Klohn Crippen Berger

Teck Metals Ltd.

Pinchi Lake Mine Tailings Storage Facility

2018 Dam Safety Inspection

CANADA'S BEST MANAGED COMPANIES Platinum member

ISO 9001
ISO 14001
OHSAS 18001

M07728A33.730

February 2019

Klohn Crippen Berger

February 21, 2019

Teck Metals Ltd.
Kimberley Operations
Bag 2000
Kimberley, British Columbia
V1A 3E1

Ms. Michelle Unger
Mine Manager

Dear Ms. Unger:

Pinchi Lake Mine Tailings Storage Facility
2018 Dam Safety Inspection

We are pleased to submit the 2018 Dam Safety Inspection Report on the Pinchi Lake Mine Tailings Storage Facility for your review and comments.

Please contact us if you have any questions regarding this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Daniel Klassen

Daniel Klassen, P.Eng.
Project Manager

DK:jc

190221R-2018 DSI.docx
M07728A33.730

Teck Metals Ltd.

Pinchi Lake Mine Tailings Storage Facility

2018 Dam Safety Inspection

EXECUTIVE SUMMARY

This report presents the 2018 Dam Safety Inspection (DSI) of Teck Metals Ltd.'s (Teck) Pinchi Lake Mine Tailings Storage Facility (TSF) by Klohn Crippen Berger Ltd. (KCB). The dam safety inspection of the TSF facilities was conducted in June 2018 by the Engineer of Record, Bob Chambers, of KCB. Routine inspections were carried out in May 2018 by the Site Surveillance Officer, Mark Pokorski, of EcoFor.

This summary section is provided in accordance with the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (MEM 2016, 2017), and Teck's "Guideline for Tailings and Water Retaining Structures" (Teck 2014). The summary is provided solely for purposes of overview. Any party who relies on this report must read the full report. The summary omits a number of details, any one of which could be crucial to the proper application of this report.

Summary of Facility Description

Pinchi Lake Mine has been closed since 1975. Teck completed the reclamation/closure works for the TSF in 2011. The TSF and associated water management infrastructure include the following:

- An earthfill tailings dam: 3 m to 15 m high, approximately 1300 m long.
- A tailings impoundment containing approximately one million cubic metres of tailings. The impoundment is a dry facility with glacial till cover and vegetation on the tailings surface. There is no storage of water in the impoundment.
- A free-flowing, riprap lined open channel Closure Spillway.
- The Ed Creek Diversion Channel, which diverts Ed Creek away from the TSF.

Summary of Key Hazards

As a required component of the annual dam safety inspection, key observations related to the potential hazards associated with the TSF are summarized as follows:

Earthquakes: There is lacustrine clay in the foundation of the dam that may be susceptible to cyclic softening under earthquake loading. However, the dam is located in a region of low seismicity, with a peak ground acceleration of less than 0.05 g for the 1/2475 annual exceedance probability earthquake. Simplified deformation and post-earthquake stability analyses were performed and show that the dam meets CDA guidelines for seismic stability (CDA 2014) and that the predicted seismic deformation is 10 cm, which is tolerable for this facility (KCB 2017c). **Summary – no present concern and no long-term concern indicated.**

Surface Erosion: A portion of the Ed Creek Diversion Channel is located close to the dam toe, and failure of the channel during a flood could potentially erode the dam toe. The riprap in the channel is weathering and breaking down, and Teck is looking at options for remediating the channel, including replacing the riprap and possibly realigning the channel away from the dam. **Summary – no present concern but some long-term concern is possible and further evaluation recommended.**

Consequence Classification

Consequence classification is not related to the likelihood of a failure, but rather the potential impact resulting from a failure if it did occur. The downstream consequence classification of the TSF was reviewed in 2012 after the completion of the reclamation/closure works, and the Tailings Dam was classified as Significant based on the 2007 Dam Safety Guidelines published by the Canadian Dam Association (CDA 2007). There have been no material changes to the TSF or the upstream and downstream conditions since the previous review, and the 2013 update to the Dam Safety Guidelines (CDA 2013) did not change the classification scheme; therefore, there is no change in the dam classification.

Summary of Key Observations and Significant Changes

There has been no construction or any other significant changes to the TSF or associated water management infrastructure since the 2017 DSI. Maintenance activities in 2018 included clearing of vegetation from around the inlets of the Ed Creek culverts at Pinchi Lake Road.

There are six vibrating wire piezometers at three locations around the dam and fourteen survey monuments. Piezometers are read twice per year, and survey monuments are measured every ten years. There were no significant changes in the measurements made from these instruments in 2018, and the quantifiable performance objectives (QPOs) were met. Piezometer readings show seasonal fluctuations between spring and summer/fall. Survey monitoring stations were last read in December 2016, and the readings were below the alert criteria and did not give any cause for concern. There is normally no storage of water in the TSF and no instrumentation for water level or flow monitoring.

Cracks on the north slope of Borrow Area A downstream of the Tailings Dam have been monitored twice per year since 2015 by measuring the distance between metal rods on either side of the cracks. The readings have shown either minor fluctuations with no net change over time, or a decrease (narrowing of the cracks) over time. The borrow area slope should continue to be monitored for further development of cracks, seeps and movement as described in the OMS Manual, but measurement of the rods can be discontinued until there is a noticeable change in the condition of the slope.

Overall, there were no significant changes to the stability of the dam in 2018, which means the dam is in a good state of repair. A stability assessment of the Tailings Dam was performed in 2017, which concluded that the dam meets industry standard static and seismic stability design criteria (KCB 2017c).

OMS Manual and EPRP

The Operation, Maintenance and Surveillance (OMS) Manual and the Emergency Preparedness and Response Plan (EPRP) for the Pinchi Lake Mine TSF were revised in 2017 (KCB 2017b). Updates to these documents are in progress.

