TETRA TECH EBA

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Attention: Mr. Erik Pit
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Subject: Data Gap Assumption Report
Abandoned Clinton Creek Asbestos Mine Site, Yukon

1.0 INTRODUCTION

Government of Yukon, Assessment and Abandoned Mines (AAM) has retained Tetra Tech EBA Inc. (Tetra Tech EBA) to assist with the summary and evaluation of geotechnical information related to closure of the Clinton Creek asbestos mine near Dawson City, YT. This report presents a summary of the geotechnical assumptions required to conduct stability analyses on the Clinton Creek waste rock pile and Wolverine tailings pile. The assumptions reported herein are based on filling data gaps identified by Tetra Tech EBA during preparation of the Existing Geotechnical Subsurface and Monitoring Data Summary Report.

1.1 Scope

Tetra Tech EBA has been retained to provide engineering services for this project in an attempt to better understand the mechanisms driving the slope instability of the waste rock and tailings piles. The general scope of work includes summarizing existing information and data gaps, evaluating the data and monitoring programs undertaken to date, as well as assessing stability, site access mitigations, and fish passage for the short-listed closure options. This work aims to guide project parties in making decisions regarding future design and implementation of the various closure options.

2.0 SURFICIAL GEOLOGY AND TOPOGRAPHY

A literature review of surficial geology for the site was completed to guide assumptions with respect to pre-development ground surface and permafrost conditions. The following is a brief summary of surficial geology findings that some of the assumptions stated herein are based on.

2.1 Surficial Geology

The area where the site is located has never been glaciated, although larger adjacent valleys to the north and south were glaciated during the Middle Pleistocene (about 200,000 years ago) (Duk-Rodkin 1999). As a result, the area has experienced a significant period of weathering. Weathered bedrock, **colluvium** derived from weathered bedrock and loess, and **fluvial** deposits (including small **fluvial fans**), make up the surficial geology of the region (Duk-Rodkin 1996, McKenna and Lipovsky 2014, CGE 2016). Colluvium is expected to be coarser grained on steeper slopes, while colluvial aprons on lower slopes commonly contain ice-rich resedimented **loess** and **peat** (informally called “muck” as all three deposit types are present) (McKenna and Lipovsky 2014). Fluvial deposits may also contain reworked **eolian** silt and sand (McKenna and Lipovsky 2014).

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Regionally and within the project area, colluvial deposits dominate high elevation areas, while fluvial deposits are found in valley bottoms. These deposits may be affected by **cryoturbation**, **solifluction**, permafrost processes, **periglacial** processes (CGE 2016), and landslides and snow avalanches (McKenna and Lipovsky 2014). A type of colluvium called “pediment” is found on the ridge tops and upper slopes east of Wolverine Creek and east of the southeastward-flowing portion of Clinton Creek, both of which are east of the project area. Pediment consists of rubble, which may be overlain by more than 3 m of loess (Duk-Rodkin 1996).

Adjacent to Clinton Creek Road, thin colluvium consisting of rubbly, sandy silt is common. At lower elevations, sandy gravel or sandy, gravelly silt make up terraced fluvial deposits (CGE 2016). The Clinton Creek mill site was interpreted as containing granular fluvial-lacustrine deposits (UMA 2000).

2.2 Topography

Smooth, rolling, unglaciated mountainous landscapes cut by narrow valleys characterize the regional terrain (CGE 2016). Valleys are generally v-shaped in this area, reflecting their lack of glaciation (Duk-Rodkin 1996).

3.0 GEOTECHNICAL ASSUMPTIONS

The following sections summarize the assumptions required to conduct stability analyses on the Clinton Creek waste rock pile and the Wolverine tailings pile. Brief explanations of the rationale for each assumption are included where appropriate. Figure 1 presents a site plan showing the location of cross-sections. Cross-sections showing existing grade elevations and assumed subsurface material interfaces are presented on Figures 2 and 3 for the Clinton Creek waste rock pile and Wolverine tailings pile, respectively.

3.1 Pre-Development Ground Surface

AAM provided a topographical survey for the Clinton Creek site based on surface information collected in 2012. No survey data is available for the original ground surface prior to mining activities, which began in 1968. To complete the stability analyses, a pre-development ground surface model was required. To this end, Tetra Tech EBA acquired air photos for the year 1949, as high-resolution digital images, from the National Air Photo Library (NAPL) (Table 3-1). The air photos were digitally triangulated and a pre-development digital elevation model (DEM) was produced. This model was used for stability analyses as it is much more accurate than an estimated model.

Table 3-1: Air Photos used for DEM Creation and Permafrost Mapping

Year	Scale	NAPL Roll Number	Photo Numbers
1949	1:40,000	A12285	239, 240

The air photos were examined in PurVIEW, which allows the mapper to zoom in and out of the air photos while analyzing them in 3D on a computer screen with specialized 3D glasses. Clinton Creek is located in a U-shaped valley, while Wolverine Creek rests in a V-shaped valley more typical of the region (Figure 4, 1949 georeferenced air photo compilation). The following sections describe the pre-development topography and surficial deposits in more detail.

3.1.1 Clinton Creek

3.1.1.1 Valley Floor

Our analysis shows that Clinton Creek occupied mainly the south side of the valley prior to mine development, as seen on Figure 4. It had a small active floodplain flanking the creek that was forested for the most part. The remainder of the valley bottom was flat and covered with organic deposits that appear to have been greater than 1 m thick. These likely overlie thick fluvial deposits. Sections showing the assumed subsurface stratigraphy of the Clinton Creek waste rock area are presented on Figure 2.

3.1.1.2 Southern Slopes

The southern slopes of the valley in the vicinity of the waste rock pile were steep and covered with colluvial veneer (colluvium less than 1 m thick). Bedrock may have been exposed in a few places, but it is difficult to tell due to shade on the slope on the air photo images. Near the base of the slope, colluvial deposits were thicker at one location in the east adjacent to the point where the creek forms two large meanders. Here, colluvium was greater than 1 m thick, and was possibly up to 3 m thick or more. It may consist of the muck described in Section 2.1.

3.1.1.3 Northern Slopes

Colluvial veneer was common on the northern slopes as well. Bedrock was exposed on near vertical faces at higher elevations in the central part of the valley and at low elevations opposite the two creek meanders. A few **colluvial fans** of varying size were present and a few of these had coalesced. Colluvial deposits near the base of the northern slopes appear to have been much thicker than those at the base of the southern slopes. Again, these may consist of the widespread muck deposits common in this area.

3.1.2 Wolverine Creek

3.1.2.1 Valley Floor

Although Wolverine Creek occupies the valley floor, it has no obvious floodplain except at the southern part of the valley near its confluence with Clinton Creek (Figure 4). Sections showing the assumed subsurface stratigraphy of the Wolverine tailings pile area are presented on Figure 3.

