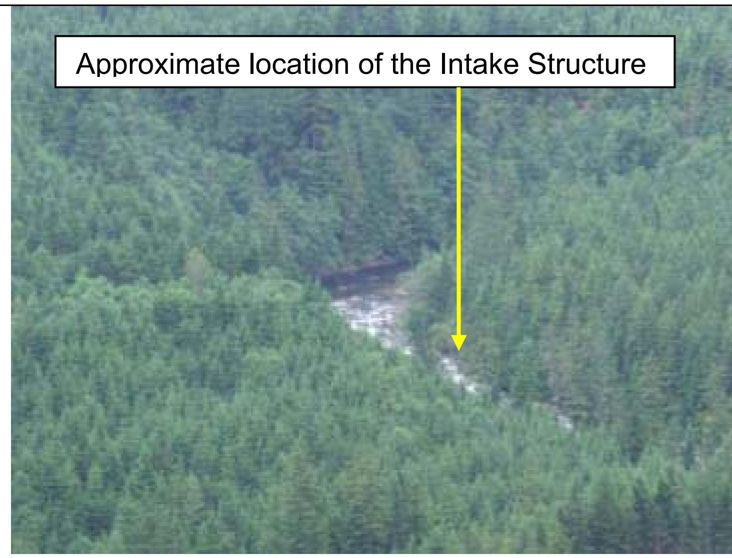
DAILY FIELD REPORT

	PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Project	12PROPENGY.RP00.0002	1
ADDRESS Snoqualmie, King County, Washington	DATE July 18, 2012	PAGE 4 OF 7

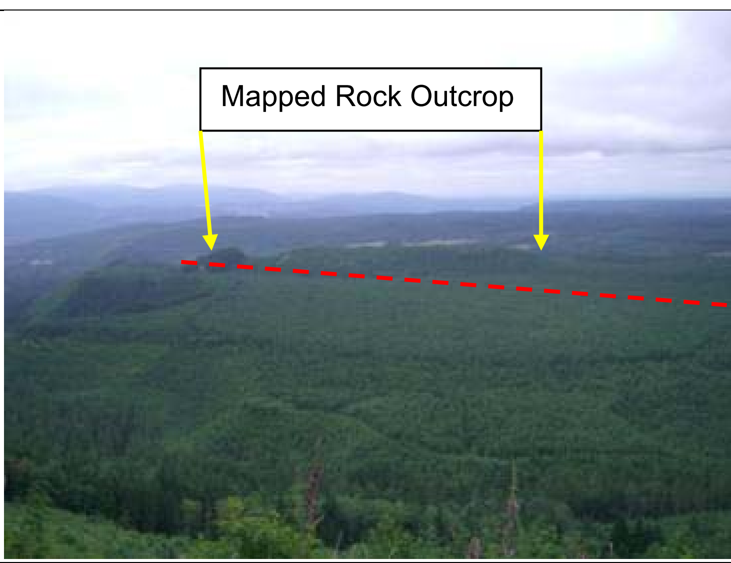
COMMENTS

the way back down the hill, we were able to get a great overview of the project site from the east side of Black River Canyon. Photographs were taken of the Intake Structure site and surrounding area (Photographs # 7 & 8). Photographs were also taken of the alignment for the upper Tunnel (Photographs # 9 & 10).

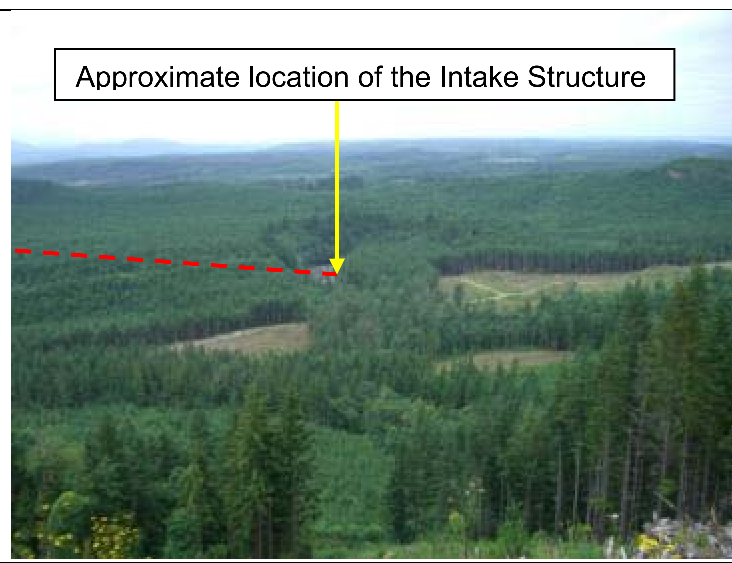
Proposed Intake site for the Hydroelectric Project (Photograph #7).



Proposed Intake site for the Hydroelectric Project (Photograph #8).



View of the proposed Tunnel alignment that cuts across



Another view of the Tunnel alignment starting at the

AMEC FIELD REPRESENTATIVE

AMEC PROJECT MANAGER

AMEC Environment & Infrastructure, Inc.
11810 North Creek Parkway N Tel (425) 368-1000
Bothell, WA 98011 Fax (425) 368-1001

DAILY FIELD REPORT

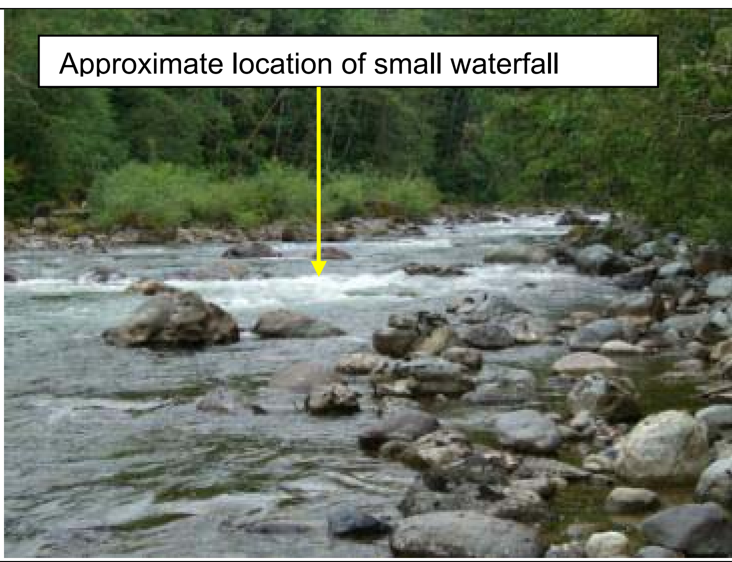
	PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Project	12PROPENGY.RP00.0002	1
ADDRESS Snoqualmie, King County, Washington	DATE July 18, 2012	PAGE 5 OF 7