Dam Safety Review

A Dam Safety Review (DSR) of the Pinchi Lake Mine TSF and associated water infrastructure was completed in 2013 (Golder 2014); the next DSR is scheduled for Q4 2018.

Summary of Recommendations

The deficiencies and recommendations related to dam safety are summarized in the following table. Aligned with the noted good state of repair of the facility and no observed or computed stability concerns, none of the issues are high priorities. The levels of priority assigned to each item in the table are based on priority ratings developed by Teck (and consistent with HSRC) as follows:

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 as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks.

As shown in the table, none of the issues are expected to result in a dam safety issue upon occurrence and are therefore considered “best practice” issues rather than urgent, dam safety items.

Structure	ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Ed Creek Diversion Channel	2014-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering.	HSRC	Measures to re-establish the required erosion protection along the channel should be undertaken. This may include the replacement of the riprap or other suitable alternative(s). As this work may take some time to undertake, in the interim, the channel should be inspected twice per year and the riprap along selected sections of the channel should be replaced when deemed necessary.	3	End of 2022
Pinchi Lake Road Culverts	2017-01	Excessive vegetation around inlets	OMS Manual	Clear dead vegetation and debris from upstream of the Pinchi Lake Road culverts to a distance of 6 m upstream of the inlet. Clear or trim living vegetation overhanging the area immediately upstream of the inlet. Until this work is completed, perform weekly inspections starting the first week of April 2018. Increase inspection frequency to twice per week when daytime temperatures regularly exceed 10°C.	3	CLOSED - Vegetation cleared from around inlet on March 29, 2018.
TSF	2018-01	N/A	OMS Manual	Remove the West Ditch from regular surveillance in the 2019 DSI and in the next update of the OMS Manual.	4	End of 2019
Borrow Area A	2018-02	N/A	OMS Manual	Discontinue Borrow Area A monitoring rod measurements and remove from the 2019 DSI and the next update of the OMS Manual.	4	End of 2019

Notwithstanding the deteriorating riprap in the Ed Creek Diversion Channel, which has both an interim and longer term remedial plan, the Pinchi Lake Mine TSF appears to be in good condition and there are no major concerns related to dam safety.

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

List of Tables

List of Figures

List of Appendices

1 INTRODUCTION

1.1 Purpose, Scope of Work and Methodology

This report presents the 2018 Dam Safety Inspection (DSI) of Teck Metals Ltd.'s Pinchi Lake Mine Tailings Storage Facility (TSF) by Klohn Crippen Berger Ltd. (KCB). The following activities were undertaken by KCB as part of the DSI:

- Site inspections by Mr. Bob Chambers, P.Eng. (the Engineer of Record) and Mr. Daniel Klassen, P.Eng. on June 13, 2018.
- Review and update of the list of outstanding recommendations from the previous dam safety inspections.
- Review instrumentation and confirm that readings are within acceptable limits.

KCB was accompanied by Ms. Michelle Unger (Teck), Ms. Kathleen Willman, P.Eng. (Teck), and Mr. Mark Pokorski, R.P.Bio. (Ecofor Consulting Ltd.). Mr. Pokorski conducted the spring freshet inspection of the TSF and associated facilities.

The 2018 DSI was conducted and this report prepared in accordance with the Teck Guideline for Tailings and Water Retaining Structures (Teck 2014).

1.2 Regulatory Requirements

This DSI addresses the performance of the TSF and associated water management infrastructure in accordance with the Health, Safety and Reclamation Code for Mines in British Columbia (HSRC) (MEM 2016, 2017) and the Permit Amendment Approving Closure Plan (Permit No. M-5) dated July 12, 2010.

1.3 Engineer of Record and TSF Qualified Person

The Engineer of Record for the TSF is Mr. Bob Chambers, P.Eng., of KCB. The responsibilities of the TSF Qualified Person, as defined in the HSRC (MEM 2016), are performed by the Mine Manager, Ms. Michelle Unger of Teck.

1.4 Facility Description

The Pinchi Lake Mine is located in central British Columbia on the northern shore of Pinchi Lake approximately 25 km northwest of Fort St. James and 75 km northwest of Vanderhoof. Pinchi Lake is long (23 km) and narrow (ranging from approximately 1000 m to 3250 m wide) and lies at an elevation of approximately 720 metres above sea level (masl). At the mine site, Pinchi Lake is only 1250 m wide. The terrain near the mine site is heavily wooded with rolling hills and generally less than 300 m of relief, although some hills rise to over 1000 masl.

The mine was originally commissioned in the 1940s and operated from 1940 to 1944 during the Second World War. The mine was closed until 1968, when it re-opened and operated from 1968 to 1975. The property was placed on care and maintenance in 1975. Teck substantially completed the mine reclamation and closure works from 2010 to 2012.

A mine site plan and the general arrangement of the TSF are presented in Figures 1.1 and 1.2, respectively. Cross-sections of the Tailings Dam, based on 2012 topography, are shown in Figure 1.3.

The Pinchi Lake Mine TSF is a side hill impoundment covering approximately 24 ha and contained on three sides by an embankment dam. Approximately one million cubic metres of tailings are stored in the TSF. The Tailings Dam is approximately 1300 m long, and 3 m to 15 m high. The original dam was designed and constructed in the late 1960s, and it was raised in 1975 as shown in the historical drawing presented in Appendix V. The dam was originally a homogeneous dam constructed with local glacial till and upstream slopes of 2.0H:1V near the crest and 2.5H:1V elsewhere, and downstream slopes of 2.0H:1V near the crest and 3.0H:1V elsewhere. When the dam was raised in 1975, a zone of rockfill was placed on the downstream slope with a transition zone between the glacial till and the rockfill.

