Klohn Crippen Berger

Teck Resources Limited

Bullmoose Mine

2017 Dam Safety Inspection

Bullmoose Tailings Dam

Rev. 1

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March 2018

Klohn Crippen Berger

March 16, 2018

Teck Resources Limited
Legacy Properties
601 Knighton Road
Kimberley, British Columbia
V1A 1C7

Mr. Bruce Donald, P.Eng.
Principal Advisor, Environment

Dear Mr. Donald:

Bullmoose Mine
Bullmoose Tailings Dam
2017 Dam Safety Inspection – Rev. 1

We are pleased to submit the 2017 Dam Safety Inspection Report for the Bullmoose Tailings Dam. Please contact us if you have any questions regarding this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Robert W. Chambers, P.Eng.
Engineer of Record
Senior Geotechnical Engineer, Principal

OL/NG:jcp

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EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Resources Limited (Teck) to complete the 2017 Dam Safety Inspection (DSI) of the Bullmoose Tailings Dam (BTD) to comply with Section 10.5.3 of the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (the Code), revised in 2017. This report was prepared following:

- Ministry of Energy and Mines[1] (MEM), British Columbia (BC) Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the 2016 HSRC Guidance Document;
- MEM Guidelines for Annual Dam Safety Inspection Report; and
- Teck's 2014 Guideline for Tailings and Water Retaining Structures (TWRS).

The 2017 DSI inspection was completed by the Engineer of Record (EoR), Mr. Bob Chambers, P.Eng., of KCB on August 16, 2017. Mr. Bruce Donald, P.Eng., of Teck is the Tailings Storage Facility (TSF) Qualified Person, as defined by the Code, for the BTD. The 2017 routine monthly visual inspections were completed by Facility Surveillance Officers (FSOs) Mr. Rob Muise and Mr. Ray Proulx of Teck.

Summary of Facility Description

The Bullmoose Mine has been closed since 2003. The mine site is about 45 km northwest of Tumbler Ridge in northeastern BC. The BTD is classified as being under "Closure-Passive Care" based on CDA (2014). Key aspects of the facility include:

- The BTD is a horseshoe-shaped structure, with approximately 4.6 million m^3 storage capacity, situated on the south flank of the broad valley bottom, with South Bullmoose Creek to the west and West Bullmoose Creek to the north.
- The BTD is constructed of compacted coarse coal rejects (CCR) up to a final crest elevation of 1123 masl. The dam downstream and upstream slopes are approximately 2.5H:1V and 2H:1V, respectively. The crest length is approximately 1050 m long, and 10 m to 15 m wide. The dam maximum height is 38 m from crest to downstream toe.
- Fine coal refuse tailings (approximately 4.4 million m^3), produced during operations (1983 to 2003), were placed between the BTD and the natural valley slope, forming the TSF. The TSF is reclaimed with a vegetation cover over the slopes and tailings.
- A closure spillway was constructed in 2002 at the west abutment of the BTD (inlet El. 1122 masl). The spillway channel follows a southwesterly route from the tailings impoundment, discharging onto the natural ground at approximately elevation 1120 masl.
- The TSF has a catchment of 36 ha: 20 ha tailings impoundment and 16 ha upslope.

[1] Ministry of Energy and Mines (MEM) is now Ministry of Energy, Mines and Petroleum Resources (MEMPR).

Summary of Key Potential Hazards and Failure Modes

The Code requires that potential hazards and failure modes described in CDA (2013) be assessed and included in the DSI report as a standard practice. The following hazards were reviewed:

Internal Erosion and Piping: The 2015 Dam Safety Review (DSR) (Golder 2016) noted that approximately one third of the available gradations of CCR are potentially internally unstable and recommended the potential for critical hydraulic gradients through the dam, which could result in internal erosion of the CCR, be assessed (DSR Recommendation PD-2015-03). KCB completed the assessment in 2018 and concluded that the likelihood of a failure due to internal instability and the potential for hydraulic gradient triggering internal erosion is considered to be "Rare"[2].

Erosion During Bullmoose Creek Flood: South and West Bullmoose Creeks flood studies were completed by KCB in 2017 as per 2015 DSR recommendation (PD-2015-02). The studies assessed the potential for erosion resulting from the flooding of the West Bullmoose Creek and the South Bullmoose Creek, and concluded that the likelihood of a failure of the BTD due to floods in both creeks is considered to be "Close to Non-Credible"[3].

Earthquakes: For seismic stability, CDA (2014) recommends a ½ way between 2475-year and 10,000-year return period earthquake for the design of a "High" consequence classification dam under "Closure-Passive Care". A simplified seismic hazard assessment was completed in 2017 (KCB 2017c) and an Earthquake Design Ground Motion (EDGM) of 0.09g was obtained. The EDGM is slightly lower than the seismic acceleration of 0.1g used in the original BTD design. Although the BTD seismic design meets the CDA (2014) design criteria, KCB recommends a site specific seismic hazard assessment be completed to improve confidence in the EDGM appropriate for the BTD and to derive a Uniform Hazard Response Spectra (UHRS) for an appropriate return period.

Other Hazards: such as overtopping, slope instability, foundation failure, and surface erosion are not considered "key hazards" for this facility and are discussed in the main text of this report.

Consequence Classification of Dam

Consequence classification is not related to the likelihood of a failure, but rather the potential impact resulting from of a failure if it did occur. The BTD was classified as a "High" consequence classification structure based on CDA (2013). There have been no significant changes to the structure, the upstream and downstream environment, or the operation of the structure that would require a revision to this classification.

[2] "Rare" Likelihood Rating is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is between 1 in 100 years and 1 in 1000 years; this rating is also applicable for failure modes such as instability and internal erosion that are rare. Factor of safety (FoS) against slope instability of 1.3 to 1.5.

[3] "Close to Non-Credible" Likelihood Rating is defined similar to "Rare" rating, except with a natural hazard return period greater than 1 in 10,000 years; this rating is also applicable for failure modes that are close to non-credible. FoS for slope instability of 2.0 or greater.

Significant Changes in Instrumentation and/or Visual Monitoring Records

There are 13 functional piezometers and 7 survey monuments at the BTD. The piezometers are read annually during the DSI site visit. Survey monuments were monitored twice in 2017 to help define baseline trends and establish more refined Quantifiable Performance Objectives (QPOs). No exceedances of thresholds were recorded and no event-driven inspections were triggered in 2017.

Piezometer data prior to 2003 and from 2014 to 2017 indicates that pore pressures have been stable and the dam downstream shell is well drained with a low gradient.

Seven survey monuments have been monitored since 2015 and no general trend or significant settlement was measured. Thresholds and responses have been established for on-going surveillance of the BTD.

The routine inspections and 2017 DSI observations do not indicate any significant change in the BTD or dam safety issues.

Significant Changes to Dam Stability and/or Surface Water Control

During the 2017 site visit, the BTD appeared to be in good working condition and the observed performance is consistent with the expected design conditions. No significant changes in dam stability or surface water control were observed.

In October 2017, Teck cleared vegetation from the BTD spillway inlet and channel. Vegetation clearing requirements have been included in the updated Operation, Maintenance, and Surveillance (OMS) manual.

An erosion gully (approximately 0.2 m to 0.3 m wide, 0.8 m to 1.1 m deep, and 10 m to 15 m long), likely formed during the 2017 spring freshet, was observed on the east downstream slope during the DSI site visit; this feature does not represent an immediate dam safety concern.

Operation, Maintenance, and Surveillance Manual

The OMS manual was updated in 2018. The document format meets Teck's 2014 TWRS requirements and the format recommended in the Mining Association of Canada (MAC) 2011 Guideline for Developing an OMS for Tailings and Water Management Facilities.

Emergency Preparedness and Response Plan

The Emergency Preparedness and Response Plan (EPRP) was updated by Teck in 2017, but the document has not been issued as final. Teck is planning to issue the EPRP in the first quarter of 2018.

Dam Safety Review

The first and most recent DSR of the BTD was completed in 2015 (Golder 2016). The next DSR should be completed in 2020 (in 5 years from the previous), based on requirements under the Code and Teck's internal requirements.

2017 DSI Observations and Summary of Recommendations

Comparison of the observed condition of the dam with the available design and inspection reports indicates there has been no significant change to the condition of the dam since the site was closed in 2003.

Past recommendations regarding the dam that are outstanding are summarized in Table 1. Closed recommendations are shown in italics and will be removed from the table in next year's DSI report. Recommendations resulting from the 2017 DSI are summarized in Table 2. The recommendations from the DSR by Golder (2016) are summarized in Table 3.

Priority guidelines, specified in the Code, are assigned to each recommendation by KCB.

Table 1 Previous Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
BTD-2015-01 (DSI-BTD-10)	*Survey Monitoring Requirements*	*n/a*	*After 6 (minimum) monument surveys have been completed, review available data and define appropriate threshold values, which should then be added to the OMS manual.*	*3*	*CLOSED*
BTD-2016-01	*EoR Named in OMS*	*OMS Manual*	*Update the EoR currently listed in the OMS manual.*	*3*	*CLOSED*

Table 2 2017 Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
BTD-2017-01	Seismic Hazard Assessment for "Closure-Passive Care"	HSRC Code	Conduct a site specific seismic hazard and stability assessment for the BTD using the Code recommended design criteria for a "High" consequence classification dam under "Closure-Passive Care" condition.	4	December 2019 (OPEN)
BTD-2017-02	Erosion Gully	OMS Manual	KCB to review erosion gully observed at the BTD downstream slope near the east abutment in 2018 DSI.	3	December 2018 (OPEN)
BTD-2017-03	Piezometers and Freeboard Threshold Levels	HSRC Code	Teck to install a stake during routine visual inspection at the BTD in spring of 2018. The stake should be installed 1 m above the steady state pond level.	3	June 2018 (OPEN)

Table 3 DSR Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
2016-02	*Seismic Assessment*	*HSRC Code*	*DSR Recommendation (PD-2015-01): Update the seismic assessment with respect to the maximum design earthquake (MDE) based on the revised national building code.*	*2*	*CLOSED*
2016-03	*Flood Assessment*	*n/a*	*DSR Recommendation (PD-2015-02): Assess the risk of erosion of the BTD toe due to the flooding of the West Bullmoose Creek and the South Bullmoose Creek.*	*2*	*CLOSED*
2016-04	*Filter Compatibility Assessment*	*n/a*	*DSR Recommendation (PD-2015-03): Assess the potential for critical hydraulic gradients through the dam based on the assessment that approximately one third of the coarse coal rejects (CCR) gradations were noted to be potentially unstable.*	*2*	*CLOSED*
2016-06	*Surveillance Officer Training*	*OMS Manual*	*DSR Recommendation (ONC-2015-01): Training to be provided to the surveillance officer and in the event of new personnel or role changes.*	*3*	*CLOSED*
2016-08	*Alternate Personnel*	*OMS Manual*	*DSR Recommendation (ONC-2015-03): Identify alternate contacts for roles relating to the BTD. Also, develop and implement an organizational chart and chain-of-command.*	*3*	*CLOSED*
2016-09	*Sign-off Procedures*	*OMS Manual*	*DSR Recommendation (ONC-2015-04): Include a sign-off and indication of recorded documentation in the OMS.*	*3*	*CLOSED*
2016-13	Procedure Documentation	OMS Manual	DSR Recommendation (ONC-2015-08): Procedures regarding instrumentation readings, frequency and data management should be documented within the OMS as well as the threshold values and procedures relating to the triggering of thresholds.	3	December 2018 (OPEN – to be closed once survey monuments reading procedures are included in the OMS manual)

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
2016-14	Flood Management	EPRP	DSR Recommendation (ONC-2015-09): Flood management due to flooding of West Bullmoose Creek should be included in the EPRP.	3	December 2018 (OPEN – to be closed once EPRP is finalized)
2016-15	Emergency Training Records	EPRP	DSR Recommendation (ONC-2015-10): Include records of personnel emergency training in emergency procedures.	3	December 2018 (OPEN - to be closed once EPRP is finalized)
2016-16	Updating of EPRP	EPRP	DSR Recommendation (ONC-2015-11): Document the frequency of the revisions to the EPRP in the EPRP.	3	December 2018 (OPEN - to be closed once EPRP is finalized)
2016-17	Roles and Responsibilities	EPRP	DSR Recommendation (ONC-2015-12): Develop a chain-of-command and organization chart and include within the EPRP.	3	December 2018 (OPEN – chain-of-command is included in the draft EPRP. Recommendation can be closed once EPRP is finalized)

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1 INTRODUCTION

KCB was engaged by Teck Resources Limited (Teck) to complete the 2017 Dam Safety Inspection (DSI) at the Bullmoose Tailings Dam (BTD), also previously referred to as the South Fork Tailings Dam. This report was prepared following:

- Ministry of Energy and Mines[1] (MEM), British Columbia (BC) Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the 2016 Health, Safety and Reclamation Code (HSRC) Guidance Document;
- MEM Guidelines for Annual Dam Safety Inspection Report; and
- Teck's 2014 Guideline for Tailings and Water Retaining Structures (TWRS).

1.1 Purpose, Scope of Work and Methodology

This report outlines the 2017 DSI of the BTD at the closed Bullmoose Mine site. The following activities were undertaken by KCB as part of the DSI:

- Site visit to inspect the facility on August 16, 2017 between 11:15 am and 14:45 pm by the Engineer of Record (EoR), Mr. Bob Chambers, P.Eng., of KCB, along with Mr. Nat Gullayanon, P.Eng., of KCB.
- Review of the site data, water management and instrumentation measurements.
- Review and update of the list of outstanding recommendations from previous annual reviews.

KCB was accompanied by Mr. Rob Muise, Mr. Ray Proulx and Mr. Gerry Murdoch of Teck during the DSI site visit.

1.2 Regulatory Requirements

This DSI addresses the performance of the BTD and associated water management infrastructure in accordance with Section 10.5.3 of the HSRC (the Code) for Mines in BC, revised in 2017.

1.3 Engineer of Record and Tailings Storage Facility Qualified Person

Mr. Bob Chambers, P.Eng., a representative of KCB, assumed the role of the EoR of the BTD on September 1, 2016. The responsibilities of the Tailings Storage Facility (TSF) Qualified Person, as defined in the Code (MEM 2017), are performed by the Mine Manager, Mr. Bruce Donald, P.Eng., of Teck.

1.4 Facility Description

The Bullmoose Mine site is about 45 km northwest of Tumbler Ridge in northeastern BC. The mine has been closed since 2003 and the BTD is reclaimed with vegetation.

[1] Ministry of Energy and Mines (MEM) is now Ministry of Energy, Mines and Petroleum Resources (MEMPR).

BTD is considered to be in "Closure-Passive Care" phase (KCB 2018a) as defined by the Canadian Dam Association (CDA) Technical Bulletin Application of Dam Safety Guidelines to Mining Dam (CDA 2014).

The mine area is characterized by moderate topographic relief, with mountains several hundreds of meters above broad glacial and river formed valleys. The area is generally forested at lower elevations, with some ridgelines extending above tree line.

Fine coal refuse (i.e., tailings) (approximately 4.4 Mm^3) produced during operations (1983 to 2003) were stored to an average elevation of 1118.5 masl between the BTD and the natural valley slope, which formed the TSF impoundment. The TSF has approximately 4.6 million m^3 of storage capacity. The BTD is a horseshoe-shaped structure situated on the south flank of the broad valley bottom, with South Bullmoose Creek to the west and West Bullmoose Creek to the north. Overview of the BTD and the impoundment is shown in Figure 1.

The BTD is constructed of compacted coarse coal rejects (CCR) and has a crest elevation of 1123 masl. The dam crest varies from 10 m to 15 m wide and the embankment is approximately 1050 m long. The dam maximum height is 38 m from crest to downstream toe. The BTD has a 15 m wide upstream low permeability zone. Refer to Drawing D-108 in the Appendix III for typical cross-section of the BTD.

A closure spillway was constructed in 2002 at the west abutment of the BTD. Downstream slope of the BTD was re-sloped to achieve the design 2.5H:1V slope in 2003 (BOC 2003). The spillway channel follows a southwesterly route from the tailings impoundment, discharging onto the natural ground at approximately El. 1120 m.

A summary of BTD key information is presented in the Facility Data Sheet in Appendix I. The ultimate dam configuration is presented in Appendix III.

2 BACKGROUND AND RECENT ACTIVITIES

2.1 Background Information

Coal production at Bullmoose began in December 1983, and produced about 1.7 million tonnes of clean metallurgical coal and 0.6 million tonnes of clean thermal coal annually. Waste from the coal preparation process included CCR and fine coal refuse (i.e., tailings). Coal production at Bullmoose ceased in 2003 and has been inactive since then. A summary of the available BTD reference documents is included in Appendix V.

Tailings production varied considerably depending on the ratio of thermal coal to metallurgical coal. Tailings were transported as slurry, 35% solids by weight, to a single discharge point located at the southern ridge of the impoundment.

A starter embankment, about 10 m high, was constructed of borrow material to store tailings from the first year of operations which commenced in 1983 (KL 1984). Crest raises were constructed using the downstream method to a final crest elevation of 1122 masl. A layer of glacial till was placed on the crest for erosion protection (BOC 2003) which raised the tailings dam to elevation 1123 masl based on 2010 LiDAR (received from Teck in 2014). However, field observations suggest the glacial till placement was likely not consistent (in terms of thickness and coverage) across the full length and width of the crest.

Since 2003, the impoundment has been maintained as a closed facility. Reclamation work completed on the facility includes re-sloping of the downstream slope and seeding on the tailings surface and dam slopes (upstream and downstream) (BOC 2003). A closure spillway was constructed in 2002 (BOC 2004) at the left (west) abutment with an invert elevation of 1122 masl. There has been no construction since 2003. The 2010 LiDAR survey indicates the current spillway invert and the crest elevations are 1 m higher than the post-construction as-built survey. This difference in survey does not impact this assessment as the difference in elevation between the crest and spillway invert (1 m) is the same for both surveys. During the site inspection the spillway invert appeared to be 1 m lower than the dam crest.

The foundation consists of alluvial sands and gravels with interbedded silts and glacial till. The alluvial soils are sufficiently pervious to allow pond water to seep from the impoundment. As the thickness of the deposited tailings increased, the seepage rate decreased (Teck 2013a). There are two aquifers underlying the impoundment: an upper gravelly aquifer with piezometric level approximately 4 m below the original ground surface, which is similar to the elevation of Bullmoose Creek; and a lower gravelly aquifer with piezometric level 8 m to 10 m below the original ground surface. The two aquifers are reported to be separated by a low permeability glacial till layer.

2.2 Recent Activities

The Bullmoose TSF is a closed facility and does not require operational intervention, except for routine and event driven inspections, and maintenance work carried out on an as-required basis (refer to Section 4.1 for more details).

Maintenance work completed in 2017 by Teck includes vegetation clearing at the inlet and along the channel of the BTD spillway in October. Photographs of the BTD spillway after vegetation clearing (provided by Teck) are included in Appendix II. KCB reviewed the photographic records and concluded that the spillway is in satisfactory condition.

The following activities were also completed as part of an on-going stewardship of the BTD by the EoR and to address previous DSIs and Dam Safety Reviews (DSRs) non-compliances or recommendations:

- Completed 2017 DSI at the BTD (this document);
- Reviewed routine visual inspection record submitted by Teck's FSO;
- Reviewed Operation, Maintenance and Surveillance (OMS) manual and Emergency Preparedness and Response Plan (EPRP) document;
- Reviewed instrumentation data and established/updated Quantifiable Performance Objectives (QPOs);
- Reviewed climate data and update water balance of the BTD;
- Completed simplified seismic hazard assessment of the BTD using an updated National Building Code of Canada (NBCC) (2015) hazard values;
- Completed flood studies of the West Bullmoose Creek and South Bullmoose Creek and their potential impact on the BTD toe; and
- Completed internal stability and critical hydraulic gradient assessment.

Results of these activities are discussed in detail in the following sections of this report.

3 WATER MANAGEMENT, CLIMATE AND WATER BALANCE

3.1 Water Management

The catchment for the BTD impoundment is 36 ha: 20 ha tailings and pond surface, and 16 ha of natural upslope catchment (KCB 2015b). A pond (approximately 2 ha) is located along the northeast boundary and is approximately 400 m from the spillway inlet at the southwest corner of the impoundment (see Figure 1). Based on inspection reports since 2014, a pond has been present at that location. During that period, the pond level has ranged from El. 1115 masl to El. 1116 masl and has an estimated volume of 26,000 m^3.

The closure spillway invert is at elevation 1122 masl with a channel width of approximately 3 m and grades ranging from 3% to 1% (KCB 2015b). The spillway is both excavated within overburden and bedrock. The spillway sections excavated in overburden are armoured with riprap with side slopes of 2H:1V; in bedrock the spillway has side slopes of 1H:1V (KC 2002).

A diversion ditch was constructed upslope of the impoundment to divert approximately 14 ha away from the impoundment for normal conditions. However, the diversion ditch is overgrown and no longer performing as designed. The ditch was assumed to not function for the spillway design (i.e., it does not divert upstream runoff away from the BTD impoundment). A steady pond elevation and no water accumulation in the impoundment demonstrates that the diversion ditch is not required to maintain a suitable water balance for the impoundment or for dam safety. In addition, a hydrotechnical review (KCB 2015b) indicates that the BTD impoundment has a flood storage capacity more than 5 times the design flood volume (refer to Section 3.4 for details). Therefore, re-establishing the diversion ditch is not required for flood conditions.

3.2 Climate

Bullmoose Mine climate normals data (1981-2003), based on Bullmoose climate station No. 1181120 at elevation 1102 masl, is summarized in Table 3.1 and Table 3.3. No climate data is available from this station since 2003; therefore, data from Chetwynd Airport climate station No. 1181508, at elevation 610 masl and 62 km north of Bullmoose, was used to estimate precipitation for water balance calculation in 2017.

Annual precipitation for the Bullmoose and Chetwynd Airport climate stations, for the period when the records overlap, were used to determine the correlation factor to apply to the Chetwynd Airport data. It appears that the Chetwynd Airport data should be multiplied by a correlation factor of 1.8 to represent the Bullmoose site. Based on this correlation factor, precipitation estimated between September 1, 2016 and August 31, 2017 was 921 mm at Bullmoose site.

2017 monthly precipitation was estimated using the mean annual precipitation distribution (see Table 3.2) for Bullmoose site, taken from Baseline Hydrology and Design Basis (Teck 2013b).

2017 monthly temperatures at Bullmoose site were estimated by applying correlation factors. These factors were determined by comparing monthly climate normals at the Chetwynd Airport (1981-

2010) and Bullmoose (1981-2003) climate stations. The established correlation factors (see Table 3.1) were then applied to the 2017 monthly temperatures measured at Chetwynd Airport to estimate monthly temperatures at Bullmoose site.