COMMENTS

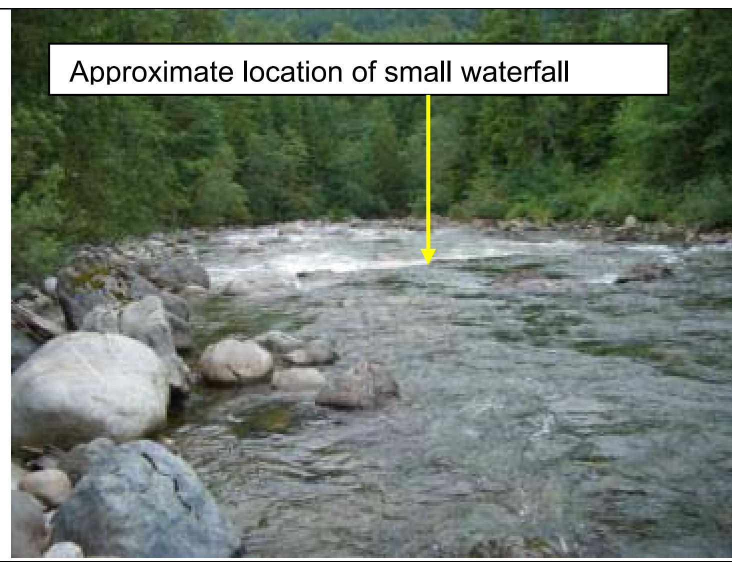
the east side of rock outcrop (Photograph #9).	Intake Structure (Photograph #10).

We then went to the proposed Intake site where time was taken to walk the area and determine where the approximate location of the Intake Structure will be sited. Whitewater personnel indicated that they would like to site the Intake Structure at or above a small 1- to 3-foot high waterfall (Photographs # 11 & 12). Here they plan to construct a 7-foot high inflatable dam to divert the river flow into the Intake Structure. The location of the proposed Intake Structure lies to the east of the section line marked between Sections 18 and 24, T24N, R8E (Photographs # 13 & 14).

There is a turn out off of Raptor Campground Road that can be used to access the site. There has been some brushing and logging at the end of the road that should provide adequate space for running a seismic line to the northeast of the proposed Intake Structure (Photographs # 15 & 16).



Looking upstream at the approximate location of the 1- to 3-foot waterfall where a 7-foot inflatable dam will be used to divert river water into the Intake Structure (Photograph# 11).



Looking downstream at the approximate location of the 1- to 3-foot waterfall where a 7-foot inflatable dam will be used to divert river water into the Intake Structure (Photograph# 12).

AMEC FIELD REPRESENTATIVE

AMEC PROJECT MANAGER

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DAILY FIELD REPORT

	PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Project	12PROPENGY.RP00.0002	1
ADDRESS Snoqualmie, King County, Washington	DATE July 18, 2012	PAGE 6 OF 7

COMMENTS

View of monument marking the east section line of Section 24, T25N R8E (Photograph # 13).

Blazed tree showing the location of the monument along the east section line of Section 24, T25N R8E (Photograph # 14).

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DAILY FIELD REPORT

Black Canyon Hydroelectric Project	PROJECT NO. 12PROPENGY.RP00.0002	FIELD REPORT NO. 1
ADDRESS Snoqualmie, King County, Washington	DATE July 18, 2012	PAGE 7 OF 7

COMMENTS

Approximate location of proposed seismic line down slope of clearing for the proposed Intake Site (Figure 15).

Approximate location of proposed seismic line down slope of clearing for the proposed Intake Site (Figure 16).

Based on our observations and quick review of site geology, we have derived the following conclusions:

1) The project site lies adjacent to the Cascade Mountains comprised of rocks of the western mélange belt;
2) There have been plutonic intrusions of early Eocene and volcanic intrusions of Miocene age into the bedrock;
3) These intrusions most likely caused folding and faulting of the bedrock creating zones of weak rock;
4) Multiple episodes of glaciations have gouged out the weak rock and covered the bedrock with glacial soils; depths to bedrock could be deeper than anticipated if carved into the river channel by the glaciers;
5) Work by Thorson shows that Fraser glaciations extended all the way to the foothills of the Cascades, masking the depth to bedrock;
6) Glacial melt waters and rain waters have eroded drainage channels that comprise the current river channels that are choked with alluvial sediments;
7) In the areas of the proposed Intake Structure and Powerhouse, the bedrock is masked by glacial and alluvial deposits; depth to rock is unknown horizontally and vertically along the proposed Tunnel alignment;
8) The proposed Tunnel alignment cuts in front of a hogback of older bedrock that could be folded and faulted; glacial sediments are smeared along the eastern flank of the hogback down to the river; depth to bedrock could be lower than the currently proposed Tunnel alignment; and
9) Depth to bedrock at the proposed Shaft Collar is also unknown.

The proposed seismic survey should help address some of these unknowns. Results of the seismic surveys coupled with a more thorough literature search should aid in determining if the construction of project is feasible as currently planned or if adjustments need to be made. After the project layout has been finalized, a drilling program is recommended to determine depth and condition of bedrock.

Henry W Brenniman

AMEC FIELD REPRESENTATIVE

AMEC PROJECT MANAGER

August 17, 2012
AMEC Project 2-915-17460-0

Whitewater Engineering
3633 Alderwood Avenue
Bellingham, Washington 98225

Attention: Mr. Brandon Hausmann, P.E., Design Manager

Subject: Preliminary Geophysical Study
Black Canyon Hydroelectric Project
FERC Project No. P-14110
King County, Washington

Dear Brandon:

At your request, AMEC Environment & Infrastructure, Inc. (AMEC) is pleased to submit this preliminary geophysical study. For this initial study, geophysical measurements were taken at three locations using non-intrusive methods. At each location, our subcontract firm, Global Geophysics LLC (Global) ran profile lines that were approximately 250 feet in length.

A daily field report is attached, summarizing the field activities and showing the approximate locations of each of the three profiles. The three profiles are designated as:

- Intake Structure Profile 1 (see plot on Figure 1);
- Power House Profile 1 (Figure 2); and
- Power House Profile 2 (Figure 3).

These locations were selected based on available site access, as directed by Whitewater Engineering. The purpose of this initial work was to assess if the subsurface conditions are amenable to the selected geophysical methods, and can provide useful information regarding the thickness of soil overburden, as well as depth and quality of underlying bedrock. The methods selected by Global were seismic refraction and electrical resistivity tomography (ERT). The plots assumed an arbitrary surface elevation of 100 feet. All distances shown on the plots are in feet.

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DRAFT

A brief discussion of the results follows.