Ed Creek originally flowed through the impoundment area as shown in the drawing in Appendix V (labelled as “Main Creek” and “Ed Main Creek” in the drawing). The creek was diverted to Pinchi Lake via the Ed Creek Diversion Channel, which was constructed on the east side of the TSF (see Figure 1.2).

Water management for the TSF, prior to the implementation of the reclamation/closure works in 2010, comprised a low level decant system supplemented by an open channel Emergency Spillway. The decant box and spillway were located near the west abutment of the Tailings Dam as shown in the drawing in Appendix V. The decant box and the spillway are labelled in the drawing as “new water collection box” and “overflow ditch”, respectively. The decant system and the Emergency Spillway were decommissioned, and a Closure Spillway was constructed, as part of the closure works completed by Teck in 2010 and 2011.

A facility data sheet for the TSF is presented in Appendix I.

1.5 Background Information and History

1.5.1 General

The design and construction history, from start-up to closure, is summarized below.

1.5.2 Pre-2010 Construction

The Pinchi Lake Mine TSF was constructed in 1967 and utilized between 1967 and 1975. The design/construction chronology was as follows:

- 1967 engineering of the facility (Stage 1) by Ripley, Klohn and Leonoff;

- 1967 construction under Kootenay Engineering inspection with Tara Engineering Laboratories carrying out fill placement quality control;
- 1971 inspection letter from Cominco Civil Designer noting settlement (approximately 2 ft) and resulting loss of freeboard - remedial measures were suggested;
- 1974 engineering report by Golder Associates for a 10 ft dam raise (Stage 2);
- 1975 letter by Golder Associates approving design drawings for a reduced dam raise of 5 ft;
- 1975 construction of the 5 ft raise;
- 2000 stabilization and rehabilitation of the Ed Creek Diversion Channel;
- 2001 rehabilitation of the Ed Creek Diversion Channel as the riprap and fish habitat were eroded by a large flood wave that resulted from a series of beaver dam failures; and
- 2001 Emergency Spillway excavation to increase flow capacity.

1.5.3 2010 and 2011 Reclamation/Closure Works

The following reclamation/closure works for the TSF were completed by Teck in 2010 and 2011:

- drained the water from the Tailings Impoundment;
- abandoned the Emergency Spillway;
- abandoned the decant system and backfilled the concrete decant inlet box with soil;
- placed and seeded soil cover over the tailings in the TSF;
- trimmed the crest of the western leg of the Tailings Dam for use as cover material for the tailings; and
- constructed the TSF Closure Spillway.

In addition to trimming the TSF dam crest for the 2010/2011 closure works, Teck developed three borrow areas adjacent to the TSF as a source of cover material for the tailings (see Figure 1.2): Borrow Areas B and C are located upstream of the TSF and Borrow Area A is located downstream of the south leg of the Tailings Dam.

The Closure Spillway is located in the area of the former supernatant pond. The spillway invert is set such that water would not be stored in the Tailings Impoundment under normal conditions. Draining of the water from the impoundment and constructing the spillway has converted the TSF into a “dry” facility.

2 SITE ACTIVITIES DURING 2018

The TSF is a closed facility and does not require operational intervention, except for scheduled and event driven inspections and maintenance work carried out on an as-required basis. Requirements for routine inspection and monitoring, and trigger levels for inspection following an extreme event are presented in the Operation, Maintenance and Surveillance (OMS) Manual and Emergency Preparedness Plan (KCB 2017b).

Ms. Michelle Unger (Pinchi Mine Manager) or her designate carries out an inspection of the facility following freshet each year. In 2018 this inspection was carried out on May 3 by the Site Surveillance Officer, Mr. Mark Pokorski of EcoFor Consulting Ltd. This inspection did not identify any dam safety issues. An annual inspection of the TSF is conducted by the Engineer of Record, previously in late summer or early fall but moved to late spring starting in 2018. The former site caretaker, Mr. Dave Bjork, is still residing on-site; although surveillance of the mine site is no longer his formal role, he will most likely report unusual occurrences to Teck.

On March 29, 2018, vegetation was cleared from around the inlets of the Ed Creek culverts at Pinchi Lake Road.

A site tour with the Independent Tailings Review Board was carried out immediately after the DSI in June 2018.

Apart from these routine inspections and site maintenance, there were no other site activities during 2018.

3 CLIMATE DATA AND WATER BALANCE DURING 2018

3.1 Climate Data

There is no climate station at the mine site; however, temperature and precipitation data for Fort St. James (Environment Canada climate station no. 1092975, located approximately 25 km southeast of the mine) were reviewed. Table 3.1 presents a comparison of the recorded monthly temperatures and precipitation from Sep. 1, 2017 to Aug. 31, 2018 with the station's temperature and precipitation normals for 1981 to 2010. The records of temperature and total precipitation (rainfall + snowfall) from this station are fairly complete, but separate measurements of rain and snow are only available from another climate station at essentially the same location (Environment Canada climate station no. 1092970, located about 1.5 m from the other station based on the provided latitude and longitude). However, these rain and snow measurements were recorded only 3 or 4 days per week in 2017 and 2018, so they are too incomplete for calculating monthly totals.

The climate data shows that temperatures during the period examined were close to average conditions, apart from an unusually cold February (daily average -13.7°C compared to -6.8°C climate normal). The precipitation data shows drier than average conditions overall (total precipitation 380 mm compared to 487 mm normal). December, May, and August were particularly dry months, with 1 mm, 7 mm, and 3 mm of precipitation, respectively, compared to climate normal of 43 mm, 39 mm and 45 mm. However, February had much higher precipitation than usual with 62 mm compared to the normal of 30 mm.

