March 24, 2016

ISSUED FOR USE
FILE: 704-ENG.WARC03039-01.003
Via Email: erik.pit@gov.yk.ca

Assessment and Abandoned Mines
Energy Mines and Resources
Room 2C – Royal Centre
PO Box 2703, Whitehorse, YT Y1A 2C6

Attention: Mr. Erik Pit
A / Senior Project Manager

Subject: Evaluation of Existing Movement Data Including Correlation of Seasonality
Abandoned Clinton Creek Asbestos Mine Site, Yukon

1.0 INTRODUCTION

Government of Yukon, Assessment and Abandoned Mines (AAM) have retained Tetra Tech EBA Inc. (Tetra Tech EBA) to assist with the summary and evaluation of geotechnical information related to closure of the abandoned Clinton Creek asbestos mine near Dawson City, Yukon. This report presents an evaluation of the existing movement data of the Clinton Creek waste rock pile and Wolverine tailings pile. It also includes an assessment of the correlation between existing movement rates and seasonality.

1.1 Scope

Tetra Tech EBA has been retained to provide engineering services for the above captioned 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, as well as assessing site access mitigations, fish passage, and stability for the short listed closure options. This work is being conducted to guide project parties in making decisions regarding future design and implementation of short listed closure options.

2.0 EXISTING INFORMATION

Existing information referenced in this report was presented in R124 (see Table 2-1). The data was used to evaluate rates of movement of the Clinton Creek waste rock pile and Wolverine tailings pile. An attempt to establish and assess correlations between seasonality, wet/dry years or high precipitation events, and recorded movements was also undertaken. The following information (presented in R124) was utilized for this assessment, but is not appended to this report:

- Survey Monitoring Information;
- Local and Regional Meteorological Information; and
- Surface Water Flow Data.

Table 2-1 presents the deliverables which either have been, or will be, submitted to AAM as part of this scope of work, and indicates a reference number for each report which will be used when referring to any of those documents in this report.

Tetra Tech EBA Inc.
61 Wasson Place
Whitehorse, YT Y1A 0H7 CANADA
Tel 867.668.3068 Fax 867.668.4349

Table 2-1: Tetra Tech EBA Report Submissions to AAM

Report No.	Report Name	Status
R124	Existing Geotechnical Subsurface and Monitoring Data Summary Report	Issued for Use February 25, 2016
R125	Preliminary Dam Classification – Mine Waste Structures Memo	Issued for Use March 7, 2016
R126	Data Gap Assumption Report	Draft Issued February 18,2016
R127	Evaluation of Existing Movement Data Including Correlation of Seasonality	Issued for Use March 24, 2016
R128	Geotechnical Stability Analysis Report and Dam Breach Update	Draft Issued March 17, 2016
R129	Geotechnical Monitoring Program Review Memo	Draft Issued March 17, 2016
R130	Geotechnical Investigations Program Scope of Work Memo	Draft Issued March 21, 2016
R131	Site Access Geotechnical Engineering Review and Mitigation Memo	Draft Issued March 10, 2016
R132	Fish Passage Memo	Draft Issued March 15, 2016

3.0 PROGRESSIVE MOVEMENT PATTERNS

3.1 General

Progressive movement of different areas of the waste rock and tailings piles was evaluated in an attempt to develop an understanding of the acceleration and deceleration patterns. Movements were assessed as follows:

- Magnitude and direction, and rate of movement at each monitoring point – both incremental and cumulative;
- General direction of waste rock and tailings pile movements; and
- Movements as they pertain to future stability analysis and remedial design options.

Plots showing rates of movement in R124 for the waste rock pile and the two lobes of the tailings pile, clearly indicate a site-wide pattern of deceleration since 1976 when survey monitoring was initiated. In the 1970s and 1980s the movement rate was in the order of metres per year. In the more recent past (since 2003) the movement has decreased to rates that are measured in cm per year. As a result, the focus of this report has been on the more recent data since 2003, which is more relevant to the present day concerns.

Movement monitoring points have historically been separated into zones based on elevation (upper, mid, and lower) for both the waste rock pile and the two lobes of the tailings pile. These zones of movement for the waste rock and tailings piles are illustrated on Figure 1. In addition to evaluating the movement in the upper, mid, and lower zones, movement data was also assessed separately for the waste pile, north lobe and south lobe of the tailings pile. Figure 3.1 (below) presents a summary of the data for each of these three areas of the site since 2004.

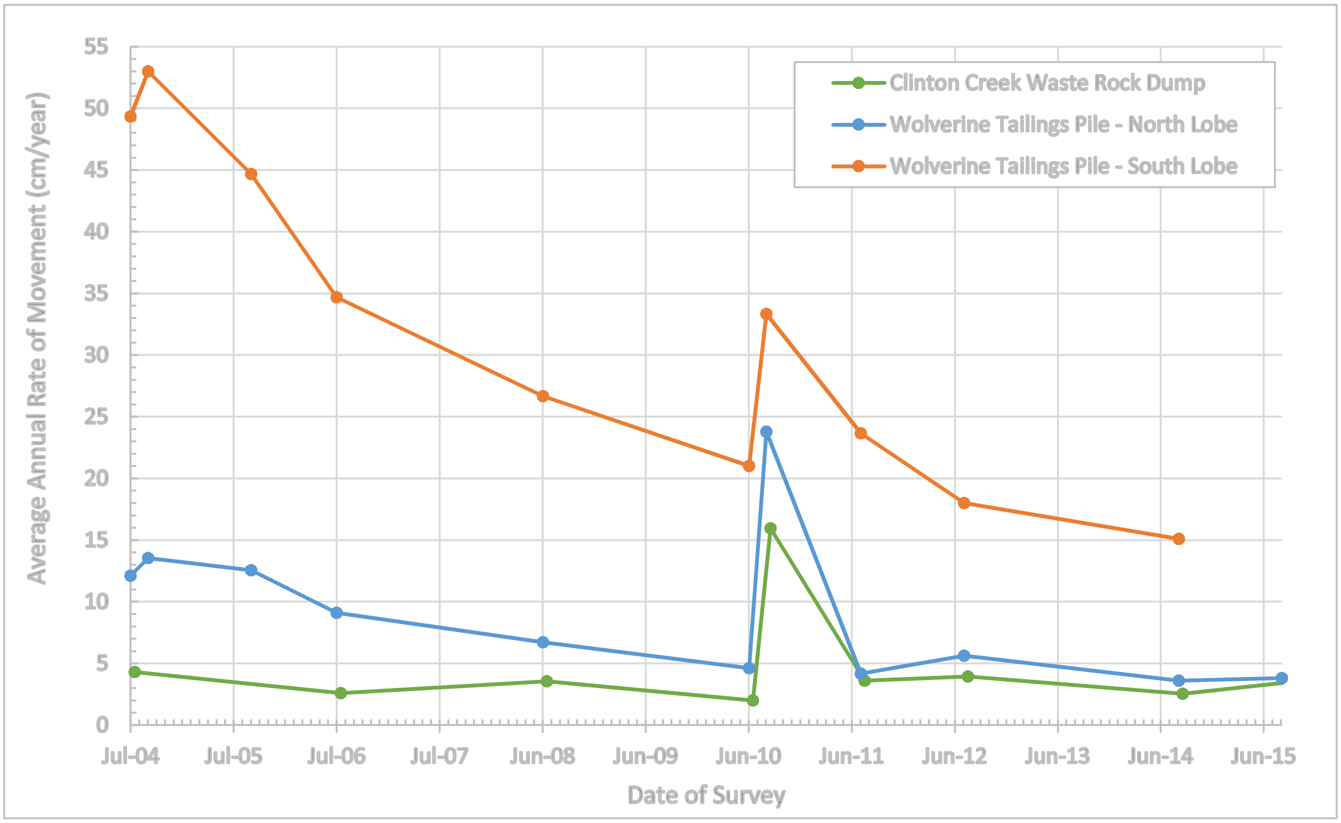


Figure 3.1: Summary of Average Rates of Movement for Waste Rock Pile and Tailings Pile since 2004

The survey conducted in 2015 was a partial survey of the site and only captured the movement in the upper zone of each area. The South Lobe of the Wolverine tailings pile historically has minimal movement in this zone in comparison to the mid and lower zones. As such, the data is considered to be non-representative of the actual rates of movement for the South Lobe, and consequently the 2015 survey data for the South Lobe is not included in Figure 3.1.

The rates of movement in Figure 3.1 are representative of site-wide movements. Movements in other directions (cross-valley, up-valley, down-valley, etc.) for the waste rock pile were also considered. Measurements of monitoring points in all areas are showing the same trends which indicate movement site-wide is attenuating. Additional areas and directions of movement have not been included as it is known that the movement is occurring radially for the waste rock pile. The movement for the tailings pile lobes is not broken down into additional areas/directions in this report since the tailings more or less continue to slide down the slope in a general easterly direction. More detailed discussion on the failure and stability of the waste rock pile and tailings pile are presented in R128.