Table 3.1 Chetwynd Airport/Bullmoose Temperature Normals and Correlation Factors

Climate Normals Data	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Daily Average (°C)												
Chetwynd Station (1981-2010)	-10.2	-7.2	-2.9	4.6	9.5	13.4	15.4	14.5	9.9	4.1	-5.5	-9.1
Bullmoose Station (1981-2003)	-8.0	-6.6	-4.2	1.7	6.9	11.0	13.3	12.8	8.2	2.5	-4.7	-7.4
Correlation Factors	0.78	0.92	1.45	0.37	0.73	0.82	0.86	0.88	0.83	0.61	0.85	0.81
Daily Maximum (°C)												
Chetwynd Station (1981-2010)	-5.0	-1.4	2.9	11.2	16.6	20.1	22.2	21.6	16.3	9.4	-1.1	-4.1
Bullmoose Station (1981-2003)	-3.4	-2.0	0.3	6.7	12.4	16.3	18.9	18.3	12.9	6.3	-1.0	-3.1
Correlation Factors	0.68	1.43	0.10	0.60	0.75	0.81	0.85	0.85	0.79	0.67	0.91	0.76
Daily Minimum (°C)												
Chetwynd Station (1981-2010)	-15.3	-12.9	-8.7	-2.1	2.4	6.6	8.5	7.4	3.5	-1.3	-10.0	-14.1
Bullmoose Station (1981-2003)	-12.6	-11.2	-8.7	-3.4	1.5	5.6	7.8	7.2	3.4	-1.2	-8.5	-11.6
Correlation Factors	0.82	0.87	1.00	1.62	0.63	0.85	0.92	0.97	0.97	0.92	0.85	0.82

Table 3.2 Precipitation Averaged Monthly Distribution for Bullmoose Site

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Bullmoose Monthly Distribution	8%	6%	6%	5%	6%	13%	13%	9%	8%	9%	10%	7%

Snowpack depth is not measured at the Bullmoose and Chetwynd Airport stations; therefore, 2017 snowpack data is not available for review.

Precipitation and temperature data at Bullmoose from September 1, 2016 to August 31, 2017 is summarized in Chart 3.1 and Table 3.3. Climate normals between 1981 and 2003 (updated by Environment Canada Record - 1981 to 2010) were obtained from Bullmoose climate station and are also summarized in Chart 3.1 and Table 3.3 for comparison.

Chart 3.1 Climate Data for Bullmoose Mine Site – 2017 and Climate Normals

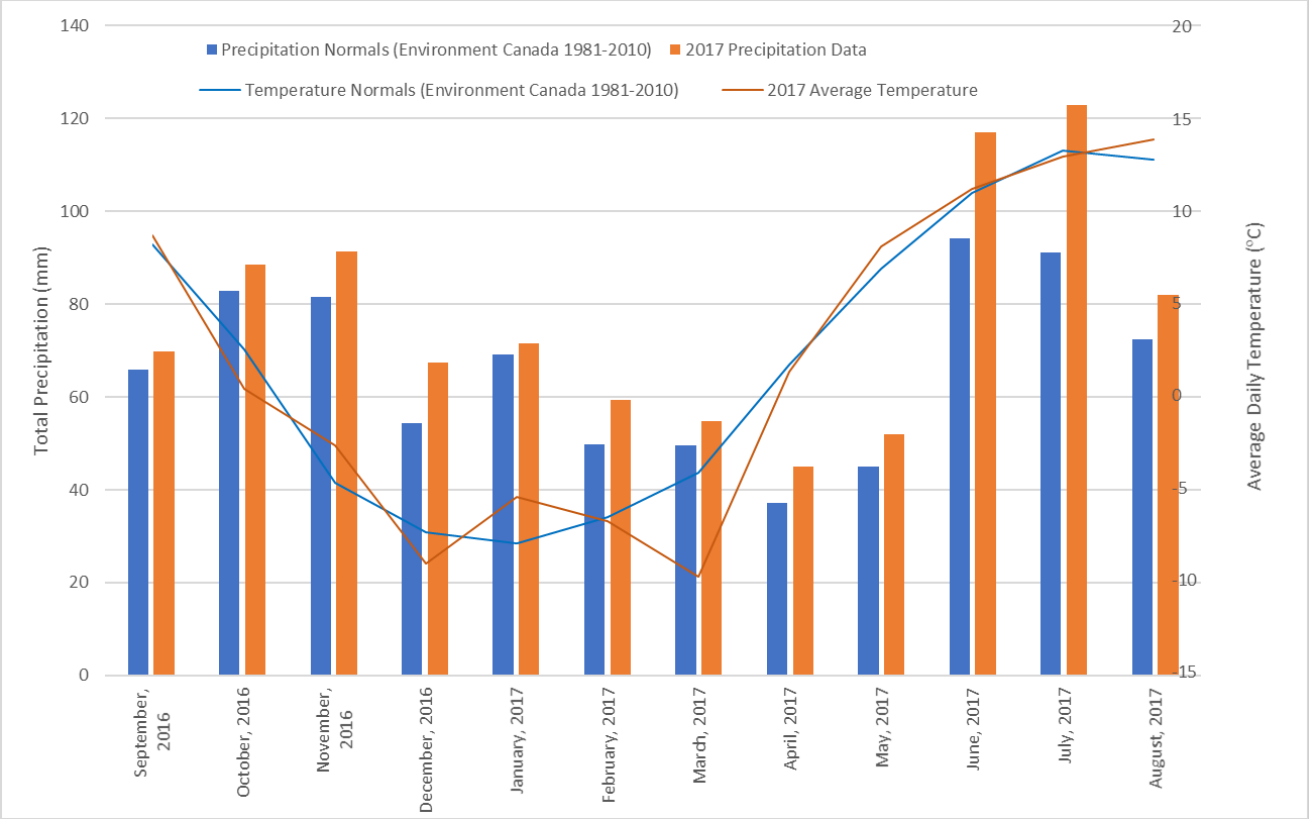

Table 3.3 Climate Data for Bullmoose Site

Month	Normals Average Monthly Precipitation[1] (mm)	2016-2017 Precipitation[2] (mm)	Normals Daily Max. Temperature[1] (°C)	Normals Daily Min. Temperature[1] (°C)	Normals Daily Average Temperature[1] (°C)	2016-2017 Daily Max. Temperature[3] (°C)	2016-2017 Daily Min. Temperature[3] (°C)	2016-2017 Daily Average Temperature[3] (°C)
September	65.8	69.7	12.9	3.4	8.2	13.2	4.1	8.7
October	82.8	88.6	6.3	-1.2	2.5	2.4	-2.3	0.4
November	81.5	91.4	-1.0	-8.5	-4.7	1.1	-6.4	-2.7
December	54.4	67.3	-3.1	-11.6	-7.4	-5.2	-12.7	-9.1
January	69.1	71.6	-3.4	-12.6	-8.0	-1.9	-9.2	-5.5
February	49.8	59.3	-2.0	-11.2	-6.6	-3.9	-10.5	-6.8
March	49.6	54.7	0.3	-8.7	-4.2	-0.1	-12.3	-9.8
April	37.1	45.0	6.7	-3.4	1.7	5.3	-3.0	1.3
May	45.0	51.9	12.4	1.5	6.9	13.5	2.6	8.1
June	94.2	116.9	16.3	5.6	11.0	17.0	0.2	11.2
July	91.2	122.8	18.9	7.8	13.3	19.3	6.8	13.0
August	72.3	81.9	18.3	7.2	12.8	20.0	7.6	13.9
Total	**792.8**	**921.1**						

Notes:

1. Environment Canada Record - 1981-2010 climate normals record based on Bullmoose climate station available data from 1981 to 2003.
2. Annual precipitation was estimated using precipitation data from Chetwynd Airport climate station (station No. 1181508; elevation 610 masl; and 62 km north of Bullmoose Mine) data and correlation factor of 1.8. Monthly precipitation values were estimated using the mean annual precipitation distribution for Bullmoose site, taken from 2013 Baseline Hydrology and Design Basis (Teck 2013b).
3. Bullmoose site monthly temperatures were estimated by applying correlation factors to monthly temperatures obtained from Chetwynd Airport climate station.

The following observations are made based on the climate data from September 1, 2016 to August 31, 2017:

- Total precipitation estimated during this period was 921 mm, which is above the precipitation normals of 793 mm, but lower than 2016 total precipitation (1214 mm).
- In general, 2017 monthly average daily temperatures are similar to the normals with the exceptions of December and March where temperatures are lower than the normals.
- Wettest month of the period is July 2017 where a total precipitation of 122.8 mm was estimated.
- Event-driven inspections are required after a 10-year rainfall event (67 mm in 24-hour duration (Teck 2017b)). No rain event exceeding the 10-year return period precipitation was recorded between September 1, 2016 and August 31, 2017 based on Chetwynd Airport climate data. The largest precipitation event was 31 mm in 24-hour recorded on June 9, 2017.

During the 2017 DSI site visit, the weather was overcast with scattered light rain.

3.3 Water Balance

There is no visual evidence that water has flowed through the spillway since construction and therefore all inflows to the impoundment are assumed to be lost through evaporation or seepage. A simplified water balance calculation for the BTD impoundment for September 1, 2016 to August 31, 2017 is summarized below:

- Inflows:
  - Runoff from natural upstream catchment = 59,587 m^3;
  - Precipitation on pond surface = 18,758 m^3 (assumed pond surface on average is at El. 1115.5 masl); and
  - Precipitation on tailings surface = 166,355 m^3 (average annual runoff coefficient of 0.6 assumed to account for water lost to evaporation from the beach surface and evapotranspiration).
- Outflows:
  - Evaporation from pond surface = 10,229 m^3 (evaporation rate for this site is 502 mm/year adopted from another mine site in the region); and
  - Seepage losses from the impoundment = 234,472 m^3 (the remainder of inflows minus evaporation).

The estimated average seepage rate from the impoundment based on the simplified water balance is 7.4 L/s over the 12-month period. No seepage from the BTD toe or fill was observed during the inspection. The water balance is within the range of previously estimated seepage rates (2.7 L/s in 2014 DSI (KCB 2014d) and 9.9 L/s in 2016 DSI (KCB 2017a) and less than the estimated seepage during operations (267 L/s to 1318 L/s). There are no planned changes to the surface water management that would alter the water balance.

3.4 Freeboard and Flood Storage

3.4.1 Freeboard

The estimated freeboard of the BTD during the 2017 DSI site visit was approximately 7 m to 8 m. The following are the proposed freeboard QPOs, which are based on pond level and design flood levels above spillway invert determined in KCB (2015b):

- Threshold Level 1 if the water level is 1 m above steady state pond level (i.e., maximum "normal" pond level under closure condition). KCB recommends Teck to install a stake during routine visual inspection at the BTD in spring of 2018. The stake should be installed 1 m above the steady state pond level.
- Threshold Level 2 if the water level reaches 1000-year return period flood level: water level ≥ 1122.3 masl, leaving 0.7 m of freeboard[5]; and
- Threshold Level 3 if the water level reaches $^2/_3$ between 1000-year return period and Probable Maximum Flood (PMF) level: water level ≥ 1122.5 masl, leaving 0.5 m of freeboard[5].

Threshold Levels 2 and 3 are considered conservative when compared to the minimum required freeboard of 0.2 m, determined using the CDA (2013) wave setup and wave runup methodologies (KCB 2015b). The recommended responses for the Threshold Levels are summarized in Table 3.4.

Table 3.4 Proposed Responses to Freeboard Thresholds Exceedances

Response Level	Exceedance Threshold	Action
1	Pond level is 1 m above steady state pond level	▪ Notify EoR within 1 week upon verification of pond level measurement and exceedance. ▪ EoR may recommend increased monitoring of pond level and toe inspection.
2	0.7 m Freeboard	▪ Notify EoR within 24 hours upon verification of pond level measurement and exceedance. ▪ EoR may recommend increased monitoring of pond level and tie inspection.
3	0.5 m Freeboard	▪ Notify EoR immediately upon verification of pond level measurement and exceedance. ▪ Increased monitoring frequency as directed by the EoR. ▪ EoR may recommend mitigation measure(s) to reduce the probability of overtopping. ▪ Teck to initiate emergency response as required.

3.4.2 Flood Storage

The Inflow Design Flood (IDF) for the BTD, a "High" consequence classification dam under "Closure-Passive Care" phase, is the $^2/_3$ between the 1000-year return period and PMF (CDA 2014). The IDF flood volume is 114,370 m^3 (KCB 2015b). The Bullmoose TSF has 680,000 m^3 of available flood storage, which is more than 5 times the IDF volume (see Section 5.6.2 for more details).

[5] KCB (2015b) assumed the pond elevation to be at the spillway invert (El. 1122 masl) at the start of the design storm events (see Sections 3.4.2 and 5.6.2 for more information on flood storage and flood routing, respectively).

4 MONITORING PROGRAM AND SITE OBSERVATIONS

4.1 Visual Inspections

The BTD monitoring program includes the following visual inspections:

- Annual DSI (this report) – completed by the EoR.
- Routine – completed monthly when site is accessible by Teck Facility Surveillance Officer (FSO) - Mr. Rob Muise and Mr. Ray Proulx (Alternate FSO) of Teck. Inspections are documented on a standard site inspection checklist. In 2017, routine inspections were completed between June and November 2017 and the inspection checklists were submitted to KCB by the FSO (included in Appendix IV). No adverse conditions or indicators of potential issues were identified during the routine inspections.
- Event-driven – completed by Teck FSO following a 24-hour rainfall event greater than the 10-year return period (67 mm total precipitation), M5 or greater earthquake recorded in the area (i.e., within 100 km of the site), or flooding of Bullmoose Creek.

  In 2017, no earthquakes were recorded by the Geological Survey of Canada within 100 km of the site and no rain event exceeding the 10-year return period precipitation was recorded; hence, no event-driven inspection was triggered. However, 2017 DSI site visit observations at nearby Bullmoose Sedimentation Ponds indicate a flood event had occurred, likely during 2017 spring freshet, in the Bullmoose Creek. The magnitude of the flood is not known but appeared to be significant based on observed amount of sediments and wooden debris along the creek. No event-driven inspection was carried out following the flood because precipitation threshold was not exceeded indicating the flood may have been caused by snowmelt, a localized rainfall event that wasn't measured at Chetwynd climate station, or combination of both.

The inspection program is appropriate for the BTD, given the long performance history of the dam, adequacy of instrumentation coverage, large flood storage capacity and provision of an open channel spillway.

4.2 Dam Safety Inspection Observations and Inspection Photographs

Refer to Figure 1 for an overview of the facility with 2017 inspection photograph locations. Inspection photographs are included in Appendix II. The following observations were made during the 2017 DSI site visit:

- **Dam Crest**: Good condition. No sign of lateral movement, significant differential settlement or cracking of the dam crest (Photos II-1 and II-10).
- **Downstream Slope**: Good condition. No visible sign of significant erosion or displacement, bulging at toe or crest settlement (Photos II-9, II-13, iI-16, and II-18 to II-22). Vegetation

(grasses and moss) is well established and there is minor rilling of the downstream slope. Refer to Section 5 for further discussion.

An erosion gully, likely caused by concentrated local flow during 2017 spring freshet, was observed on the east downstream slope (Photo II-15 at BTD-2017-12 on Figure 1). The gully is approximately 0.2 m to 0.3 m wide, 0.08 m to 0.11 m deep and 10 m to 15 m long. However, this feature does not represent an immediate dam safety concern but should be monitored and inspected during the routine visual inspections and the 2018 DSI site visit. If the gully's size appears to be increasing over time, for example by the time of the 2018 DSI, some repair may be indicated.

- **Upstream Slope**: Good condition. No sign of significant erosion or displacement (Photos II-2 to II-4, II-23 and II-24).
- **West Abutment**: Good condition. The spillway is excavated through the west abutment, no sign of erosion at the abutment (Photo II-27).
- **East Abutment**: Good condition. No sign of significant erosion or displacement of the natural slope. Vegetation is well established at the abutment and along the abutment/downstream slope contact (Photos II-12 and II-13). A small channel running along BTD downstream slope contact with east abutment towards the toe with estimated flow of 1 L/min was observed and appears to be unchanged from 2016 DSI's observation (Photo II-14).
- **Tailings Impoundment and Pond**: A pond (approximately 2 ha) is located along the northeast boundary (Photo II-5) and is approximately 400 m from the spillway inlet (see Figure 1). The impoundment is well vegetated (Photos II-11, II-23, and II-24) except near the pond (Photos II-5 and II-6). Away from the pond the impoundment is well drained and supports human/animal traffic (Photo II-11). The pond elevation was approximately 1115.5 masl which is similar to previous inspection records since 2014 (KCB 2014a). Minimal fluctuation of the pond elevation post closure seems to suggest that seepage at the BTD is fairly constant.
- **Spillway:** Good condition (Photos II-25 to II-30). Minor vegetation obstruction at the inlet and along the channel during the DSI site visit. However, Teck cleared vegetation at the inlet and along the channel in October 2017 as described in Section 2.2. Minor degradation of the riprap within the channel was observed and should be monitored during future DSI site visits and event-driven inspections follow flood events. Previous observations suggest vegetation inside spillway channel and at the inlet requires routine monitoring and removal. Vegetation clearing requirement every 2 years as specified in the OMS manual is considered adequate.
- **Depressions and Gullies in Tailings Beach:** The 2013 DSI (KCB 2014a) noted potential development of sinkholes and erosion gullies in the tailings surface and recommended annual monitoring. Since that time there is no visual change or evidence to support these features as sinkholes. These features are believed to be local depressions caused by ponded water or differential settlement and pose no identifiable risk to dam safety.
- **Historical Slope Failure in South Slope Above Impoundment:** a failure is present in the natural slope on the south side of the impoundment. The failure is also visible in photos from

previous inspection reports (Teck 2013a, KCB 2011, and KCB 2014a) indicating this has been present since at least 2010. The failed mass is overgrown with vegetation including small trees. A comparison of photographs between 2010 and 2016 does not indicate any significant change (KCB 2017a). This feature is not a risk to the dam safety.

4.3 Instrumentation Review

Instrumentation at BTD includes 13 piezometers (11 standpipes and 2 pneumatics) to monitor piezometric levels across the BTD, and 7 survey monuments installed on the BTD crest and downstream slope to monitor dam movement and settlement. Locations of the piezometers and the survey monuments are shown in Figure 1.

4.3.1 Piezometers

A summary of the functional piezometers is presented in Table 4.1. The OMS manual requires piezometers be read once per year to continue to document the low piezometric surface in the dam.

11 standpipes and 2 pneumatic piezometers were measured during the 2017 DSI site visit (see Figure 2). Four monitoring wells were also monitored; however, because no proper labels were provided to these wells, water levels obtained from these wells are not relied upon. These monitoring wells are not critical for on-going monitoring of the BTD.

Simplified falling head tests and instrument sounding were performed on standpipe piezometers PA-1, PA-2, PB-1, PB-3, PC-1, PC-2 and PC-3 during the 2017 DSI site visit and verified that these standpipe piezometers are operational (i.e., increased water head dissipated and water level returned to, or within 1% difference to the original water level within 1 hour). Instrument sounding and review of historical data indicates that piezometers PA-1 and PA-2 labels were likely switched in 2015; as a result, 2015 and 2016 piezometric data for PA-1 and PA-2 were revised.

Table 4.1 Summary of Piezometers

Piezometer ID	Tip Location	Instrument Location	Coordinates[1] (m)		Original Ground Elevation (masl)	Existing Ground Elevation (masl)	Instrument Tip Elevation (masl)
			Easting	Northing			
PA-1	Foundation	Crest	597396	6111244	1084.0	1112.5	1077.3
PA-2	Dam	Crest	597396	6111244	1084.0	1112.5	1083.4
PA-4	Foundation	Downstream Slope	597402	6111284	1081.0	1092.7	1077.3
PA-5	Dam	Downstream Slope	597402	6111284	1081.0	1092.7	1079.0
PA-3N	Dam	Crest	597364	6111174	1082.0	1123.0	1094.8
PB-1	Foundation	Crest	597126	6111148	1086.0	1123.0	1081.9
PB-3	Dam	Crest	597126	6111148	1086.0	1123.0	1099.5
PB-4	Foundation	Downstream Slope	597094	6111219	1086.0	1100.5	1080.1
PB-5	Foundation	Downstream Slope	597094	6111219	1086.0	1100.5	1081.6
PC-1	Foundation	Crest	596949	6110991	1091.0	1120.5	1083.7
PC-2	Dam	Crest	596949	6110991	1091.0	1120.5	1090.3
PC-3	Dam	Crest	596949	6110991	1091.0	1120.5	1101.8
PC-4N	Foundation	Downstream Slope	596881	6111020	1094.0	1109.5	1093.5

Notes:
1. Coordinates are from GPS readings (NAD83 UTM Zone 10N).

Threshold values (i.e. QPOs) were developed during operations based on stability and seepage analysis, with the threshold warning levels determined as follows (KC 1999):

- Threshold Warning Level I = the facility is still meeting a design factor of safety (FoS) of 1.5;
- Threshold Warning Level II = the facility is experiencing piezometric conditions that have reduced the FoS to between 1.2 and 1.5; and
- Threshold Warning Level III = the facility is experiencing piezometric conditions that have reduced the FoS to less than 1.2.

In the event that a piezometer threshold is reached or exceeded, the following procedures were to be followed (Teck 2014a):

- Threshold Warning Level I = Normal impoundment operations may continue if piezometer water elevations are at or below;
- Threshold Warning Level II = Notify design engineer if exceeded; and
- Threshold Warning Level III = Notify design engineer if exceeded; Mine Manager to initiate emergency response as required (refer to Teck's EPRP document).

The above threshold levels and responses were appropriate during operations of the BTD. KCB completed detailed review of the piezometer data prior to 2003 and from 2014 and 2017 and recommends that the following piezometer threshold levels and responses be adopted for on-going surveillance of the BTD under "Closure-Passive Care" condition. Threshold responses are summarized in Table 4.2.

- Threshold Level 1 if piezometer reaches conditions that reduce the FoS of the dam equal to or below 1.5 (i.e., equivalent to KC (1999) Threshold Warning Level II – see Figure 2); and
- Threshold Level 2 if there are Threshold Level 1 exceedances at 2 or more piezometers on an instrumentation section.

Table 4.2 Proposed Responses to Piezometer Thresholds Exceedances

Response Level	Exceedance Threshold	Action
1	Exceedance of established threshold in an individual piezometer	▪ Measure again within 24 hours and increase monitoring frequency to weekly. ▪ Notify EoR within 24 hours of second reading. ▪ EoR to evaluate data for reliability, and review piezometer data within the general vicinity of the individual piezometer in question.
2	Common trend of threshold exceedances in a group of piezometers	▪ Increase monitoring frequency of the piezometers as recommended by EoR based on assessment of common trend. ▪ EoR to assess stability, stability analysis may be initiated.

Figures 2 and Figure 3 summarize recent and historical piezometer readings. Figure 4 shows piezometric level across dam schematic Sections A to C.