3.2 Water Balance

The HSRC (MEM 2016, 2017) calls for a water balance review. Since the Pinchi Lake Mine TSF is a dry facility, there is no storage of water in the Tailings Impoundment and stormwater inflows are passively released from the impoundment via the Closure Spillway. Based on observations, there has been no indication of ponding of water behind the spillway, except in small local depressions in the tailings cover. Because inflow to the impoundment is limited to direct precipitation and stormwater runoff from small catchments upslope of the TSF, an annual water balance review is deemed to be unnecessary. However, a water balance was prepared in 2016 based on average precipitation from the Fort St. James 1981-2010 climate normals (Environment Canada climate station no. 1092970). The water balance is included in Appendix VI. The average discharge through the spillway was estimated to be 3.0 L/s. This water balance is under review and will be updated in 2019 to refine the estimate of average discharge.

3.3 Water Quality

Water quality was not assessed by KCB. The surface water quality discharging from the TSF is currently monitored annually under effluent permit PE-224. The groundwater quality at Pinchi Lake Mine is currently monitored under the Contaminated Sites Regulation (B.C. Reg. 375/96). Both surface and groundwater quality are reported by Teck to B.C. Ministry of Environment and B.C. Ministry of Energy, Mines & Petroleum Resources.

Table 3.1 Fort St. James (No. 1092975) Temperatures and Precipitation – Sep. 2017 to Aug. 2018 vs. Normal Values

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Year
1981-2010 Normals													
Temperature													
Daily Average (°C)	10.2	4.3	-3.0	-7.8	-9.5	-6.8	-1.8	3.9	9.2	13.4	15.4	14.8	3.5
Daily Maximum (°C)	16.4	9.0	0.6	-3.8	-5.3	-1.7	4.0	9.9	15.6	19.6	21.8	21.7	9.0
Daily Minimum (°C)	3.9	-0.5	-6.5	-11.7	-13.7	-11.8	-7.7	-2.2	2.8	7.2	8.9	7.9	-2.0
Precipitation													
Rainfall (mm)	39.1	38.7	15.7	4.2	4.9	3.6	5.9	18.0	38.2	50.6	50.6	45.0	314.5
Snowfall (cm)	0.2	9.5	28.8	38.4	43.3	26.4	19.8	5.7	0.7	0.0	0.0	0.0	172.7
Precipitation (mm)	39.3	48.1	44.5	42.6	48.1	30.0	25.7	23.7	38.9	50.6	50.6	45.0	487.2
Sep. 2017 – Aug. 2018													
Temperature													
Daily Average (°C)	11.7	5.3	-3.3	-8.9	-8.0	-13.7	-3.9	2.6	12.0	13.1	16.7	16.8	3.4
Daily Maximum (°C)	17.2	10.1	-0.2	-5.1	-4.2	-7.5	2.1	8.6	18.7	18.8	23.6	23.4	8.8
Daily Minimum (°C)	6.1	0.3	-6.5	-12.7	-11.8	-19.8	-9.7	-3.5	5.3	7.4	9.9	10.2	-2.0
Precipitation													
Rainfall (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Snowfall (cm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Precipitation (mm)	46.5	60.6	54.1	1.2	28.8	62.1	34.8	15.2	7.3	40.6	25.8	3.2	380.2
No. of days of missing data	0	0	0	0	0	0	0	0	1	0	2	0	3

4 SITE OBSERVATIONS – JUNE 2018

4.1 Visual Inspection

The following areas were inspected during the June 13, 2018 site visit:

- Tailings Storage Facility:
  - Tailings Impoundment (drained and covered with soil);
  - West Ditch (abandoned Emergency Spillway channel);
  - Tailings Dam; and
  - Closure Spillway.
- Borrow Area A Slope
- Ed Creek:
  - Ed Creek Diversion Channel; and
  - Ed Creek culverts under Pinchi Lake Road.

Site observations and recommendations are presented in the following sub-sections. Observation locations referred to in the following sub-sections are identified in Figure 4.1. Selected photographs taken during the inspection are presented in Appendix II, and inspection forms are presented in Appendix III.

4.1.1 Tailings Storage Facility

Tailings Impoundment

- There was no flowing or standing water in the Tailings Impoundment at the time of inspection, apart from a small pond on the south side of the Closure Spillway as described below.
- The soil cover on the tailings is covered in grass (Photos II-9, II-11 and II-25 in Appendix II). A detailed inspection of the cover was not conducted as it was not a part of the scope of this DSI.
- As noted during previous inspections, a channel has formed in the soil cover parallel to the southwest leg of the Tailings Dam adjacent to the dam (Location 3 in Figure 4.1; Photos II-19 and II-20). There is good growth of grass and some cattails along most of the channel, with no signs of erosion.
- In 2014, Teck placed riprap at the downstream end of the above-mentioned channel where it discharges into the Closure Spillway (Location 2 in Figure 4.1; Photos II-29 and II-30). The riprap appears to be performing well. A small pond (about 2 m wide) and a few associated wet areas were observed south of the riprap.

West Ditch

- The West Ditch, which carries local surface runoff from the west abutment of the Tailings Dam, is covered with vegetation (Photo II-38). There were no signs of erosion of the ditch. The invert of the West Ditch is approximately 4 m higher than the invert of the Closure Spillway; therefore, no discharge of water from the Tailings Impoundment via the West Ditch is expected. The West Ditch is not relevant to dam safety, and regular surveillance is no longer required.

  Recommendation/Action:

  Remove the West Ditch from regular surveillance in next update of the OMS Manual.