As stated above, historical movement data (i.e., during operations and post-operations, prior to 2003) was reviewed; however, rates of movement have decreased by orders of magnitude over the time period of 1976 to 2003 (as presented in R124). Following the review of the entire data set and other available information it was concluded that the mechanism of failure which is represented by historical data differs from the mechanism of failure that is occurring today; for this reason, only data relevant to evaluating the current failure mechanism was assessed. Data collected before movement rates began to stabilize (prior to 2003) was summarized for completeness (and included in R124), but is not presented as part of this evaluation. The time period of 2003 to 2015 was selected to assess movement rates as they have been relatively consistent since 2003.

As stated in R124, there is a gap in the survey data when information was not collected between 1986 and 1999 for the waste rock pile and 1986 to 2003 for the tailings pile. 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. The exception to these rates of movement is immediately following the 2010 extreme rainfall event, which caused rates of movement to spike and then decrease again the following year. This spike in movement is illustrated in Figures 3.2, 3.3, and 3.4, which were taken from R124. This trend, along with the current nominal rate of movement, suggest that the internal stability of the waste rock pile and tailings pile have more or less reached a state of equilibrium. 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.

Some monitoring points were either destroyed, replaced, or are missing data so not all points could be evaluated over the exact same time period. Tables presented in Figures 2 and 3 indicate relevant time periods evaluated for each monitoring point. Due to the fact that the time period for the monitoring points varies, the preferred method of presenting direction and magnitude of movement was to provide an average movement rate per year for the time period 2003 to 2015.

Movement specific to the waste rock pile, tailings pile, and Clinton Creek channel are discussed in the following subsections.

3.2 Waste Rock Pile Movement Patterns

Although the failure history is not well documented, it is understood that continued dumping and failures of the waste rock face resulted in the waste rock spreading across the valley. Minor instability was originally identified on the face of the waste rock pile in 1970 or 1971 and a major failure occurred in 1974, which resulted in the formation of Hudgeon Lake. Placement of waste rock ceased in the summer of 1977.

In reviewing magnitude and direction of movements of the monitoring points on the waste rock pile during the selected time period, only four monitoring points show movement rates greater than 5 cm/year and include monitoring points 186, 2836, 994, and 995.

A plot showing movement rates and decreasing or level trend in movement rate for the waste rock pile is presented below in Figure 3.2.

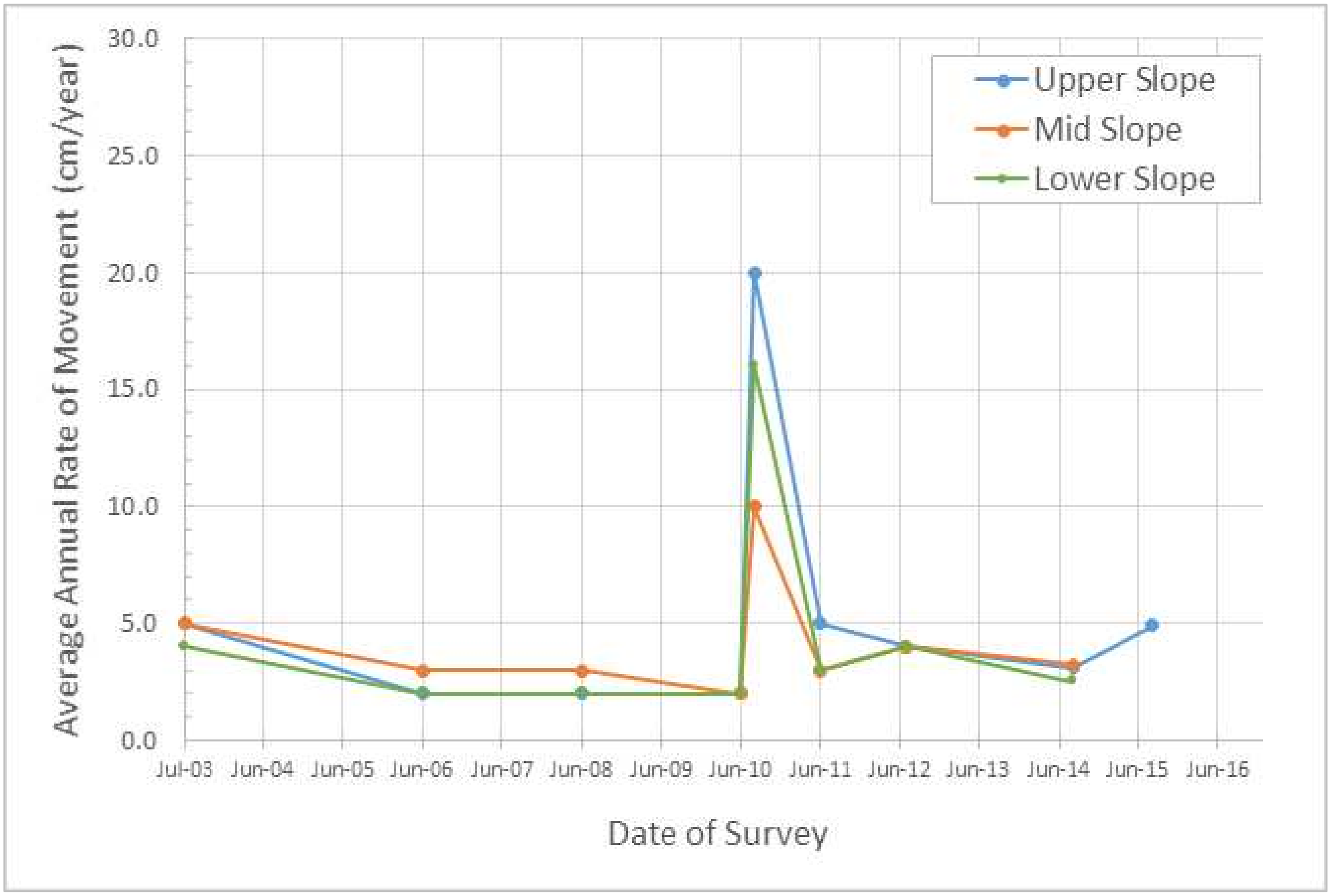


Figure 3.2: Clinton Creek Waste Rock Pile – Summary of Historical Movement Data 2003 to 2015

Figure 2 presents a vector map illustrating all monitoring points on the waste rock pile as well as a tabular summary of data used to develop the vectors. The direction of movement on Figure 2 indicates a radial spreading pattern with the west side of the waste rock pile moving in a west or northwesterly direction, the central portion moving in a northerly direction, and the east side moving in the northeasterly direction. Radial movements detected by surficial monitoring could be indicative of localized surficial movements or movements generated by deep-seated failure planes. The best method to characterize the failure mechanism is to install deep-seated instrumentation to supplement the monitoring point survey data.

3.3 Tailings Pile Movement Patterns

Historically the tailings pile has been separated into a north and south lobe due to the differing behaviours, and are discussed separately in the following sections. As presented historically and in R124, the monitoring points within each lobe have been separated into an upper, middle, and lower slope. This convention has been adopted in this report for continuity. Individual monitoring point movements are shown on Figure 3, which presents a vector map along with a summary of data used to develop vector directions and rates. The lowest movement rates are within the upper slope and greater movement rates within the mid and lower slopes.

In reviewing magnitude and direction of movement of the tailings pile, it is clear that movements within the tailings pile are of higher magnitude than those for the waste rock pile. It is also apparent that the south lobe is more active than the north lobe. A discussion of the movement rates for each lobe is presented in the following subsections.

3.3.1 North Lobe

The monitoring point data for the North Lobe indicates minor differences between slope sections in the past few years and decreasing or level trend in movement rate as shown below in Figure 3.3. In 2004 the movements in the North Lobe were in the range of 10 to 20 cm/year. There is a general trend of gradual decrease in movement to 4 to 7 cm/year until 2010, when there was a sharp increase due to the peak rainfall event. Following 2010, the average rates gradually decline to less than 5 cm/year.

Movement direction in upper slope (Figure 3) is a general northerly direction, while the lower and mid slope indicate movement in a general easterly direction. There is no apparent reason for this discrepancy, but it is speculated that the underlying surface topography may be influencing the movement direction.