3.1.2.2 Western Slopes

The Western Slopes of Wolverine Creek valley were covered with a mix of colluvial veneer (<1 m thick) and blanket (>1 m thick). In veneer areas on the upper half of some slopes, horizontal bedding can be identified in the bedrock, but no exposed bedrock was apparent. **Debris slides** and **debris flows**/creek flows appear to have created colluvial and possibly fluvial fans at the base of the slopes, which may or may not include muck. These appear to be 3 to greater than 15 m thick. Wetter areas of thicker colluvium on the slopes may also include muck. The former mill site appears to have consisted of thin to thick colluvium. There is no evidence on the air photos of lacustrine material as described in UMAs report (2000). It is possible that this area had a cover of loess, which may have been interpreted as lacustrine sediment at the time of drilling. The flat surface of the ridge top resembled the adjacent ridge top to the east of Clinton Creek valley, which was mapped as pediment by Duk-Rodkin (1996). This ridge is smoother-looking on the photo images than the ridge tops south of Clinton Creek valley, so it is concluded that loess was likely present on the Wolverine western ridge top.

3.1.2.3 Eastern Slopes

The eastern slopes are similarly covered with colluvial veneer and blanket, but the deposits at the base of the slopes are thinner, forming thin talus aprons that may have been less than 10 m thick at the base. Bedrock is exposed on south- and southwest-facing slopes near the base of the slopes at the confluence of an unnamed creek and Wolverine Creek, south of the current waste rock pile location. Bedrock is exposed at higher elevations opposite the waste rock pile and near the confluence of another unnamed creek and Wolverine Creek, which is north of the Wolverine site.

3.1.3 Permafrost Mapping

Permafrost distribution within the project area was mapped in PurVIEW using the 1949 pre-development air photo images (Figure 5). The wetland occupying the Clinton Creek valley bottom is considered to have been very ice-rich, as is common for wetlands in the discontinuous permafrost zone. Portions of the Wolverine Creek valley bottom, particularly in the upper areas north of the Wolverine tailings pile, are considered to be ice-rich due to the presence of poorly-drained organic material.

Other areas that likely contain visible ground ice (ice-rich but not very ice-rich) flank the very ice-rich areas or are found in small gullies (Figure 5). In general, the floodplain bordering Clinton Creek is considered to have contained permafrost with non-visible ice, with the exception of the area between Porcupine and Wolverine creeks where unfrozen ground is anticipated, based on the presence of deciduous forest cover.

3.1.4 Bedrock

3.1.4.1 Clinton Creek Waste Rock Pile

Golder Associates (Golder) advanced several boreholes through the existing Clinton Creek waste rock pile and into the underlying foundation soils in 1978. The investigation concluded that there was very little overburden soil on the southern valley wall, an observation consistent with the findings stated in Section 3.1.1.2. Tetra Tech EBA has assumed that weathered bedrock becoming more competent with depth is immediately below the waste rock pile.

3.1.4.2 Wolverine Tailings Pile

Boreholes advanced through the Wolverine tailings pile (Golder 1978) indicate that depth to bedrock varies from near the ground surface to greater than 12 m (below the depth of investigation), an observation consistent with the findings stated in Section 3.1.2.2. Tetra Tech EBA has assumed weathered bedrock is 12 m below the ground surface near the top of the pile and at the surface near the bottom of the pile.

3.1.5 Overburden Thickness

3.1.5.1 Clinton Creek Waste Rock Pile

As mentioned above, the subsurface investigation completed within the Clinton Creek waste rock pile concluded that there was very little overburden soil on the southern valley wall. No boreholes were advanced on the northern valley wall opposite the Clinton Creek waste rock pile, but the air photo analyses revealed the presence of thicker colluvium at the base of the slopes prior to development, as described in Section 3.1.1.3. Tetra Tech EBA has assumed an overburden thickness of 8 m below the waste rock near the south valley slope, which increases in thickness at lower elevations for the north valley slope opposite the waste rock pile. Although an overburden thickness has been assumed for the purposes of the analysis, the thickness of this material, in particular the colluvium, is expected to be variable throughout the Clinton Creek waste rock area. A section showing the assumed overburden thickness for the Clinton Creek waste rock pile is shown in Figure 2.

Tetra Tech EBA has assumed that the valley floor beneath the Clinton Creek waste rock pile is relatively flat and was around 200 m wide prior to failure of the waste rock pile, based on the 1949 DEM model. Considering the distribution of colluvial, fluvial, and organic deposits on the valley slopes and valley bottom as described in Section 3.1.1, we have assumed that the unknown wedge of subsurface soils bounded by the waste rock above and bedrock below in the historic valley bottom contains a uniform colluvium/alluvium deposit.

3.1.5.2 Wolverine Tailings Pile

As mentioned above, the subsurface investigation completed within the Wolverine tailings pile determined that overburden thickness ranged from greater than 12 m near the top to less than 1 m near the toe. Tetra Tech EBA has assumed colluvium/alluvium overburden soils under the Wolverine tailings pile extend from the ground surface down to the assumed bedrock surface described in the previous section.

3.2 Physical Properties

Limited laboratory testing on the physical properties of the waste rock, tailings, overburden soils, and bedrock have been completed previously. Where appropriate, Tetra Tech EBA has relied on this existing laboratory data to determine the physical properties of the soils to be included in the stability analyses. Where laboratory testing is insufficient to provide physical parameters, Tetra Tech EBA has assumed conservative values based on experience and engineering judgement. A summary of the physical properties of the soils to be included in the stability analyses is presented in Table 3-2.

Table 3-2: Physical Properties

Soil Type	Internal Friction Angle (degrees)		Bulk Density (kg/m^3)	Natural Moisture Content (%)
	Peak	Residual		
Waste Rock	40	23	2,000	9.0
Tailings	35	30	1,850[A]	9.0
Overburden (colluvium/alluvium)	27.5		1,950[A]	13.0
Weathered Bedrock (Argillite)	27		2,200[A]	12.0

[A] Values that Tetra Tech EBA has assumed (not based directly on laboratory results)

3.3 Piezometric Elevations

At the Clinton Creek waste rock pile, Tetra Tech EBA has assumed that an average hydraulic gradient exists within the waste rock from the elevation of Hudgeon Lake to the east toe of the waste rock pile on the valley floor. This assumed phreatic surface is approximately 3 to 4 m lower than the 1999 standpipe readings (UMA 2002), likely due to the close proximity of the standpipes to Clinton Creek.

Tetra Tech EBA has assumed that the top of the water table is near the bottom of the deposited tailings on the valley slope and at the elevation of Wolverine Creek at the toe of the tailings pile on the valley floor.

In all cases where permafrost exists, we have assumed that permafrost soils are not subject to piezometric pressures.

3.4 Permafrost

The project area lies within the zone of widespread discontinuous permafrost (Heginbottom 1995). Limited permafrost information was available for the site prior to this study; however, Golder (1978) found that permafrost was present near or just below the contact between the mine waste (waste rock or tailings) and the original ground surface in most locations at that time and also noted visible ice in four boreholes (BH1, 2, 14, and 18) (Figure 5). Other previous work shows that permafrost may be up to 60 m thick and that the active layer is likely 0.3 to 0.5 m thick (Copland 2005, in CGE 2016).

Ground temperatures likely vary across the valley. Areas overlain by standing water are likely permafrost-free or contain permafrost that has degraded to a depth beyond that which will impact the stability of the Clinton Waste rock and Wolverine tailings piles. Available ground temperature data shows that the permafrost varied in temperature between 0 and -2°C with most temperatures reported between 0 and -1.5°C at that time (Golder 1978).

Permafrost may exist beneath the waste rock and tailings piles. The long-term strength of permafrost in the fluvial and colluvial deposits is a function of temperature, ice content, and material type. The ice-rich permafrost tends to creep over time: the rate of creep is a function of the applied shear stress, temperature and ice content of the soil.