Tailings Dam

- The dam crest, and upstream and downstream slopes of the Tailings Dam appeared to be in good condition, except as noted below.
- Longitudinal cracks (up to 5 m long, 20 mm wide, and 250 mm deep) were observed on the dam crest along the southwest leg of the Tailings Dam (Location 4 in Figure 4.1; Photo II-18), similar to those observed in 2015 and 2017. There appeared to be fewer cracks than during the 2017 inspection. The cracks appear to be aligned with tire tracks. The cracks are believed to have been formed by loosening and drying of the soil as part of the reclamation and seeding. The cracks are not a dam safety issue.
- There is vegetation on the slope of the east leg of the dam, especially on the north section, including trees up to about 3 m tall (Location 8 in Figure 4.1; Photos II-1 to II-4, II-6, and II-8). This vegetation is not currently considered to be a dam safety concern, although it may be prudent to clear it before the trees become more difficult to remove. The vegetation management plan recommends vegetation clearing prior to vegetation exceeding 1.5 m in height (Spectrum 2017).
- A pond was observed in the trees near the toe of the east leg of the Tailings Dam (see Figure 1.2 for location; Photo II-5) as in previous inspections, except that the pond level was higher since this year's inspection was carried out in June rather than August or September. This pond is located near a drainage channel that was shown on historical drawings of the TSF (see Appendix V) and labelled "runoff channel." The channel ran parallel to the main Ed Creek channel, and apparently once joined up with Ed Creek just inside the TSF. The pond appears to collect local runoff, and it drains through a channel to the south and through a culvert into Ed Creek Diversion Channel.
- Apart from the pond noted above, the ground at the downstream toe of the dam was dry and no ponded water or seepage were observed.
- A 50 cm diameter, 60 cm deep hole (Photo II-13) was discovered at the upstream side of the dam crest near a stake marked "1018". This appears to be a former survey monument location (see Figure 1.2). It is not known when or why the monument was removed.

Closure Spillway

- There was no flow or standing water in the Closure Spillway channel at the time of inspection; there was a 30 cm deep pond at the downstream end of the riprap (Photo II-37).
- The riprap along the entire Closure Spillway channel appeared to be in good condition (Photos II-28, II-31 to II-34, II-36). The spillway has likely not experienced any high flood discharges since it was constructed. Vegetation growth in the channel was minimal at the time of inspection, only a few small shrubs (Photo II-36).
- There is a small slump in the slope above the riprap on the right (north) side of the spillway channel (Location 1 in Figure 4.1; Photo II-35). A 30 cm high head scarp was visible over a distance of 25 m. The upstream side of the slump is located about 90 m downstream of the dam centreline. There were no noticeable changes in the slump area since the 2017 inspection and the slump is not expected to impact the Tailings Dam or the performance of the spillway.
- The spillway downstream channel was observed at the culvert crossing on the road to the former caretaker's residence. There is minor growth of vegetation in the middle reach of the channel (Photo II-40), and the culvert inlet is clear (Photo II-39). There is flow into the culvert, with about 1 cm of flow depth. The lower reach of the channel is backed up due to a high lake level to about 15 cm depth at the culvert outlet (Photos II-41 and II-42). This results in reduced capacity in the culvert and in the lower reach of the channel.

4.1.2 Borrow Area A Slope

- Cracks were observed in 2013 on the slope of Borrow Area A, downslope of the Tailings Dam (Location 5 in Figure 4.1). The locations of the cracks are shown in plan and on the cross-sections in the figures presented in Appendix IV. The cracks were covered with vegetation and difficult to see at the time of the inspection. No notable changes were observed since the 2017 DSI.
- Metal rods were installed on either side of the cracks at selected locations (shown in Figure 2 in Appendix IV) by Ecofor in April 2015 such that movements at the cracks can be measured and the trend of the movements can be established. The results of the measurements at the monitoring rods are presented in Section 4.2.4.
- A 60 m long wet area was observed at the toe of the slope in the northeast corner of Borrow Area A (Location 6 in Figure 4.1; Photos II-46 and II-47). No flow was observed at the time of the inspection, but the wet area is located approximately where four small seepage areas were identified in July 2011. The surveyed locations of the seeps are shown in Figure 1.2, and in the figures presented in Appendix IV. Ed Creek originally flowed through the Tailings Impoundment area north of the four seeps, and it is suspected that Ed Creek is the source of the water. Outside of this wet area, the ground on the slope and along the toe was dry.

4.1.3 Ed Creek

Ed Creek Diversion Channel

- The 460 mm diameter HDPE culvert on the north bank of the Ed Creek Diversion Channel had some vegetation growing in front of the inlet (see Figure 1.2 for culvert location, and Photos II-61 and II-62). This is not considered a dam safety concern.
- Vegetation growth within Ed Creek Diversion Channel was reasonable at the time of the inspection (Photos II-51 to II-52, and II-54 to II-60), as the vegetation was cleared in October 2017.

  Previous annual inspection reports have noted that the riprap along some areas of the Ed Creek Diversion Channel is weathering and breaking up (Photo II-53). The condition of the riprap appeared similar to previous inspections.

  The riprap along a small section of the channel (Location 7 in Figure 4.1; Photo II-56), where a depression had formed in the riprap surface, was replaced in 2014. This riprap appeared to be in good condition.

  A complete failure of the Ed Creek Diversion Channel could potentially affect the Tailings Dam by eroding the west bank of the channel towards the dam and undermining the dam foundation. That level of event could not occur within a one-year period given the current level of inspection occurring. However, a long-term solution remains the recommendation, first made in 2014, for Teck to re-establish erosion protection. Teck has committed to complete this work by the end of 2022 and are actively investigating erosion protection options for the channel given the lack of immediately available riprap material at site of appropriate size.