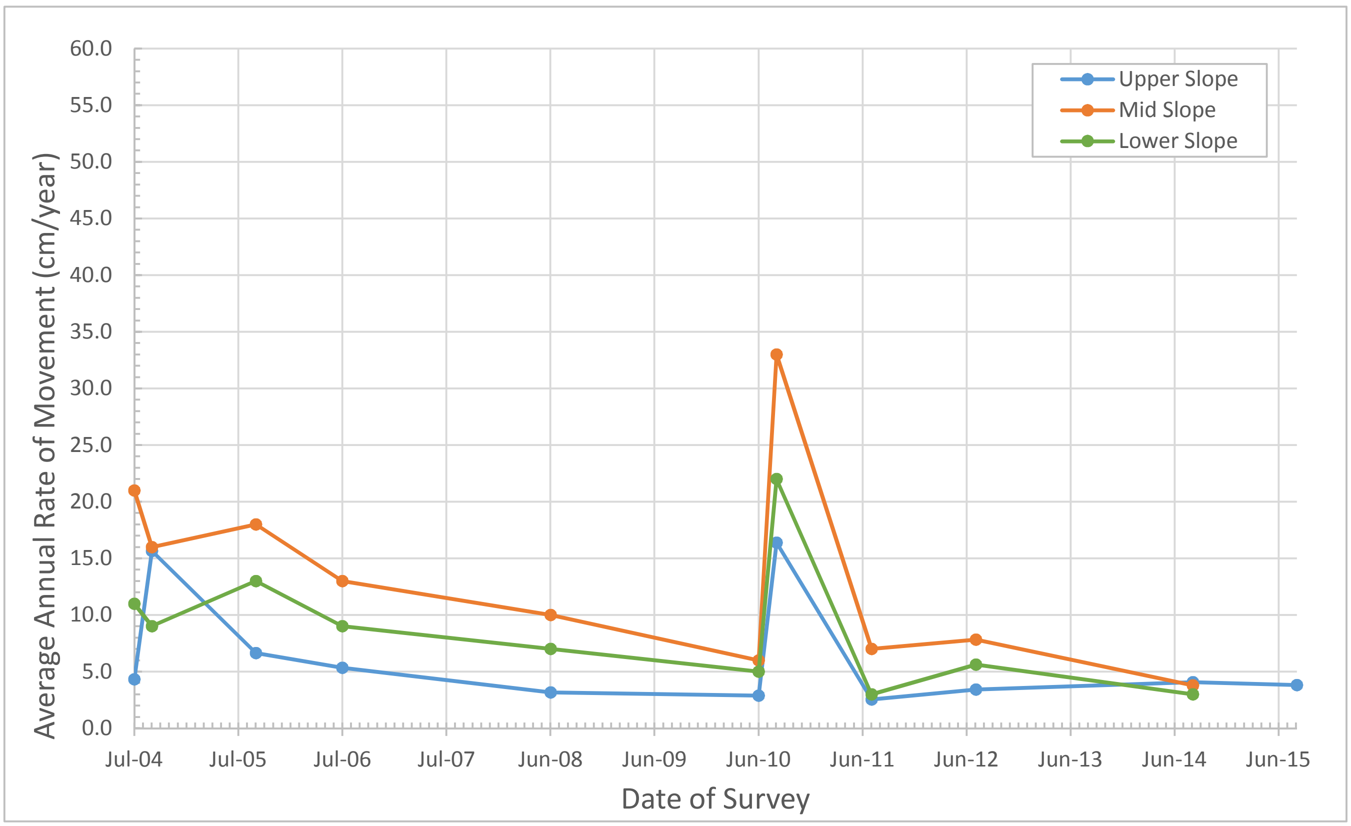


Figure 3.3: Wolverine Creek Tailings Pile North Lobe – Summary of Historical Movement Data 2004 - 2015

3.3.2 South Lobe

The general trend in the movement rate data (Figure 3.4) indicates that the middle of the South Lobe is most active and the upper slope is least active. In 2004 the movements in the South Lobe were in the range of 15 to 85 cm/yr. Similar to the North Lobe, there is a gradual decrease in movement rates until 2010. Following the short term spike in movement due to the 2010 rainfall event, the trend of decreasing movement continues until the latest readings, which indicates average rates are in the range of 5 to 25 cm/yr.

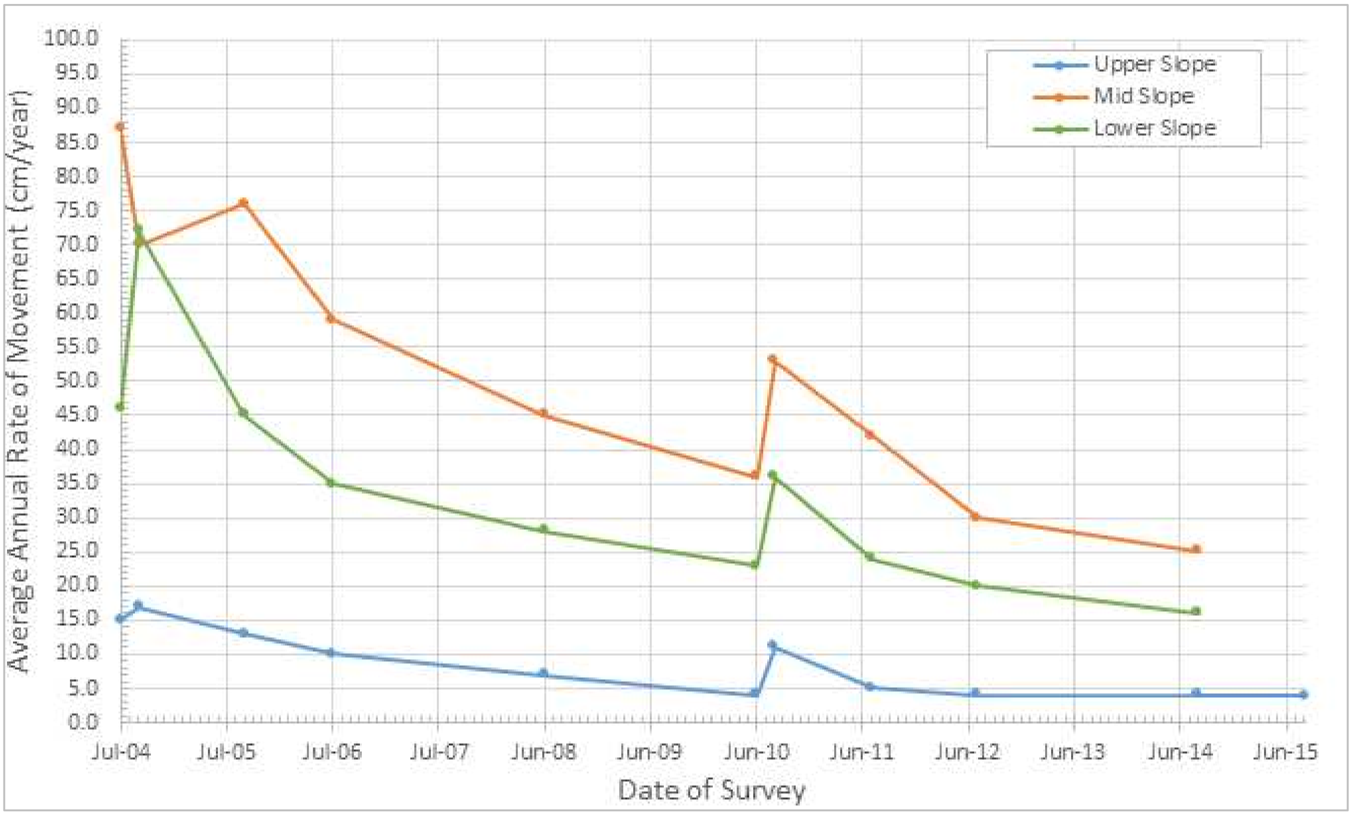


Figure 3.4: Wolverine Creek Tailings Pile South Lobe – Summary of Historical Movement Data 2004 - 2015

The general direction of movement for the south lobe is easterly for the upper, middle, and lower slopes (Figure 3). At the toe of the lower slope there is a spreading of the tailings into the Wolverine Creek channel in a northeasterly and southeasterly direction.

3.4 Clinton Creek Channel Alignment

As a result of continuous waste rock pile failures and slides over the years since mining operations commenced, the creek has been raised in elevation and forced north towards the north valley slope within the limits of the waste rock pile. The creek reached the north valley slope decades ago and further movement will be constrained by this slope. The annual freshet and periods of heavy rainfall have resulted in erosion of the north valley slope and toe of the waste rock pile.

Available data for the creek centreline and top of bank was compared and reviewed to identify significant changes. The most recent survey of the creek was conducted in 2014 and Worley presented a detailed analysis (in report R118) of creek alignment and profile since 2004 (which was established as the baseline year for long term monitoring). This evaluation clearly indicates that the 2010 rainfall event not only caused severe downcutting near Drop Structure 4, but also, in many areas, caused the creek centreline to shift closer to the waste rock pile which indicates toe erosion and temporary widening of the channel. Near station 0+650 (approximately 450 m downstream of Drop Structure 4) the course of the creek was completely altered by the 2010 event. The plan and profile drawings from R118 which summarize this comparison are presented as Appendix B. Additional discussion and details of the different areas of movement is available in R118.