Minimal ground temperature data exists and as such limits the amount of information on permafrost temperature available for review. Where permafrost exists in the foundation material, Tetra Tech EBA has assumed an undrained shear strength of 60 kPa for the colluvium/alluvium in the stability analysis. This strength correlates to a ground temperature of approximately -1°C (Johnston, G. J. 1981).

3.5 Failure Slip Surface

Based on our review of available historic reports and subsurface data, the exact location of the failure surface currently responsible for ongoing movement of the Clinton Creek waste rock and Wolverine tailings pile is unclear.

Movement rate data indicates a site-wide deceleration trend. Historical movements recorded following the initial failure of the waste rock pile and up until 1986 were measured in metres per year. When surveying recommenced in 1999, movement rates had decreased substantially. Since 2003 the average rates of movement have diminished to a rate of approximately 5 cm/year for the waste rock pile and range from 5 to 25 cm/year for the various sections of the tailings pile. It was concluded that the mechanism of failure which is represented by historical data differs from the mechanism of failure that is occurring today.

It is reasonable to assume that the initial failures (beginning in 1970) and the 1974 failure surfaces developed within the weathered argillite layer (as stated in the stability discussion of the 2002 UMA report). Since the mid-1980s failure, the deceleration trend in movements suggest that the internal stability of the waste rock pile and tailings pile has reached a state of equilibrium.

Tetra Tech EBA has assumed that the current failure mechanism differs from the mechanism that has caused the failure in 1974. The creep-like nature of the measured movements currently occurring is indicative of ongoing failure in either saturated weak foundation soils or frozen ice-rich foundation soils. The analysis of permafrost distribution prior to development of the site supports this ice-rich soil scenario as it indicates the presence of permafrost within foundation materials.

It is assumed that the failure surface has propagated through weak foundation material and that the backscarp is likely within the weathered argillite or waste rock near the interface between the two materials. Monitoring data supports this conclusion; however, does not particularly lend itself to confirming the existing cause of movement in the waste rock pile. Deep-seated instrumentation is required to further characterize the failure surface(s) and validate these assumptions. Tetra Tech EBA will be evaluating this scenario in the stability analysis.

3.6 Climate Change Considerations

Tetra Tech EBA acknowledges that climate change has, and will continue to, impact temperature (air and ground) and precipitation at Clinton Creek. We will be relying on information presented in the Canadian Standards Association, (CSA) *Climate Change Guideline* to provide direction for assessing the impact temperature changes associated with climate change may have on future stability of the Clinton Creek waste rock pile and Wolverine tailings pile. We will be relying on the Yukon Climate Change Indicators and Key Findings 2015 report (Streicker 2016) to provide direction for assessing anticipated increases to precipitation associated with climate change.

3.7 Seismic Analyses

3.7.1 Local Seismicity

The seismicity of this general area is controlled by the Queen Charlotte-Fairweather transform region, the Yakutat collision zone, and the Alaska-Aleutian subduction zone (Mazzotti et al. 2008). The Clinton Creek site is located near the northwestern end of the Tintina fault (see red arrow in Figure 1b). Other major fault systems include: the Denali, Fairweather, Queen Charlotte, Chugach-St. Elias, Pamplona, Chatham Strait, and Transition Faults. There is only minor historical seismic activity (M<3) reported near Tintina fault (Cassidy et al. 2005), compared to the neighboring high-seismicity zones such as Denali fault to the west and Richardson-Mackenzie Mountains to the east.

Figure 1(a)

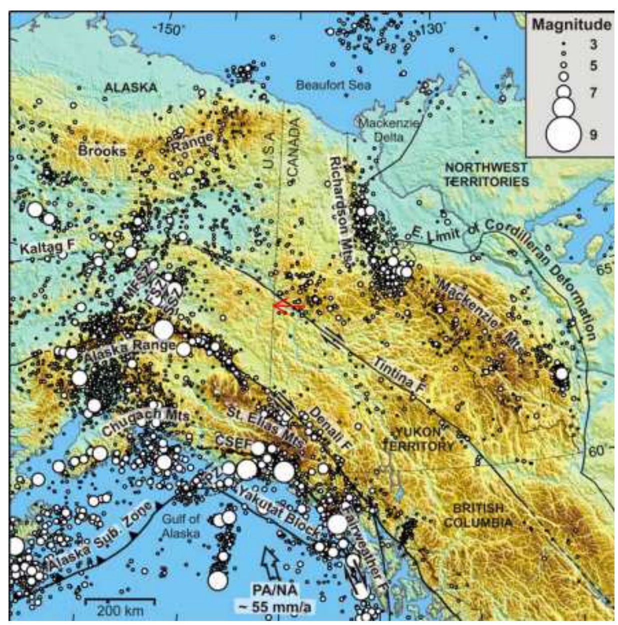

Figure 1(b)

Figure 1 (a): Tectonic framework of the Northern Cordillera (Tintina Fault-TF, Denali Fault-DF, Fairweather Fault-FF) (after Mazzotti et al. 2008), and **Figure 1(b):** seismicity of the northern Canadian Cordillera of Canada and eastern Alaska. White circles represent earthquakes with magnitude, M ≥ 3 recorded between 1899 and 2004. The red arrow shows the location of the Clinton Creek site (after Leonard et al. 2008).

According to the recommendations in the 2014 Canadian Dam Association, *Guidelines for Mining Dams*, the return period of the applicable seismic event should be determined based on a classification that depends on the consequences of failure.

Tetra Tech EBA understands that the Clinton Creek waste rock pile is classified as "Significant", and as such, appropriate seismic parameters will be assumed based on an annual exceedance probability of 1 in 2,475 (CDA 2014).

Based on a water level of approximately 408 m, from the Long-Term Monitoring Program 2014 Survey Results (Worley 2015), the volume of water retained by the north lobe of the tailings pile was estimated to be about 80,000 m^3, which meets the criteria of a dam as per the CDA definition (over 2.5 m in height and over 30,000 m^3 of impounded water). As a result, the existing tailings pile should be treated as a dam. However, all closure options except for Option C disqualify the tailings pile as a dam by either permanently lowering the creek level or displacing the ponded water with waste rock fill. Therefore, when analyzing the tailings stability for the closure options, it is rational to categorize the tailings pile as a mine waste pile.

Tetra Tech EBA has assumed that the tailings will be categorized as a mine waste pile and follow the waste pile guidelines (BCMWRPRC 1991). According to these guidelines an annual exceedance probability of 1 in 475 will be used to assume appropriate seismic parameters in the analysis.

3.7.2 Liquefaction Susceptibility

The liquefaction susceptibility of soils is typically assessed using the simplified Seed-Idriss method. In this approach, the seismic demand (i.e., Cyclic Stress Ratio) will be obtained either using empirical stress-reduction factors (r_d) or site-specific ground response analysis. The resistance to liquefaction (i.e., Cyclic Resistance Ratio) is estimated using the penetration resistance (Cone or Standard Penetration Tests) and/or shear wave velocity. However, in the absence of penetration test results and shear wave velocities to estimate CRR and CSR, the liquefaction susceptibility of saturated deposits will be qualitatively assessed based on index tests, gradation tests, and available shear strengths. Such analysis is suitable for a screening level assessment but not intended to replace the state-of-practice liquefaction triggering assessment. Subsequently, the degree of strength loss in each soil unit will be assumed based on the estimated risk of liquefaction or cyclic softening.