Ed Creek Culverts Under Pinchi Lake Road

- There are two culverts on Ed Creek under Pinchi Lake Road east of the mine gate (see Figure 1.2 for location). Vegetation was cleared from the inlet of the culverts on March 29, 2018. The inlets were clear of debris at the time of the inspection; there was debris and vegetation in the channel upstream that could be mobilized during flood conditions (Photos II-64 and II-65). A blockage of the culverts could potentially cause a washout of the road, and a sudden failure of the road embankment may subject the Ed Creek Diversion Channel to large flood flows. Monitoring of these culverts is included in the inspection checklists in the OMS Manual, and they will continue to be monitored in future inspections.

4.2 Instrumentation Review

4.2.1 Tailings Dam Instrumentation

There are six vibrating wire piezometers at three locations around the dam (four piezometers at the toe, two at the crest) as shown in Figure 1.2, and these are read twice per year at minimum. These are currently the only functional instruments in the dam. Quantifiable performance objectives (QPOs)

for the piezometers are defined as threshold piezometric elevations, and these are given in Appendix VII.

Piezometer readings taken during 2018 are included in Table 4.1, and threshold values are shown for comparison. The readings are all below the threshold values. The readings show that the phreatic surface is 1 m to 3 m below ground at the toe of the dam, and 10 m below the crest at the highest dam section. Piezometer readings are shown as elevations versus time in Figure 4.2. The readings in the piezometers at the dam toe (DH16-01-VWP1,2 and DH16-03-VWP1,2) show seasonal fluctuations up to 1.6 m, with higher readings in the spring and lower readings in summer and fall. The piezometers installed below the dam crest (DH16-02-VWP1,2) have shown less variation in the readings apart from an initial drop from October 2016 to April 2017. The drop in readings is likely due to the piezometers having not yet reached equilibrium with the ground around the grout column after the September 2016 installation.

Prior to the installation of the 2016 piezometers there had been no functioning instruments in the Tailings Dam for several years. One piezometer (BH3) was installed on the dam at the highest dam section in 1998 (located 10 m from 2016 piezometers DH16-02-VWP1,2). Teck indicated that the piezometer was destroyed sometime after 2008. Piezometer readings from May 2000 to October 2008, presented in the 2008 Annual Review Report (KCB 2009a), indicate that the phreatic surface at the piezometer was typically around El. 733.5 m, which is 1.3 m higher than the June 13, 2018 reading in DH16-02-VWP1. This suggests the piezometric levels in the dam have gone down compared to the condition before the pond was drained.

Table 4.1 2018 Piezometer Readings

Piezometer ID	Piezometric Elevation (m)			Depth Below Ground (m)	
	Threshold Value	May 3, 2018	June 13, 2018	May 3, 2018	June 13, 2018
DH16-01-VWP1	736.1	735.4	734.7	0.7	1.4
DH16-01-VWP2	736.1	734.4	734.2	1.7	1.9
DH16-02-VWP1	738.5	732.3	732.2	9.7	9.8
DH16-02-VWP2	738.5	732.4	732.3	9.6	9.7
DH16-03-VWP1	737.0	735.7	735.2	2.2	2.7
DH16-03-VWP2	737.0	735.6	735.1	2.3	2.8

4.2.2 Flow and Water Level Measurements

Since there is no pond, there is no flow measurement or water level instrumentation at the TSF. Prior to decommissioning, flow out of the decant system was measured. Water is now released through the Closure Spillway but, given that the spillway channel is lined with large riprap, most of the low flows pass through the riprap, making it difficult to measure flow.

4.2.3 Survey Monitoring Monuments

Survey monitoring stations were installed on the Tailings Dam crest in 1998; however, some stations were destroyed over the years. New survey monitoring stations were installed in June 2014. The

locations of the 2014 monuments and the surviving 1998 monuments are shown in Figure 1.2. QPOs for the survey monuments are provided in Appendix VII.

Readings were last taken in December 2016, and the readings met the QPOs and did not give any cause for concern (KCB 2017a). The monitoring stations are to be read every ten years, so the next readings will be in 2026.

4.2.4 Borrow Area A Cracks Monitoring

As mentioned in Section 4.1.2, metal rods were installed in April 2015 on the slope of Borrow Area A to monitor the movements at the cracks; measurements have been taken twice a year since then. The purpose of the measurements is to identify slope movements early so that maintenance can be performed. This slope is located downstream of the dam toe and a local slumping failure here would have to retrogress over time to the dam toe before it could be considered a threat to dam safety. Therefore, QPOs are not considered necessary.

The rod measurements are given in Table 4.2, and changes in the measurements relative to the initial reading are plotted in Figure 4.3.

The readings in 2018 showed minor fluctuations within a few millimetres of the 2017 readings. The readings since 2015 show no sign of long term trends, except for Location 103A which decreased (narrowing of the cracks) during the first two years of readings. The other locations have shown minor fluctuations in the readings with no net change over time.

The cracks have not shown any signs of widening since they were first observed in 2013, and the rod measurements taken since 2015 have confirmed this. The slope appears to have reached a stable state under the range of conditions encountered over several years. The slope should continue to be inspected as part of the surveillance of the dam, but measurements of these rods can be discontinued until there is a noticeable change in the condition of the slope.

Recommendation/Action:

Discontinue Borrow Area A monitoring rod measurements and remove from the 2019 DSI and in the next update of the OMS Manual.

Table 4.2 Borrow Area A Crack Measurements

Rod Pair #	Distance Between Rods[1] (change from previous) (mm)							
	Apr. 24, 2015	Sep. 23, 2015	Apr. 15, 2016	Sep. 17, 2016	Apr. 21, 2017	Aug. 30, 2017	May 3, 2018	June 13, 2018
103	402	401 (-1)	403 (+2)	400 (-3)	402 (+2)	401 (-1)	403 (+2)	399 (-4)
103A	450	436 (-14)	438 (+2)	427 (-11)	431 (+4)	428 (-3)	430 (+2)	425 (-5)
203	359	354 (-5)	358 (+4)	355 (-3)	359 (+4)	360 (+1)	355 (-5)	354 (-1)
403	357	351 (-6)	350 (-1)	349 (-1)	363 (+14)	364 (+1)	362 (-2)	358 (-4)

Notes:

1. Distance between rods is not a measure of the crack width.
2. Negative change indicates narrowing of the crack, and positive change indicates widening of the crack.