The changes in the creek channel in the future are expected to be minimal, as the creek is now bound by the north valley slope. Downcutting and channel realignment are still likely to continue, however they are likely to be associated primarily with a large freshet or heavy rainfall event. Erosion is likely to continue along the south creek bank (i.e., toe of the waste rock pile) and as such will continue to adversely affect stability at the toe of the waste rock pile.

4.0 ASSESSMENT OF SEASONALITY

4.1 General

In assessing correlations between rates of movement and meteorological or surface flow data, trends in the movement data were analyzed to determine which years appeared to have increased rates of movement.

Regional data within 150 km was obtained and reviewed from the public Government of Canada records, as discussed and presented in R124. Only data within 50 km was assessed for this scope of work in order to determine whether there is a relevant correlation. Local meteorological information was obtained from weather station data collection at Clinton Creek, and provided to Tetra Tech EBA by AAM; this data is also discussed and summarized in R124.

Infiltration of runoff and its effect on movement rates at the subject site could not be evaluated due to a lack of porewater pressure data, as the few piezometers that were installed in 1978 reportedly never functioned properly.

4.2 Review of Historical Rainfall Events

In reviewing surface flow and meteorological data, it is understood above-average flows have occurred several times since mining operations commenced in 1968. The following is a summary of those events based on available data:

- 1971 saw a rainfall event on June 13 similar to that of 2010, in which just over 60 mm of rain fell in one day and 1972 saw a rainfall event on July 16 with 45 mm of rain in one day. The summers of 1971 and 1972 appear to have larger rainfall events than "average", but the summers as a whole were not wetter than average. The data does indicate, however, an above average total snowfall in 1971 and 1972 which could have impacted movement rates during freshet. There is no survey data to correlate precipitation data to increased movement;
- 1977 did not have any significant individual rainfall events, however total recorded rainfall is considered to be above average (note the data set at the Boundary station did not have any data for the month of June which is why it is lower than other stations in the area for that summer) as well as an average total snowfall. Available incremental movement rates over the summer of 1977 for the waste rock pile indicate an increase in horizontal rate of movement (vertical movement data unavailable for most monitoring points);
- 1983 did not have any significant individual rainfall events, however total recorded rainfall was the highest of all years recorded at the Little Gold weather station (data only available at Forty Mile and Little Gold weather stations). Movement data from 1983 is limited, but general trends show a marginal increase in rates of movement during that time period;
- 1986 saw a higher rainfall event of 42 mm on July 20, but an average total rainfall for the year. The movement data cannot be correlated to the rainfall data as the 1986 monitoring survey was conducted five days before the rainfall occurred;

- 1990 and 1992 recorded above average total rainfall amounts. No survey data exists between 1986 and 1999 and neither local meteorological data nor surface water flow data for 1997 exist, although it is understood from discussion in historical reports that high flows occurred in 1997 (evidenced by damage to drop structures). As a result, the effect of the 1997 flows on the movement of the waste rock pile and tailings pile is unknown. Regional meteorological data exists for 1997 but has gaps throughout the summer and does not provide applicable information relating to the high flows. The lack of data does not allow for any correlations to be established between movement data and seasonality; and
- No information for the flood of 2010 has been located during review of available documents, and no regional meteorological data nor surface flow data is available. Local meteorological data is available (as presented in R124) which indicate 60 mm of rainfall on August 7, 2010. Available survey data sets indicate monitoring data was collected on July 20, 2010 prior to the rainfall event, and again on September 25, 2010 and there is a definitive spike in movement rates site-wide from July to September 2010. Based on a review of all the data available, including post-flood site photos, construction reports, and site inspection notes, it is inferred that the spike in movements detected for the waste rock pile immediately following the 2010 event resulted in downcutting and widening of the creek bed. The site inspection report prepared following the 2010 floods (AECOM 2010) indicates general bank erosion along both sides of the creek channel, in addition to significant downcutting (4 to 5 m) downstream of Drop Structure 4. There is a high likelihood that a loss of material at the toe of the slope would have contributed to an increase in movement rates immediately following the rainfall event, as a result of decreased resisting forces. Survey data shows those spikes in movement have returned to those rates exhibited prior to the rainfall event. In addition to the erosion, there could have been an increase in porewater pressure in the waste rock and tailings piles as a result of an increased lake level and surface infiltration.

A summary of total annual rainfall for the weather stations of interest is attached to this report as Table A. It should be noted that annual totals are based on available data and that gaps in precipitation data exist throughout the data sets for the various weather stations.

Based on the limited data, it is not possible to accurately determine whether increased movement rates following the rainfall event(s) were influenced more by erosion or increased porewater pressures as a result of surface infiltration. Until further remediation measures are implemented onsite, it is likely that another extreme rainfall event will result in another short-term spike in movement site-wide.

4.2.1 Wet Versus Dry Summers

As part of the local and regional meteorological data review, attention was given to the movement patterns associated with wetter/dryer summers and the impact on movement related to the waste rock and tailings piles. Although data gaps are substantial and make it difficult to simultaneously compare wet summers to increased movement, it is likely that the two are directly related.

The data discussed in the previous section consistently lends itself to support the conclusions drawn from the 2010 flood data in which increased precipitation is directly related to increased trends in short-term movement.

4.2.2 Winter Versus Summer Movement

A correlation between summer and winter movement rates was attempted, however most surveys were conducted during summer months on an annual or biennial basis. Incremental movement between survey dates was reviewed and the following conclusions were drawn:

- “Winter” surveys have not been conducted since 1979. In 1979 and prior, surveys were conducted up to seven times per year. From 1977 to 1979, inclusive, the incremental data from one season to another does not follow any specific pattern of increased or decreased movements. The evaluation of interim time steps during that time period when “winter” data was available only serve to further conclude that a correlation between winter and summer data cannot be achieved with the limited data; and
- Winter versus summer correlations cannot be derived beyond 1979 as the available survey data does not include readings throughout the year and therefore does not lend itself to drawing any seasonal conclusions.

5.0 DISCUSSION

With regards to progressive movement of different areas of the waste rock and tailings piles, it is apparent that in general the rates of movement have reached a relatively steady state condition. The monitoring points located along the middle portion of the South Lobe of the tailings pile continue to move at higher rates than other areas; however, even these areas of movement have reached a plateau. A review of the complete data set was essential in establishing trends onsite and distinguishing the orders of magnitude differences between movement during and after operations in comparison to those occurring since 2003. The data prior to 2003 was not directly used in this evaluation as it is not relevant to the current movement mechanisms or design of closure options.

The movement data cannot explicitly confirm the basis for the stability analysis which assumes creep-like failure of the waste rock pile, and infinite failure along the slope for the tailings pile, as it is limited to surficial movements. Additional information (instrumentation) is required to define the failure mechanisms for both areas of the site.

Based on the evaluation regarding seasonality, it is concluded that the only correlation which can be determined is that significant rainfall events will likely cause another spike in movement rates site-wide, as a result of increased porewater pressures in the waste rock and tailings piles and erosion at the toe. The data is too sporadic or incomplete to allow any further correlations to be developed.

6.0 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.

7.0 CLOSURE

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

Tetra Tech EBA Inc.

Prepared by:

Colin Dreger, E.I.T. (Alberta)
Geotechnical Engineer
Direct Line: 780.451.2130 x27
Colin.Dreger@tetratech.com

Prepared by:

Shelly E. Bratke, E.I.T. (Alberta)
Geotechnical Engineer
Direct Line: 780.451.2130 x278
Shelly.Bratke@tetratech.com

Reviewed by:

PROFESSIONAL
YUKON
JUSTIN PIGAGE
TERRITORY
MAR 24/16
ENGINEER

Justin Pigage, P.Eng.
Geotechnical Engineer – Arctic Region
Direct Line: 867.668.9213
Justin.Pigage@tetratech.com

Reviewed by:

A.F. (Tony) Ruban, M.Eng., P.Eng. (Alberta)
Principal Consultant
Direct Line: 780.451.2130 x236
Tony.Ruban@tetratech.com

/my

PERMIT TO PRACTICE
TETRA TECH EBA INC.
SIGNATURE ____
Date Mar 24/16
PERMIT NUMBER PP003
Association of Professional
Engineers of Yukon

REFERENCES

AECOM (2011). R97: “Clinton Creek Technical Options Assessment”.

AECOM (2010). R100: “Former Clinton Creek Asbestos Mine – Site Inspection on 23 August, 2010”.

Associated Engineering (2013). R104:“Long Term Performance Monitoring 2012”.

UMA Engineering (2002). R47: “Abandoned Clinton Creek Asbestos Mine – Conceptual Design Report”.