The following observations are made based on the 2017 piezometric data:

- 13 piezometers, and 4 monitoring wells installed in the dam (KC 1999) were identified and measured.
- None of the measured piezometers exceed Threshold Level 1.
- All measured piezometers have similar water levels to those measured in 2016 except PA-2, PA-4 and PA-5 (see Figure 3).
  - PA-2 water level has dropped about 4 m between 2014 and 2015; the instrument has been relatively stable since 2015 with a slight increase in 2017.
  - PA-4 water level is also relatively stable with a slight increase in 2016 and 2017.
  - PA-5 2017 water level is similar to 2015. A drop of water level by 3 m in PA-5 was noted in 2016 ("dry" condition); however, no dam safety related issues or observations were noted in the 2016 DSI report (KCB 2017a). PA-5 and adjacent piezometer PA-4 are showing similar water level in 2017 (1082 masl).
- 6 piezometers (PB-1, PB-3, PB-5, PC-2, PC-3 and MW-1/5) were "dry" (no water table measured within piezometer casing). Piezometers PB-4 located adjacent to PB-5 indicates water level slightly below PB-5 tip elevation (Figure 4).

Low pore pressures in the downstream shell of the dam indicate that dam drainage and foundation seepage capacity exceeds flow requirements (see Figure 4). Pore pressures have been stable and the dam shell is drained with low gradient of approximately 0.04 to 0.05 (KCB 2018b). Operation and construction induced pore pressure responses are no longer observed. Therefore, piezometers monitoring frequency of once per year is sufficient for ongoing monitoring of the structure under "Closure-Passive Care" conditions.

KCB recommends Teck to provide new caps and labels to the standpipe piezometers to avoid labels from being switched during future readings. PA-1 top of casing appears to be broken and requires some repair work (Photo II-8).

4.3.2 Survey Monument Pins

7 survey monuments were installed on the BTD in July 2015. Teck has completed 6 survey readings (2 readings per year) which are summarized in Figure 5. Survey measurements are also shown in Figures 6 through 8. After the completion of May 2017 reading, QPOs for the survey monuments and their reading frequency have been established and were recommended in a separate letter (KCB 2017b). QPOs summary and recommendations are as follow:

- Thresholds Level 1 were developed based on the maximum observed survey measurement to date plus approximately 20%. The threshold is exceeded if:
  - Horizontal movement ≥ 25 mm from the initial reading;
  - Vertical movement ≥ 25 mm from the initial reading; or
  - Vertical movement ≥ 15 mm between successive readings.

Threshold Level 1 values are illustrated in Figures 6 to 8.

- Threshold Level 2:
  - If there are Threshold Level 1 exceedances at 2 or more monuments on a section.

Threshold Level 2 was developed such that responses are based on a trend of instruments exceeding Threshold Level 1 rather than an individual monument exceeding a threshold in a single occurrence, which may have been caused by reading error or faulty instrument, leading to unnecessary increase in monitoring of the instrument.

The recommended responses for the Threshold Levels are summarized in Table 4.3.

Table 4.3 Proposed Responses to Survey Monument Thresholds Exceedances

Response Level	Exceedance Threshold	Action
1	Exceedance of established threshold in one survey monument	▪ Notify EoR within 24 hours upon verification of reading exceedance. ▪ EoR to evaluate data for reliability, and review survey data within the general vicinity of the individual survey monument in question. EoR may recommend repeat measurement and increased on-going monitoring frequency.
2	Common trend of threshold exceedances in a group of survey monuments (2 or more adjacent monuments)	▪ Notify EoR within 24 hours upon verification of reading exceedance. ▪ Repeat reading within 1 week. ▪ EoR to assess dam integrity and may recommend analyses, site visit or other action.

A comparison between the initial readings (October 2015) and the May 2017 readings is summarized in Table 4.4. From a review of the data, there appears to be no general trend or significant settlement and the observed movement appears to be within the survey accuracy. Overall trends can be more confidently interpreted as the number of survey readings increase.

Table 4.4 2015/2017 Survey Monument Comparison

Monument	Changes Between 2017 and Initial (2015) Surveys		
	E[(1)] (mm)	N[(1)] (mm)	Elevation[(2)] (mm)
M1	10.27	-0.71	-5.57
M2	10.08	-2.98	-3.60
M3	-0.21	0.35	-0.20
M4	2.01	-2.15	-0.57
M5	-6.43	7.49	-9.77
M6	-2.68	8.26	-4.96
M7	-7.08	7.36	7.23

Notes:
1. The monument surveys are reported in an assumed ground coordinate system, in order to make it clear that the monitoring is a ground system where the measurements recorded are true ground distances and not derived from a projected coordinate system. This eliminates the need to apply project specific related scale factors to the measurements, prior to movement analysis being undertaken.
2. Elevations reported are relative elevations.

Based on the available survey data to date, the survey frequency for each monument can now be reduced to once per year based on the following:

- The dam has been inactive for 15 years, the water level within the impoundment tailings has significantly below the spillway invert since the facility was closed and there are no noted issues of slope instability.
- No general trend in the downstream direction based on available survey data since installation in October 2015.
- No significant settlement was observed and recorded settlements can be accommodated without reducing the minimum required freeboard.
- Reading the survey monuments annually is consistent with the current piezometer reading frequency.

4.4 Discharge Water Quality

Inflows and outflows at the Bullmoose TSF is summarized in Section 3.3. Groundwater sampling wells are installed downstream of the tailings dam, with samples collected for water quality analyses. Teck reports the results to MOE as specified in Permit No. PE-06757. These results are not repeated or discussed herein.

5 DAM SAFETY ASSESSMENT

5.1 Design Basis Review

The relevant criteria from CDA (2014) and the Code (MEM 2017) are compared in Table 5.1. The BTD is considered to be under "Closure-Passive Care" since sufficient time has passed since the closure work was completed in 2003 and instrumentation data has indicated the dam has reached a steady state condition (KCB 2018a). The dam was reviewed with respect to these design criteria as described in Sections 5.3 and 5.6.

Table 5.1 Comparison of CDA and HSRC Design Criteria for Tailings Dams Classified as "High"

Parameter	CDA (2014) "High" Consequence Classification	HSRC (MEM 2017)[1]
Inflow Design Flood (IDF) Annual Exceedance Probability (AEP)	$^2/_3$ Between 1000-Year and Probable Maximum Flood (PMF)	$^1/_3$ Between 975-Year and PMF
Earthquake Design Ground Motion (EDGM) AEP	½ Between 2475-Year and 10,000-Year	2475-Year
Factor of Safety (FoS) for Slope Stability: 1) Static – Long-term 2) Pseudo-Static 3) Post-Earthquake	 1.5 1.0 1.2	 1.5 Not Specified Not Specified
Steepest Allowable Downstream Slope	Not Specified (BTD steepest overall slope is 2.5H:1V at Section A – see Figure 1)	2H:1V

Notes:
1. The HSRC Code (MEM 2017) does not specify IDF or EDGM for "Closure-Passive Care" phase.

5.2 Dam Safety Review

The first and most recent DSR of the BTD was completed in 2015 (Golder 2016). The next DSR should be completed in 2020 (in 5 years from the previous), based on requirements under the Code and Teck's internal requirements (Teck 2014b).

5.3 Failure Modes Review

The Code requires identification of potential hazards and failure modes described in CDA (2013) be assessed and included in the DSI report as a standard practice. Based on the DSI observations and review of available documents regarding the BTD (Appendix V), the potential failure modes were reviewed:

- **Overtopping:** The pond level (visually estimated) is 7 m to 8 m below spillway invert level. At this level, the available flood storage before spilling is more than 5 times the IDF volume (KCB 2015b) (see Section 5.6.2 for more details). In the extreme event where the pond is at the spillway invert level at the start of the IDF, the spillway would have sufficient capacity to pass the peak flow (KCB 2015b). If the spillway was completely blocked and the pond was at the spillway invert at the start of the IDF event, the IDF can be contained with 0.4 m freeboard.

Based on these factors, the likelihood of an overtopping failure is considered to be "Close to Non-Credible"[6] per the previous detailed evaluation (KCB 2015b).

- **Internal Erosion and Piping:** The dam is a semi-pervious design (i.e., no compacted core or seepage barrier) which allows seepage flow through the dam fill. The DSR noted that (PD-2015-03): "Approximately one third of the available gradations of CCR are potentially internally unstable" (Golder 2016). They recommended the potential for critical hydraulic gradients through the dam, which could result in internal erosion of the CCR, be assessed (Golder 2016). KCB reviewed this issue and concluded:
  - No visual indicators of tailings or CCR being washed through the dam have been observed during recent inspections (i.e., sinkholes, turbid seepage).
  - No noted issues relating to internal erosion were referenced during construction and operations in the available documentation (Appendix V).
  - Seepage rates and piezometric gradients for the existing BTD are lower than those experienced during operations; this significantly reduces the risk of internal erosion developing under existing conditions.
  - No known trigger to initiate internal erosion in the current condition, or to establish gradients above critical hydraulic gradient (KCB 2018b).

  Based on performance to date and the KCB (2018b) internal stability assessment, the likelihood of a failure due to piping is considered to be "Rare"[7]. KCB 2015 filter assessment showed adequate filter compatibility at interfaces between tailings and CCR, as well as between the starter dam fill and CRR (KCB 2015a).

- **Slope Instability:** The dam is composed of compacted fill with a free draining downstream shell and drainage layers. The downstream slope of the dam is 2.5H:1V. The FoS reported in design was greater than 1.7 (KC 1996), which exceeds the Code requirements. 2017 piezometer readings indicate that the pore pressures in the dam are similar to mine closure levels and are all below Threshold Level 1. This analysis and the long performance history with no visible or documented displacements indicates the likelihood of a failure due to slope instability is considered to be "Very Rare"[8].
- **Foundation Failure:** The dam is constructed on a competent foundation with no known weak layers identified in the available design documents (refer to Section 5.6.1 for more

[6] "Close to Non-Credible" Likelihood Rating is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is greater than 1 in 10,000 years; this rating is also applicable for failure modes such as instability and internal erosion that are close to non-credible. Factor of safety (FoS) against slope instability of 2.0 or greater.
[7] "Rare" Likelihood Rating is defined similar to "Close to Non-Credible" rating, except with a natural hazard return period between 1 in 100 years and 1 in 1000 years; this rating is also applicable for failure modes that are rare. FoS against slope instability of 1.3 to 1.5.
[8] "Very Rare" Likelihood Rating is defined similar to "Rare" rating, except with a natural hazard return period between 1 in 10,000 years; this rating is also applicable for failure modes that are rare. FoS against slope instability of 1.5 to 2.0.

information). The likelihood of a failure due to foundation irregularities is considered to be "Rare".

- **Surface Erosion:** Both the upstream and downstream slopes of the dam have a vegetation cover to protect against surface erosion. The erosion gully observed during 2017 site visit appeared to be well vegetated, indicating the erosion has not progressed since its formation. In addition, the vegetation should also help protect the gully from 2018 spring freshet runoff. The gully poses no immediate dam safety and stability concern.

  Some minor rilling of the downstream slope was observed. They and appears to be stable based on comparison with previous DSI photographs; therefore, they are not considered a dam safety concern.

  The likelihood of failure due to surface erosion is considered to be "Very Rare".

- **Erosion During Bullmoose Creek Flood:** South and West Bullmoose Creeks flood studies were completed by KCB in 2017, as per DSR recommendation (PD-2015-02) (Golder 2016), to determine the potential for erosion resulting from the flooding of the West Bullmoose Creek and/or the South Bullmoose Creek. The studies indicate the likelihood of an erosion at the BTD toe due to the design flood events in both creeks is considered to be "Close to Non-Credible"; maximum flood level corresponding to the $^2/_3$ between 1000-year and PMF event is 2 m below Bullmoose Mine Road and the flood inundation extent is at least 40 m from the BTD toe (KCB 2017d) (see Figure 1 for Bullmoose Mine Road location).

- **Earthquakes:** The latest pseudo-static stability analysis completed by KC (1996) used a seismic acceleration of 0.1g with the resulted FoS of 1.2 against significant deformation. CDA (2014) recommends a ½ way between 2475-year and 10,000-year return period earthquake for the design of a "High" consequence classification dam.

  The Peak Ground Acceleration (PGA) for the design return period is 0.181g based on a simplified seismic hazard assessment using an updated NBCC (2015) hazard values and a log-log extrapolation methodology (KCB 2017c). Hynes-Griffin and Franklin (1984) states that if a yield acceleration is greater than 50% of the PGA (0.091g), a deformation is likely to be minimal with respect to dam integrity (less than 1 m). The BTD meets this criteria, indicating the likelihood of a failure caused by deformation during the design EDGM is considered to be "Very Rare". KCB recommends a site specific seismic hazard assessment to improve confidence in the EDGM appropriate for the BTD and to derive a Uniform Hazard Response Spectra (UHRS) for an appropriate return period.

5.4 Upstream and Downstream Conditions Review

5.4.1 Upstream

There have been no significant changes in the upstream condition since mine closure in 2003. No mine infrastructure is located upstream of the BTD impoundment with the exception of a mine road, and a diversion ditch as described in Section 3.1.

5.4.2 Downstream

There have been no significant changes in the downstream condition since mine closure in 2003. KCB (2014b) flood inundation study indicates the flood route downstream of the tailings storage facility is generally unpopulated. The town of Tumbler Ridge is the only populated center within the study area. There are recreation sites including walking, hiking and all-terrain vehicle trails throughout the downstream drainage route, as well as industrial sites and other infrastructures. No loss of life is expected from the permanent population within the studied flood zone.

Bullmoose Creek and flood plain along the creek is considered an important fisheries and wildlife habitat. A number of animal species listed under the federal Species at Risk Act (SARA) are potentially present in the area as well as species listed provincially as red or blue and regionally important bird species (KCB 2014b).

The most significant industrial site, due to its proximity to the dam, is the Talisman Gas Plant and supporting infrastructures (i.e., powerlines and pipelines). The gas plant is located approximately 2 km downstream of the TSF, and its electric sub-station is less than 200 m from the dam. A tailings runout analysis completed by KCB (2014b) indicates that the sub-station is located within an inundation extent of a hypothetical “Sunny Day” tailings runout failure.

5.5 Dam Classification Review

Consequence classification is not related to the likelihood of a failure, but rather related to the potential impact resulting from of a failure if it did occur. Design basis for dams are then selected based on their consequence rating. The BTD was classified as a “High” consequence classification structure based on CDA (2013) and an inundation study and consequence review completed by KCB (2014b). The factors considered in the classification of the BTD are listed in Table 5.2.

Table 5.2 Classification of BTD Based on Consequence Category

Population at Risk	Loss of Life	Economic and Social Loss	Environmental and Cultural Losses
No Permanent Population	Significant	High	High

There have been no significant changes to the TSF, upstream or the downstream condition since last consequence classification review (KCB 2014b) that would require a revision to this classification.

5.6 Physical Performance

5.6.1 Geotechnical

The dam has performed adequately for over 30 years, and there is no record of slumping or instability since operations ceased in 2003. The closure work in 2003 included re-sloping of the downstream slope to approximately 2.5H:1V (BOC 2003, Teck Cominco 2003).

The dam is composed of compacted fill with a free draining downstream shell and drainage layers (refer to Drawing D-108 in Appendix III). Review of piezometer data prior to 2003 and from 2014 to 2017 indicates pore pressures have been stable and the dam shell is drained with a low gradient (i.e., dam drainage and foundation seepage capacity exceeds flow requirements).

The dam is constructed on dense to very dense, non-liquefiable surficial silty sand and gravel, glacial till consisting of a silt-sand-gravel mixture and alluvial silty granular soils (KCB 2015a). No weak layers were identified in the available design documents, and organics and surficial unsuitable materials were reported to be excavated prior to fill placement. Stability analysis indicate that the dam meets the static and seismic stability criteria as described in Section 5.3.

5.6.2 Hydrotechnical

The BTD spillway was designed for an IDF equivalent to the 1000-year return period (KC 2001). This complied with dam safety guidelines at the time (CDA 1999). However, under CDA (2014), the recommended IDF for the BTD, a "High" consequence classification dam, is the $^2/_3$ between the 1000-year return period and PMF, which is considered appropriate under the Code. A hydrotechnical review of the spillway undertaken in 2015 by KCB (2015b) concluded the spillway can safely route the IDF recommended by CDA (2014) while maintaining 0.5 m of freeboard[9] (or 0.4 m of freeboard assuming a fully blocked spillway). The minimum required freeboard of 0.2 m was determined in the KCB (2015b) assessment using the wave setup and wave runup methodologies described in CDA (2013).

The TSF has approximately 680,000 m^3 of available storage before discharging through the spillway. There is an additional 187,600 m^3 of flood storage between the spillway invert and the BTD crest.

Historical observations show the pond vary between elevations 1115 masl to 1116 masl and is approximately 400 m from the spillway. Discharge through the spillway has not been observed in the past.

Based on these factors, the likelihood of an overtopping failure is considered to be "Close to Non-Credible" as discussed in Section 5.3.

5.7 Operational Performance

The BTD has been closed for about 15 years and, as indicated in Section 2, there are no operational requirements.

5.8 Documentation Review

5.8.1 Operation, Maintenance and Surveillance Manual

The OMS manual for the BTD was updated by Teck in 2018. In general, the updated OMS manual addressed all the recommendations from the 2015 DSR (Golder 2016) with exception of

[9] KCB (2015b) conservatively assumed the pond elevation to be at the spillway invert (El. 1122 masl) at the start of the design storm events.

recommendation ONC-2015-08 with regards to instrumentation reading procedures. Survey monument reading procedures still need to be included in the OMS manual (see Table 6.3 for reference).

The OMS manual specifies that the FSO must be trained (workshops) to be familiar with the OMS requirements, BTD design and components, environmental and safety awareness, and emergency preparedness and response procedures. Mr. Rob Muise of Teck is the current designated FSO for the BTD and Mr. Muise meets the stated requirements.

BTD management organization chart is up to date. Teck has indicated that the OMS document was added to Teck's Legacy Properties document control system and was signed by Teck's BTD Engineering and Remediation Manager before being distributed to the parties included in the document distribution list. The OMS manual requires the document be reviewed and, if necessary, updated on an annual basis.

Guidance on visual inspections are included as well as thresholds (i.e., QPOs) for the piezometers and survey monuments that are used to indicate compliance with stability assessment assumptions. If a threshold is exceeded, the OMS manual includes a corresponding response action and timeline to complete.

In general, the OMS document meets the CDA (2013) and Teck (2014) TWRS requirements and the document follows the format recommended in MAC (2011).

5.8.2 Emergency Preparedness and Response Plan

An EPRP was updated and issued in draft version in January 2017; however, the following DSR (Golder 2016) recommendations are remaining to be addressed (see Table 6.3 for reference):

- Recommendation No. ONC-2015-09: Flood management due to flooding of West Bullmoose Creek should be included in the EPRP – flood studies were completed by KCB (2017d); and
- Recommendation No. ONC-2015-10: Include records of personnel training in emergency procedures.

BTD management and incident command organization charts are up to date in the EPRP document. Teck indicates that the EPRP document was added to Teck's Legacy Properties document control system and must be signed by Teck's BTD Engineering and Remediation Manager, before being distributed to the parties included in the document distribution list. The EPRP requires the documents be reviewed and, if necessary, updated on an annual basis. Teck is planning to issue the updated EPRP in the first quarter of 2018.

6 SUMMARY AND RECOMMENDATIONS

The BTD appears to be in good working condition and the observed performance is consistent with the expected design conditions. Comparison of the observed condition of the dam with the referenced design and inspection reports indicates there has been no significant change to the condition of the structure since the site was closed in 2003. Review of the instrumentation data indicates that the BTD has reached steady state condition.

Maintenance work carried out in 2017 at the BTD includes vegetation clearing at the spillway inlet and along the channel in October. Routine visual inspections, instrumentation readings, and the DSI were completed as per the Code, OMS and Teck's internal requirements. Visual inspections and instrumentation data indicate no dam safety issues.

Total precipitation measured in 2017 was higher than the climate normals but not sufficient to trigger event-driven inspections. The water balance assessment estimated seepage rates within the expected range.

The BTD is a "High" consequence classification dam as per CDA (2013). The facility is considered to be under "Closure-Passive Care" as per CDA (2014) (KCB 2018a). There have been no significant changes to the upstream and downstream conditions since the last consequence classification review (KCB 2014b); therefore, no change in the dam consequence classification is required.

The OMS manual was updated in early 2018 and is considered up to date. Teck is planning to update the EPRP in the first quarter of 2018.

Past recommendations regarding the dam that are still outstanding are summarized in Table 6.1. Closed recommendations are shown in italics and will be removed from the table in next year's DSI report. Recommendations resulting from the 2017 DSI are summarized in Table 6.2. The recommendations from the 2015 DSR (Golder 2016) are summarized in Table 6.3.

Priority guidelines, specified in the Code, are assigned to each recommendation by KCB. Priority guidelines are as follow:

- Priority 1: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
- Priority 2: If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
- Priority 3: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
- Priority 4: Best Management Practice – further improvements are necessary to meet industry best practices or reduce potential risks.