For the purposes of the stability analysis, Tetra Tech EBA assumes the waste rock is likely not susceptible to liquefaction due to its gradation and the relatively low groundwater level.

Gradations of the seven tailings samples from existing investigations have been reviewed against the Tsuchida (1970) liquefiable boundaries. The plot indicates that all tailings samples are considerably coarser than the upper limit of the potentially liquefiable soil. Based on this, Tetra Tech EBA assumes that the tailings is likely not susceptible to liquefaction.

It should be noted that Tsuchida's work was conducted in the late 1960s when liquefaction was not well studied, and no similar approaches have been undertaken since. Therefore, simply assessing the liquefaction potential using the gradation limit only may not be sufficient. As a result, additional investigations are still recommended to qualitatively evaluate the liquefaction potential of the tailings.

3.7.3 Seismic Ground Deformation

Following the liquefaction susceptibility assessment, the seismic slope displacements will be estimated using methods such as Newmark (1965), Makdisi and Seed (1978), and Bray and Travasarou (2007). The ground motions and site-specific ground response analysis are not required since the ground deformations are estimated using simplified charts which generally yield conservative estimates for displacement compared to more detailed analysis performed using acceleration time histories. For these analyses, the yield acceleration (i.e., minimum acceleration required to overcome the soil resistance) will be obtained from the limit equilibrium slope stability analysis described earlier. For this preliminary assessment, the amplification caused by soils and topography will be determined based on published correlations (Idriss 1990; Ashford and Sitar 1997).

The vertical displacement caused by dynamic loading will be determined from methods proposed by Wu (2002), Wijewickreme and Sanin (2010), and Seed et al. (2003). In essence, the seismic ground displacements estimated using these methods depend on the assumptions made for the slope stability and liquefaction susceptibility.

4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Yukon, Assessment and Abandoned Mines and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Government of Yukon, Assessment and Abandoned Mines, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

5.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

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GLOSSARY OF TERMS

Term	Definition
Colluvial Deposits	Materials deposited as a result of downslope movements due to gravity, such as rockfall, landslides, and debris flows, including talus slopes and mantles of weathered bedrock. Colluvial deposits are composed of rock fragments of all sizes derived from the local bedrock and reworked glacial sediments, as well as finer textured material derived from in situ weathering of the rock fragments. These deposits are generally poorly sorted and poorly consolidated.
Cryoturbation	Heaving, churning, and sorting of soil and surficial materials due to repeated freezing and thawing (frost action); results in the development of convoluted and flame-like structures in the soil and patterned ground.
Debris Flow	A sudden and destructive landslide where loose material on a slope, with more than 50 percent of particles larger than sand size, is mobilized by saturation and flows down a channel or canyon. The flow contains a combination of or all of the following: soil, surficial materials, bedrock, and plant material. Whether saturated or dry, a debris flow behaves much like a viscous fluid when moving.
Debris Slide	A shallow slide consisting of a mass of soil, vegetation and surficial material; initial displacement is along one or several surfaces of rupture. Composed of comparatively dry and largely unconsolidated earthy material and results in an irregular, hummocky deposit. May initiate downstream debris flows.
Eolian	Well sorted materials, predominantly silt and fine to medium sand, which have been eroded, transported, and deposited by wind.
Fluvial Fan	A fan-shaped deposit built by streams, usually located at the mouth of a tributary valley. The sediment flows start at the apex of the fan, and over time move to occupy many position on the fan surface. Sediments generally consist of sand and gravel, and are formed by a combination of stream flood and debris flow activity. Fluvial fans typically have gradients of less than 10 percent.
Fluvial Deposits	Sediments transported and deposited by streams and rivers, including floodplain deposits, river terraces, and fluvial fans. ”Alluvial” is an older term meaning the same thing.
Loess	A homogeneous massive deposit formed by wind consisting mainly of silt. Loess sediment sources are dominantly from either glacial meltwaters or from non-glacial, arid environments, such as deserts.
Peat	Unconsolidated compressible material consisting largely of undecomposed, or slightly decomposed, organic matter accumulated under water-saturated conditions. Peat is commonly formed by the slow decay of successive layers of aquatic and semi-aquatic plants in swampy or water-logged areas, where oxygen is absent.
Solifluction	Slow downslope movement of moist or saturated, seasonally frozen surficial material and soil.

APPENDIX A
TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT – YUKON GOVERNMENT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of Tetra Tech EBA’s Client, the Yukon Government. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA’s Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of the Yukon Government, the Client, or Tetra Tech EBA. It is acknowledged that the Yukon Government, the Client, may reproduce the report freely for internal usage.

2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA’s instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. Tetra Tech EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Tetra Tech EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

11.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

13.0 SAMPLES

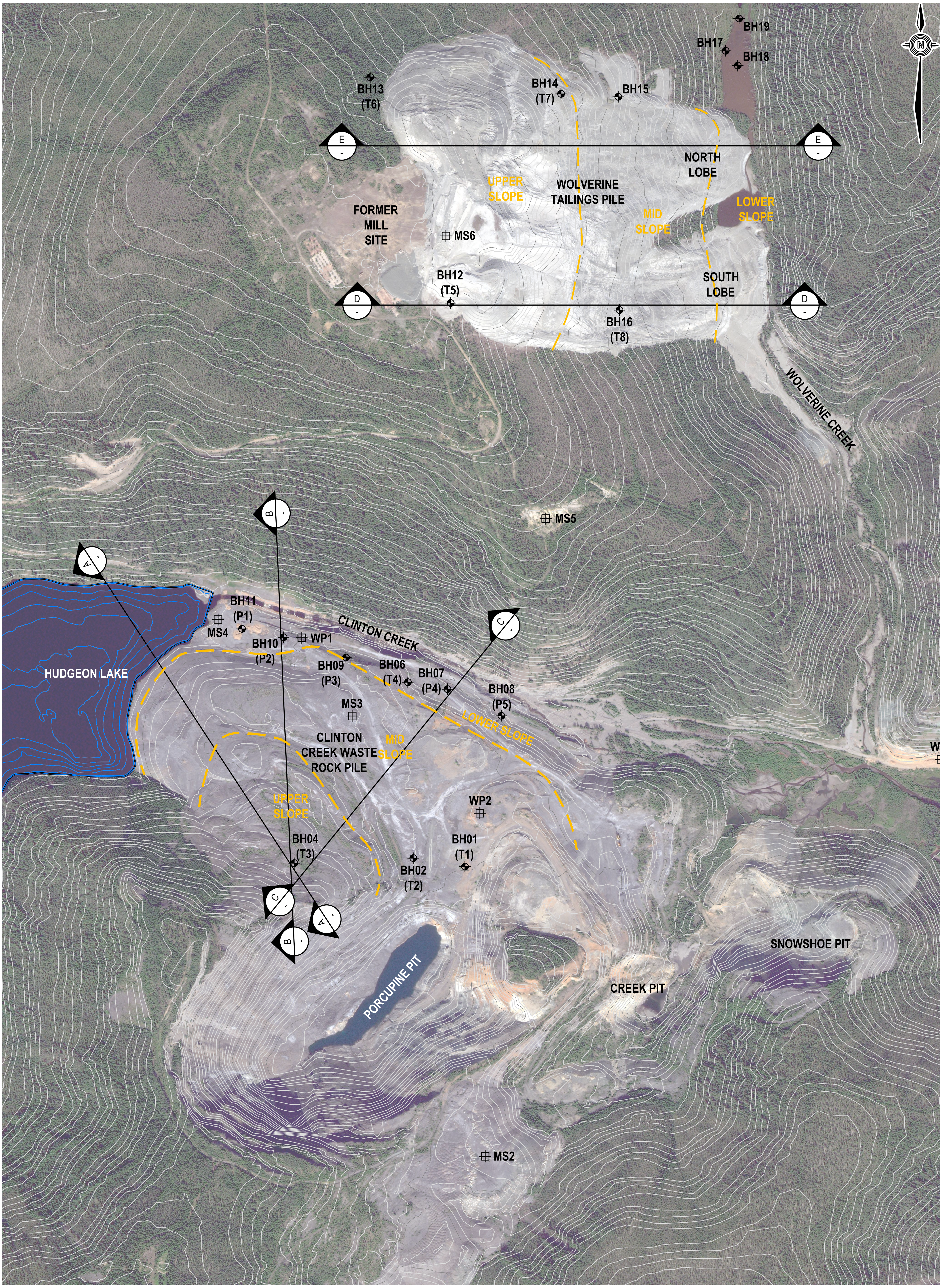
Tetra Tech EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