WorleyParsons Group (2014). R118: “Clinton Creek Long Term Monitoring Program”.

WorleyParsons Group (2015). R120: “Clinton Creek Long Term Monitoring Program”.

Tetra Tech EBA (2016). R124: “Existing Geotechnical Subsurface and Monitoring Data Summary Report”.

Tetra Tech EBA (2016). R126: “Data Gap Assumption Report”.

TABLE

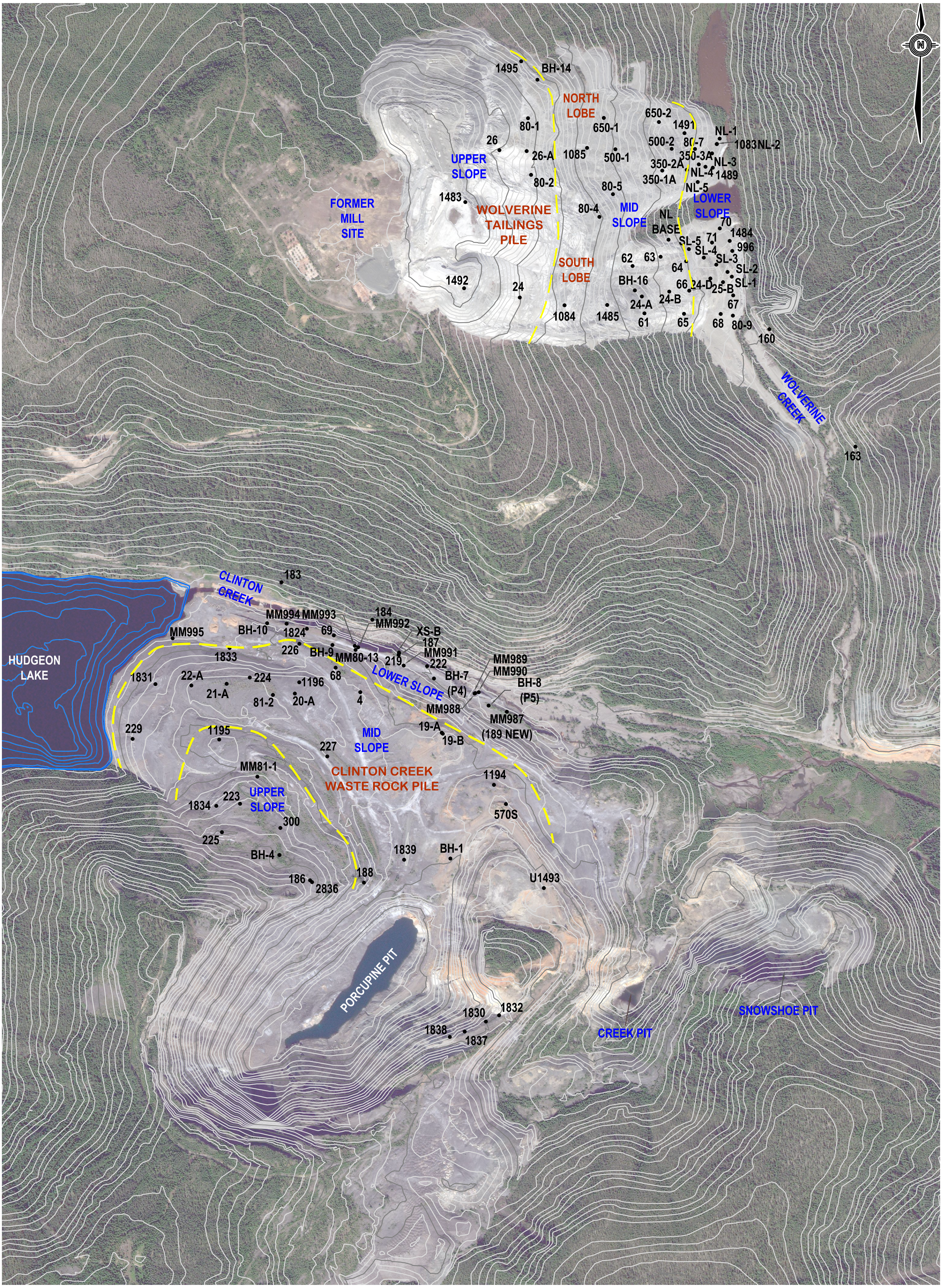
Table A: Summary of Annual Rainfall from Local and Regional Weather Stations (within 50 km of Clinton Creek)

Year	Total Annual Rainfall (mm)					Total Annual Snowfall (cm)				
	Clinton Creek (local)	Clinton Creek	Boundary	Forty Mile	Little Gold	Clinton Creek (local)	Clinton Creek	Boundary	Forty Mile	Little Gold
1966	-	-	-	-	-	-		-	-	-
1967	-	20	-	-	-	-	189	221	-	-
1968	-	201	-	-	-	-	155	257	-	-
1969	-	133	-	-	-	-	99	169	-	-
1970	-	194	21	-	-	-	174	254	-	-
1971	-	173	218	-	-	-	193	318	-	-
1972	-	187	299	-	-	-	154	298	-	-
1973	-	176	251	-	-	-	129	240	-	-
1974	-	135	208	-	192	-	147	318	-	33
1975	-	162	189	-	227	-	-	173	-	18
1976	-	103	165	-	198	-	138	187	-	-
1977	-	231	191	-	237	-	-	237	-	17
1978	-	174	37	-	-	-	92	46	31	-
1979	-	-	-	59	-	-	-	-	84	-
1980	-	-	-	185	-	-	-	-	107	-
1981	-	-	-	90	-	-	-	-	80	-
1982	-	-	-	245	209	-	-	-	70	-
1983	-	-	-	223	379	-	-	-	52	6
1984	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	190	-	-	-	-	3
1986	-	-	-	-	293	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	259	-	-	-	-	25
1989	-	-	-	-	228	-	-	-	-	4
1990	-	-	-	-	342	-	-	-	-	18
1991	-	-	-	-	247	-	-	-	-	23
1992	-	-	-	-	350	-	-	-	-	62
1993	-	-	-	-	247	-	-	-	-	2
1994	-	-	-	-	329	-	-	-	-	7
1995	-	-	-	-	282	-	-	-	-	5
1996	-	-	-	-	254	-	-	-	-	22
1997	-	-	-	-	266	-	-	-	-	-
1998	-	-	-	-	190	-	-	-	-	1
1999	-	-	-	-	230	-	-	-	-	-
2000 - 2003	No Data Available									
2004	82	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-
2006	137	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-
2008	249	-	-	-	-	-	-	-	-	-
2009	207	-	-	-	-	-	-	-	-	-
2010	262	-	-	-	-	-	-	-	-	-
2011	203	-	-	-	-	-	-	-	-	-
2012 - 2014	No Data Available									
2015	144.4	-	-	-	-	-	-	-	-	-

Note: All regional precipitation data was obtained from Environment Canada's public records and contains gaps in the information. Caution should be exercised when referring to the totals shown in this table, as the data set may be incomplete.

FIGURES

Q:\Kelowna\Drafting\ENG.WARC\ENGWARC03039-01 Abandoned Clinton Creek Mine Geotech Evaluation\ENGWARC03039-01 Fig.1-R0.dwg [FIGURE 1] March 24, 2016 - 12:35:31 pm (BY: BRATKE, SHELLY)