5 DAM SAFETY ASSESSMENT

5.1 Design Basis Review

The relevant design criteria from CDA (2014) and HSRC (MEM 2016, 2017) are compared in Table 5.1. The site conditions are being evaluated to confirm that the TSF meets design criteria for the Closure – Passive Care phase, as described by CDA (2014). The criteria in HSRC are similar to the CDA criteria for Closure – Passive Care.

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

Parameter	CDA		HSRC
	Construction, Operation, and Transition Phases	Closure – Passive Care Phase	
Annual Exceedance Probability (AEP) – Floods	Between 1/100 and 1/1000	1/3 between 1/1000 and PMF	1/3 between 1/975 and PMF
AEP – Earthquakes	Between 1/100 and 1/1000	1/2475	1/2475
Factor of safety for slope stability: Static, Long Term Pseudostatic Post-Earthquake	 1.5 1.0 1.2	 1.5 1.0 1.2	 1.5 Not specified Not specified
Steepest Allowable Downstream Slope	Not specified	Not specified	2H:1V

5.2 Dam Safety Review

A Dam Safety Review (DSR) of the Pinchi Lake Mine TSF and associated water infrastructure was completed in 2013 (Golder 2014), and the next DSR is scheduled for Q4 2018.

5.3 Failure Modes Review

The potential failure modes included in the CDA Dam Safety Guidelines (2013) were reviewed based on the inspection and review of available documents:

- **Overtopping:** There is no permanent pond in the TSF, and the Closure Spillway is designed to convey flood flows passively without developing a large pond in the TSF. A hydrotechnical review of the Closure Spillway is in progress, but based on previous assessments the freeboard during the design flood is expected to be several metres (KCB 2009b). Based on these factors, the likelihood of an overtopping failure is considered to be "Close to Non-Credible"[1].

[1] "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.

- **Internal Erosion and Piping:** The dam includes three fill zones: local silt-clay and glacial till borrow material, a rockfill zone on the downstream slope, and a transition material between the silt-clay/glacial till and the rockfill. The filter adequacy was reviewed previously, and it was found that the as-built information is insufficient to assess the filter compatibility of these materials (KCB 2015). However, the observed performance of the dam, combined with the fact that the TSF is now a dry facility, provide evidence that the filter is functioning adequately to prevent piping. Seepage water or evidence of piping at the dam toe have not been observed during annual inspections. Since the pond was drained during the 2010 to 2011 closure works the seepage gradients through the dam have reduced, and this is reflected in lower piezometer readings in the dam compared to the pre-2010 readings, as discussed in Section 4.2.1. Checking the dam toe for seepage is included in the scheduled surveillance in the OMS Manual (KCB 2017b). The likelihood of failure due to piping is considered to be "Very Rare"[2].
- **Slope Instability:** A stability assessment of the TSF was completed in 2017 (KCB 2017c) and found that the stability criteria described in Section 5.1 are met. The assessment included analyses using undrained strengths in the foundation clay. The condition of the dam is generally more favourable for stability now than it was during operations due to the draining of the pond, and trimming of the dam crest in some areas. Based on the stability assessment and the long performance history with no visible or documented displacements, the likelihood of failure due to slope instability is considered to be "Very Rare".
- **Foundation Irregularities:** A drilling and laboratory testing program was carried out in 2016 to confirm whether silt or clay soils are present beneath the dam and to characterize their geotechnical properties (KCB 2017d). The investigation identified lacustrine clay below the west leg and the east leg of the dam, but the drill hole at the southwest leg of the dam, where the dam is highest, did not encounter lacustrine clay. The Borrow Area A slope has exposed foundation soils near the south leg of the dam and no lacustrine clay was visible, and earlier drill holes in this area confirm glacial till-like soils. The foundation investigation is believed to be sufficiently detailed for this facility.

  The stability assessment described above examined slip surfaces through the lacustrine clay and found that design criteria were met. Based on this analysis and the long performance history with no visible or documented displacements, the likelihood of failure due to a foundation irregularity is considered to be "Very Rare".
- **Surface Erosion:** There are no significant erosion features on the crest or slopes of the dam. Surface runoff from the impoundment drains towards the closure spillway and will not erode the dam surface. The dam surface is vegetated and well protected against surface erosion. The downstream slope of the dam includes coarse rockfill, so any erosion channels that form would be unlikely to rapidly erode through the dam. However, a portion of the Ed Creek Diversion Channel is located close to the dam toe, and failure of the channel during a flood

[2] "Very Rare" Likelihood Rating is defined similar to "Close to Non-Credible" rating, except with a natural hazard return period of 1 in 10,000 years; this rating is also applicable for failure modes that are very rare. FoS against slope instability of 1.5 to 2.0.

could potentially erode the dam toe. The riprap in the channel is weathering and breaking down, and Teck is looking at options for remediating the channel, including replacing the riprap and possibly realigning the channel away from the dam.