14.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

FIGURES

Q:\Kelowna\Drafting\ENG.WARC\ENGWARC03039-01 Abandoned Clinton Creek Mine Geotech Evaluation\Civil 3D\Production Drawings\ASSUMED SUBSURFACE CONDITIONS\ENGWARC03039-01 Fig.1-R0.dwg [FIGURE 1] March 31, 2016 - 11:52:01 am (BY: HALLEY, RICHARD)



NOTES :
- IMAGERY WAS EXTRACTED FROM GOOGLE EARTH PRO EDITION (DATED 2012)
- ONSITE TOPOGRAPHY CONTOURS PROVIDED BY CLIENT (DATED 2012), AND ARE SET TO INTERVALS OF 10 m

0 250m

Scale: 1:7,500 @ 11"x17"

LEGEND

- BOREHOLE LOCATION
- TESTPIT LOCATION
- P - INDICATES HISTORIC PIEZOMETER
- T - INDICATES HISTORIC THERMISTOR

- MS1 - CHILKOOT (2015) - 6 LOCATIONS
- BH01 - GOLDER (1978) - 19 LOCATIONS
- CLMS - RRU (1999) - 13 LOCATIONS (NOT SHOWN)
- CLWS - RRU (1999) - 7 LOCATIONS (NOT SHOWN)
- WP1 - WORLEY (2015) - 3 LOCATIONS

CLIENT

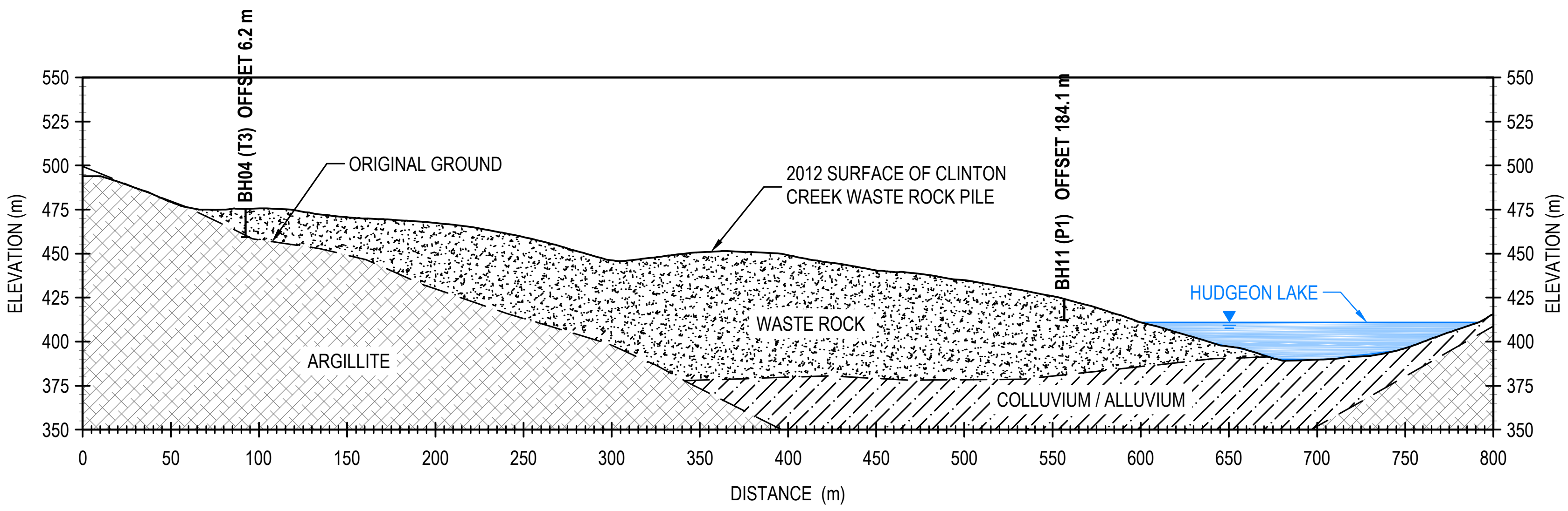
Yukon
Government
Energy, Mines & Resources
Assessment & Abandoned Mines Branch