Table 6.1 Previous Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
BTD-2015-01 (DSI-BTD-10)	*Survey Monitoring Requirements*	*n/a*	*After 6 (minimum) monument surveys have been completed, review available data and define appropriate threshold values, which should then be added to the OMS manual.*	*3*	*CLOSED*
BTD-2016-01	*EoR Named in OMS*	*OMS Manual*	*Update the EoR currently listed in the OMS manual.*	*3*	*CLOSED*

Table 6.2 2017 Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
BTD-2017-01	Seismic Hazard Assessment for "Closure-Passive Care"	HSRC Code	Conduct a site specific seismic hazard and stability assessment for the BTD using the Code recommended design criteria for a "High" consequence classification dam under "Closure-Passive Care" condition.	4	December 2019 (OPEN)
BTD-2017-02	Erosion Gully	OMS Manual	KCB to review erosion gully observed at the BTD downstream slope near the east abutment in 2018 DSI.	3	December 2018 (OPEN)
BTD-2017-03	Piezometers and Freeboard Threshold Levels	HSRC Code	Teck to install a stake during routine visual inspection at the BTD in spring of 2018. The stake should be installed 1 m above the steady state pond level.	3	June 2018 (OPEN)

Table 6.3 DSR Deficiencies and Recommendations

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
2016-02	*Seismic Assessment*	*HSRC Code*	*DSR Recommendation (PD-2015-01): Update the seismic assessment with respect to the maximum design earthquake (MDE) based on the revised national building code.*	*2*	*CLOSED*
2016-03	*Flood Assessment*	*n/a*	*DSR Recommendation (PD-2015-02): Assess the risk of erosion of the BTD toe due to the flooding of the West Bullmoose Creek and the South Bullmoose Creek.*	*2*	*CLOSED*
2016-04	*Filter Compatibility Assessment*	*n/a*	*DSR Recommendation (PD-2015-03): Assess the potential for critical hydraulic gradients through the dam based on the assessment that approximately one third of the coarse coal rejects (CCR) gradations were noted to be potentially unstable.*	*2*	*CLOSED*
2016-06	*Surveillance Officer Training*	*OMS Manual*	*DSR Recommendation (ONC-2015-01): Training to be provided to the surveillance officer and in the event of new personnel or role changes.*	*3*	*CLOSED*
2016-08	*Alternate Personnel*	*OMS Manual*	*DSR Recommendation (ONC-2015-03): Identify alternate contacts for roles relating to the BTD. Also, develop and implement an organizational chart and chain-of-command.*	*3*	*CLOSED*
2016-09	*Sign-off Procedures*	*OMS Manual*	*DSR Recommendation (ONC-2015-04): Include a sign-off and indication of recorded documentation in the OMS.*	*3*	*CLOSED*
2016-13	Procedure Documentation	OMS Manual	DSR Recommendation (ONC-2015-08): Procedures regarding instrumentation readings, frequency and data management should be documented within the OMS as well as the threshold values and procedures relating to the triggering of thresholds.	3	December 2018 (OPEN – to be closed once survey monuments reading procedures are included in the OMS manual)
2016-14	Flood Management	EPRP	DSR Recommendation (ONC-2015-09): Flood management due to flooding of West Bullmoose Creek should be included in the EPRP.	3	December 2018 (OPEN – to be closed once EPRP is finalized)
2016-15	Emergency Training Records	EPRP	DSR Recommendation (ONC-2015-10): Include records of personnel emergency training in emergency procedures.	3	December 2018 (OPEN - to be closed once EPRP is finalized)

ID Number	Deficiency or Non-Conformance	Applicable Regulation or OMS Manual Reference	Recommended Action	Priority	Recommended Deadline (Status)
2016-16	Updating of EPRP	EPRP	DSR Recommendation (ONC-2015-11): Document the frequency of the revisions to the EPRP in the EPRP.	3	December 2018 (OPEN - to be closed once EPRP is finalized)
2016-17	Roles and Responsibilities	EPRP	DSR Recommendation (ONC-2015-12): Develop a chain-of-command and organization chart and include within the EPRP.	3	December 2018 (OPEN – chain-of-command is included in the draft EPRP. Recommendation can be closed once EPRP is finalized)

7 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Teck Resources Limited (Client) for the specific application to the 2017 Dam Safety Inspection. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

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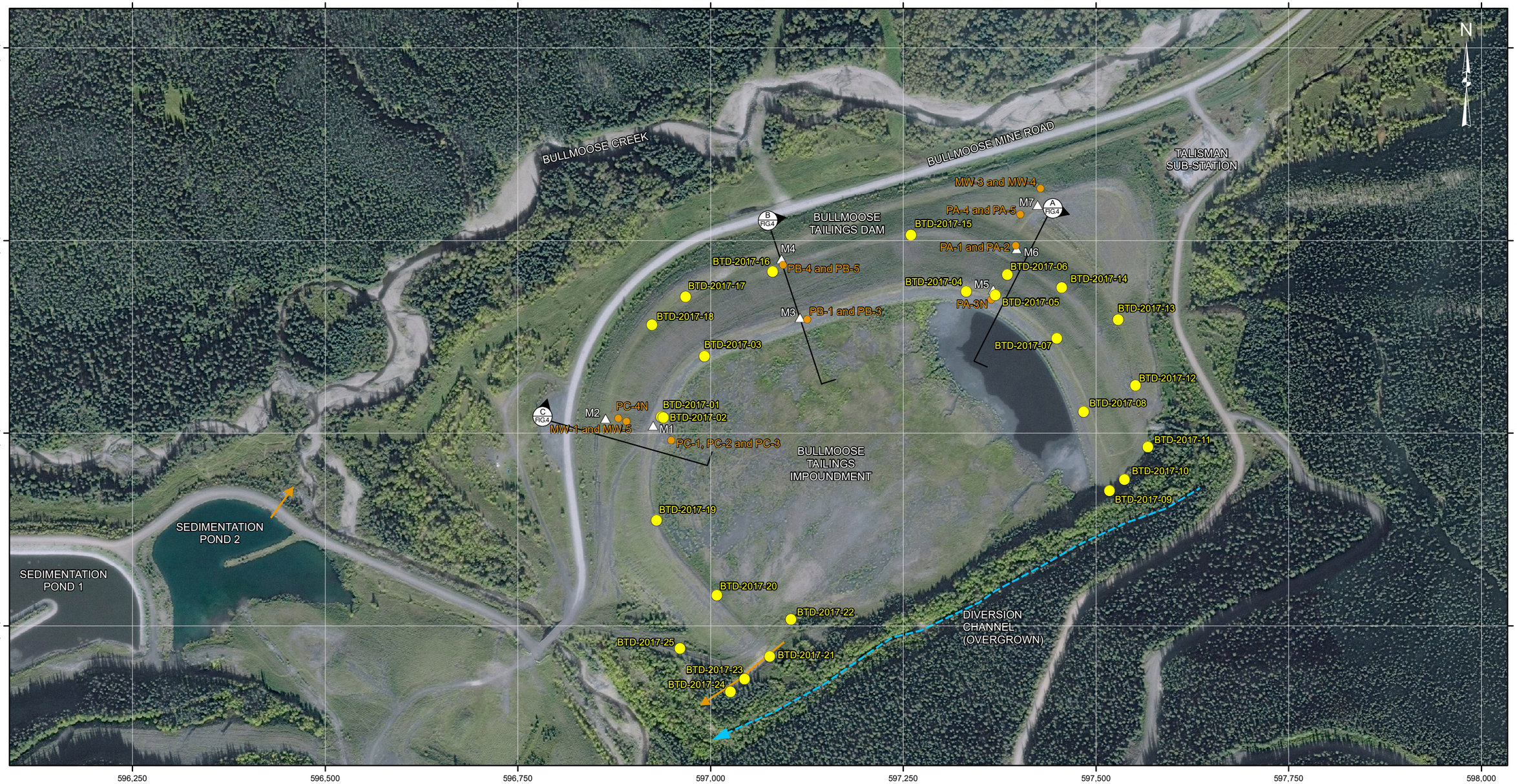
FIGURES



NOTES:
1. PROJECTION: NAD83 UTM ZONE 10N.
2. BASE DATA: TRIM, DATE: 1996.
3. SEPTEMBER 2013 IMAGERY FROM TECK.

LEGEND:

- BTD-2017-23 — 2017 DSI PHOTOGRAPH LOCATIONS
- M1 — SURVEY MONUMENTS
- PC-4N — PIEZOMETERS
- SPILLWAY
- DIVERSION CHANNEL

NOT FOR CONSTRUCTION

SCALE 0 150 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

TITLE: BULLMOOSE TAILINGS DAM
GENERAL ARRANGEMENT

PROJECT No. M09893A07

FIG No. 1

Path: Z:\MV\CR\M09893A07-TML-Bullmoose 2017 Consulting\400 Drawings\GIS\MXD\Reports\2017_Dam_Safety_Inspection\Bullmoose_Tailings_Dam.mxd

SECTION	PIEZOMETER	COORDINATES (m)		ORIGINAL GROUND (masl)	EXISTING GROUND ELEVATION (masl)	PIEZO. SCREEN / TIP ELEVATION (masl)	MEASURED STICKUP (m)	PNEUMATIC READING (PSI)	2017 STANDPIPE READING (m)	2017 DSI WATER ELEVATION (masl)	WATER ELEVATION LOWER THAN (IF DRY)	THRESHOLD LEVEL 1 (masl)	WATER LEVEL ABOVE ORG. GROUND (m)	2016 DSI WATER ELEVATION (masl)	CHANGE FROM 2016 (m)	PIEZOMETER LOCATION	
		EASTING	NORTHING													LOCATION	UNIT
SECTION A	PA-1 (RELABELLED IN 2017)	597396	6111244	1084.0	1112.5	1077.3	0.76	-	34.9	1078.4	-	≥1100.0	-5.6	PLUGGED	-	DOWNSTREAM SLOPE	FOUNDATION
	PA-2 (RELABELLED IN 2017)	597396	6111244	1084.0	1112.5	1083.4	0.71	-	27.9	1085.3	-	≥1100.0	1.3	1084.7	0.6	DOWNSTREAM SLOPE	DAM
	PA-4	597402	6111284	1081.0	1092.7	1077.3	1.74	-	12.1	1082.4	-	≥1088.0	1.4	1081.5	0.9	DOWNSTREAM SLOPE	FOUNDATION
	PA-5	597402	6111284	1081.0	1092.7	1079.0	1.83	-	12.3	1082.2	-	≥1088.0	1.2	1079.2	3.0	DOWNSTREAM SLOPE	DAM
	PA-3N	597364	6111174	1082.0	1123.0	1094.8	-	0.3	-	1095.0	-	≥1107.0	13.0	1094.9	0.1	CREST	DAM
	NO LABEL (MW-3)	597428	6111318	1076.7	1090.0	1053.7	1.30	-	23.7	1067.7	-	≥1095.0	-9.1	1067.4	0.3	DOWNSTREAM SLOPE	FOUNDATION
	NO LABEL (MW-4)	597428	6111318	1076.7	1090.0	1068.3	1.23	-	16.4	1074.9	-	≥1095.0	-1.8	DRY	≥6.6	DOWNSTREAM SLOPE	FOUNDATION
SECTION B	NO LABEL (LIKELY PB-1)	597126	6111148	1086.0	1123.0	1081.9	0.20	-	40.6	DRY	1082.7	≥1107.0	N/A	DRY	N/A	CREST	FOUNDATION
	PB-3	597126	6111148	1086.0	1123.0	1099.5	1.06	-	24.2	DRY	1099.9	≥1107.0	N/A	DRY	N/A	CREST	DAM
	PB-4	597094	6111219	1086.0	1100.5	1080.1	1.33	-	20.4	1081.5	-	≥1095.0	-4.6	1081.4	0.1	DOWNSTREAM SLOPE	FOUNDATION
	PB-5	597094	6111219	1086.0	1100.5	1081.6	1.36	-	20.3	DRY	1081.6	≥1095.0	N/A	DRY	N/A	DOWNSTREAM SLOPE	FOUNDATION
SECTION C	PC-1	596949	6110991	1091.0	1120.5	1083.7	1.04	-	36.2	1085.3	-	≥1110.0	-5.7	1085.4	-0.1	CREST	FOUNDATION
	PC-2	596949	6110991	1091.0	1120.5	1090.3	1.74	-	30.0	DRY	1092.2	≥1110.0	N/A	DRY	N/A	CREST	DAM
	PC-3	596949	6110991	1091.0	1120.5	1101.8	1.38	-	17.7	DRY	1104.2	≥1110.0	N/A	DRY	N/A	CREST	DAM
	NO LABEL (MW-1/MW-5)	596891	6111015	1093.5	1111.5	UNKNOWN	0.68	-	22.7	1089.5	-	-	-4.0	1089.7	-0.2	DOWNSTREAM SLOPE	FOUNDATION (MW1 OR MW5)
	NO LABEL (MW-1/MW-5)	596891	6111015	1093.5	1111.5	UNKNOWN	1.04	-	17.7	DRY	1094.9	-	N/A	DRY	N/A	DOWNSTREAM SLOPE	FOUNDATION (MW1 OR MW5)
	PC-4N	596881	6111020	1094.0	1109.5	1093.5	-	0.8	-	1094.1	-	≥1100.0	0.1	1094.1	0	DOWNSTREAM SLOPE	FOUNDTATION

NOTES:

1. COORDINATES LOCATIONS ARE FROM GPS READINGS (NAD83 UTM ZONE 10N). ORIGINAL GROUND ELEVATION IN TABLE ARE FROM KL (1982). EXISTING GROUND ELEVATIONS WERE PROVIDED BY TECK COAL LTD.

CLIENT: Teck

Klohn Crippen Berger

PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

TITLE: BULLMOOSE TAILINGS DAM
2017 PIEZOMETER READINGS

PROJECT No. M09893A07

FIG. No. 2

Date & Time: 2018-03-12 16:02
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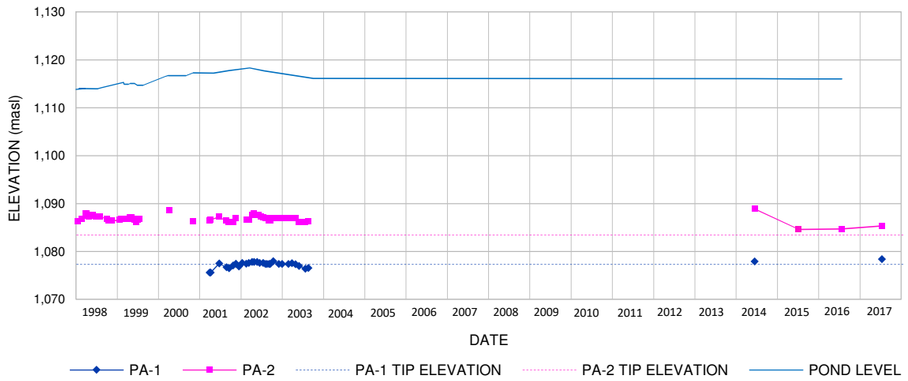

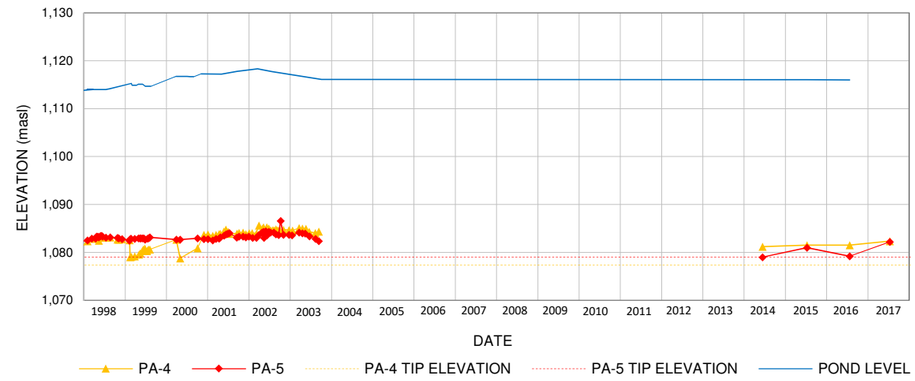

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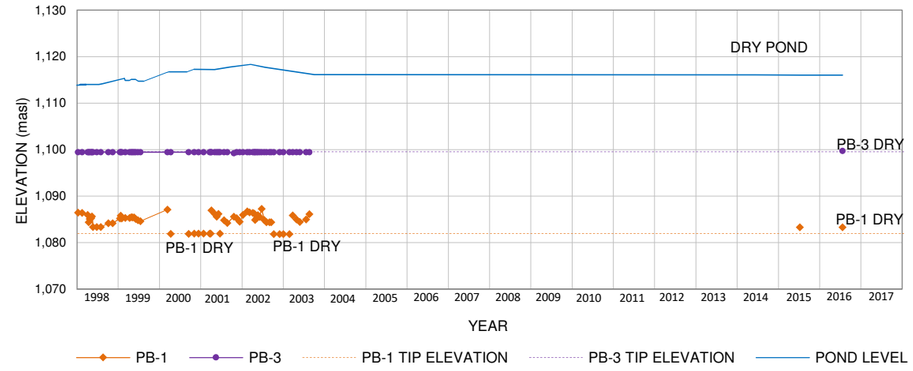
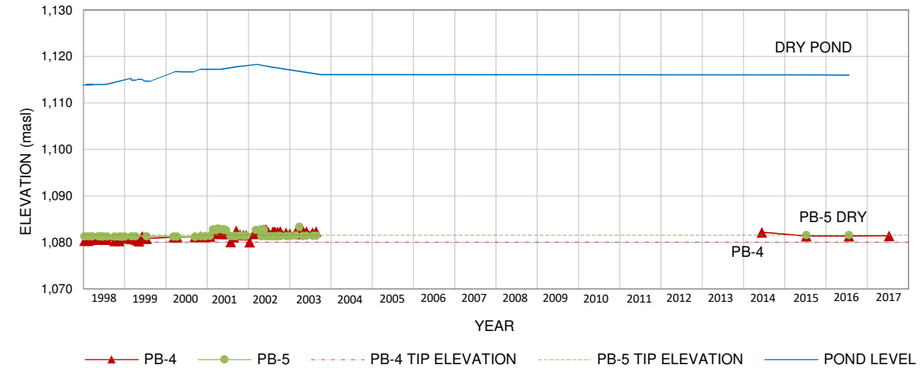
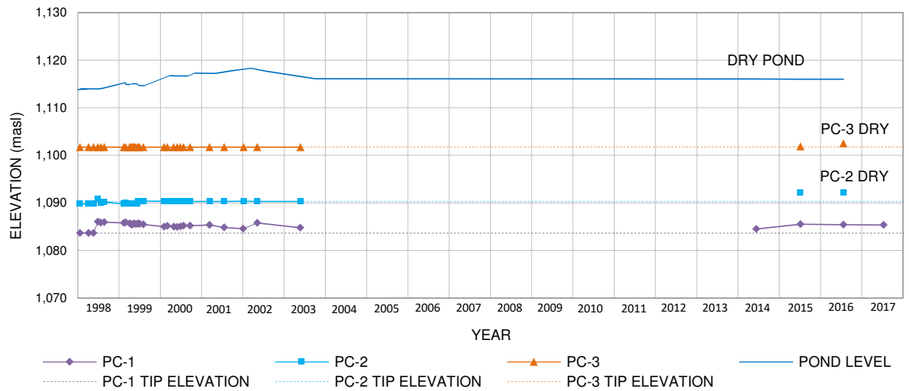




INSTRUMENTATION SECTION B



INSTRUMENTATION SECTION C

CLIENT: Teck

Klohn Crippen Berger

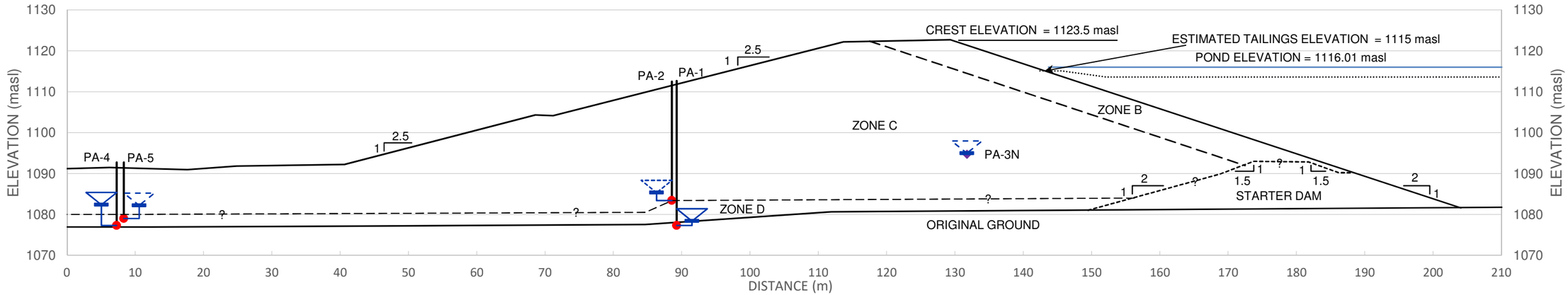
PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

TITLE: BULLMOOSE TAILINGS DAM
HISTORICAL PIEZOMETER READINGS

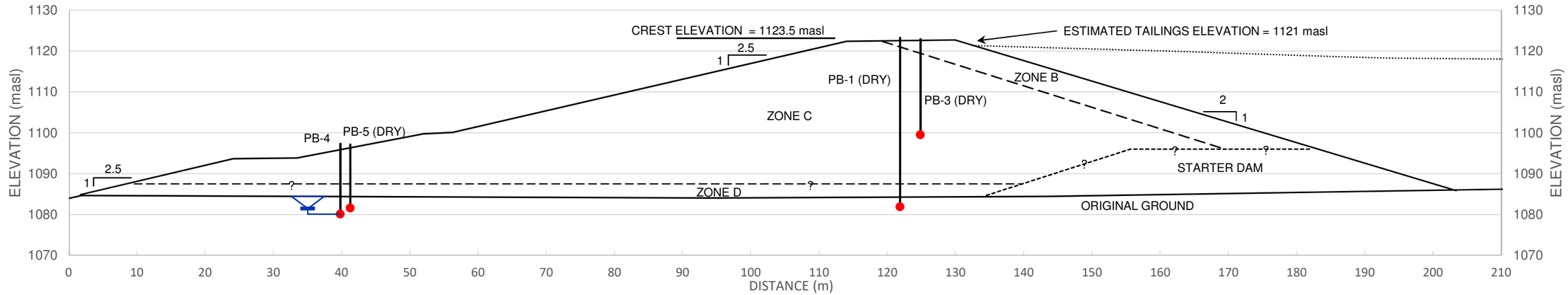
PROJECT No. M09893A07

FIG. No. 3

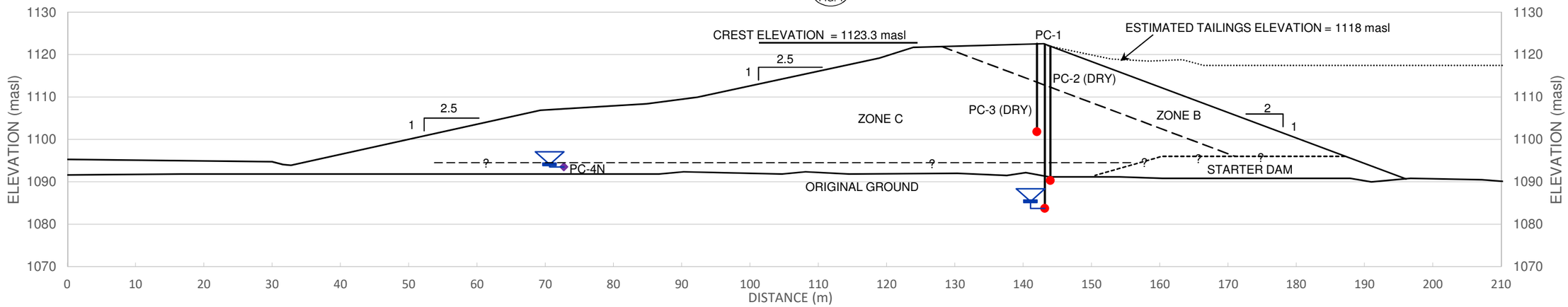
Date & Time: 2018-03-12 16:02
Figure File: \\int.klohn.com\ProjData\MVCR\M09893A07-TML-Bullmoose 2017 Consulting\300 Design\350 Ph04-EngSupport\351 Instrumentation\Piezometer\[180223 Bullmoose Piezometer.xlsx]Project & Figure Info.



SECTION A
FIG. 1



SECTION B
FIG. 1



SECTION C
FIG. 1

NOTES:

1. SECTION DRAWINGS PRODUCED BY TECK COAL LTD. (2004).
2. STARTER DAM SECTION OBTAINED FROM KL (1984).
3. ZONE B AS-BUILT PRODUCED BY TECK COAL LTD. (2000).

LEGEND:

- STANDPIPE PIEZOMETER TIP
- PNEUMATIC PIEZOMETER TIP
- EMBANKMENT PIEZOMETER WATER LEVEL
- FOUNDATION PIEZOMETER WATER LEVEL

Klohn Leonoff 1982 Design Report:

ZONE	MATERIAL	LIFT THICKNESS	COMPACTION* %Standard proctor
A Impervious	Silty sand & gravel (borrow)	0.3m	98%
B low permeability	Coarse refuse	0.15m	98%
C General Fill	Coarse refuse	0.5m	98%
D Drainage	Coarse refuse	1.0m	95%

* 98% standard proctor should be achieved with 4 passes with a large vibratory roller and 95% with about 2 passes

NOT FOR CONSTRUCTION

CLIENT: Teck

Klohn Crippen Berger

PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

TITLE: BULLMOOSE TAILINGS DAM INSTRUMENTATION SCHEMATIC SECTIONS A, B AND C

PROJECT No. M09893A07

FIG. No. 4

Date & Time: 2018-03-12 16:02
Figure File: \\int.klohn.com\ProjData\MVCR\M09893A07-TML-Bullmoose 2017 Consulting\300 Design\350 Ph04-EngSupport\351 Instrumentation\Piezometer\[180223 Bullmoose Piezometer.xlsx]Project & Figure Info.