Intake Structure Profile 1 – of the three profiles, bedrock was least evident at this site. An interpretation of the bedrock surface as provided by Global is shown. The ERT plot is interpreted to show a bedrock at 15 to 20 feet below ground surface near the center of the profile, but sloping steeply away at each end of the profile. Typically, seismic P-wave velocities for competent bedrock would be 10,000 feet per second or more. If bedrock is present it would be highly fractured and decomposed. Seismic P-wave velocities of groundwater would be 5,000 feet per second, however measured velocities were lower than this. Given the proximity to the river, it was expected that a groundwater table would have been encountered. This plot suggests the river is “losing” flow into the underlying gravelly formation in this stretch, which may be the case.

Powerhouse Profile 1 – a sloping bedrock surface was interpreted for this site. This appeared reasonable based on the surrounding site conditions (deeper bedrock toward the center of the valley). P-wave velocities of about 8,000 feet per second would be representative of moderately competent bedrock.

Powerhouse Profile 2 – a fairly flat-lying bedrock surface was interpreted for this site. This appeared reasonable based on the surrounding site conditions (approaching the flank of the valley and a bedrock outcrop further toward the west). P-wave velocities of about 10,000 feet per second would be representative of competent bedrock.

Conclusions and Recommendations - On the basis of the evaluation, these geophysical methods appeared to be effective at evaluating the depth to bedrock. Figures 2 and 3 appear to have shown reasonable interpretations of bedrock depths and orientation based on our observations of site topography and bedrock outcrops at the site. Geophysical methods will need to be combined with test borings in areas where deeper gravel or landslide deposits are present such as the Intake site. Once definitive bedrock contacts can be identified, geophysical methods will be useful for inferring the shape of the bedrock surface between borings.

We appreciate the opportunity to be of service and would be pleased to answer any questions you may have.

Sincerely,

DRAFT

AMEC Environment & Infrastructure, Inc.

James S. Dransfield, P.E.
Principal Geotechnical Engineer

Enclosures:

Daily Field Report
Figure 1 – Velocity and Resistivity Profiles Along Intake Line 1
Figure 2 – Velocity and Resistivity Profiles Along Power House Line 2
Figure 3 – Velocity and Resistivity Profiles Along Power House Line 2

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DAILY FIELD REPORT

PROJECT NAME		PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Project		2915174600.002.003	2
ADDRESS: Sections 24-26, T24N, R8E & Section 18, T24N, R9E		DATE: July 30 & 31, 2012	PAGE: 1 OF 4
CITY OR COUNTY: Snoqualmie, King County, WA	PERMIT NO.	ARRIVAL TIME: 8:15 & 7:30	DEPARTURE TIME: 14:45 & 15:45
CLIENT: Whitewater Engrg. Corp./ Brandon Hausmann, P.E.	AMEC PROJECT MANAGER/PHONE NO.: Jim Dransfield, P.E. / (425) 368-1000		
GENERAL CONTRACTOR	AMEC FIELD REPRESENTATIVE/ MOBILE NO.: Henry Brenniman (425) 864-0165		
SUBCONTRACTOR: Global Geophysics / John Liu / (425) 890-4321	WEATHER: Partly cloudy in am with mist to partly sunny in pm, 55-70°F		
TYPE OF WORK PERFORMED: Select seismic line alignments in field and assist geophysical personnel with initial set-up			
EQUIPMENT USED: Resistivity and seismic equipment			

COMMENTS

AMEC arrived at the Snoqualmie Casino parking lot meeting spot at 8:15 am on July 30 and at 7:30 am on July 31, and met with representatives from Global Geophysics (Messrs. John Liu and Scott). On July 30, we went to the Intake site to conduct resistivity and seismic testing. Upon arriving at the Intake site at ~9:00 am, we were informed by representatives from Whitewater (Messrs. Jason Cohn and Tim) that they would be arriving on site at ~9:30 am. Time was taken to go down to the section line marker between Section 24, T24N, R8 E and Section 18, T24N, R9E, and use a Brunton compass to run a north-south line to confirm that our resistivity and seismic surveys would be conducted in Section 18 as requested by Whitewater. After the location of the section line was determined, discussions were held with Global Geophysics to determine a favorable location for testing. A sand and gravel terrace 5 to 7 feet above the river level was selected. The end of the Intake survey line was determined to be ~43 feet N and 14 feet E of the survey stake and extended for a distance of ~270 feet to the start of the line. The bearing of the line was determined using a Brunton compass, and measured to be S 86 deg W (see Sketch p. 3 for the approximate location). After the line was laid out, representatives from Whitewater and AMEC brushed the path of the line so that Global Geophysics could layout the cable for the resistivity testing which was done first. While the resistivity testing was in progress, AMEC took time to take measurements to locate the seismic line. AMEC left the Intake site at ~2:45 pm.

On July 31, we were in route to the second site for resistivity and seismic testing located near the junction of N Fork Road SE, SE 88th Street and NE 5700. While in route, we were informed by Whitewater that they had decided they no longer want to conduct testing in this area, and wanted to concentrate our efforts on the Powerhouse site. Upon arriving at the site at ~8:00 am, we were informed by the Whitewater representative, Mr. Alex Grant, he would be arriving on site at ~9:00 am. We held discussions with Global Geophysics to determine a favorable location for testing. After a straight line of site for ~300 feet was determined on the City of Snoqualmie access road, we started brushing the line, and Global Geophysics started laying out the resistivity line and placing pins. After Mr. Grant arrived on site, we were informed by Whitewater that they would like to change the location of the seismic line to start at ~550 feet of the Chlorination Building. After several minutes of discussion, it was agreed to run two seismic

☒ The contents of this field report were discussed with the contractor's on-site representative.

☐ A preliminary copy of this field report was left on site. All recommendations contained herein are subject to change pending review by the AMEC project manager.

Henry W Brenniman

James Dransfield

AMEC PROJECT MANAGER

AMEC Environment & Infrastructure, Inc.
11810 North Creek Parkway N Tel (425) 368-1000
Bothell, WA 98011 Fax (425) 368-1001

amec

DAILY FIELD REPORT

PROJECT NAME	PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Plant	2915174600.002.003	2
ADDRESS	DATE	PAGE
Snoqualmie, King County, WA	July 30 & 31, 2012	2 OF 4

COMMENTS

lines, time permitting at the Powerhouse site. The end of the alignment for the first test line was measured to end ~74 feet from the SE corner of the Chlorination Building, and extended for a distance of ~270 feet to the start of the line. The bearing of the line was determined using a Brunton compass, and measured to be S 86 degrees W (see Sketch p. 4 for the approximate location). During the testing of Powerhouse Line 1, Whitewater and AMEC laid out the location of Powerhouse Line 2, and cleared brush so there would not be delays in testing. After the resistivity and seismic testing were completed on Powerhouse Line 1 Global Geophysics moved their equipment to Powerhouse Line 2, and set-up to conduct the seismic testing first. End of Powerhouse Line 2 was ~253 feet up the access road from the start of Powerhouse Line 1, and extended for a distance of ~270 feet to the start of the line. The bearing of the line was determined using a Brunton compass, and measured to be N 70 degrees W (see Sketch p. 4 for the approximate location). After taking measurements on the locations of the seismic lines, AMEC was informed by Whitewater that the surveying crew would be out tomorrow, and requested that all the seismic lines at the Intake and Powerhouse sites be marked with paint. Time was taken to go back to the Intake sight and mark the start and ending of the seismic site. It took ~1 hour to make the trip and mark the line. Upon returning to the Powerhouse site, AMEC completed marking the ends of the two seismic lines. AMEC left the Powerhouse site at ~3:45 pm.