TETRA TECH EBA

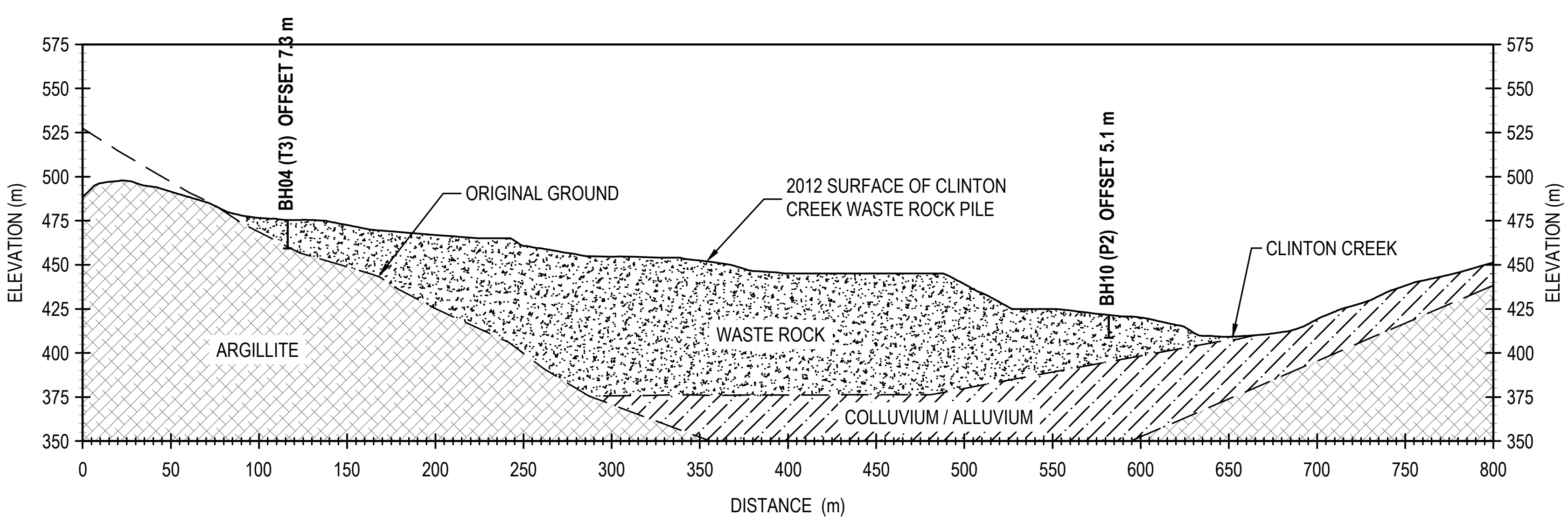
DATA GAP ASSUMPTION REPORT
ABANDONED CLINTON CREEK MINE, YUKON

SITE PLAN

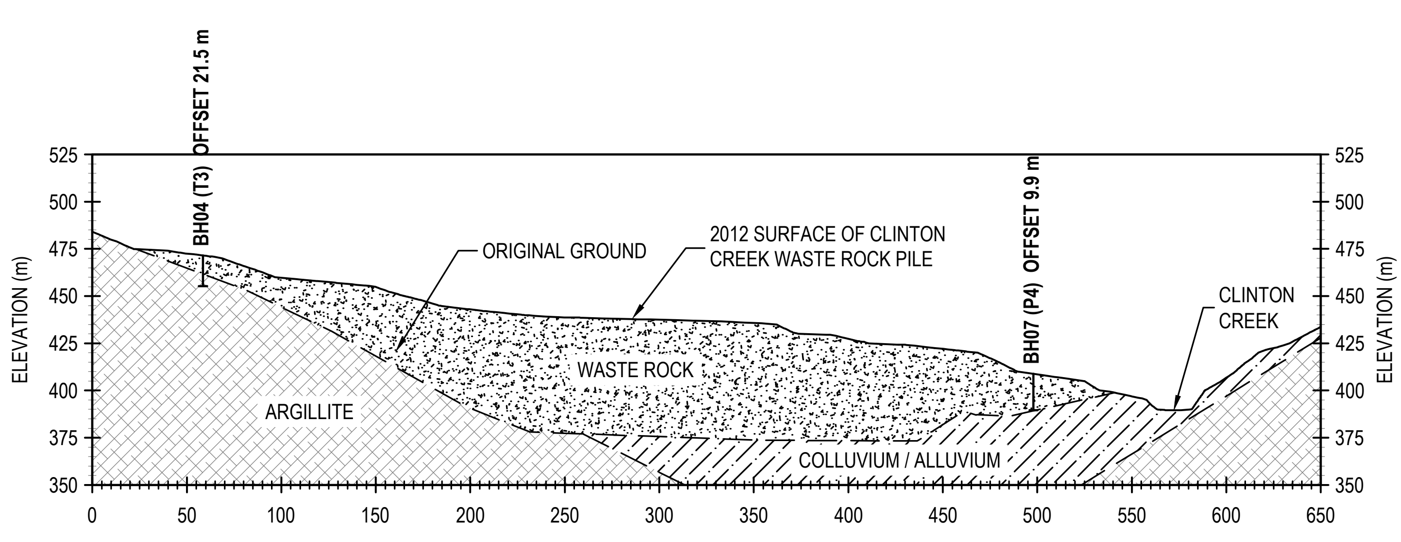
PROJECT NO.	DWN	CKD	REV	
ENGWARC03039	RERH	SB	0	Figure 1
OFFICE	DATE			
EBA-WHSE	March 30, 2016			



SECTION A - A'



SECTION B - B'



SECTION C - C'

0 200m

Scale: 1:4,000 @ 11"x17"