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

- ● - MONITORING POINT LOCATION

CLIENT

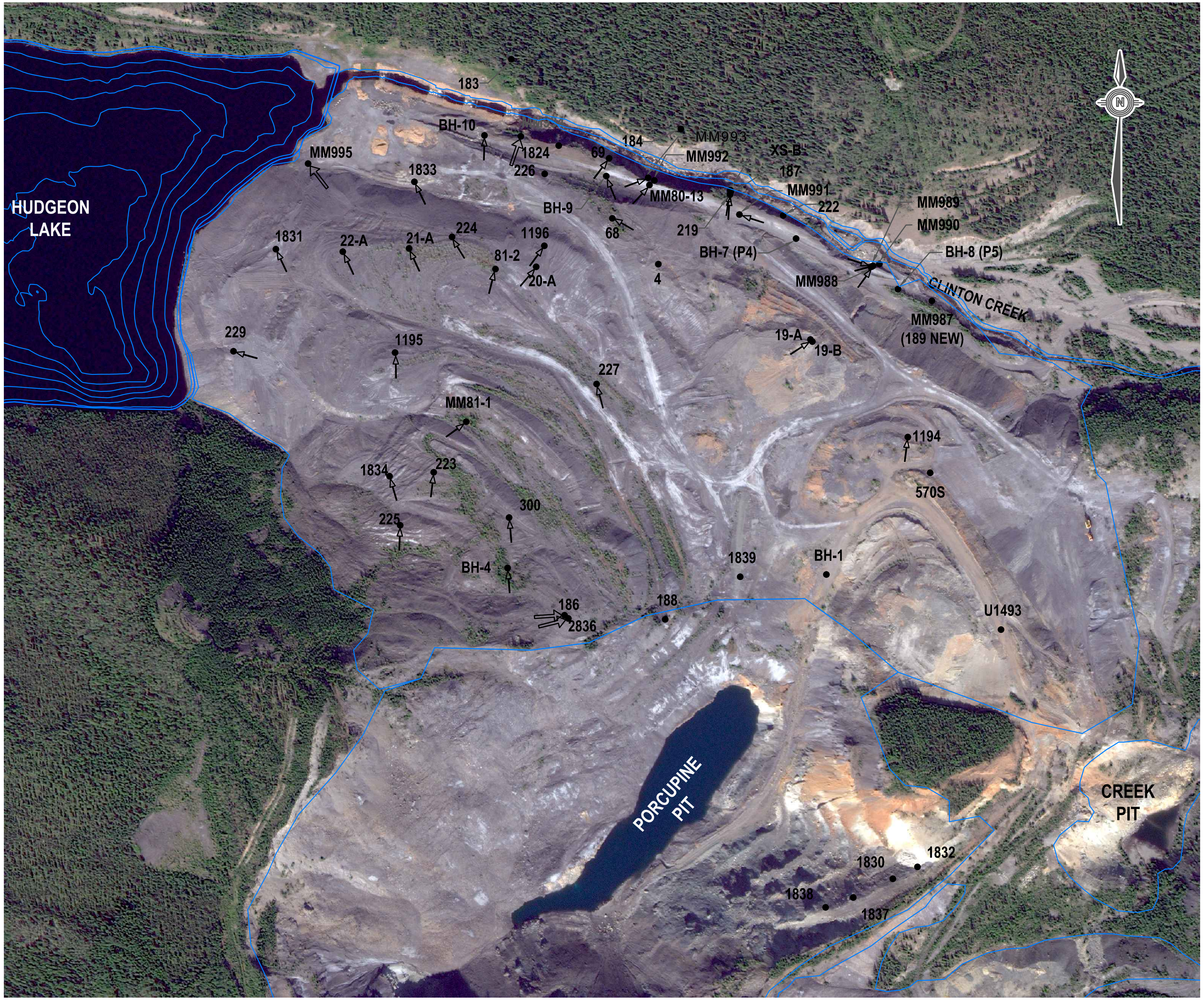
Yukon Government
Energy, Mines & Resources
Assessment & Abandoned Mines Branch

TETRA TECH EBA

EXISTING MOVEMENT RATES AND SEASONALITY REPORT ABANDONED CLINTON CREEK MINE, YUKON

SITE PLAN

PROJECT NO.	DWN	CKD	REV	
ENGWARC03039	RERH	SB	0	**Figure 1**
OFFICE	DATE			
EBA-WHSE	March 24, 2016			



Monitoring Point	Movement	Azimuth	Movement Rate in Principle Direction	Evaluated Monitoring Period
	cm	degrees	cm/year	
Upper Slope				
81-1	5.1	54	0.4	2003-2015
223	25.0	7	2.1	2003-2015
225	19.6	2	1.6	2003-2015
1195	17.2	359	1.4	2003-2015
1834	26.0	344	2.2	2003-2015
186	24.2	85	7.8	2012-2015
300	5.6	355	1.8	2012-2015
2836	25.8	76	8.3	2012-2015
BH-4	negligible movement			2012-2015
BH-4 CABLE	3.9	356	1.3	2012-2015
Mid Slope				
4	erroneous data - not used			2003-2014
19/19B	10.8	56	1.0	2003-2014
19A	data only available for 2014			2014
20/20A	14.3	40	1.3	2003-2014
21/21A	28.9	345	2.6	2003-2014
22/22A	49.2	345	4.4	2003-2014
68	21.6	300	2.0	2003-2014
81-2	10.0	14	0.9	2003-2014
224	26.3	329	2.4	2003-2014
227	8.1	345	0.7	2003-2014
229	24.3	286	2.2	2003-2014
1194	30.7	7	2.8	2003-2014
1196	33.2	36	3.0	2003-2014
1831	54.7	335	4.9	2003-2014
BH-1	data only available for 2014			2014
BH-1 Cable	data only available for 2014			2014
226	data only available for 2014			2014
2835	data only available for 2014			2014
570S?	data only available for 2014			2014
1192	data only available for 2014			2014
188	data only available for 2014			2014
Lower Slope				
69	7.2	37	1.0	2010-2014
80-13	erroneous data - not used			2003-2014
80-14	erroneous data - not used			2003-2010
991	0.3	288	0.2	2012-2014
84-1	5.0	307	0.7	2003-2010
987/189	relocation data unavailable			-
217	erroneous data - not used			2003-2010
993	3.8	70	1.8	2012-2014
218	erroneous data - not used			2003-2010
990	1.1	75	0.5	2012-2014
219	4.5	4	0.6	2010-2014
220	2.2	297	0.3	2003-2010
988	0.6	108	0.3	2012-2014
222	5.3	27		2010-2014
226	31.8	44		2003-2012
228	35.8	330	5.0	2003-2010
995	20.5	322	9.8	2012-2014
1833	37.4	334	3.4	2003-2014
BH-10 (P2)	52.4	1	4.7	2003-2014
BH-9 (P3)	10.0	338	0.9	2003-2014
BH-7 (P4)	erroneous data - not used			2003-2014
BH-8 (P5)	erroneous data - not used			2006-2010
XS-A	5.0	1	0.7	2003-2010
992	4.2	43	2.0	2012-2014
XS-B	8.0	9	0.7	2003-2014
XS-E	erroneous data - not used			2003-2010
989	2.4	36	1.1	2012-2014
XS-G	no data past 2003 (and replaced by 994 in 2012)			-
994	13.3	19	6.3	2012-2014
1824	16.2	22		2011-2014
187	data only available for 2014			2014

* Infers total movement in principle direction over specified monitoring period.

LEGEND

- MONITORING POINT LOCATION

DIRECTION OF MOVEMENT RATE AT MONITORING POINT

- < 5.0 cm/y AVERAGE MOVEMENT

- > 5.1 - < 10.0 cm/y AVERAGE MOVEMENT

NOTES :

- IMAGERY WAS EXTRACTED FROM GOOGLE EARTH PRO EDITION (DATED 2012)

0 250m

Scale: 1:5,000 @ 11"x17"