Henry W Brenniman

AMEC FIELD REPRESENTATIVE

AMEC PROJECT MANAGER

NOT TO SCALE

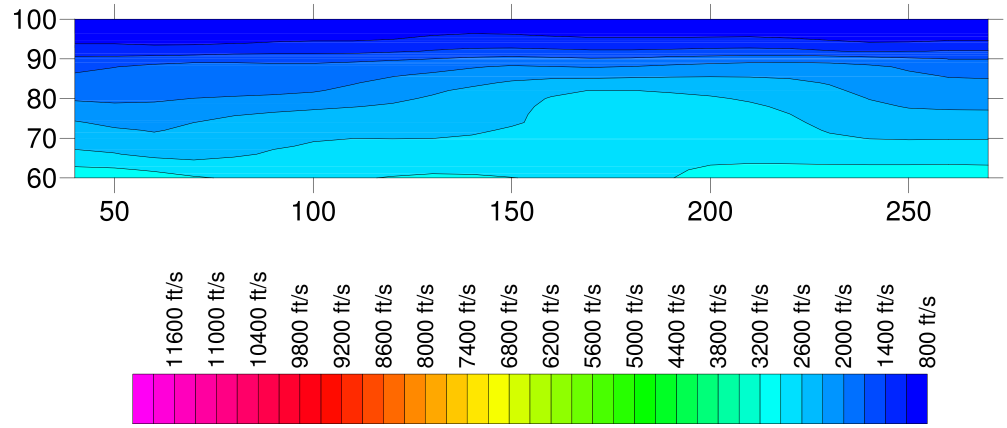
PROJECT NAME	PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Project	2915174600.002.003	2
DESCRIPTION	DATE	PAGE
Intake Site Seismic Line 1 Location	July 30, 2012	3 OF 4

NOT TO SCALE

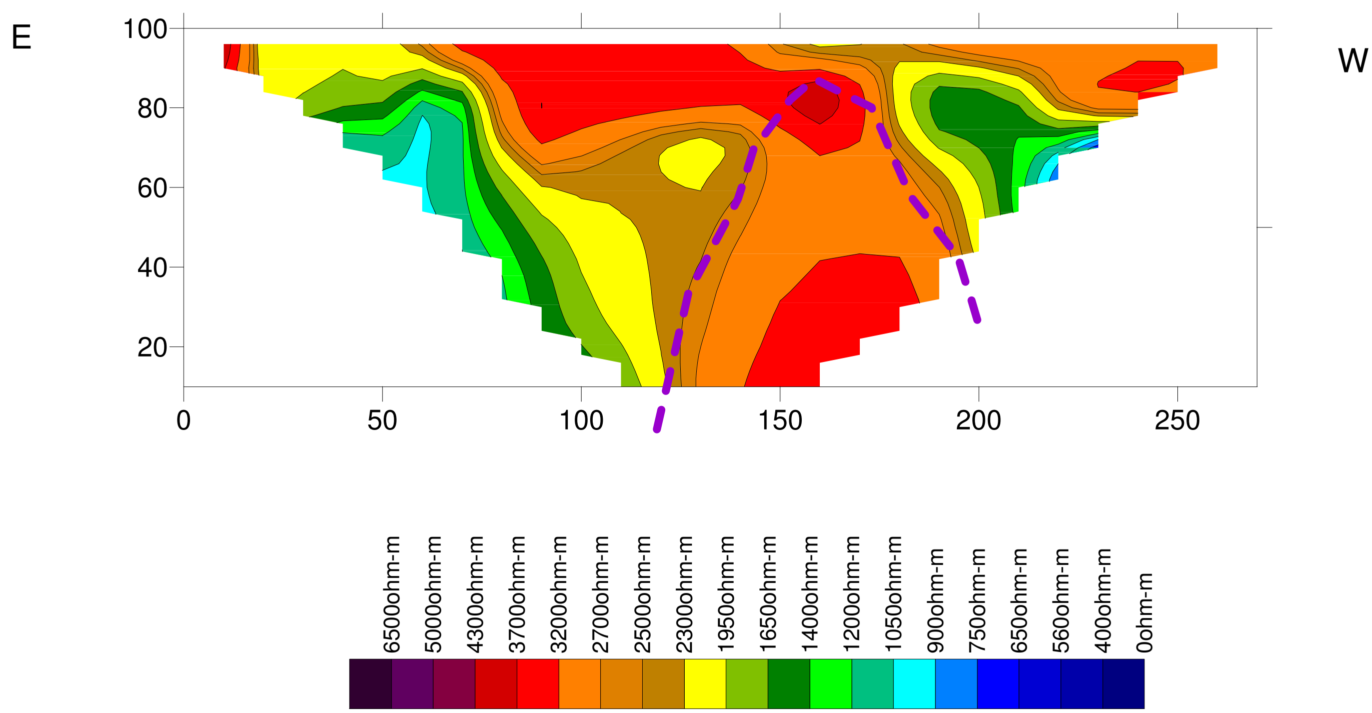
PROJECT NAME	PROJECT NO.	FIELD REPORT NO.
Black Canyon Hydroelectric Project	2915174600.002.003	2
DESCRIPTION	DATE	PAGE
Powerhouse Site Seismic Lines 1 & 2 Locations	July 31, 2012	4 OF 4

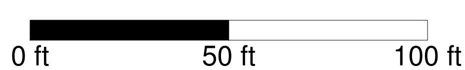
Line 1

Seismic refraction P-wave profile



Resistivity profile





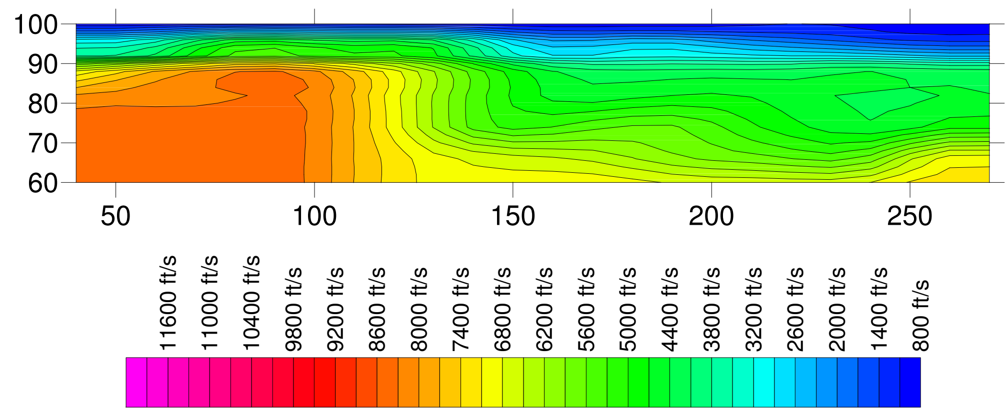
Legend:

Interpreted bedrock surface

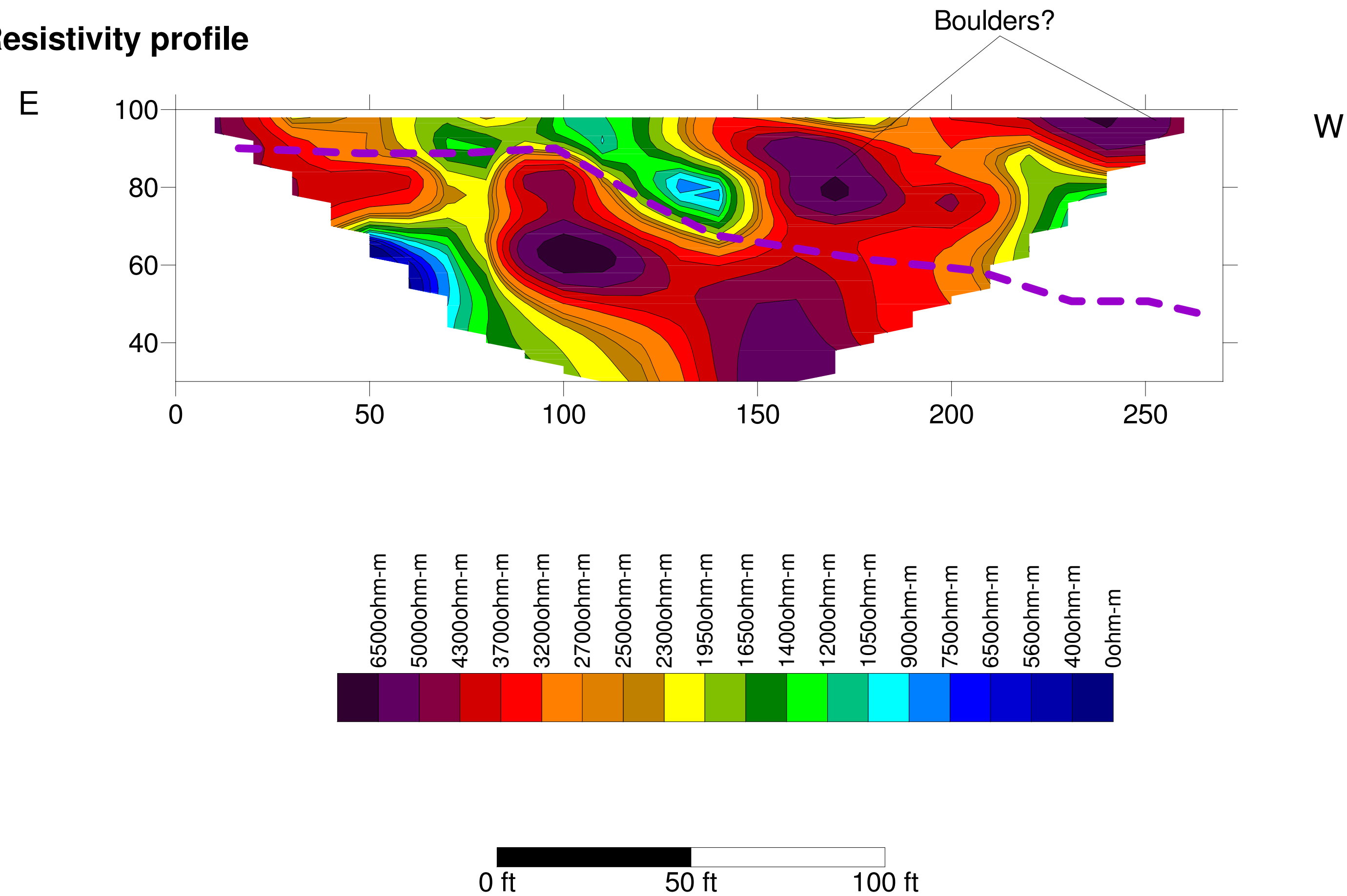
PROJECT	PILOT STUDY USING SEISMIC REFRACTION AND RESISTIVITY TOMOGRAPHY	
TITLE	VELOCITY AND RESISTIVITY PROFILES ALONG INTAKE LINE 1	
Global Geophysics 16651 White Mountain Road SE Monroe, WA, 98272 Tel: 425-890-4321	PROJECT No. 102-0715 DESIGN -- CADD JL CHECK -- REVIEW --	FILE No. SCALE AS SHOWN REV. **FIGURE 1**

Power House Line 1

Seismic refraction P-wave profile



Resistivity profile



Legend:

Interpreted bedrock surface

PROJECT
PILOT STUDY USING SEISMIC REFRACTION AND RESISTIVITY TOMOGRAPHY

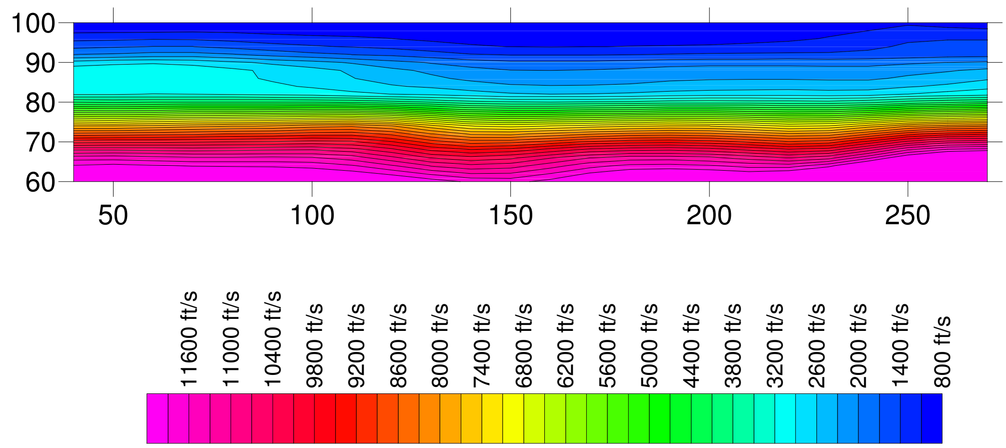
TITLE
VELOCITY AND RESISTIVITY PROFILES ALONG POWER HOUSE LINE 1

Global Geophysics
16651 White Mountain Road SE
Monroe, WA, 98272
Tel: 425-890-4321