MONUMENT	NORTHING (m)					
	October 1, 2015	December 1, 2015	February 1, 2016	September 1, 2016	February 1, 2017	May 23, 2017
M1	5082.830	5082.823	5082.834	5082.836	5082.832	5082.829
M2	5100.194	5100.189	5100.195	5100.197	5100.194	5100.191
M3	5231.547	5231.547	5231.547	5231.547	5231.547	5231.547
M4	5307.344	5307.347	5307.340	5307.339	5307.340	5307.342
M5	5257.995	5257.999	5257.999	5258.001	5258.002	5258.003
M6	5320.391	5320.394	5320.395	5320.397	5320.398	5320.400
M7	5371.856	5371.859	5371.850	5371.858	5371.861	5371.863

MONUMENT	EASTING (m)					
	October 1, 2015	December 1, 2015	February 1, 2016	September 1, 2016	February 1, 2017	May 23, 2017
M1	5239.400	5239.399	5239.419	5239.416	5239.417	5239.410
M2	5181.277	5181.272	5181.298	5181.294	5181.291	5181.287
M3	5438.104	5438.104	5438.104	5438.104	5438.104	5438.104
M4	5408.275	5408.273	5408.277	5408.278	5408.278	5408.277
M5	5687.275	5687.274	5687.260	5687.259	5687.260	5687.268
M6	5715.759	5715.760	5715.746	5715.746	5715.749	5715.756
M7	5739.531	5739.535	5739.517	5739.515	5739.518	5739.524

MONUMENT	ELEVATION (m)					
	October 1, 2015	December 1, 2015	February 1, 2016	September 1, 2016	February 1, 2017	May 23, 2017
M1	125.512	125.517	125.517	125.512	125.515	125.506
M2	109.830	109.837	109.838	109.833	109.836	109.827
M3	125.762	125.762	125.762	125.762	125.762	125.762
M4	100.020	100.018	100.026	100.022	100.023	100.019
M5	125.863	125.859	125.856	125.858	125.858	125.853
M6	100.320	100.321	100.324	100.320	100.323	100.315
M7	95.748	95.748	95.764	95.754	95.759	95.755

SURVEY ACCURACY:
HORIZONTAL: +/- 5 mm to 10 mm
VERTICAL: +/- 5 mm to 10 mm

NOTES:

1. SURVEY DATA PROVIDED BY TECK RESOURCES LTD. LATEST READINGS RECEIVED ON MAY 23, 2017.
2. BASE READING: OCTOBER 2015
3. SURVEYS COMPLETED USING A GPS BASE STATION WITH A PORTABLE ROD MOUNTED GLOBAL NAVIGATION SATELLITE SYSTEM ANTENNA.
4. SURVEY COORDINATES ARE MEASURED USING LOCALLY ESTABLISHED DATUM.

CLIENT: Teck

Klohn Crippen Berger

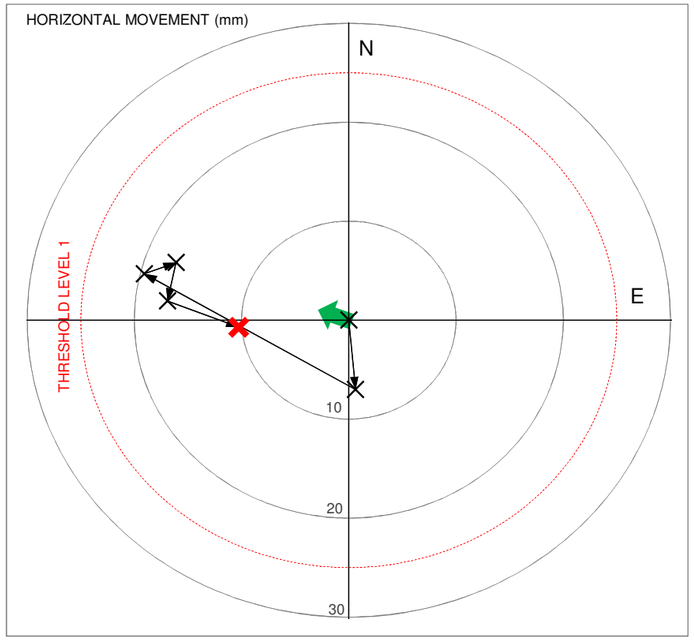
PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

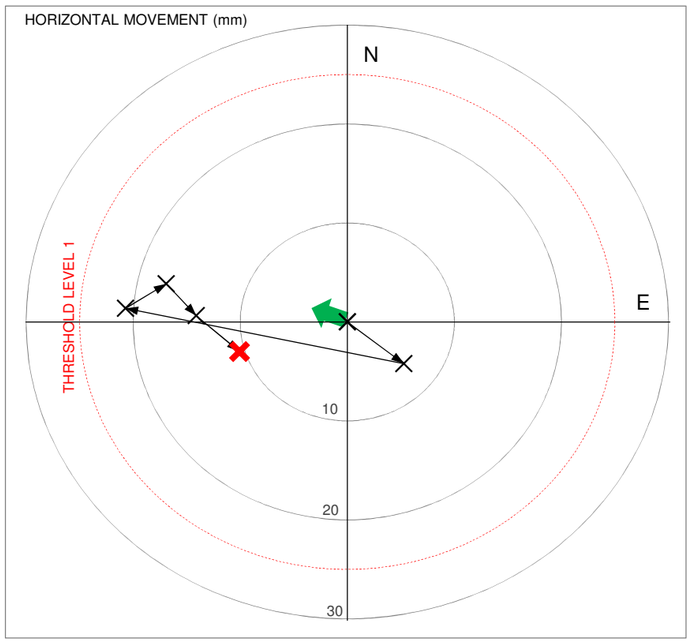
TITLE: BULLMOOSE TAILINGS DAM
2017 SURVEY MONUMENTS READINGS

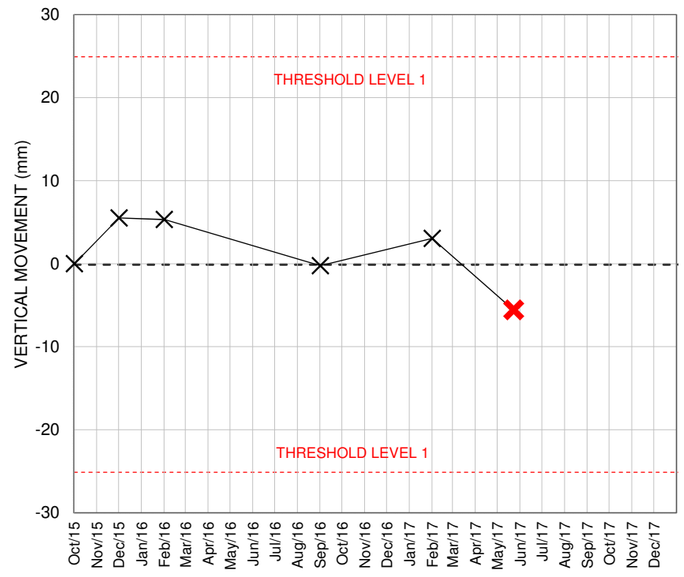
PROJECT No. M09893A07

FIG. No. 5

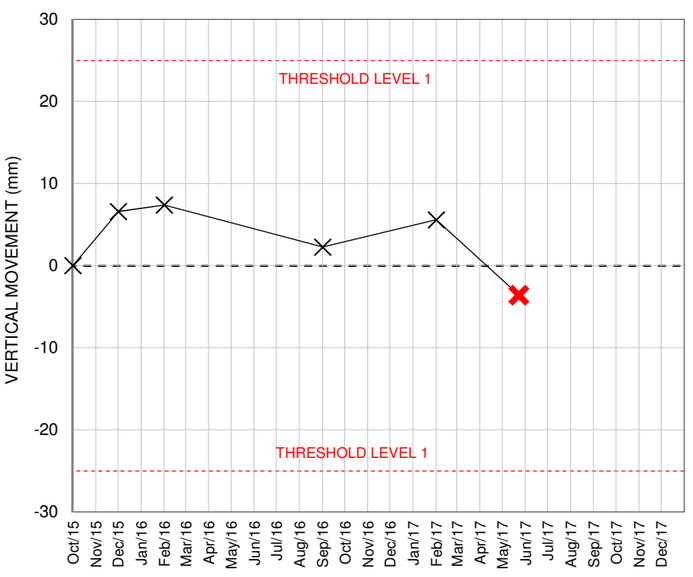
Date & Time: 2018-03-12 16:04
Figure File: \\int.klohn.com\ProjData\M\VCR\M09893A07-TML-Bullmoose 2017 Consulting\300 Design\350 Ph04-EngSupport\351 Instrumentation\Survey\180119 Bullmoose Survey.xlsx]Project & Figure Info.







M1 SURVEY RECORDS



M2 SURVEY RECORDS

NOTES:

1. SURVEY DATA PROVIDED BY TECK RESOURCES LTD. LATEST READINGS RECEIVED ON MAY 23, 2017.
2. SURVEYS COMPLETED USING A GPS BASE STATION WITH A PORTABLE ROD MOUNTED GLOBAL NAVIGATION SATELLITE SYSTEM ANTENNA.
3. SURVEY COORDINATES ARE MEASURED USING LOCALLY ESTABLISHED DATUM.

LEGEND:

DOWNSTREAM DIRECTION

LATEST SURVEY READING

THRESHOLD VALUES:

THRESHOLD LEVEL 1: ≥ 25 mm OF HORIZONTAL MOVEMENT FROM INITIAL READING;
≥ 25 mm OF VERTICAL MOVEMENT FROM INITIAL READING; OR
IF VERTICAL MOVEMENT ≥ 15 mm BETWEEN SUCCESSIVE READINGS.
THRESHOLD LEVEL 2: IF THERE IS A TREND OF THRESHOLD EXEEDANCE IN THE MONITORING MONUMENTS.

SURVEY ACCURACY:

HORIZONTAL: +/- 5 mm to 10 mm
VERTICAL: +/- 5 mm to 10 mm

CLIENT: Teck

Klohn Crippen Berger

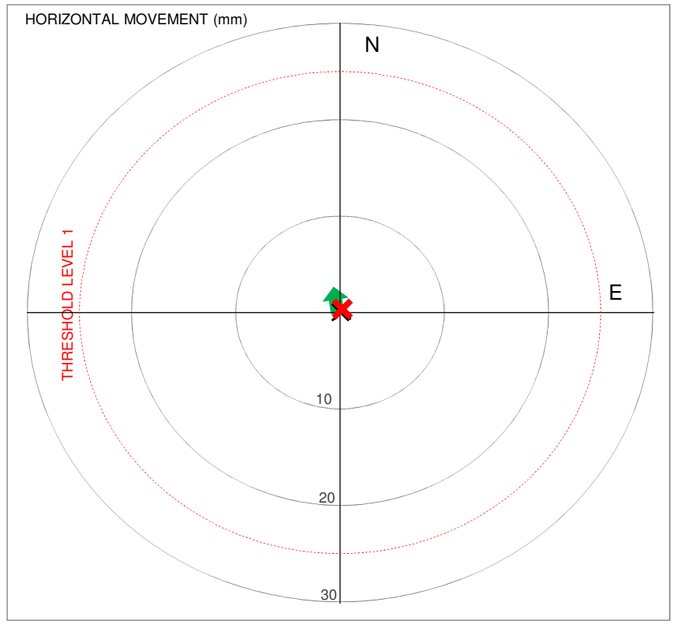
PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

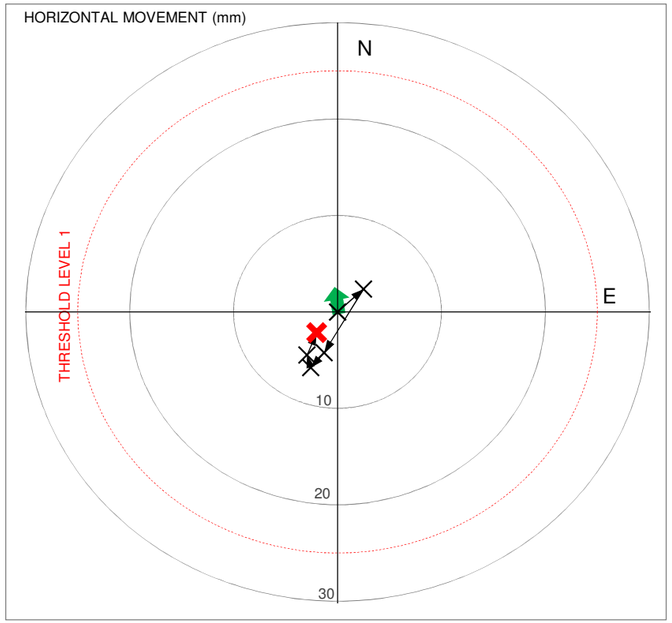
TITLE: BULLMOOSE TAILINGS DAM
SURVEY MONUMENTS (M1 AND M2) AND
THRESHOLD LEVELS

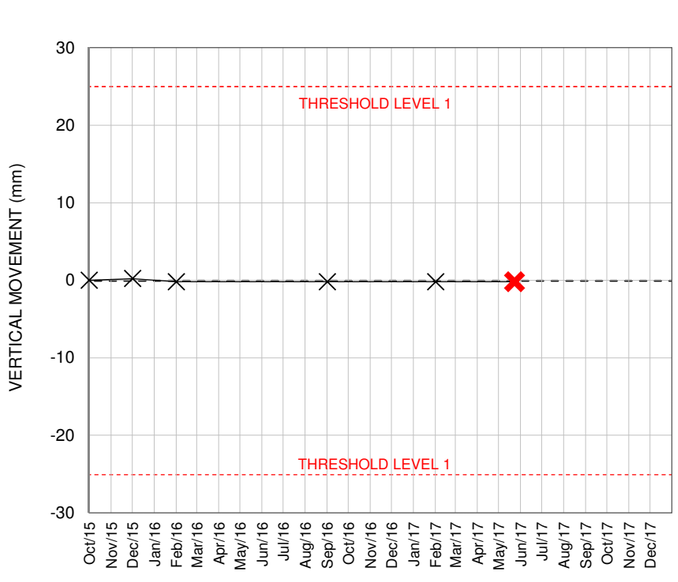
PROJECT No. M09893A07

FIG. No. 6

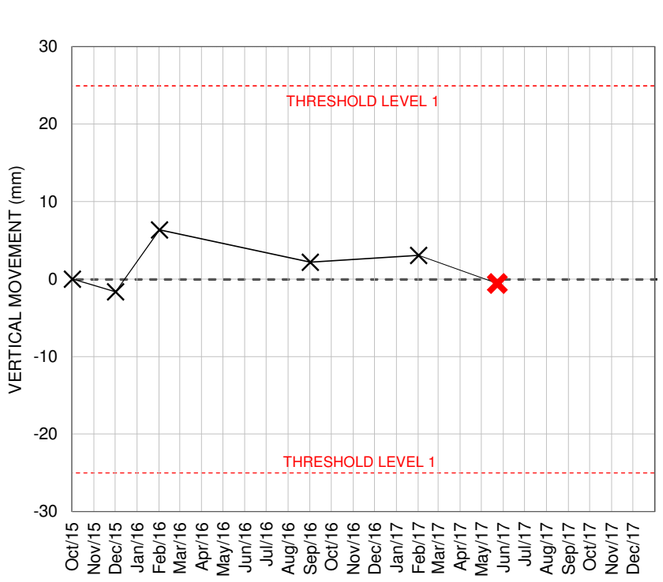
Date & Time: 2018-03-12 16:04
Figure File: \\int.klohn.com\ProjData\M\VCR\M09893A07-TML-Bullmoose 2017 Consulting\300 Design\350 Ph04-EngSupport\351 Instrumentation\Survey\[180119 Bullmoose Survey.xlsx]Project & Figure Info.







M3 SURVEY RECORDS



M4 SURVEY RECORDS

NOTES:

1. SURVEY DATA PROVIDED BY TECK RESOURCES LTD. LATEST READINGS RECEIVED ON MAY 23, 2017.
2. SURVEYS COMPLETED USING A GPS BASE STATION WITH A PORTABLE ROD MOUNTED GLOBAL NAVIGATION SATELLITE SYSTEM ANTENNA.
3. SURVEY COORDINATES ARE MEASURED USING LOCALLY ESTABLISHED DATUM.

THRESHOLD VALUES:

THRESHOLD LEVEL 1: ≥ 25 mm OF HORIZONTAL MOVEMENT FROM INITIAL READING;
≥ 25 mm OF VERTICAL MOVEMENT FROM INITIAL READING; OR
IF VERTICAL MOVEMENT ≥ 15 mm BETWEEN SUCCESSIVE READINGS.
THRESHOLD LEVEL 2: IF THERE IS A TREND OF THRESHOLD EXEEDANCE IN THE MONITORING MONUMENTS.

SURVEY ACCURACY:

HORIZONTAL: +/- 5 mm to 10 mm
VERTICAL: +/- 5 mm to 10 mm

LEGEND:

DOWNSTREAM DIRECTION
LATEST SURVEY READING

CLIENT: Teck

Klohn Crippen Berger

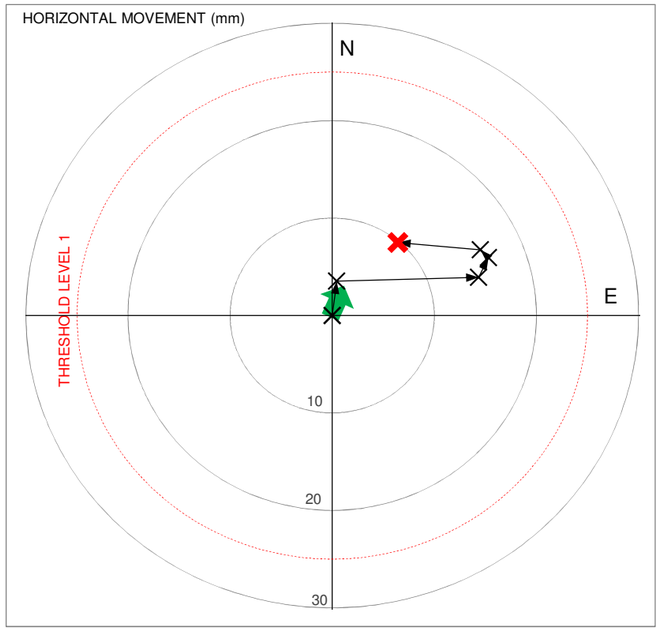
PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

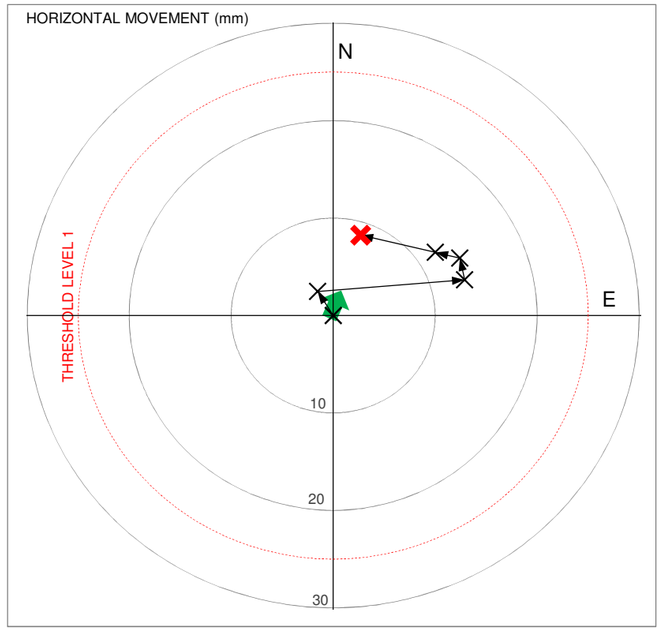
TITLE: BULLMOOSE TAILINGS DAM
SURVEY MONUMENTS (M3 AND M4) AND
THRESHOLD LEVELS

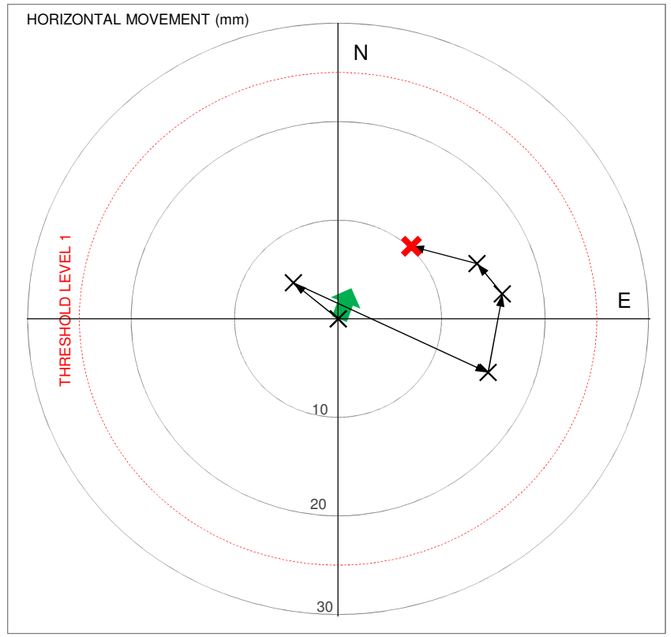
PROJECT No. M09893A07

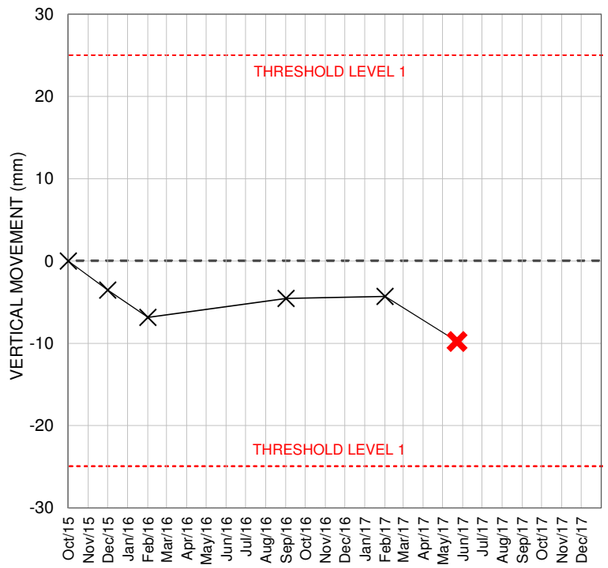
FIG. No. 7

Date & Time: 2018-03-12 16:04
Figure File: \\int.klohn.com\ProjData\MVCR\M09893A07-TML-Bullmoose 2017 Consulting\300 Design\350 Ph04-EngSupport\351 Instrumentation\Survey\[180119 Bullmoose Survey.xlsx]Project & Figure Info.