CLIENT

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

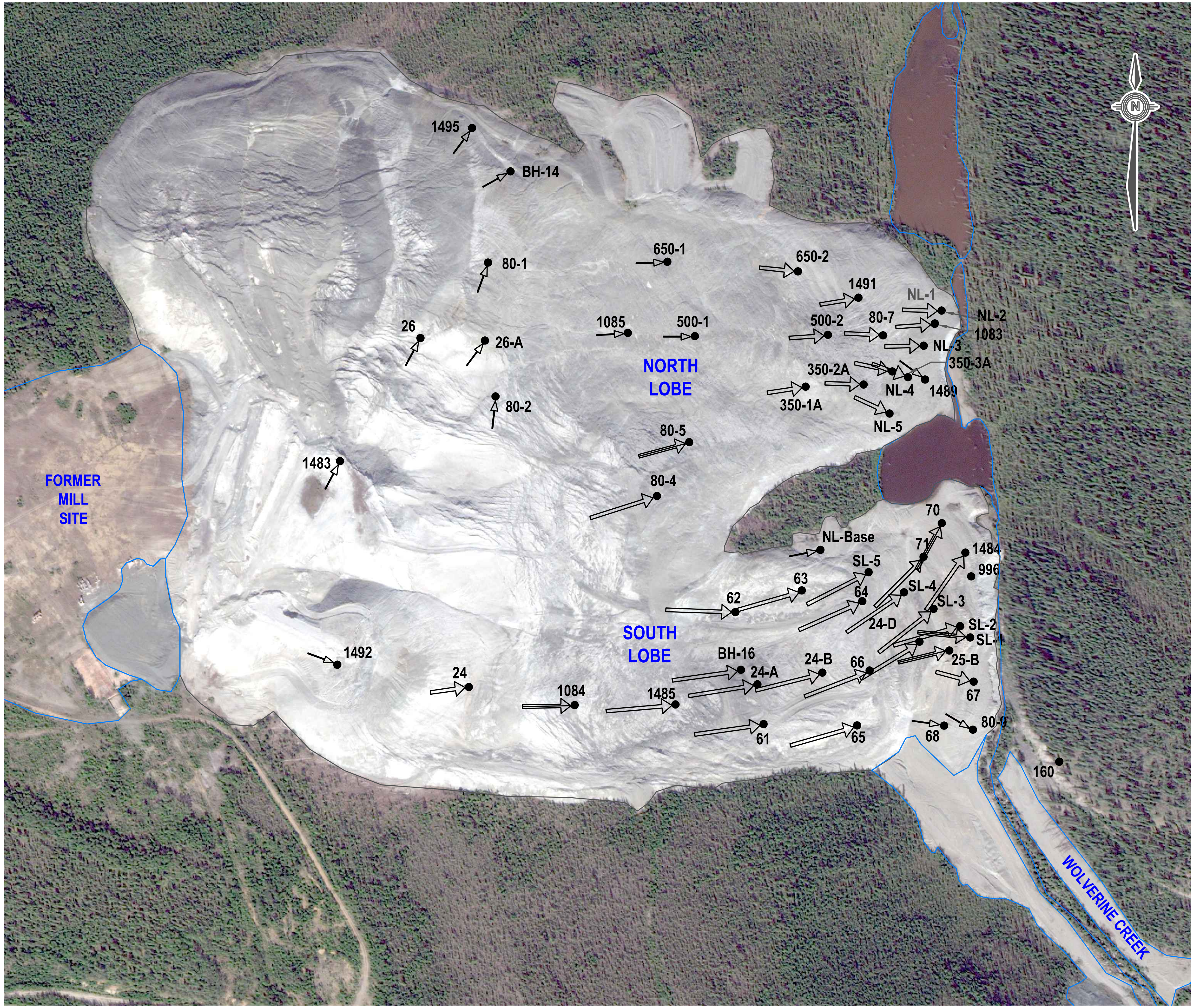
TETRA TECH EBA

EXISTING MOVEMENT RATES AND SEASONALITY REPORT
ABANDONED CLINTON CREEK MINE, YUKON

MONITORING POINT MOVEMENT
CLINTON CREEK WASTE ROCK PILE

PROJECT NO.	DWN	CKD	REV
ENGWARC03039	RERH	SB	0
OFFICE	DATE		
EDM	March 2, 2016		

Figure 2



Monitoring Point	Total Movement*	Azimuth	Movement Rate in Principle Direction	Evaluated Monitoring Period
	cm	degrees	cm/year	
Upper Slope				
1483	13.7	60	1.1	2003-2015
26	22.6	62	1.9	2003-2015
80-2	58.6	84	4.8	2003-2015
26-A	16.6	53	1.4	2003-2015
80-1	35.5	70	2.9	2003-2015
BH-14 (T7)	16.9	29	1.4	2003-2015
1495	33.5	53	2.8	2003-2015
Mid Slope				
80-4	354.6	77	32.1	2003-2014
80-5	250.5	79	22.7	2003-2014
1085	19.6	87	1.8	2003-2014
650-1	27.1	85	2.5	2003-2014
650-2	63.2	96	5.7	2003-2014
350-1A	95.5	80	8.7	2003-2014
350-2A	87.5	92	7.9	2003-2014
500-1	9.2	90	0.8	2003-2014
500-2	96.5	86	8.7	2003-2014
1491	111.8	81	10.1	2003-2014
Lower Slope				
80-7	97.0	93	8.8	2003-2014
350-3A	81.4	102	7.4	2003-2014
1489	36.9	126	3.3	2003-2014
NL-1	78.1	92	7.9	2004-2014
1083 (NL-2)	81.3	86	7.4	2003-2014
NL-3	56.5	89	5.7	2004-2014
NL-4	64.2	110	6.5	2004-2014
NL-5	49.8	115	5.0	2004-2014

Monitoring Point	Total Movement*	Azimuth	Movement Rate in Principle Direction	Evaluated Monitoring Period
	cm	degrees	cm/year	
Upper Slope				
1492	43.8	110	4.0	2003-2014
24	98.7	82	8.9	2003-2014
Mid Slope				
1084	171.5	89	15.5	2003-2014
1485	624.9	85	56.6	2003-2014
BH-16 (T8)	662.9	82	60.1	2003-2014
24A	627.6	81	56.9	2003-2014
24B	608.0	76	55.1	2003-2014
NL-Base	15.2	79	1.7	2005-2014
62 (2005-01)	359.6	92	40.1	2005-2014
63 (2005-02)	317.6	74	35.4	2005-2014
64 (2005-03)	348.1	66	38.8	2005-2014
66 (2005-04)	395.2	69	44.1	2005-2014
61 (2005-05)	477.1	82	53.2	2005-2014
65 (2005-06)	308.3	84	34.4	2005-2014
Lower Slope				
24D	440.6	59	39.9	2003-2014
25B	180.2	77	16.3	2003-2014
80-9	17.6	143	1.6	2003-2014
1484	473.7	35	42.9	2003-2014
SL-1	198.6	94	25.2	2004-2012
SL-2	304.3	74	30.1	2004-2014
SL-3	380.5	52	37.7	2004-2014
SL-4	301.3	56	33.6	2005-2014
SL-5	326.3	63	36.4	2005-2014
68 (2005-07)	17.2	172	1.9	2005-2014
67 (2005-08)	51.5	105	5.7	2005-2014
2005-09	135.1	55	22.9	2005-2011
996 (replace)	data only available for 2014			
71 (2005-10)	279.8	45	31.2	2005-2014
70 (2005-11)	255.7	29	28.5	2005-2014

* Infers total movement in principle direction over specified monitoring period.

LEGEND

- MONITORING POINT LOCATION

DIRECTION OF MOVEMENT RATE AT MONITORING POINT

- < 5.0 cm/y AVERAGE MOVEMENT
- > 5.1 - < 15.0 cm/y AVERAGE MOVEMENT
- > 15.1- < 30.0 cm/y AVERAGE MOVEMENT
- > 30.1 - < 60 cm/y AVERAGE MOVEMENT

NOTES :
- IMAGERY WAS EXTRACTED FROM GOOGLE EARTH PRO EDITION (DATED 2012)

0 200m
Scale: 1:4,000 @ 11"x17"

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

TETRA TECH EBA

EXISTING MOVEMENT RATES AND SEASONALITY REPORT
ABANDONED CLINTON CREEK MINE, YUKON

MONITORING POINT MOVEMENT
WOLVERINE CREEK TAILING PILE

PROJECT NO.	DWN	CKD	REV
ENGWARC03039	RERH	SB	0
OFFICE	DATE		
EDM	March 2, 2016		

Figure 3

C:\Users\shelly.bratke\Desktop\ENGWARC03039-01 Fig.2- 5-R1.dwg [FIGURE 3] March 24, 2016 - 12:10:57 pm (BY: BRATKE, SHELLY)

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

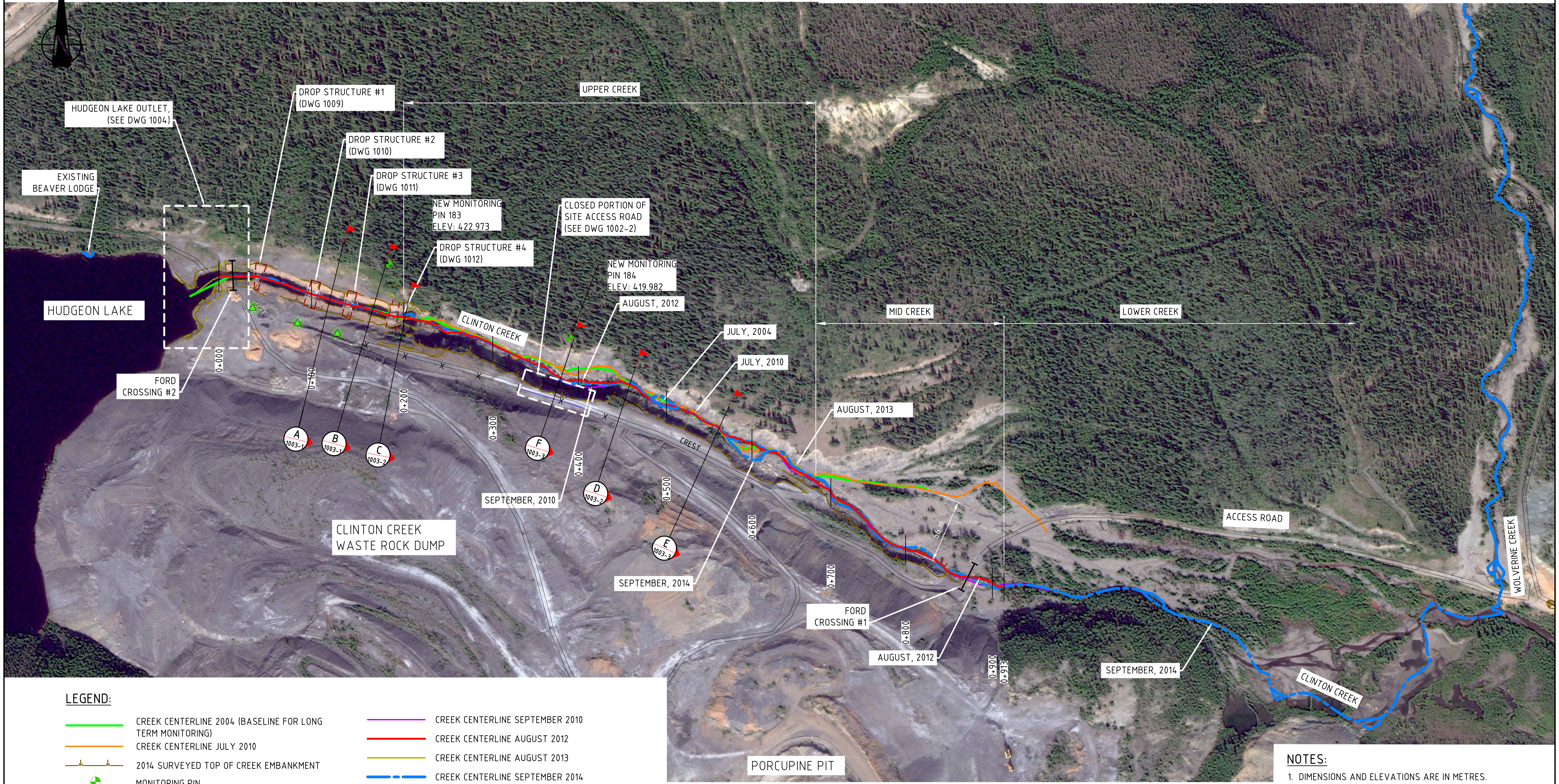
Tetra Tech EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