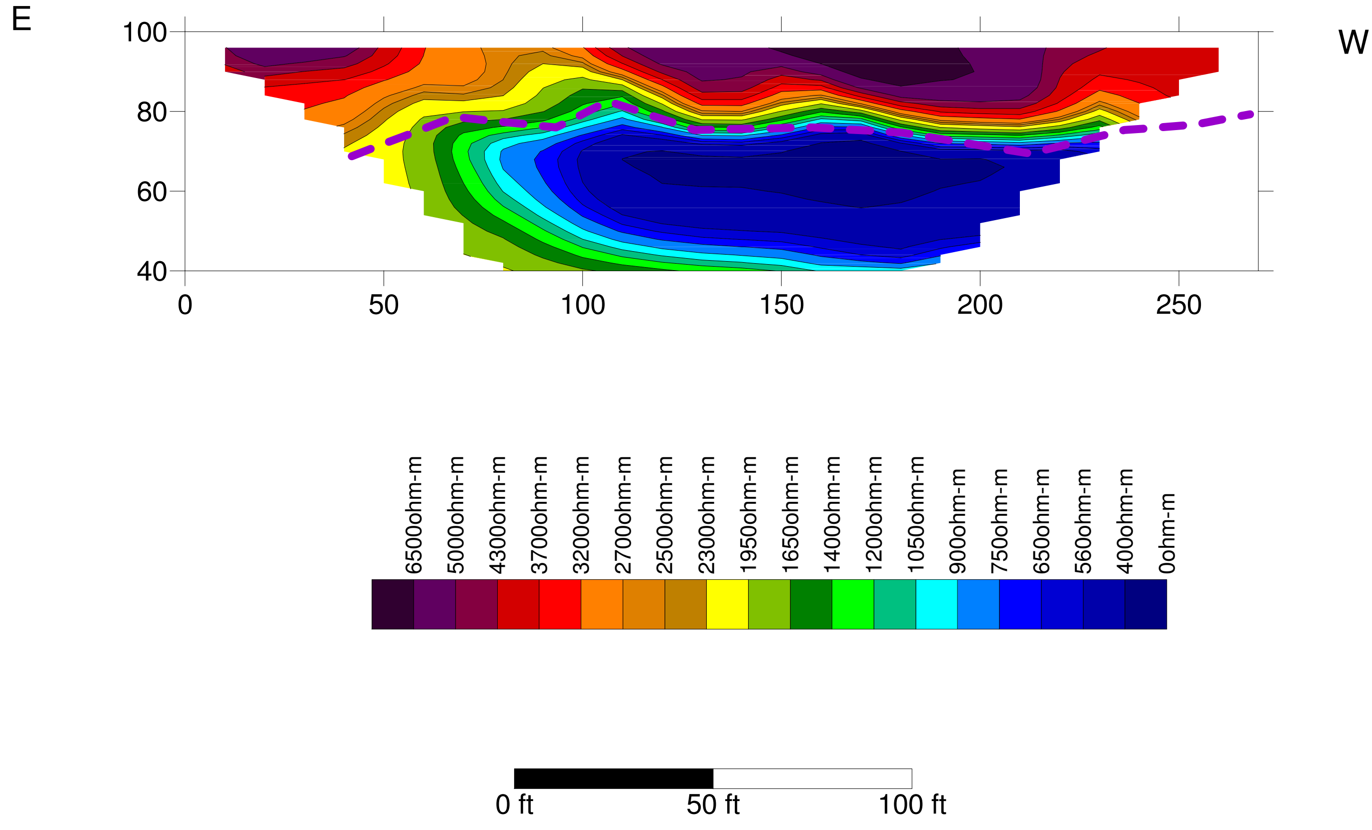
PROJECT No. 102-0715			FILE No.
DESIGN	--		SCALE AS SHOWN / REV.
CADD	JL		**FIGURE 2**
CHECK	--		
REVIEW	--		

Power House Line 2

Seismic refraction P-wave profile



Resistivity profile



Legend:

Interpreted bedrock surface

PROJECT	PILOT STUDY USING SEISMIC REFRACTION AND RESISTIVITY TOMOGRAPHY		
TITLE	VELOCITY AND RESISTIVITY PROFILES ALONG POWER HOUSE LINE 2		
Global Geophysics 16651 White Mountain Road SE Monroe, WA, 98272 Tel: 425-890-4321	PROJECT No. 102-0715		FILE No.
	DESIGN	--	SCALE AS SHOWN / REV.
	CADD	JL	FIGURE 3
	CHECK	--	
	REVIEW	--	

Appendix E

Material Testing & Consulting rock characterization and test results

Materials Testing & Consulting, Inc.

Geotechnical Engineering & Consulting • Special Inspection • Materials Testing • Environmental Consulting

December 17, 2013

Whitewater Engineering Corp.
3633 Alderwood Ave.
Bellingham, WA 98225
Attn: Brandon Hausmann

RE: Black Canyon Hydroelectric Project – 13B181

Dear Mr. Hausmann:

The following data is for the testing that was performed on the metabasalt rock samples that were delivered to the lab on December 16th, 2013.

Compression Testing

Each rock sample was cut down to an approximately 1" cube, and a compressive load was applied. Results are as follows:

Sample #	Description	Load, lbs.	PSI
B13-813	Sample #1	14,688	14,840
B13-814	Sample #2	11,994	10,900

The Sample #2 cube was characterized by a quartzose vein running approximately 5 degrees from horizontal (i.e. nearly perpendicular to the direction of compression).

Rock Classification

A rough geologic description based on approximate sample location and geologic rock type classification was performed on the samples. Please note that geologic classification of rock samples ex situ (i.e. while not present at the sample location) introduces a high level of potential error in the process, as it does not account for bedding visible rock attitude, surrounding lithologies and bedding planes. Per the information supplied with the samples, they were collected from approximately 2.6 miles along and on the western bank of the North Fork of the Snoqualmie River, north of Interstate 90. According to the Geomorphology of King County, Snoqualmie Watershed, by Booth et al, April 2004, this location may place the samples within units of either Quaternary age or Triassic age. The Quaternary age unit (Qvr) is termed Recessional outwash deposits and comprises stratified sand and gravel, while the late Cretaceous age unit (TKwa) is classified as Argillite and greywacke "well-bedded marine sandstone and argillite, …. and volcanolithic subquartzose sandstone interbedded with black argillite…containing clasts of mostly plagioclase, chert, volcanic rocks, and quartz". According to the geologic map, there exist several "slivers" of the TKwa surrounded by the Qvr located generally along the alignment of the Snoqualmie River in this vicinity. The ridge to the east of the river valley is primarily characterized by TKwa with Qf (alluvial fan deposits) at the ridge toe entering the river valley.