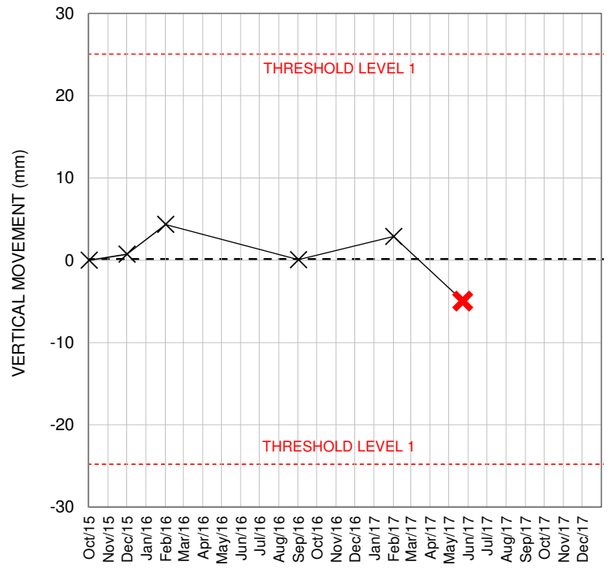




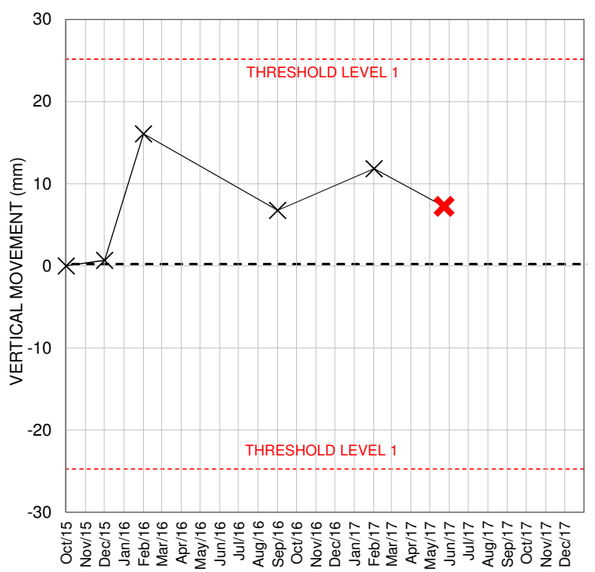




M5 SURVEY RECORDS



M6 SURVEY RECORDS



M7 SURVEY RECORDS

NOTES:

1. SURVEY DATA PROVIDED BY TECK RESOURCES LTD. LATEST READINGS RECEIVED ON MAY 23, 2017.
2. SURVEYS COMPLETED USING A GPS BASE STATION WITH A PORTABLE ROD MOUNTED GLOBAL NAVIGATION SATELLITE SYSTEM ANTENNA.
3. SURVEY COORDINATES ARE MEASURED USING LOCALLY ESTABLISHED DATUM.

THRESHOLD VALUES:

THRESHOLD LEVEL 1: ≥ 25 mm OF HORIZONTAL MOVEMENT FROM INITIAL READING;
≥ 25 mm OF VERTICAL MOVEMENT FROM INITIAL READING; OR
IF VERTICAL MOVEMENT ≥ 15 mm BETWEEN SUCCESSIVE READINGS.
THRESHOLD LEVEL 2: IF THERE IS A TREND OF THRESHOLD EXEEDANCESIN THE MONITORING MONUMENTS.

SURVEY ACCURACY:

HORIZONTAL: +/- 5 mm to 10 mm
VERTICAL: +/- 5 mm to 10 mm

LEGEND:

DOWNSTREAM DIRECTION
LATEST SURVEY READING

CLIENT: Teck

Klohn Crippen Berger

PROJECT: BULLMOOSE MINE
2017 DAM SAFETY INSPECTION

TITLE: BULLMOOSE TAILINGS DAM
SURVEY MONUMENTS (M5 TO M7) AND
THRESHOLD LEVELS

PROJECT No. M09893A07

FIG. No. 8

Date & Time: 2018-03-12 16:04
Figure File: \\int.klohn.com\ProjData\M\VCR\M09893A07-TML-Bullmoose 2017 Consulting\300 Design\350 Ph04-EngSupport\351 Instrumentation\Survey\[180119 Bullmoose Survey.xlsx]Project & Figure Info.

APPENDIX I

Facility Data Sheet

Appendix I
Facility Data Sheet

Item	Information
Dam Type	Zoned Earthfill comprises of Coarse Coal Refuse - CCR
Foundation	Competent Silty Sand and Gravel, Glacial Till and Alluvial Soils
Construction Methodologies	Downstream Raises
Operation	1983 to 2003
Maximum Dam Height	38 m (crest to downstream toe)
Crest Elevation	1123 masl
Dam Length	1050 m
Dam Crest Width	10 m to 15 m
Slopes	Upstream 2H:1V; Downstream 2.5H:1V
Impoundment Area	16 ha (surface area of covered tailings plus 2 ha of pond)
Pond Volume	26,000 m^3 (approximate)
Volume of Tailings	4.4 million m^3
Storage Capacity	4.6 million m^3
Consequence Classification	High
Phase	“Closure-Passive Care”
Inflow Design Flood (IDF)	$^2/_3$ between 1000-year return period and Probable Maximum Flood (PMF) (based on “High” consequence classification)
Design Earthquake	½ between 2475-year and 10,000-year return period earthquake (based on “High” consequence classification)
Spillway Capacity	Spillway has the capacity to route IDF with 0.5 m freeboard.
Minimum Required Freeboard	0.2 m based on CDA (2013) wave setup + wave runup methodologies.
Catchment Area	36 ha
Access to Dam	Vehicle access to the mine from Tumbler Ridge, BC, is 27 km northwest along BC Highway 29, and then 18 km southwest along Bullmoose Road.

APPENDIX II

Inspection Photographs

Appendix II
Inspection Photographs

LEGEND:

- BTD = Bullmoose Tailings Dam
- BTD-2017-## refers to the 2017 DSI photograph location, as shown on Figure 1.
- Photographs were taken during site inspection on August 16, 2017.

Photo II-1 Overview of BTD crest – good condition and no sign of erosion, settlement or cracking (BTD-2017-01)

Photo II-2 **Overview of upstream slope - looking northeast. Slope is in good condition and no sign of distress (BTD-2017-02)**

Photo II-3 **Overview of upstream slope - looking southwest. Slope is in good condition and no sign of distress (BTD-2017-02)**

Photo II-4 BTD crest and upstream slope - looking northeast; no sign of distress (BTD-2017-03)

Photo II-5 Overview of vegetated tailings surface and ponded area - looking southeast; pond is smaller than previous year (BTD-2017-04)

Photo II-6 Localized channels on tailings surface – looking south (BTD-2017-04)

Photo II-7 Typical survey monument – M5 (BTD-2017-05)

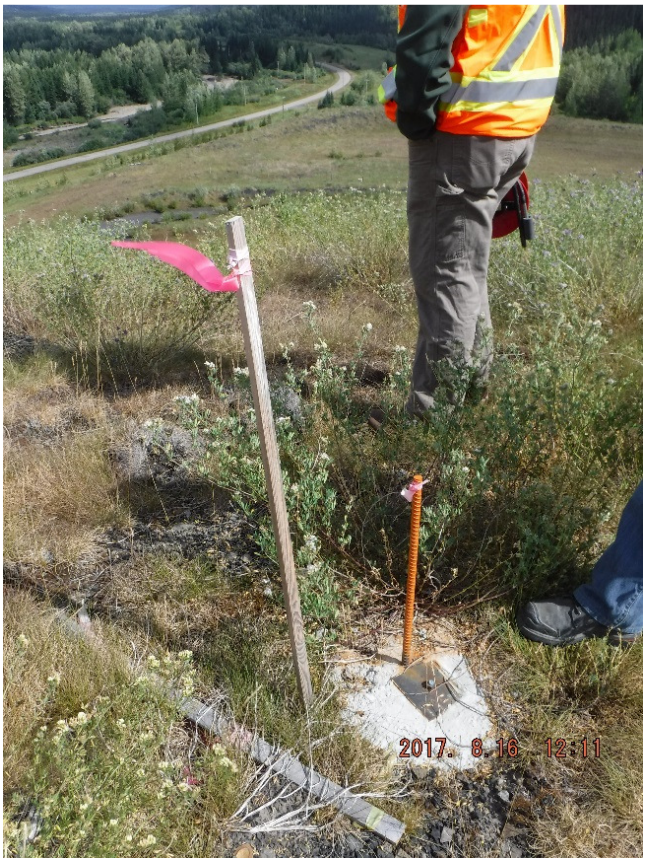


Photo II-8 Standpipe piezometers PA-1 and PA-2. PA-1 top of casing requires repair.

Photo II-9 Overview of the upper portion of the downstream slope – looking northwest. No sign of erosion or distress (BTD-2017-06)

Photo II-10 BTD crest – well vegetated. Minor rutting from vehicle traffic observed (BTD-2017-07)

Photo II-11 Looking south at tailings beach from the BTD crest – animal tracks on tailings surface observed (BTD-2017-08)

Photo II-12 Over view of BTD east abutment – more vegetation than 2016 (BTD-2017-09)

Photo II-13 Looking northeast along the downstream slope and east abutment contact – vegetation is well established (BTD-2017-10)

Photo II-14 Side channel which runs downslope from the east abutment – flow was approximately 1 L/min (BTD-2017-11)

Photo II-15 Rain/snowmelt erosion feature – the gully is approximately 0.2 m to 0.3 m wide, and 0.8 m to 1.1 m deep, and approximately 10 m to 15 m long (BTD-2017-12)

Photo II-16 **Overview of the lower portion of the downstream slope – looking northwest. Slope is in good condition with no significant sign of erosion or movement (BTD-2017-13)**

Photo II-17 **Piezometer PN-3 – area was identified as unstable in 2015 DSR report; appears to be a pad constructed to facilitate drilling**

Photo II-18 Overview of the upper portion of the downstream slope – possible slope break observed likely due to normal soil erosion and rilling (BTD-2017-14)

Photo II-19 Upper portion of the downstream slope – looking east. Slope is in good condition with no significant sign of erosion or movement (BTD-2017-15)

Photo II-20 **Upper portion of the downstream slope – looking southwest. Slope is in good condition with no significant sign of erosion or movement (BTD-2017-16)**

Photo II-21 **Upper portion of the downstream slope – looking northeast. Slope is in good condition with no significant sign of erosion or movement (BTD-2017-17)**

Photo II-22 **Downstream slope – looking southwest. Slope is in good condition with no significant sign of erosion or movement (BTD-2017-18)**

Photo II-23 **Upstream slope – looking northeast. Slope is in good condition with no significant sign of erosion or movement (BTD-2017-19)**

Photo II-24 **Upstream slope – looking southeast. Tailings surface elevation is approximately 2 m lower than the crest elevation (BTD-2017-20)**

Photo II-25 **Spillway channel - looking downstream where channel transitions from riprap lined (invert and right bank) and bedrock (left bank) to channel being entirely in bedrock (BTD-2017-21)**

Photo II-26 Typical cut in bedrock on left bank of spillway channel (BTD-2017-21)

Photo II-27 Spillway inlet – looking northeast. Vegetation is well established; no major obstructions (BTD-2017-22)

Photo II-28 Spillway inlet – looking southwest. Vegetation is well established; no major obstruction (BTD-2017-22)

Photo II-29 Spillway channel looking downstream after transition from bedrock to riprap. Channel is armoured with riprap on the invert and side slopes (BTD-2017-23)

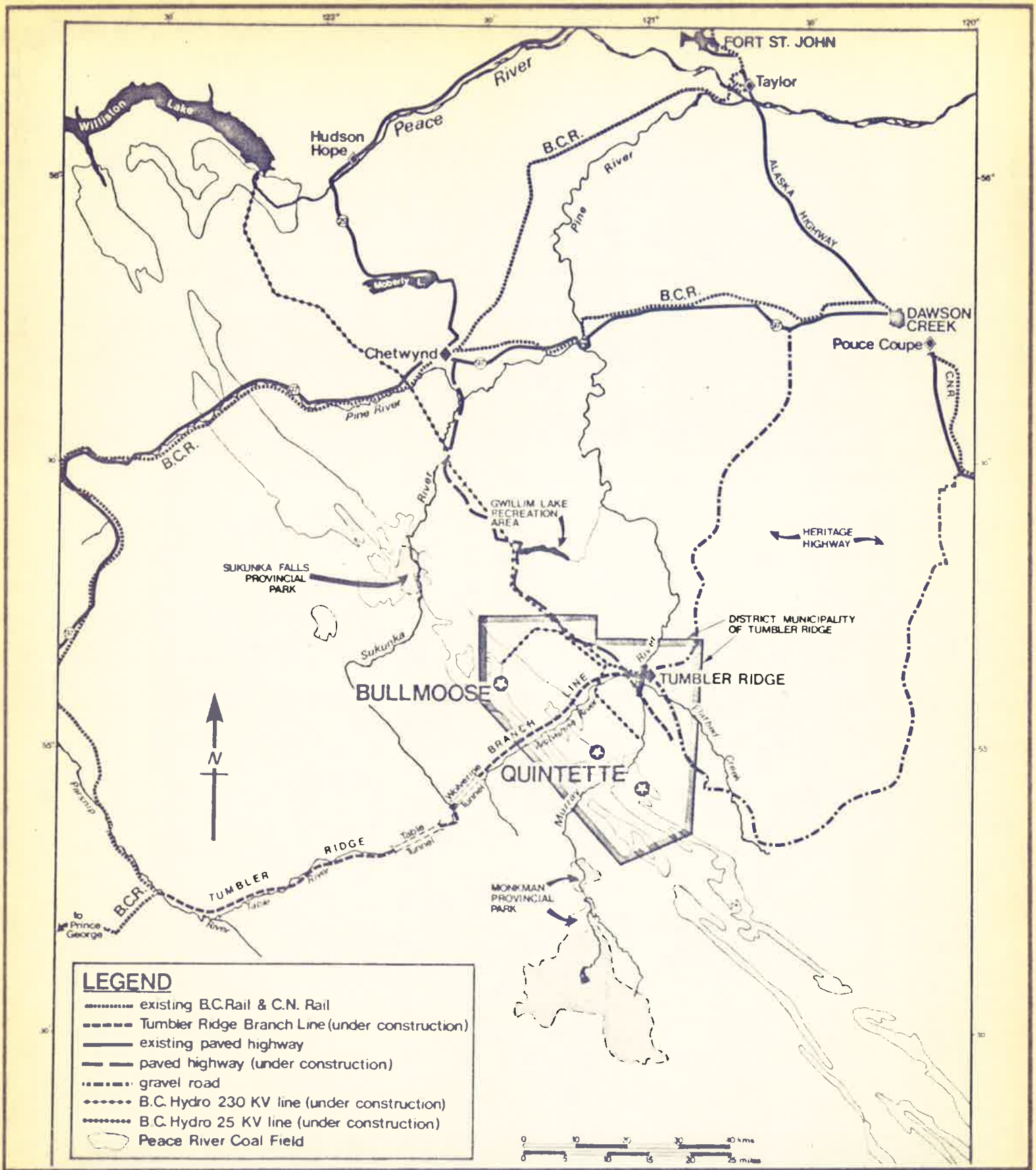
Photo II-30 **End of riprap along channel at spillway outfall. Spillway discharges over a natural steep slope (BTD-2017-24)**

Photo II-31 **Toe of the dam along west slope is approximately 1.5H:1V – possibly used as an end dump prior to closure. The slope appears to be stable with no significant sign of erosion or movement (BTD-2017-25)**

Photo II-32 Teck removed vegetation at the inlet and along the channel of spillway in October 2017 – looking northeast (near photograph location BTD-2017-21)

APPENDIX III

Dam Design Drawings



KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: BULLMOOSE COAL PROJECT

TITLE: LOCATION PLAN

CLIENT: BULLMOOSE OPERATING CORPORATION

DATE OF ISSUE: OCT. 22, 1982

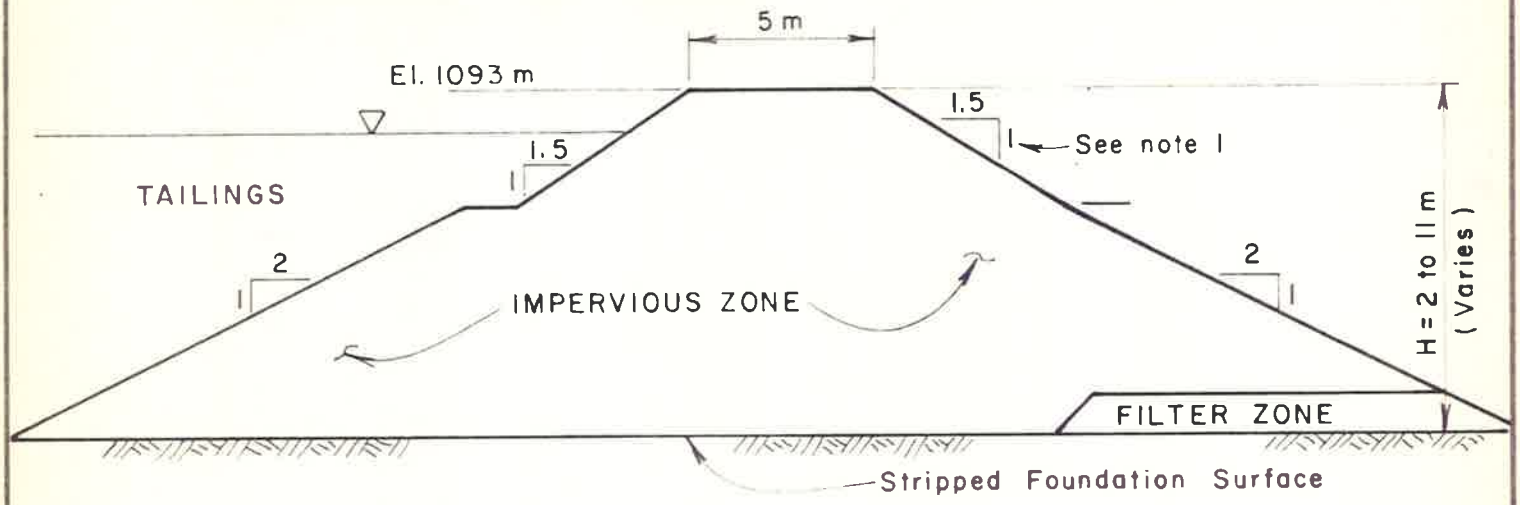
APPROVED: H. N. McLEOD

PROJECT No: PB2971-02

DWG No: A-101

REV:

PROFESSIONAL ENGINEER — BRITISH COLUMBIA



FOUNDATION SOILS

(Vary from medium dense sand and gravel to silty sands and sandy silts)

NOTES

1. Dam slope revised to 1.5 : 1, H:V over maximum top 5.0 metres of dam in October, 1984.
2. Impervious zone consists of silty sand and gravel compacted to 98 % of the Standard Proctor Density.
3. Filter zone consists of blasted mudstone and sandstone, moderately well graded; 15 percent greater than 150 mm.

SCALE 1:200

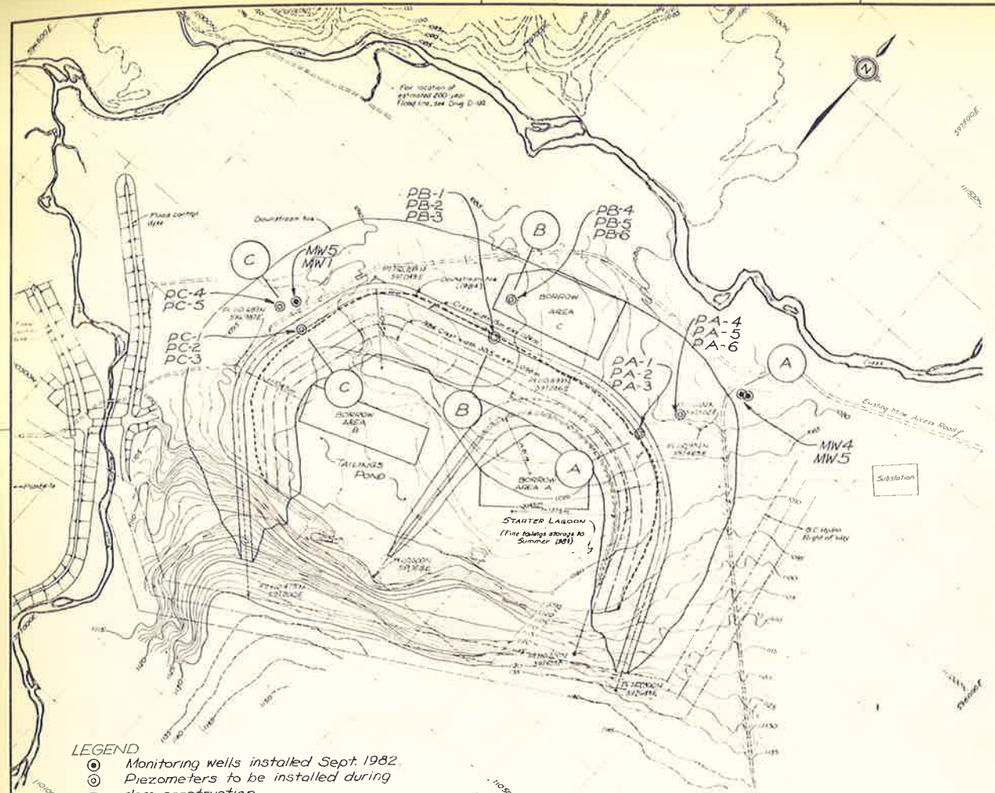
KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: BULLMOOSE COAL PROJECT

TITLE: TAILINGS STARTER DAM
TYPICAL AS-BUILT SECTION

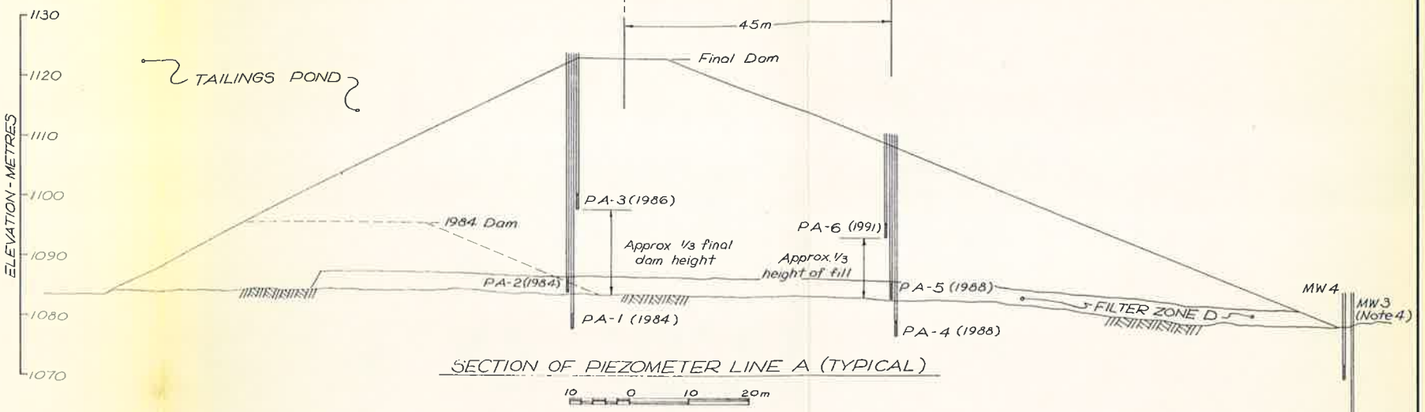
CLIENT: BULLMOOSE OPERATING CORPORATION

DATE OF ISSUE	PROJECT No	DWG No	REV
MARCH 15, 1984	PB2971-02	A-117	
APPROVED			

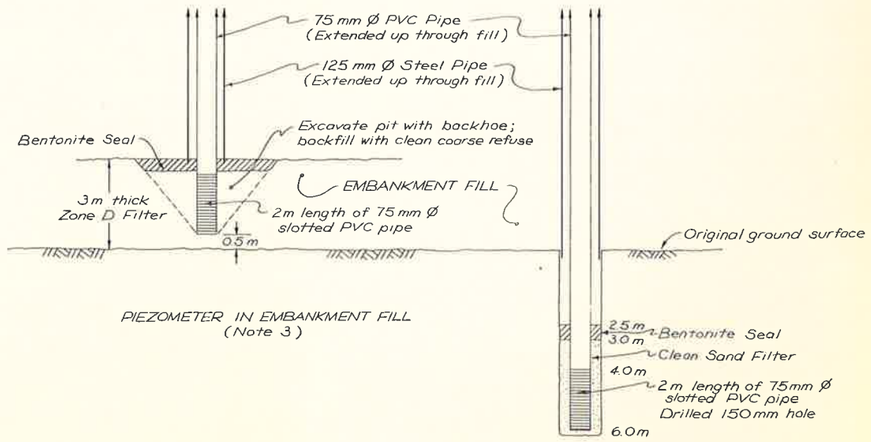


LEGEND
- ◉ Monitoring wells installed Sept 1982
- ◎ Piezometers to be installed during dam construction.
- (A) Piezometer Lines

LOCATION PLAN
50 0 50 100m



SECTION OF PIEZOMETER LINE A (TYPICAL)
10 0 10 20m



PIEZOMETER IN EMBANKMENT FILL (Note 3)

FOUNDATION PIEZOMETER (Note 1)

TYPICAL PIEZOMETER INSTALLATION DETAILS

N.T.S.