LEGEND

- TAILINGS
- WASTE ROCK
- COLLUVIUM
- ARGILLITE
- COLLUVIUM / ALLUVIUM

— — — - ASSUMED

——— - SURVEYED

CLIENT

Yukon
Government
Energy, Mines & Resources
Assessment & Abandoned Mines Branch

TETRA TECH EBA

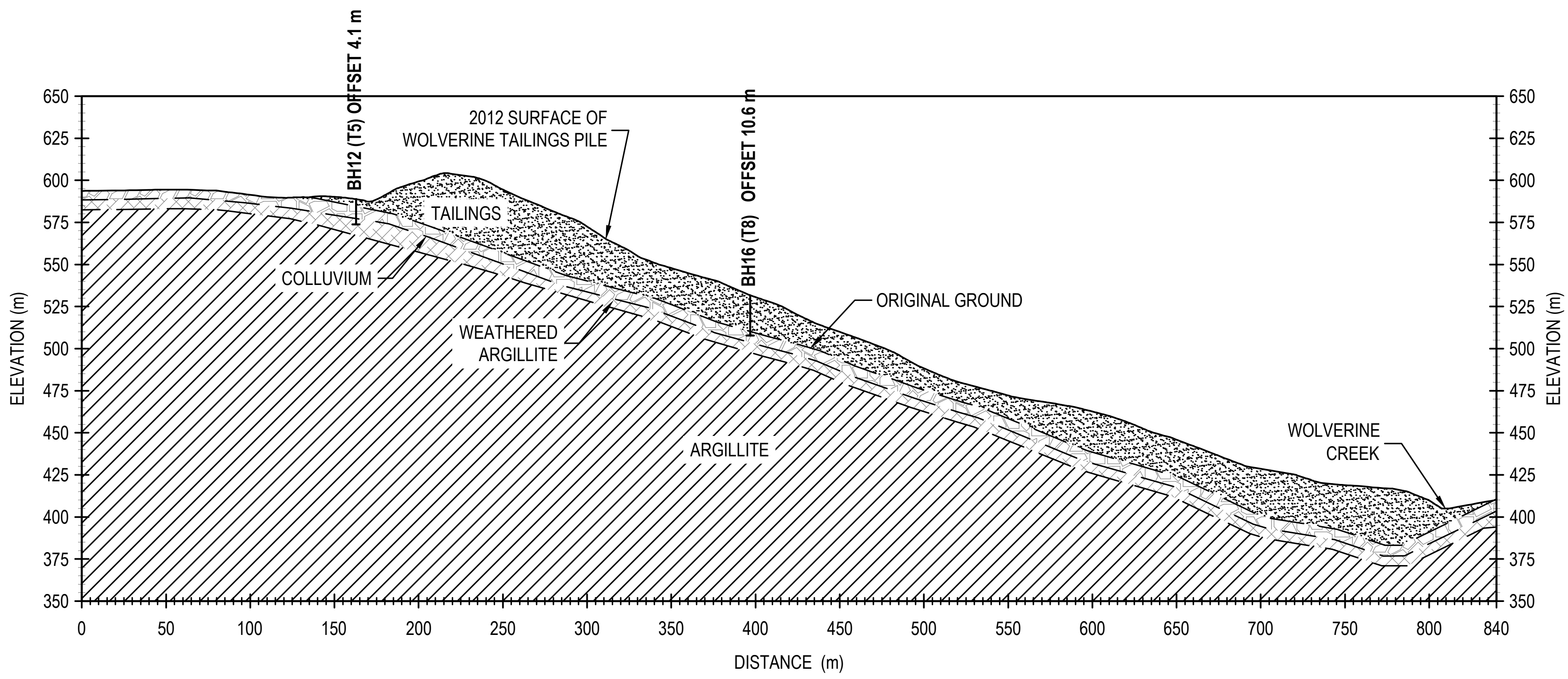
DATA GAP ASSUMPTION REPORT
ABANDONED CLINTON CREEK MINE, YUKON

WASTE ROCK PILE - ASSUMED SUBSURFACE CONDITIONS - SECTIONS A - C

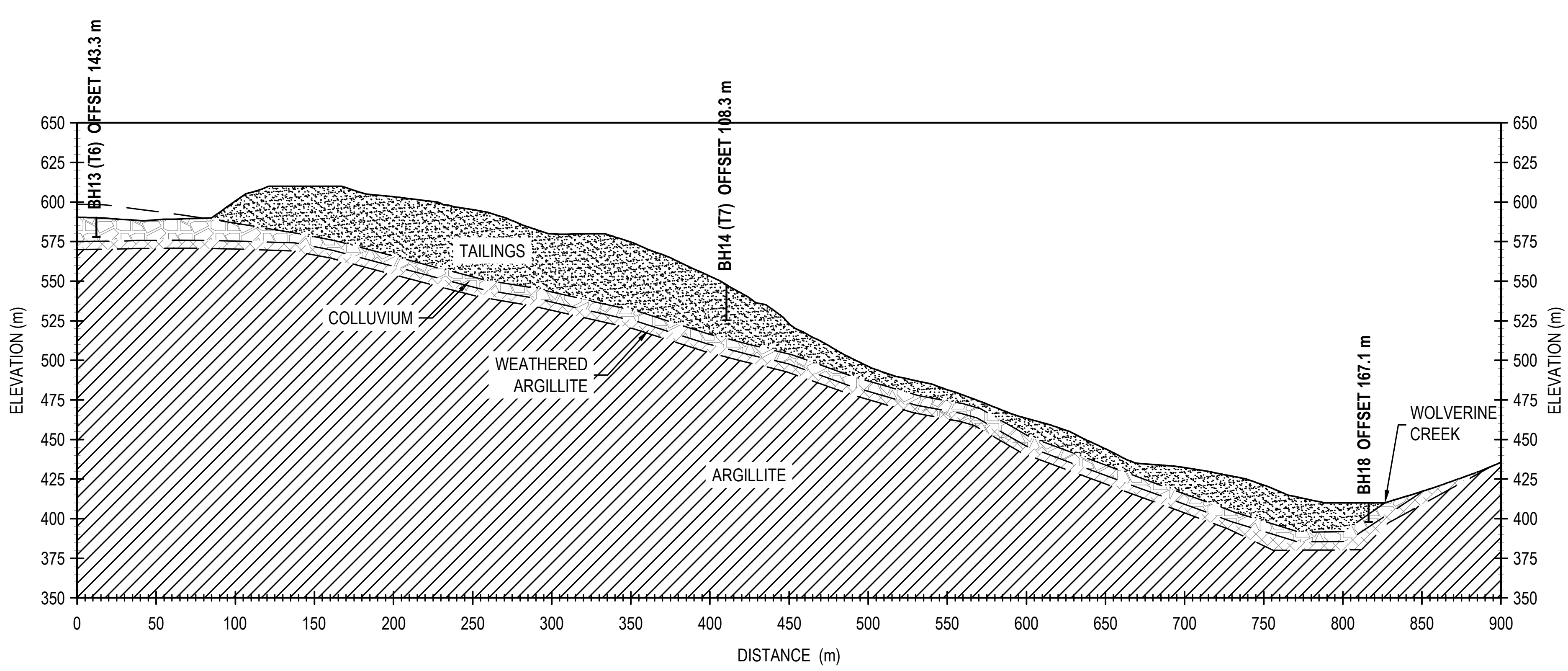
PROJECT NO.	DWN	CKD	REV
ENGWARC03039-01	CB	JTP	0

OFFICE	DATE
EBA-WHSE	March 30, 2016

Figure 2



SECTION D - D'



SECTION E - E'

0 200m

Scale: 1:4,000 @ 11"x17"

LEGEND

- TAILINGS
- WASTE ROCK
- COLLUVIUM
- WEATHERED ARGILLITE
- ARGILLITE

— — —- ASSUMED

————- SURVEYED

CLIENT

Yukon
Government
Energy, Mines & Resources
Assessment & Abandoned Mines Branch

TETRA TECH EBA

DATA GAP ASSUMPTION REPORT REPORT
ABANDONED CLINTON CREEK MINE, YUKON

TAILINGS PILE - ASSUMED SUBSURFACE CONDITIONS - SECTIONS D - E

PROJECT NO.	DWN	CKD	REV	
ENGWARC03039-01	CB	JTP	0	**Figure 3**
OFFICE	DATE			
EBA-WHSE	March 30, 2016			

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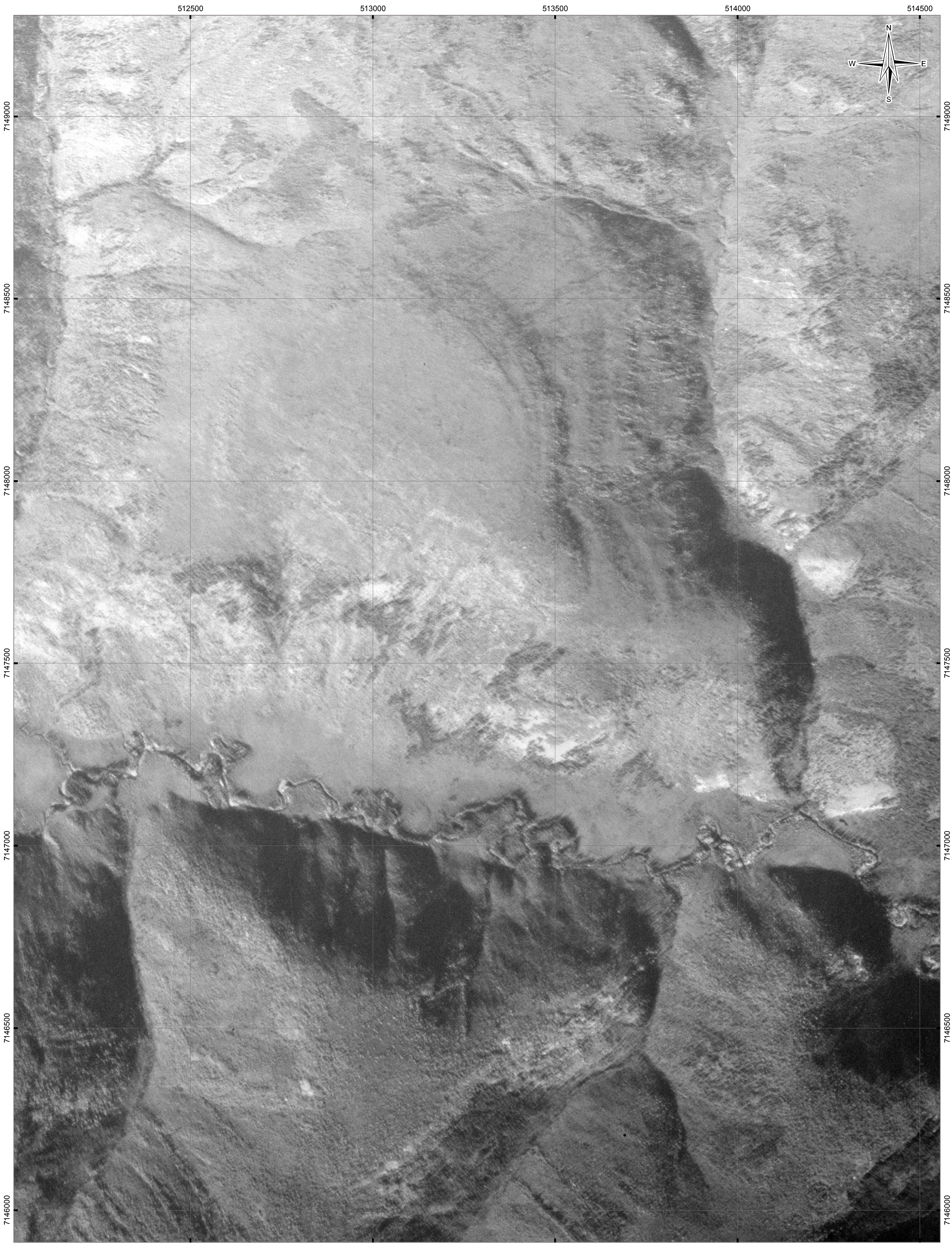