Geologist's Mohs relative hardness tests were performed, wherein a steel knife blade was scratched by and scratched the surface of the rock samples. This places it on the relative scale at about 7. A streak test was performed, which revealed a streak color of greenish grey. (Please see the attached following photographs.) A weak acid was dropped on the surface, which showed no obvious signs of effervescence (i.e. the reaction of acid ions with carbonates).

Given the hardness (approximately 7 on Mohs scale) of these samples and the fine crystalline structure, and quartzose veins, we expect that these samples are probably greywacke, basalt or volcanically altered sandstone, or highly altered argillite. Since argillite is typically a massive intermediate of shale and slate, lacking the well-defined crystalline structure of these samples, it is less likely.

We were pleased to perform this classification for your project. If you have any questions please feel free to call us at (360) 755-1990.

Respectfully Submitted,

MATERIALS TESTING & CONSULTING, INC.

Curtis M. Shear
Associate / Lab Manager

Leland B. Rupp, P.E.
Geotechnical Division Manager

Appendix F

Element Solutions, Geologic Considerations for Project Feasibility

Black Canyon Hydroelectric Project

Geologic Considerations for Project Feasibility

Prepared for Black Canyon Hydro, LLC
3633 Alderwood Avenue
Bellingham, WA 98225

January 9, 2014

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Purpose

The proposed project occurs in a region that is structurally complex, geologically diverse and has steep, mountainous and river valley terrain. The purpose of this analysis is to review the "Preliminary Geotechnical Findings" (Whitewater Engineering December 2013) and perform additional desktop LiDAR analysis to evaluate whether or not the project appears feasible to move forward to engineering design given the existing information.

Review and Assessment

The review of existing USGS and DNR geologic maps indicate three distinct lithotypes underlying the local Fraser-age glacial outwash deposits that define much of the surficial topography in our area of interest. The pre-Tertiary argillite/metagraywacke unit most commonly referenced in existing literature may be continuous across the project area (Figure 1) and likely underlies the glacial sediments to form the bedrock for the proposed tunnel. It is possible that tonalite/granodiorite and mafic intrusive bodies from the Index and Snoqualmie batholiths are also encountered within the same geologic complex contacting pre-Tertiary bedrock and may be present within the project area. The inconclusiveness of recent bedrock analyses (hand samples retained during the Whitewater Engineering field study were classified by MTC as "probably greywacke, basalt or volcanically altered sandstone, or highly altered argillite) does not refute alternative hypotheses for petrogenesis or alteration, including contact or fault-related metamorphism. The Bingham Engineering report referenced by Whitewater noted a "highly fractured" region of the bedrock containing "white calcite, quartz and pyrite veins cross-cutting white veins of quartz and calcite;" this provides compelling evidence indicating the possible presence of a relict hydrothermal system consistent with igneous intrusion. The nearest mapped fault trace proximal to the subject area is the Tokul River fault, a NNE trending subvertical reverse fault associated the Rattlesnake Mountain Fault Complex.

Desktop LiDAR analysis of the subject area revealed that Late Pleistocene glacial advance encountered the bedrock ridge southeast of the project at near 90 degree angles and likely halted, forming ice marginal lakes and deposits. Glacial outwash channel deposits showing flow towards the south are present in the project area (Figure 1). The modern day Snoqualmie River is incised into the Late Pleistocene outwash channel. In the project reach, the channel has incised down to bedrock throughout much of its length and very little lateral migration or deposition has occurred throughout the Holocene. Several stranded Holocene terraces are present along the modern alluvial plain.

Desktop LiDAR analysis of the subject area revealed a probable Holocene landslide deposit approximately 1000 feet due northeast of the proposed tunnel intake structure (Figure 1). Field analysis of the deposit and possible head scarp would be required to confirm or refute this hypothesis. We found no evidence in the in the LiDAR analysis of larger or older landslide

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deposits within the project footprint. While historical landslides are not necessarily indicative of present instability, the potential for a landslide to impact the incised river channel within the project area exists.

Methods and analysis by Whitewater Engineering to interpolate depth to bedrock in the proposed tunnel alignment were appropriate. Accompanying seismic refraction profiles were suggestive of a bedrock horizon congruent with the adjacent incised river channel, but were not definitive. However, combined with the previously collected boring and well information, it seems that there is a high likelihood that bedrock is present at the depths of the proposed alignment (Figure 2). We understand that further study will likely include systematic sampling of bedrock within the incised river channel and definitive field lithology identification supplemented by geophysical and/or core logging of the subsurface to confirm this preliminary analysis.

The proposed project occurs in a highly active seismic region associated with the Cascadia Subduction Zone. While the potential for seismic activity is a fact of life in the Pacific Northwest, locating and identifying active faults is challenged by the glacial and vegetative landscape.

Conclusion

While actual subsurface lithology could present potential challenges for project design, the preliminary feasibility assessment, given the available information, appears logical and the hypothesis that bedrock is present in the proposed tunnel alignment appears sound. It does not appear given the geomorphic evidence that the large-scale mass wasting deposits occur in the proposed tunnel alignment. No active faults displacing glacial or Holocene deposits were observed in the LiDAR or are shown on the referenced maps. Moving forward with project design and assessment will require a deeper understanding of the bedrock composition, geomorphology, and regional and local faulting.