NOTES:

1. Standpipe piezometers will be installed during construction of the dam and will be extended up through the embankment fill. PA-1, PA-2 and PB-1, PB-2 and PC-1, PC-2 to be installed in 1984. Additional piezometers to be installed as shown during later construction.
2. Foundation piezometers to be installed with a drilling rig.
3. Piezometers in embankment fill to be installed with a backhoe.
4. Monitoring wells installed by Klohn Leonoff Ltd. in Sept. 1982.

TO BE READ WITH KLOHN LEONOFF REPORT DATED OCT. 22, 1982

SCALE: AS SHOWN

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
H.M.	D.T.	OCT. 1982	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: BULLMOOSE COAL PROJECT

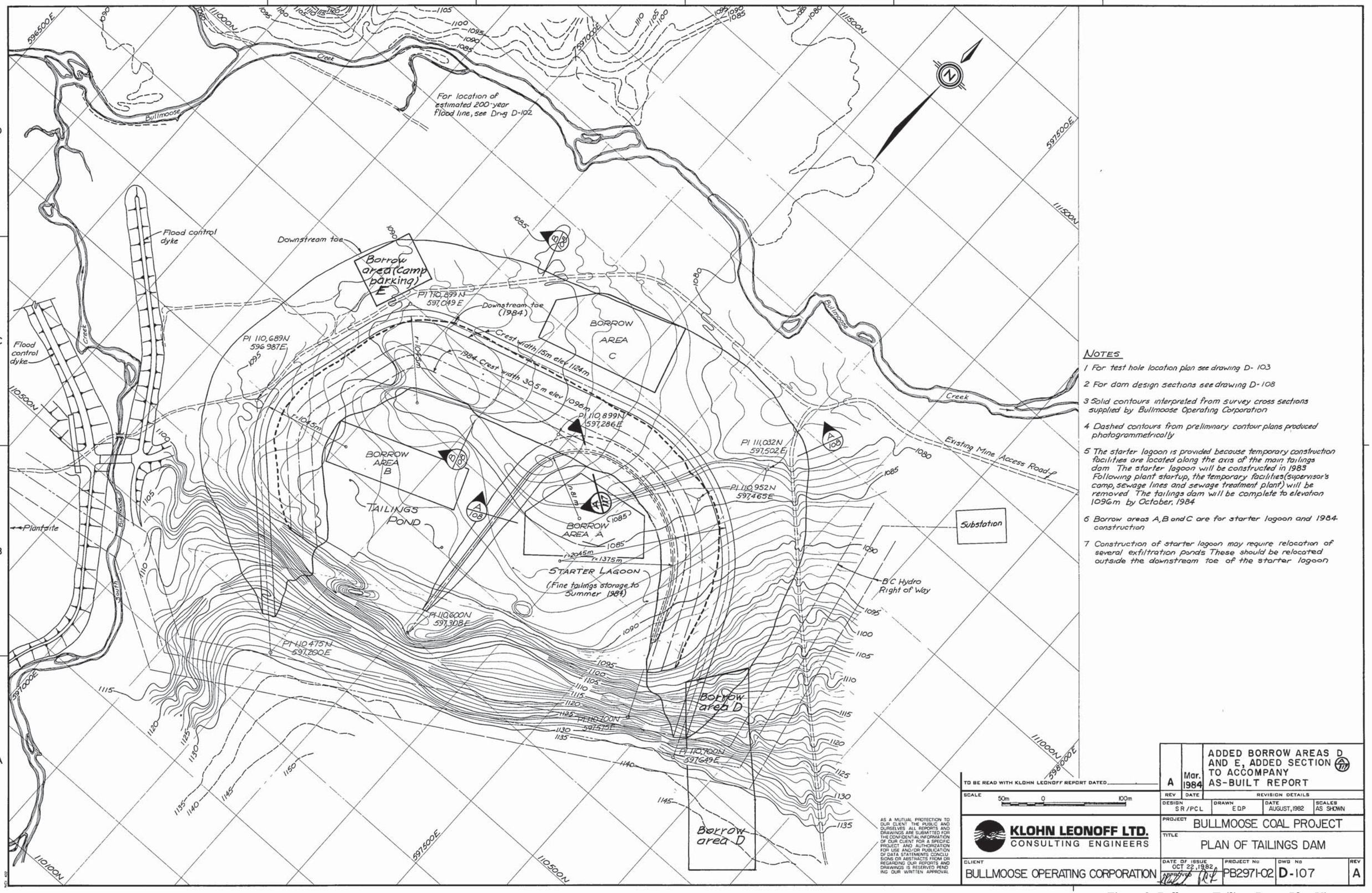
TITLE: PLAN, SECTION & DETAILS OF TAILINGS DAM PIEZOMETERS

CLIENT: BULLMOOSE OPERATING CORPORATION

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
OCT. 22, 1982	PB2971-02	D-112	

APPROVED

P. C. LIGHTHALL
PROFESSIONAL ENGINEER
BRITISH COLUMBIA



NOTES

1 For test hole location plan see drawing D-103

2 For dam design sections see drawing D-108

3 Solid contours interpreted from survey cross sections supplied by Bullmoose Operating Corporation

4 Dashed contours from preliminary contour plans produced photogrammetrically

5 The starter lagoon is provided because temporary construction facilities are located along the axis of the main tailings dam The starter lagoon will be constructed in 1983 Following plant startup, the temporary facilities (supervisor's camp, sewage lines and sewage treatment plant) will be removed The tailings dam will be complete to elevation 1096m by October, 1984

6 Borrow areas A, B and C are for starter lagoon and 1984 construction

7 Construction of starter lagoon may require relocation of several exfiltration ponds These should be relocated outside the downstream toe of the starter lagoon

TO BE READ WITH KLOHN LEONOFF REPORT DATED

REV	DATE	REVISION DETAILS
A	Mar. 1984	ADDED BORROW AREAS D AND E, ADDED SECTION (A-111) TO ACCOMPANY AS-BUILT REPORT

SCALE 50m 0 100m

DESIGN	DRAWN	DATE	SCALES
SR/PCL	EDP	AUGUST, 1982	AS SHOWN

KLOHN LEONOFF LTD. CONSULTING ENGINEERS

PROJECT BULLMOOSE COAL PROJECT

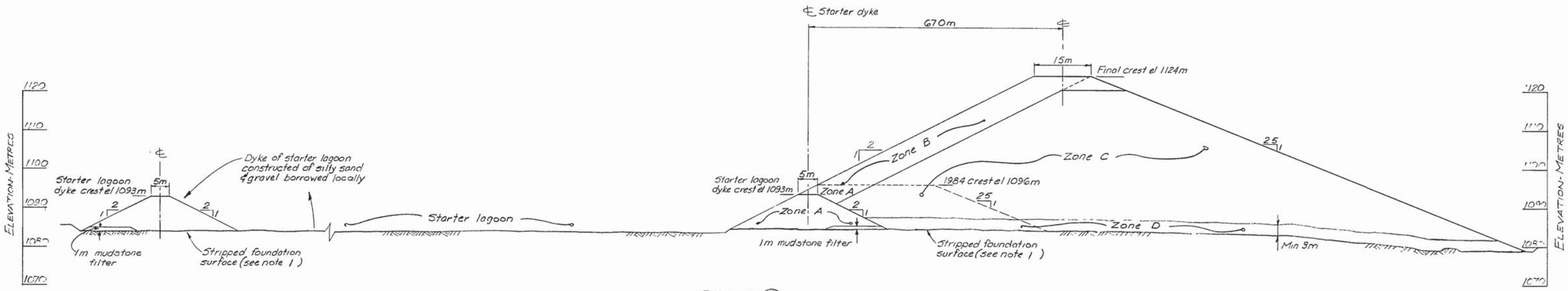
TITLE PLAN OF TAILINGS DAM

CLIENT BULLMOOSE OPERATING CORPORATION

DATE OF ISSUE	PROJECT No	DWG No	REV
OCT 22, 1982	PB2971-02	D-107	A

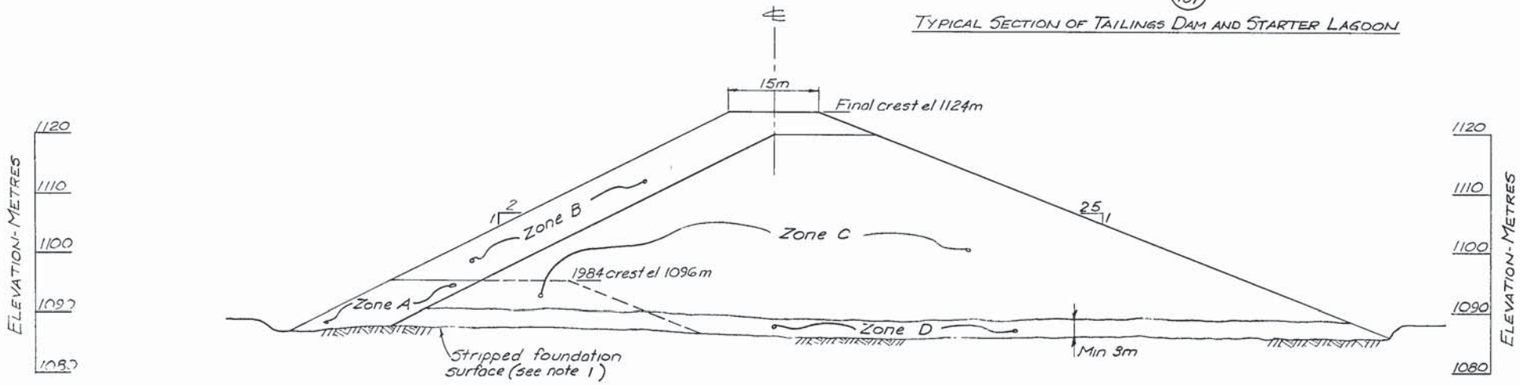
APPROVED

Figure 6 Bullmoose Tailings Dam - Plan View



SECTION A/107

TYPICAL SECTION OF TAILINGS DAM AND STARTER LAGOON



SECTION B/107

TYPICAL SECTION OF TAILINGS DAM

ZONE	MATERIAL	LIFT THICKNESS	COMPACTION* %Standard proctor
A Impervious	Silty sand & gravel (borrow)	0.3m	98 %
B Low permeability	Coarse refuse	0.15m	98 %
C General fill	Coarse refuse	0.5m	98 %
D Drainage	Coarse refuse	1.0m	95 %

* 98% standard proctor should be achieved with 4 passes with a large vibratory roller and 95 % with about 2 passes

CONSTRUCTION NOTES

1 FOUNDATION PREPARATION

All vegetation, organics and soft material shall be removed from the dam foundation area to expose silty sand and gravel soils Loose materials include areas where waste from the plantsite and construction camp excavation were placed during the 1982 site development The foundation surface should be heavily compacted prior to fill placement

2 CONSTRUCTION MATERIALS, PLACEMENT COMPACTION

GENERAL

Fill placement should be carried out during warmer parts of the year so that no frozen materials or lenses of ice or snow are incorporated in the fill

Where a vibratory roller is specified for compaction in following sections, the compactor should have a minimum static weight of 8 tonnes

ZONE A

Zone A material will be used for the starter dyke and for the upstream zone of the tailings dam for 1984 construction The material should consist of silty sand and gravel borrowed from the alluvial deposits within the tailings dam reservoir Zone A is intended to be a zone of low permeability and should have a minimum of 15 percent by weight passing the 0 075 mm sieve size

Zone A material should be placed in maximum loose lift thicknesses of 0 3 m and compacted to a minimum density equivalent to 98 percent of the maximum Standard Proctor density (ASTM D-698 Method D) This density should be achieved by compacting with at least four passes of a vibratory roller, provided the water content of the fill material is near optimum

ZONE B

Zone B is a 15 m wide zone of coarse refuse on the upstream side of the tailings dam which will be heavily compacted to provide a zone of low permeability The coarse refuse should be placed in maximum loose lift thicknesses of 0 15 m and compacted with at least 4 complete passes of a vibratory roller

ZONE C

Zone C is the general fill portion of the dam, constructed of compacted coarse refuse The coarser refuse should be placed in maximum loose lift thicknesses of 0 5 m and compacted with a minimum of 4 complete passes of a vibratory roller The fill surface should be scarified between lifts

ZONE D

Zone D is a drainage zone, constructed of loosely compacted, select coarse refuse

The coarse refuse used in Zone D should be selected to have the minimum amount of fines There should be a maximum of 5 percent, by weight, passing the 0 075 mm sieve size Coarse refuse should be placed in lifts 1 m thick Compaction should consist of 2 complete passes of a vibratory roller The fill surface should be scarified between lifts

3 QUALITY CONTROL AND TESTING

COMPACTION CONTROL

Standard Proctor compaction tests conforming to ASTM D-698 Method D should be carried out a minimum of once per week during construction or at any time when the material quality changes Compaction control should consist of frequent inspection of placement and compaction procedures, augmented by field density tests One field density test for every 1500 m^3 of fill placed should be performed Zones A, B and C should be compacted to 98% Standard Proctor density and the filter Zone D to 95% Standard Proctor

GRAIN SIZE ANALYSES

For Zone A, grain size analyses of the fill material should be performed at a minimum frequency of twice weekly For the coarse refuse, grain size analyses should be performed weekly on samples from the stockpile and the fill after compaction

4 TAILINGS DISCHARGE

Tailings may be deposited to the pond by a single point discharge, with the discharge point located at intervals along the dam crest Discharge should be adjusted so as to form a beach adjacent to the dam and to maintain the ponded water at the back of the pond adjacent to the hillside During freezing weather, tailings should be discharged near or beneath the surface of the water pond so as to minimize ice formation on the beaches.

TO BE READ WITH KLOHN LEONOFF REPORT DATED OCT 22, 1982

SCALE 10m 0 30m

REV	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
SR/PCL	EDP	SEPT, 1982	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: BULLMOOSE COAL PROJECT

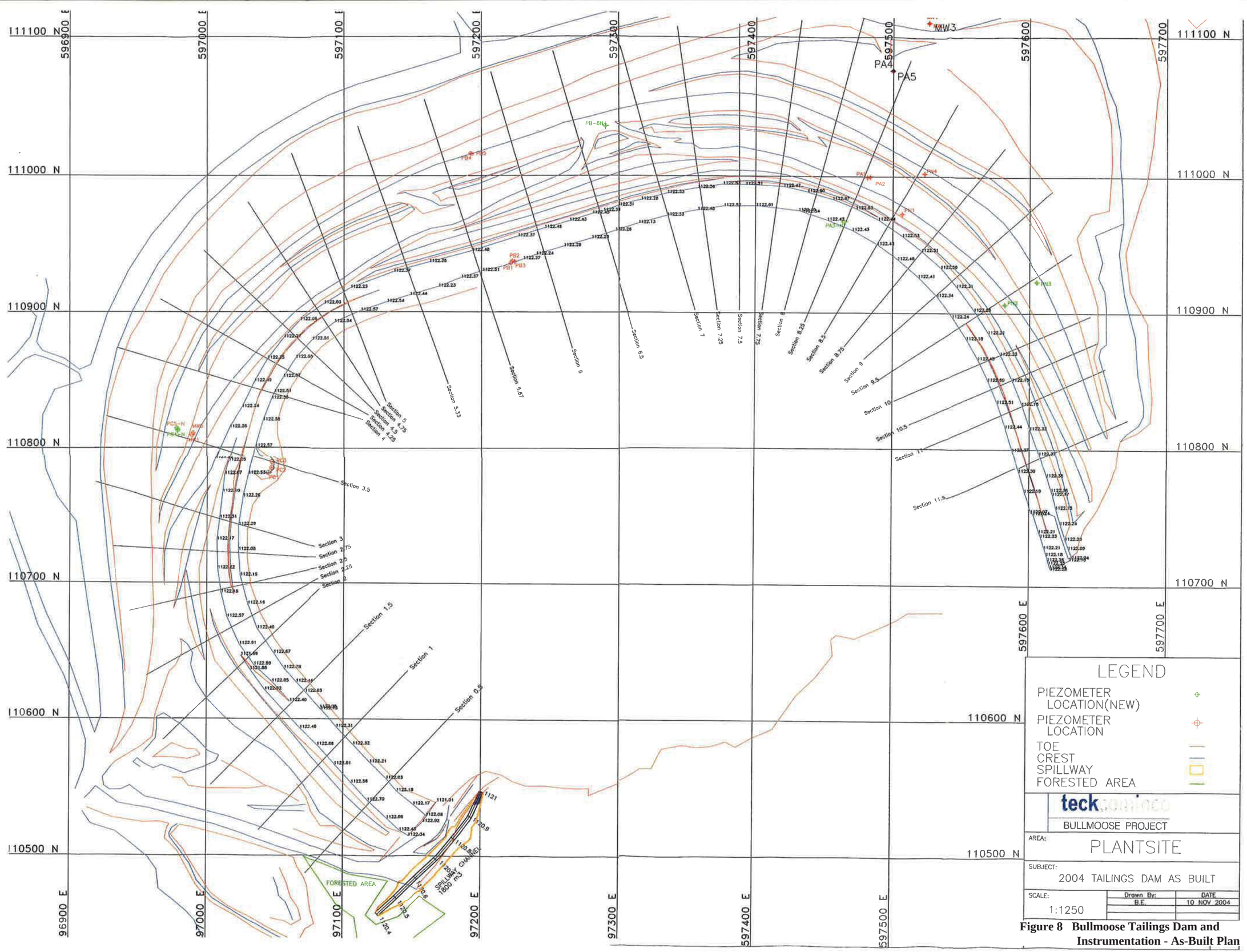
TITLE: TYPICAL SECTIONS OF TAILINGS DAM

CLIENT: BULLMOOSE OPERATING CORPORATION

DATE OF ISSUE	PROJECT No	DWG No	REV
OCT 22, 1982	PB297-02	D-108	

APPROVED

Figure 7 Bullmoose Tailings Dam - Typical Sections



LEGEND

- PIEZOMETER LOCATION(NEW)
- PIEZOMETER LOCATION
- TOE
- CREST
- SPILLWAY
- FORESTED AREA

teck COMINCO

BULLMOOSE PROJECT

AREA: PLANTSITE

SUBJECT: 2004 TAILINGS DAM AS BUILT

SCALE:	Drawn By:	DATE
1:1250	B.E.	10 NOV 2004

Figure 8 Bullmoose Tailings Dam and Instrumentation - As-Built Plan

APPENDIX IV

Teck's Bullmoose Tailings Dam
2017 Routine Inspection Checklists

BULLMOOSE TAILINGS STORAGE FACILITY SURVEILLANCE CHECKLIST

Inspector(s):	Rob Muise	**Inspection Date:**	June 12/17
Weather:	40c Sunny/Windy	**Inspection Time:**	2:45 PM
Any Trigger Event Prior to this Inspection?:	NO		
Any Failure Observed? What is the Failure Mode?:	NO		
Was the Spillway Flowing? If Yes, Estimate Flow Volume (m^3/s):	NO		
Minimum observed freeboard - pond level to dam crest (m):	NO		
Minimum observed water level below spillway entrance (m):	NONE		

Are the following components of your dam in *SATISFACTORY CONDITION*? (Check one if applicable)

DAM	YES/NO	INSTRUMENT	YES/NO
Embankment U/S slope	☑ Yes ☐ No	Piezometers/Wells	☑ Yes ☐ No
Embankment Crest	☑ Yes ☐ No	Survey Monument	☑ Yes ☐ No
Embankment D/S Slope	☑ Yes ☐ No	Others – Please Specify:	☐ Yes ☐ No
Embankment D/S Toe	☑ Yes ☐ No		
Impoundment	☑ Yes ☐ No		

SPILLWAY	YES/NO	DIVERSION DITCH	YES/NO
Entrance	☑ Yes ☐ No	Walls	☑ Yes ☐ No
Walls	☑ Yes ☐ No	Channel	☑ Yes ☐ No
Channel/Riprap	☑ Yes ☐ No	Channel Slopes	☑ Yes ☐ No
Outlet	☑ Yes ☐ No	Outlet	☑ Yes ☐ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found? If yes, take photographs and mark its location on the attached site plan.