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.

APPENDIX B

CLINTON CREEK CHANNEL PLAN AND PROFILE – HISTORICAL SURVEY COMPARISON BY WORLEY PARSONS



LEGEND:

- CREEK CENTERLINE 2004 (BASELINE FOR LONG TERM MONITORING)
- CREEK CENTERLINE JULY 2010
- 2014 SURVEYED TOP OF CREEK EMBANKMENT
- MONITORING PIN
- RECOMMENDED FUTURE MONITORING POINTS (2 AT EACH LOCATIONS)
- CREEK CENTERLINE SEPTEMBER 2010
- CREEK CENTERLINE AUGUST 2012
- CREEK CENTERLINE AUGUST 2013
- CREEK CENTERLINE SEPTEMBER 2014
- ACCESS ROAD
- CLOSED ACCESS ROAD

PRELIMINARY
DO NOT USE FOR CONSTRUCTION
Last Saved: Mar. 30/15 3:41pm

m 0 50 100 m
1:4000

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METRES.
2. STATIONING IS BASED ON 2012 CREEK CENTERLINE.
3. OFFSETS ARE SHOWN RELATIVE TO 2014 AND 2004 CENTER LINES.

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
0	31-MAR-15	ISSUED FOR USE	JH		TB	JG	AT			
B	10-DEC-14	RE-ISSUED FOR CLIENT REVIEW	JH		TB	JG	AT			
A	08-DEC-14	ISSUED FOR CLIENT REVIEW	JH		TB	JG	AT			

D SHEET | SCALE

OneWay to zero harm

ENGINEERING AND PERMIT STAMPS (As Required)

WORLEYPARSONS PROJECT No 307071-01009

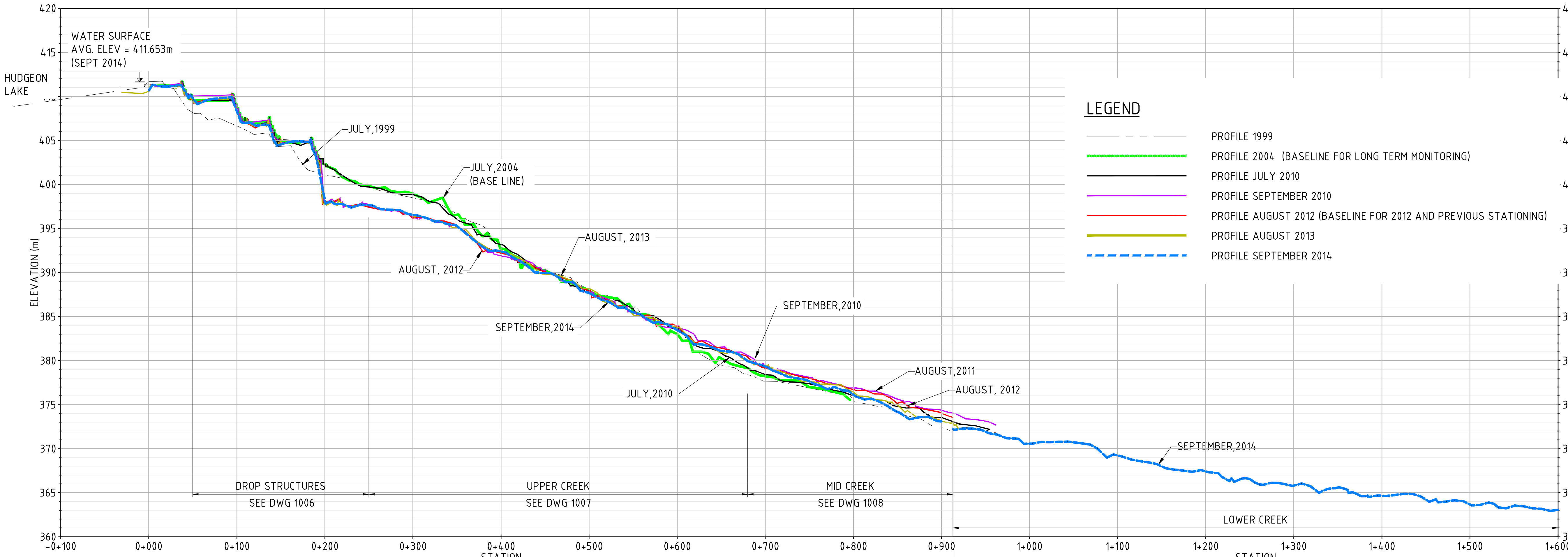
CUSTOMER
Yukon Government
Department of Energy, Mines and Resources
Assessment and Abandoned Mines

WorleyParsons resources & energy

CLINTON CREEK SITE
LONG TERM MONITORING PROGRAM (2014)
CLINTON CREEK PLAN

DRG No 307071-01009-00-SS-DGA-1002-1 | REV 0

LOCATION: U:\YVR\307071\01009_YEMR_CLINTCLMP\11_DRAWINGS\01_CIVIL\307071-01009-00-SS-DGA-1003.DWG
USER NAME: jake.gentles
PLOT DATE & TIME: 31/3/2015 10:18:12 AM
SAVE DATE & TIME: 30/3/2015 3:41:55 PM



PROFILE VIEW - 2012 SURVEYED CENTERLINE
VERTICAL X 10

2012 CREEK CENTERLINE STATIONING (HISTORICAL PROFILE DATA) ENDS AT STATION 0+913

2014 SURVEYED CLINTON CREEK CENTERLINE STATIONING STARTS AT STATION 0+913

PROFILE VIEW - 2014 SURVEYED CENTERLINE
VERTICAL X 10

m 0 50 100 150 m
1:5000

STATION	NORTHING	EASTING
0+000	7,147,427	512,863
0+250	7,147,366	513,113
0+500	7,147,272	513,363
0+750	7,147,204	513,613

COORD: UTM ZONE 7W NAD83

PRELIMINARY
DO NOT USE FOR CONSTRUCTION
Last Saved: Mar. 05/15 4:30pm

NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN METRES.
2. STATIONING BETWEEN STA. -0+150 TO SA 0+913 IS BASED ON 2012 REFERENCE LINE.
3. PROFILES OF THE CHANNEL FROM MONITORING SURVEYS COMPLETED IN 1983, 1984,2001,2006,2007,2008, AND 2011 ARE NOT SHOWN FOR THE SAKE OF CLARITY.

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
0	31-MAR-15	ISSUED FOR USE	JH		TB	JG	AT			
B	10-DEC-14	RE-ISSUED FOR CLIENT REVIEW	JH		TB	JG	AT			
A	08-DEC-14	ISSUED FOR CLIENT REVIEW	JH		TB	JG	AT			

D SHEET SCALE

OneWay to zero harm

WORLEYPARSONS PROJECT No 307071-01009

ENGINEERING AND PERMIT STAMPS (As Required)

CUSTOMER
Yukon Government
Department of Energy, Mines and Resources
Assessment and Abandoned Mines

WorleyParsons resources & energy

CLINTON CREEK SITE
LONG TERM MONITORING PROGRAM (2014)
CLINTON CREEK CHANNEL PROFILE

DRG No 307071-01009-00-SS-DGA-1005 REV 0

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SAVE DATE & TIME: 5/3/2015 4:30:28 PM