LEGEND

NOTES
Base data source:
CanVec 1:50,000
Air Photo A12285-239 (1949)

STATUS
ISSUED FOR USE

DATA GAP ASSUMPTION REPORT
ABANDONED CLNITON CREEK MINE, YUKON

Clinton Creek Mine Air Photo, 1949

PROJECTION	DATUM	CLIENT
UTM Zone 7	NAD83	Yukon Government Energy, Mines & Resources Assessment & Abandoned Mines Branch

Scale: 1:10,000

200 100 0 200

Metres

FILE NO.
WARC03039-01_Figure04_1949AP.mxd

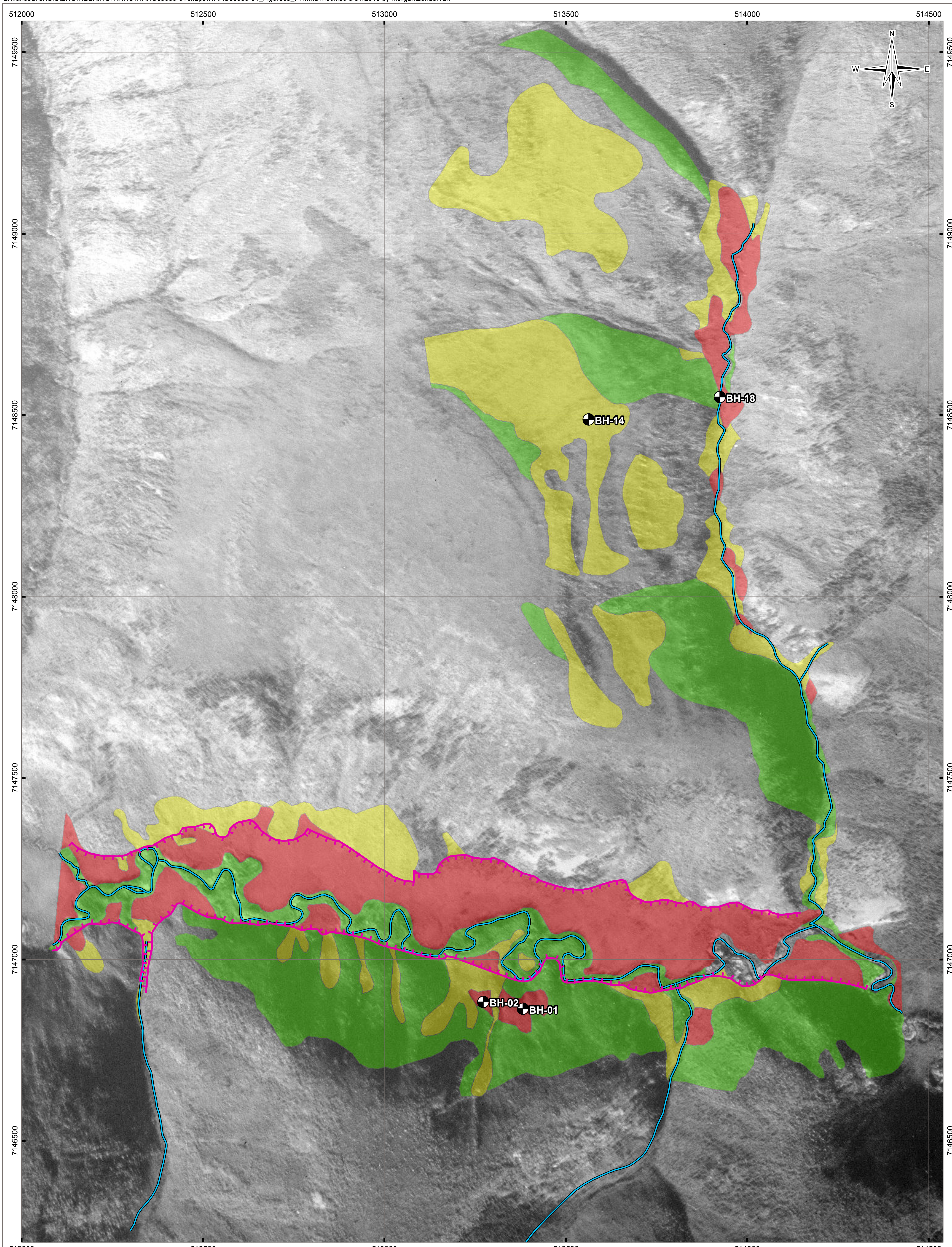
TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENG.WARC03039-01	MEZ	SL	SMC	0

OFFICE	DATE
Tt EBA-VANC	March 31, 2016

Figure 4

Q:\Vancouver\GIS\ENGINEERING\WARC\WARC03039-01\Maps\WARC03039-01_Figure05_PF.mxd modified 3/31/2016 by morgan.zondervan



LEGEND

- Borehole
- Creek Position (1949)
- Valley Slope Break

Permafrost Characterization by Ground Ice Content

- Perennially Frozen Ground - very ice-rich
- Perennially Frozen Ground - visible excess ice
- Perennially Frozen Ground - ice not visible

NOTES
Base data source:
CanVec 1:50,000
Air Photo A12285-239 (1949)

STATUS
ISSUED FOR USE

DATA GAP ASSUMPTION REPORT
ABANDONED CLNITON CREEK MINE, YUKON

Permafrost Distribution and Assumed Ground Ice Content Clinton Creek Mine, 1949

PROJECTION	DATUM	CLIENT
UTM Zone 7	NAD83	Yukon Government Energy, Mines & Resources Assessment & Abandoned Mines Branch

Scale: 1:10,000
200 100 0 200
Metres

FILE NO.
WARC03039-01_Figure05_PF.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENG.WARC03039-01	MEZ	SL	SMC	0

OFFICE	DATE
Tt EBA-VANC	March 31, 2016

Figure 5