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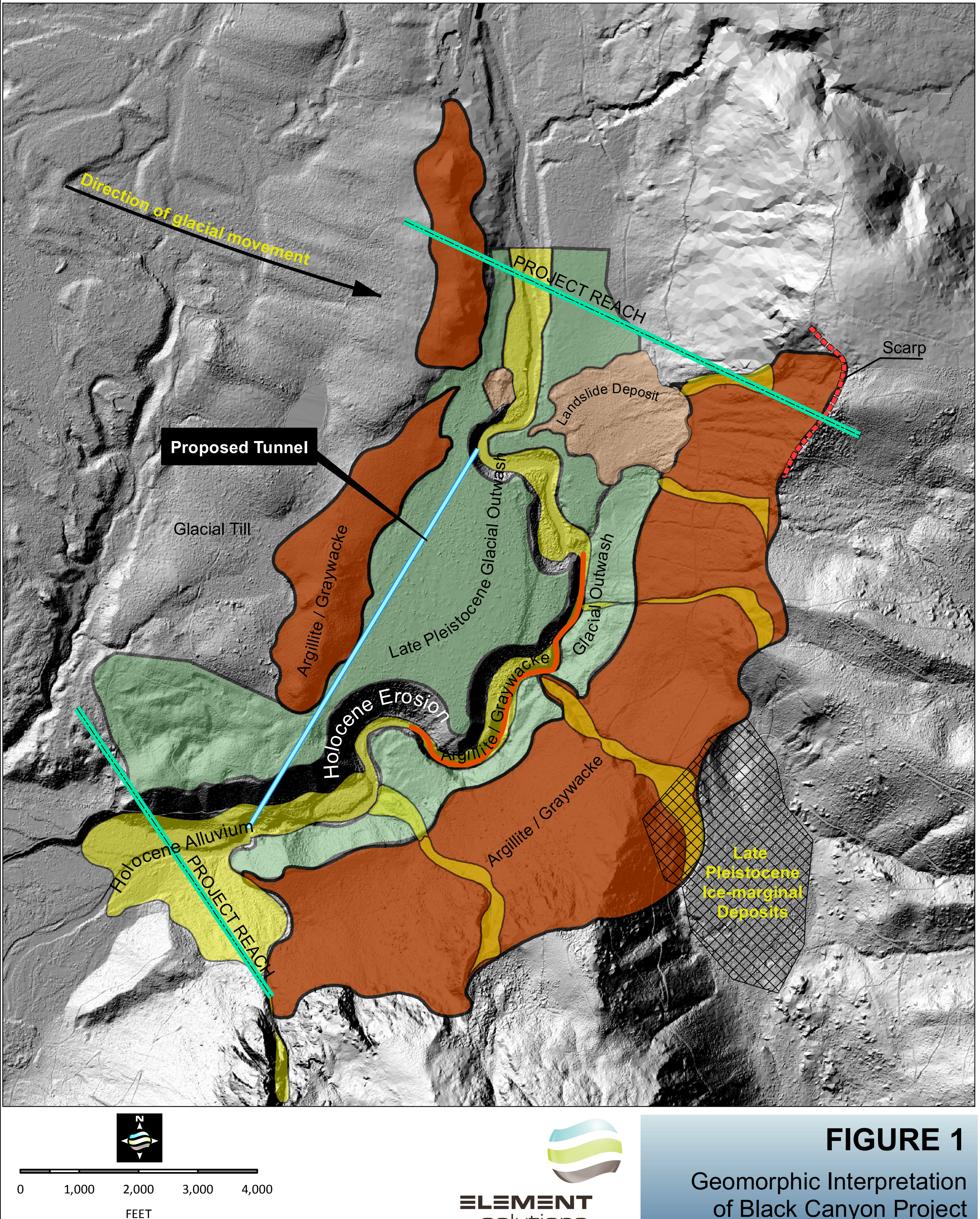

ELEMENT solutions

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Bellingham, WA 98225
info@elementsolutions.org

FIGURE 1

Geomorphic Interpretation of Black Canyon Project

Date: 1/9/2014

Path: P:\Pse Project\2014001\Fig1_BlackCanyon_Geomorphology.mxd

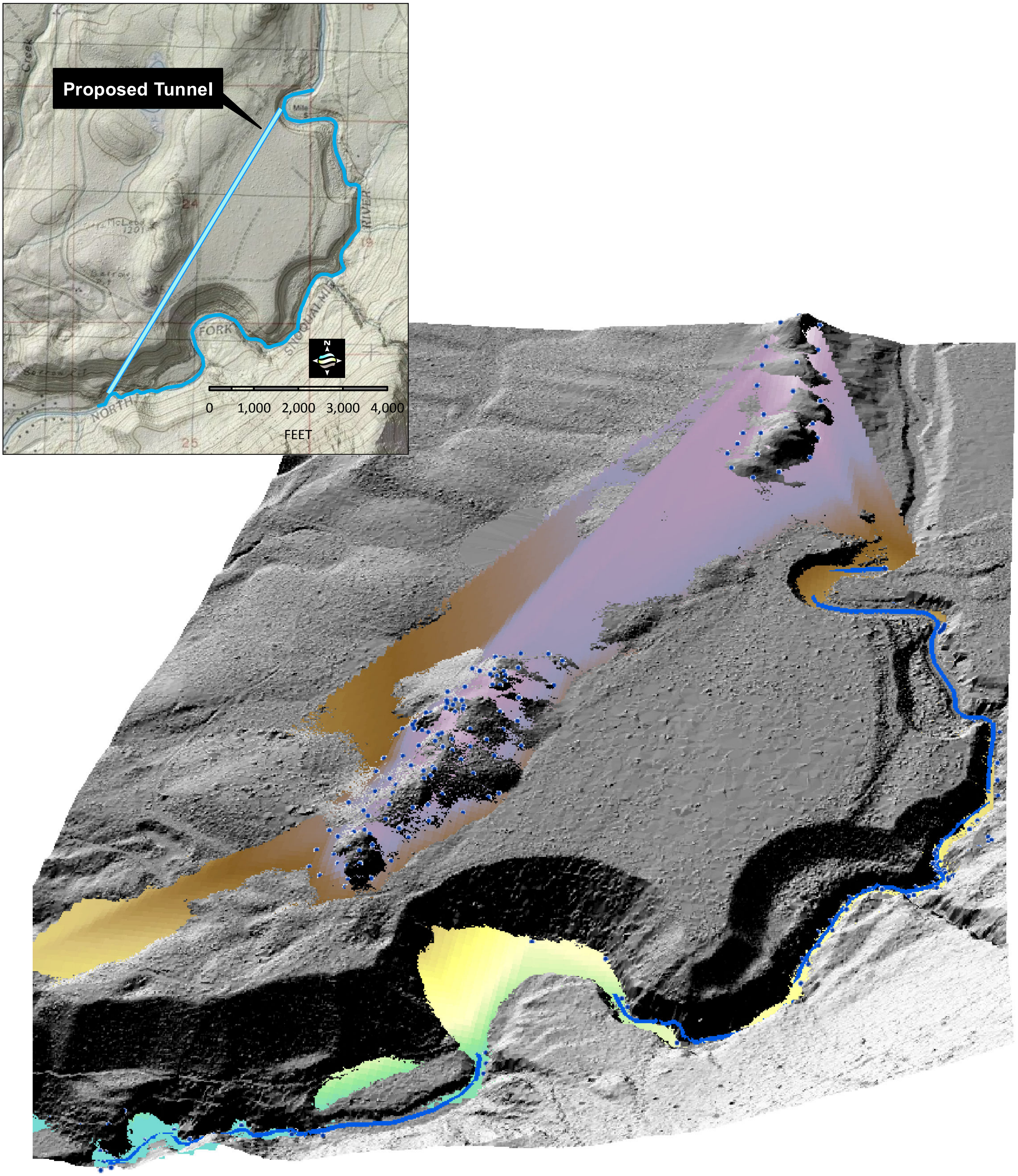

FIGURE 2

Bedrock Surface Modeling

Notes:

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solutions

info@elementsolutions.org

Date: 1/15/2014

Path: P:\Pse Project\2014001\BlackCanyon_Bedrock.mxd