INDICATOR	YES/NO	COMMENTS
Piping	☐ Yes ☑ No	
Sinkholes	☐ Yes ☑ No	
Seepage Turbidity/Clear	☐ Yes ☑ No	
External Erosion	☐ Yes ☑ No	
Cracks	☐ Yes ☑ No	
Settlement	☐ Yes ☑ No	
Slope Slough/Failure	☐ Yes ☑ No	
Animal Borrow/Digging	☐ Yes ☑ No	
Unusual Ponded Area	☐ Yes ☑ No	
Others:		

Piezometer Readings

PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)
1)		7)		13)	
2)		8)		14)	
3)		9)		15)	
4)		10)		16)	
5)		11)		17)	
6)		12)		18)	

Comments / Notes: N/A

Site Plan:

BULLMOOSE TAILINGS STORAGE FACILITY SURVEILLANCE CHECKLIST

Inspector(s):	Ray Proulx	**Inspection Date:**	July 12, 2017
Weather:	Overcast / Light Rain	**Inspection Time:**	10:12
Any Trigger Event Prior to this Inspection?:	No		
Any Failure Observed? What is the Failure Mode?:	No		
Was the Spillway Flowing? If Yes, Estimate Flow Volume (m^3/s):	No		
Minimum observed freeboard - pond level to dam crest (m):	Approx 10m		
Minimum observed water level below spillway entrance (m):	N/a → none near the entrance		

Are the following components of your dam in *SATISFACTORY CONDITION*? (Check one if applicable)

DAM	YES/NO	INSTRUMENT	YES/NO
Embankment U/S slope	☑ Yes ☐ No	Piezometers/Wells	☐ Yes ☐ No
Embankment Crest	☑ Yes ☐ No	Survey Monument	☐ Yes ☐ No
Embankment D/S Slope	☑ Yes ☐ No	Others – Please Specify:	☐ Yes ☐ No
Embankment D/S Toe	☑ Yes ☐ No		
Impoundment	☑ Yes ☐ No		

SPILLWAY	YES/NO	DIVERSION DITCH	YES/NO
Entrance	☑ Yes ☐ No	Walls	☑ Yes ☐ No
Walls	☑ Yes ☐ No	Channel	☑ Yes ☐ No
Channel/Riprap	☑ Yes ☐ No	Channel Slopes	☑ Yes ☐ No
Outlet	☑ Yes ☐ No	Outlet	☑ Yes ☐ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found? If yes, take photographs and mark its location on the attached site plan.

INDICATOR	YES/NO	COMMENTS
Piping	☐ Yes ☑ No	
Sinkholes	☐ Yes ☑ No	
Seepage Turbidity/Clear	☐ Yes ☑ No	
External Erosion	☐ Yes ☑ No	
Cracks	☐ Yes ☑ No	
Settlement	☐ Yes ☑ No	
Slope Slough/Failure	☐ Yes ☑ No	
Animal Borrow/Digging	☐ Yes ☑ No	
Unusual Ponded Area	☐ Yes ☑ No	
Others:		

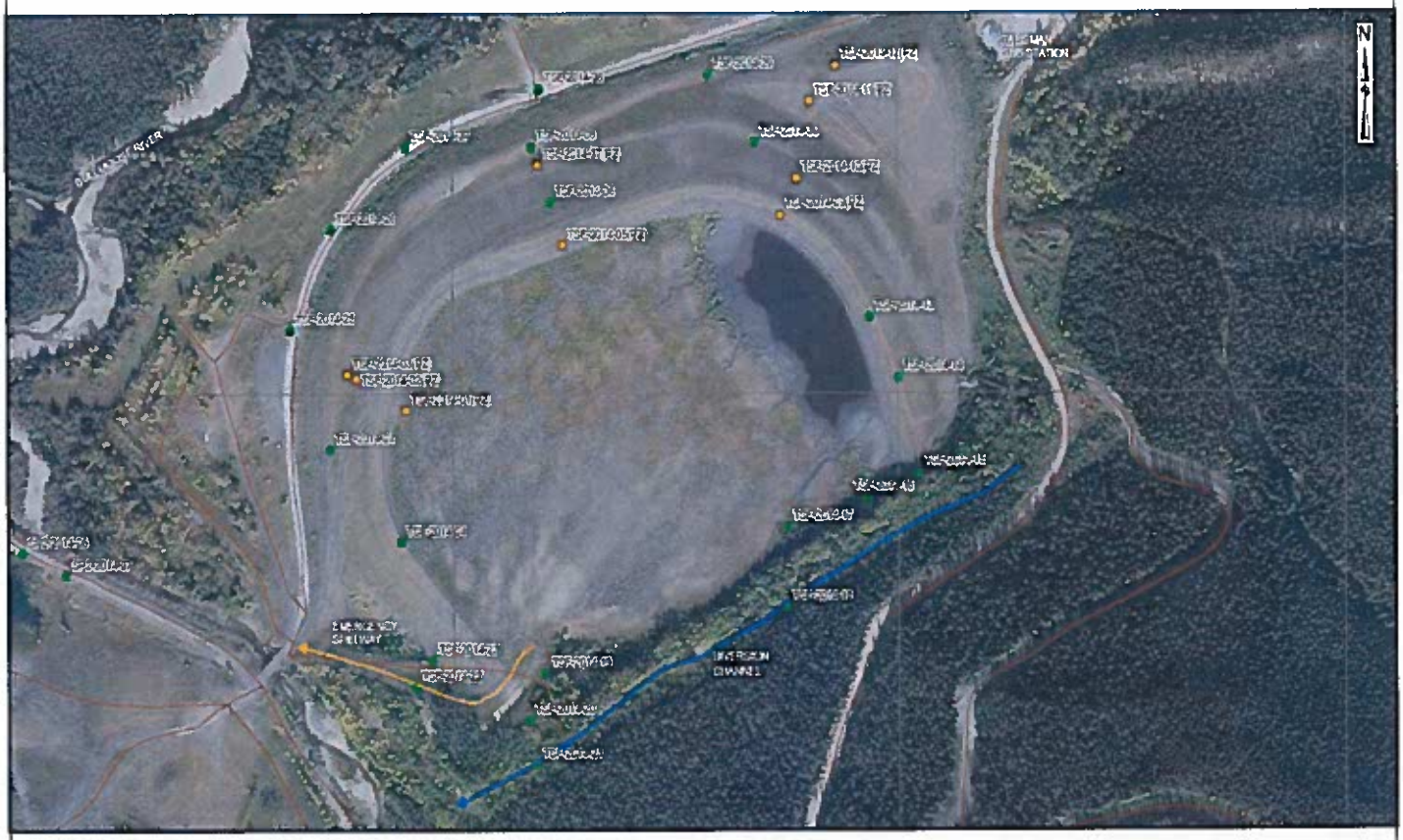
Piezometer Readings N/a

PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)
1)		7)		13)	
2)		8)		14)	
3)		9)		15)	
4)		10)		16)	
5)		11)		17)	
6)		12)		18)	

Comments / Notes:

Three white-tailed deer observed on dam (bedding slightly North of the spillway entrance)

Site Plan:



BULLMOOSE TAILINGS STORAGE FACILITY SURVEILLANCE CHECKLIST

Inspector(s):	Rob Muise	**Inspection Date:**	Aug 1/17
Weather:	+17°C Sunny	**Inspection Time:**	12:15 pm
Any Trigger Event Prior to this Inspection?:	NO		
Any Failure Observed? What is the Failure Mode?:	NO		
Was the Spillway Flowing? If Yes, Estimate Flow Volume (m^3/s):	NO		
Minimum observed freeboard - pond level to dam crest (m):	10 meters		
Minimum observed water level below spillway entrance (m):	NONE		

Are the following components of your dam in *SATISFACTORY CONDITION*? (Check one if applicable)

DAM	YES/NO	INSTRUMENT	YES/NO
Embankment U/S slope	☑ Yes ☐ No	Piezometers/Wells	☑ Yes ☐ No
Embankment Crest	☑ Yes ☐ No	Survey Monument	☑ Yes ☐ No
Embankment D/S Slope	☑ Yes ☐ No	Others – Please Specify:	☐ Yes ☐ No
Embankment D/S Toe	☑ Yes ☐ No		
Impoundment	☑ Yes ☐ No		

SPILLWAY	YES/NO	DIVERSION DITCH	YES/NO
Entrance	☑ Yes ☐ No	Walls	☑ Yes ☐ No
Walls	☑ Yes ☐ No	Channel	☑ Yes ☐ No
Channel/Riprap	☑ Yes ☐ No	Channel Slopes	☑ Yes ☐ No
Outlet	☑ Yes ☐ No	Outlet	☑ Yes ☐ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found? If yes, take photographs and mark its location on the attached site plan.

INDICATOR	YES/NO	COMMENTS
Piping	☐ Yes ☐ No	
Sinkholes	☐ Yes ☐ No	
Seepage Turbidity/Clear	☐ Yes ☐ No	
External Erosion	☐ Yes ☐ No	
Cracks	☐ Yes ☐ No	
Settlement	☐ Yes ☐ No	
Slope Slough/Failure	☐ Yes ☐ No	
Animal Borrow/Digging	☐ Yes ☐ No	
Unusual Ponded Area	☐ Yes ☐ No	
SP2 - Plugged Culverts	☑ Yes ☐ No	#1,2,3&4 ~~#3~~ 3/4 plugged.
Others:		Beaver Needs to be removed

Piezometer Readings

PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)
1)		7)		13)	
2)		8)		14)	
3)		9)		15)	
4)		10)		16)	
5)		11)		17)	
6)		12)		18)	

NOT Read

Comments / Notes:

Site Plan:

BULLMOOSE TAILINGS STORAGE FACILITY SURVEILLANCE CHECKLIST

Inspector(s):	Rob Muise	**Inspection Date:**	Sept 7/2017
Weather:	23°C Smokey	**Inspection Time:**	11:00 A.M.
Any Trigger Event Prior to this Inspection?:	NO		
Any Failure Observed? What is the Failure Mode?:	NO		
Was the Spillway Flowing? If Yes, Estimate Flow Volume (m^3/s):	NO		
Minimum observed freeboard - pond level to dam crest (m):	10m		
Minimum observed water level below spillway entrance (m):	NONE		

Are the following components of your dam in *SATISFACTORY CONDITION*? (Check one if applicable)

DAM	YES/NO	INSTRUMENT	YES/NO
Embankment U/S slope	☑ Yes ☐ No	Piezometers/Wells	☑ Yes ☐ No
Embankment Crest	☑ Yes ☐ No	Survey Monument	☑ Yes ☐ No
Embankment D/S Slope	☑ Yes ☐ No	Others – Please Specify:	☐ Yes ☐ No
Embankment D/S Toe	☑ Yes ☐ No		
Impoundment	☑ Yes ☐ No		

SPILLWAY	YES/NO	DIVERSION DITCH	YES/NO
Entrance	☑ Yes ☐ No	Walls	☑ Yes ☐ No
Walls	☑ Yes ☐ No	Channel	☑ Yes ☐ No
Channel/Riprap	☑ Yes ☐ No	Channel Slopes	☑ Yes ☐ No
Outlet	☑ Yes ☐ No	Outlet	☐ Yes ☐ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found? If yes, take photographs and mark its location on the attached site plan.

INDICATOR	YES/NO	COMMENTS
Piping	☐ Yes ☑ No	
Sinkholes	☐ Yes ☑ No	
Seepage Turbidity/Clear	☐ Yes ☑ No	
External Erosion	☐ Yes ☑ No	
Cracks	☐ Yes ☑ No	
Settlement	☐ Yes ☑ No	
Slope Slough/Failure	☐ Yes ☑ No	
Animal Borrow/Digging	☐ Yes ☑ No	
Unusual Ponded Area	☐ Yes ☑ No	
SP2 - Plugged Culverts	☑ Yes ☐ No	Partial / New grates installed → working well
Others:		

Piezometer Readings

PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)
1)		7)		13)	
2)		8)		14)	
3)		9)		15)	
4)		10)		16)	
5)		11)		17)	
6)		12)		18)	

NOT Read

Comments / Notes:

Site Plan: Pictures

BULLMOOSE TAILINGS STORAGE FACILITY SURVEILLANCE CHECKLIST

Inspector(s):	Rob Muise	**Inspection Date:**	~~2:30 PM~~ Oct 5/17
Weather:	Sunny 15°	**Inspection Time:**	2:20 PM

Any Trigger Event Prior to this Inspection?:	NO
Any Failure Observed? What is the Failure Mode?:	NO
Was the Spillway Flowing? If Yes, Estimate Flow Volume (m^3/s):	NO - Brush clearing complete
Minimum observed freeboard - pond level to dam crest (m):	10 M
Minimum observed water level below spillway entrance (m):	NONE

Are the following components of your dam in *SATISFACTORY CONDITION*? (Check one if applicable)

DAM	YES/NO	INSTRUMENT	YES/NO
Embankment U/S slope	☑ Yes ☐ No	Piezometers/Wells	☑ Yes ☐ No
Embankment Crest	☑ Yes ☐ No	Survey Monument	☑ Yes ☐ No
Embankment D/S Slope	☑ Yes ☐ No	Others – Please Specify:	☐ Yes ☐ No
Embankment D/S Toe	☑ Yes ☐ No		
Impoundment	☑ Yes ☐ No		

SPILLWAY	YES/NO	DIVERSION DITCH	YES/NO
Entrance	☑ Yes ☐ No	Walls	☑ Yes ☐ No
Walls	☑ Yes ☐ No	Channel	☑ Yes ☐ No
Channel/Riprap	☑ Yes ☐ No	Channel Slopes	☑ Yes ☐ No
Outlet	☑ Yes ☐ No	Outlet	☑ Yes ☐ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found? If yes, take photographs and mark its location on the attached site plan.

INDICATOR	YES/NO	COMMENTS
Piping	☐ Yes ☑ No	
Sinkholes	☐ Yes ☑ No	
Seepage Turbidity/Clear	☐ Yes ☑ No	
External Erosion	☐ Yes ☑ No	
Cracks	☐ Yes ☑ No	
Settlement	☐ Yes ☑ No	
Slope Slough/Failure	☐ Yes ☑ No	
Animal Borrow/Digging	☐ Yes ☑ No	
Unusual Ponded Area	☐ Yes ☑ No	
SP2 - Plugged Culverts	☒ Yes ☐ No	Partial - see Pictures
Others:		

Piezometer Readings

PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)
1)		7)		13)	
2)		8)		14)	
3)		9)		15)	
4)		10)		16)	
5)		11)		17)	
6)		12)		18)	

NOT Taken

Comments / Notes:

Site Plan: Pictures

BULLMOOSE TAILINGS STORAGE FACILITY SURVEILLANCE CHECKLIST

Inspector(s):	Rob Muise	**Inspection Date:**	Nov 6/17
Weather:	-5 snow covered	**Inspection Time:**	3:00 pm
Any Trigger Event Prior to this Inspection?:	NO		
Any Failure Observed? What is the Failure Mode?:	NO		
Was the Spillway Flowing? If Yes, Estimate Flow Volume (m^3/s):	NO		
Minimum observed freeboard - pond level to dam crest (m):	NO		
Minimum observed water level below spillway entrance (m):	NONE		

Are the following components of your dam in *SATISFACTORY CONDITION*? (Check one if applicable)

DAM	YES/NO	INSTRUMENT	YES/NO
Embankment U/S slope	☑ Yes ☐ No	Piezometers/Wells	☑ Yes ☐ No
Embankment Crest	☑ Yes ☐ No	Survey Monument	☑ Yes ☐ No
Embankment D/S Slope	☑ Yes ☐ No	Others – Please Specify:	☐ Yes ☐ No
Embankment D/S Toe	☑ Yes ☐ No		
Impoundment	☑ Yes ☐ No		

SPILLWAY	YES/NO	DIVERSION DITCH	YES/NO
Entrance	☑ Yes ☐ No	Walls	☑ Yes ☐ No
Walls	☑ Yes ☐ No	Channel	☑ Yes ☐ No
Channel/Riprap	☑ Yes ☐ No	Channel Slopes	☑ Yes ☐ No
Outlet	☑ Yes ☐ No	Outlet	☑ Yes ☐ No

Were any of the following *POTENTIAL PROBLEM INDICATORS* found? If yes, take photographs and mark its location on the attached site plan.

INDICATOR	YES/NO	COMMENTS
Piping	☐ Yes ☑ No	
Sinkholes	☐ Yes ☑ No	
Seepage Turbidity/Clear	☐ Yes ☑ No	
External Erosion	☐ Yes ☑ No	
Cracks	☐ Yes ☑ No	
Settlement	☐ Yes ☑ No	
Slope Slough/Failure	☐ Yes ☑ No	
Animal Borrow/Digging	☐ Yes ☑ No	
Unusual Ponded Area	☐ Yes ☑ No	
SP2 - Plugged Culverts	☐ Yes ☑ No	
Others:		

Piezometer Readings

PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)	PIEZOS No.	READINGS (m)
1)		7)		13)	
2)		8)		14)	
3)		9)		15)	
4)		10)		16)	
5)		11)		17)	
6)		12)		18)	

Not Read

Comments / Notes:

Snow covered

Site Plan:

APPENDIX V

Register of Reference Documents

Appendix V
Register of Reference Documents

Document No.	Document Title	Author	Date of Issue
01	Bullmoose Coal Project - Phase II - Geotechnical, Hydrogeological and Water Management Study - Report II - Project Description, Geologic Setting and Phase II Field Investigation	Hardy Associates (1978) Ltd. (Hardy)	08-Jan-82
02	Bullmoose Coal Project - Phase II - Geotechnical, Hydrogeological and Water Management Study - Report VI - Tailings Disposal Facility Geotechnical Study	Hardy	23-Feb-82
03	Bullmoose Coal Project - Phase II - Geotechnical, Hydrogeological and Water Management Study - Report X - Construction Materials	Hardy	30-Mar-82
04	Sedimentation Ponds No. 1 and No. 2 Bullmoose Coal Project - Geotechnical Design Report	Klohn Leonoff (KL)	25-Jun-82
05	Bullmoose Coal Project - Tailings Dam Design Report	KL	Oct-82
06	Bullmoose Coal Project - DESIGN: Sedimentation Pond No. 3	KL	25-Feb-83
07	Bullmoose Tailings Disposal 1983 Starter Dam Construction	KL	14-Mar-1984
08	Annual Review of Tailings Dam - 1984/85	Bullmoose Operating Corporation (BOC)	Aug-85
09	Annual Review of Tailings Dam 1986/87	KL	11-Aug-87
10	Report on Site Visit July 24, 1987 and Annual Review of Tailings Dam 1986/87	KL	11-Aug-87
11	Bullmoose Coal Project Hydrogeology Study	KL	Nov-87
12	Annual Review of Tailings Dams for 1987/88	KL	09-Sep-88
13	Annual Review of Operations - 1987/88	BOC	Aug-88
14	Annual Review of Tailings Dams for 1988/1989	KL	28-Aug-89
15	Annual Review of Operations - 1988/89	BOC	Aug-89
16	1989-90 Annual Review of Tailings Dam	KL	30-Aug-90
17	Tailings Pond Annual Review of Operations - 1989/90	BOC	Aug-90
18	1990-91 Annual Review of Tailings Dam	KL	29-Aug-91
19	Annual Review of Operations - 1990/91	BOC	Jul-91
20	1991-92 Annual Review of Tailings Dam	KL	26-Aug-92
21	Annual Review of Operations 1991/92	BOC	Jul-92
22	1992-93 Annual Review of Tailings Dam	Klohn Crippen (KC)	30-Aug-93
23	Annual Review of Operations 1992/93	BOC	Jul-93
24	Annual Review of Operations 1993/94	BOC	Jul-94
25	May Site Visit: Tailings Dam Recommendations	KC	01-Jun-95
26	South Fork Tailings Dam - Seepage and Stability Review	KC	Oct. 1996
27	1996 Annual Review of Tailings Facility	KC	17-Dec-96
28	Density Comparison, Tailings Dam Construction - Bullmoose Mine, Tumbler Ridge, BC	Peace Country Materials Testing Ltd. (PCM)	04-Jun-97
29	1997 Annual Review of Tailings Facility	KC	17-Dec-97
30	Annual Review of Operations 1997/98 Tailings Pond	BOC	Dec-98
31	1998 Annual Review of Tailings Facility	KC	13-Jan-99
32	Bullmoose Tailings Facility Establishment of Threshold Warning Levels of Piezometers	KC	Oct-99
33	Summary of Site Visit on September 23, 1999	KC	19-Nov-99
34	Annual Review of Operations 1998/99 Tailings Pond	BOC	Nov-99
35	Tailings Impoundment Closure Report - Draft	BOC	Jan-00
36	1999 Annual Review	KC	07-Feb-00
37	Annual Review of Operations	BOC	Nov-00
38	Review of 2000 Tailings Operations Report	KC	Dec-00
39	Annual Review of Operations	BOC	Nov-01
40	Tailings Impoundment Closure Spillway Design	KC	Dec-01
41	Review of 2001 Tailings Operations Report	KC	18-Dec-01
42	Tailings Impoundment Closure Spillway - Review of Proposed Layout	KC	Oct-02
43	Bullmoose Mine Review of 2002 Tailings Operations Report	KC	18-Dec-02
44	Annual Review of Operations	BOC	Nov-2003
45	Bullmoose Mine Review of 2003 Tailings Operations Report	KC	18-Dec-2003
46	Bullmoose Tailings Facility Closure Spillway Inspection on September 22, 2004	KC	Oct-2004
47	Tailings Dam Annual Review of Operations	BOC	01-Nov-04
48	Bullmoose Mine Review of 2004 Tailings Operations Report	KC	Dec. 2004
49	Bullmoose 2010 Dam Safety Inspection and Consequence Classification	Klohn Crippen Berger (KCB)	01-Mar-11
50	Bullmoose Tailings Impoundment 2012 Dam Safety Inspection	Teck	Aug-13
51	Bullmoose Mine 2013 Dam Safety Inspection	KCB	25-Mar-14
52	Bullmoose Mine Tailings Dam Design Review	KCB	15-Aug-14
53	Bullmoose Mine Tailings Storage Dam 2014 Dam Safety Inspection Revision 1	KCB	26-Nov-14
54	Bullmoose Mine Tailings Storage Facility - Dam Breach and Inundation Study	KCB	27-Nov-14
55	Bullmoose Mine Tailings Storage Facility - Response to February 3, 2015 MEM Memorandum	KCB	29-Jun-15
56	Bullmoose Mine 2015 Consulting - Tailings Storage Facility Hydrotechnical Review	KCB	22-Dec-15
57	Bullmoose Mine Tailings Storage Dam – 2015 Dam Safety Inspection	KCB	22-Mar-16
58	Bullmoose Tailings Storage Facility Engineer of Record	KCB	23-Sep-16
59	Bullmoose Mine Tailings Dam - Water Management, Water Balance and Quantifiable Performance Objectives	KCB	22-Dec-16
59	Bullmoose Mine Tailings Storage Dam – 2016 Dam Safety Inspection	KCB	01-Mar-17
60	Bullmoose Tailings Dam - Review of Monument Survey Data - May, 2017	KCB	09-Jun-17
61	Survey Monuments Quantifiable Performance Objectives	KCB	25-Aug-17
60	Review of Seismic Hazard Assessment	KCB	13-Oct-17
62	Bullmoose Creek Flood Study - Draft	KCB	20-Dec-17
63	Bullmoose Tailings Dam – Closure Passive Care - Draft	KCB	26-Feb-18
64	Bullmoose Tailings Dam - Internal Stability Assessment - Draft	KCB	09-Mar-18