- **Earthquakes:** A simplified deformation analysis was performed as part of the stability assessment (KCB 2017c) using the Hynes-Griffin and Franklin (1984) method. A peak ground acceleration (PGA) of 0.044 g was used, corresponding to the 1/2475 AEP earthquake event. The results showed that the predicted deformation is 10 cm, which is tolerable for this facility. A post-earthquake stability analysis was also performed assuming full liquefaction of the tailings. Note that a liquefaction triggering analysis has never been performed for these tailings, but given the low PGA, full liquefaction of the tailings is likely a conservative assumption. The post-earthquake analysis met the minimum FOS of 1.2 recommended by CDA (2014), indicating that a flow-slide failure due to liquefaction of the tailings is unlikely. Note that both the deformation and post-earthquake analyses used 80% of the peak undrained strength in the lacustrine clay to account for cyclic softening, which is likely conservative given the low PGA. Based on this analysis, the likelihood of failure due to earthquake loading is considered to be "Rare"[3].

5.4 Dam Classification Review

Consequence classification is not related to the likelihood of a failure, but rather the potential impact resulting from a failure if it did occur. As a follow-up on the completion of the reclamation/closure works, KCB reviewed the dam classification for the TSF in 2012 with respect to the criteria presented in the 2007 CDA Dam Safety Guidelines (CDA 2007), and the HSRC. Details of the classification review are presented in Pinchi Lake Mine Post-Reclamation Monitoring Requirements (KCB 2012), and the results are summarized below.

CDA Dam Classification

The area downstream of the dam is undeveloped, with no settlements, public roads or any other infrastructure. There is no permanent population at risk. In the event of a breach at the Tailings Dam, releases from the impoundment could enter Pinchi Lake. The TSF was classified as Low for economic and cultural losses, and Significant for loss of life and environmental losses. Therefore, the overall classification of the Tailings Dam is Significant.

There have been no material changes to the TSF or the upstream and downstream conditions since the 2012 classification review, and the consequence classification scheme has not been changed since the 2007 edition of the CDA Dam Safety Guidelines; therefore, there is no change in the Tailings Dam classification.

[3] "Rare" Likelihood Rating is defined similar to "Very Rare" 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.

HSRC Classification

The Tailings Dam and the impoundment were classified as a "major dam" and a "major impoundment" under the 2008 version of the HSRC (MEMPR 2008). The current edition of the HSRC (MEM 2017) does not include the terms "major dam" or "major impoundment". All tailings storage facilities are required to have the consequence classification determined by the Engineer of Record in accordance with the CDA Dam Safety Guidelines (CDA 2013), and design criteria are given in the Code based on the consequence classification. Design criteria that are relevant to the Pinchi TSF are described in Section 5.1.

5.5 Physical Performance

Geotechnical

The dam has performed adequately for over 40 years, and there is no record of slumping or instability since operations ceased in 1975. The closure works in 2010 and 2011 included changes that improved the stability of the dam, including:

- draining the pond, resulting in a decrease in phreatic levels within the dam (as discussed in Section 4.2.1); and
- trimming the crest of the west leg of the Tailings Dam, resulting in a reduction in driving forces for potential failure surfaces in that area.

Borrow Area A was excavated close to the toe of the south leg of the Tailings Dam during the closure works, and is therefore relevant to performance of the dam. Longitudinal cracks were identified on the north slope of Borrow Area A in August 2013. The stability of the overall slope (which includes the Tailings Dam) was reviewed in 2017 under static and seismic loadings, and was found to meet the design criteria summarized in Table 5.1 (KCB 2017c).

However, localized slumping of the borrow area slope could occur and may impact the Tailings Dam if allowed to progress. Therefore, monitoring of the Borrow Area A slope for development of cracks, seeps and movement is part of regular surveillance as described in the OMS Manual (KCB 2017b).

A foundation investigation was performed in 2016 to confirm whether silt or clay soils are present beneath the dam and to characterize their geotechnical properties (KCB 2017d). The investigation concluded that lacustrine clay is present below portions of the dam. The strength of the clay was characterized through laboratory testing of sonic core samples. The data obtained during the investigation was used to perform a stability assessment of the Tailings Dam, which concluded that the dam meets the static and seismic stability design criteria described in Section 5.1 (KCB 2017c).

Hydrotechnical

The Closure Spillway is a free-flowing riprap lined open channel, which passively releases water from the TSF. There is no storage of water in the TSF. The spillway is lined with large riprap and non-flood flows pass through the riprap with very little, if any, flow over the riprap surface. To the best of our

knowledge, the Closure Spillway has not been subjected to any large flood flows since it was constructed in 2010. Review of the Closure Spillway with respect to the Passive Care design criteria is in progress.

Vegetation should be cleared periodically from the water conveyance structures including the Closure Spillway, Ed Creek Diversion Channel, and ditches or they will not operate to design capacity. This is covered under the vegetation management plan (Spectrum 2017).

5.6 Operational Performance

The Pinchi Lake Mine TSF has been closed for about 40 years and, as indicated in Section 2, there are no operational requirements.

5.7 OMS Manual and EPRP Review

The Operation, Maintenance and Surveillance (OMS) Manual and the Emergency Preparedness and Response Plan (EPRP) for the Pinchi Lake Mine TSF were revised in 2017 (KCB 2017b). Updates to these documents are in progress.

6 CONCLUSIONS AND RECOMMENDATIONS

The deficiencies and recommendations from previous years and from the 2018 inspection are summarized in Table 6.1. The priorities assigned to each item in Table 6.1 are based on priority ratings developed by Teck (and consistent with HSRC) as follows:

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 as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks.

Notwithstanding the deteriorating riprap in the Ed Creek Diversion Channel, which has both an interim and longer term remedial plan, the Pinchi Lake Mine TSF appears to be in good condition and there are no major concerns related to dam safety.

There were no threshold exceedances in the piezometers in 2018.

The cracks on the slope of Borrow Area A have been monitored for several years and there has been no indication of ongoing movements. Metal rods installed on either side of the cracks have shown only minor fluctuations or closing of the cracks over time. The borrow area slope should continue to be monitored for further development of cracks, seeps and movement as described in the OMS Manual, but measurement of the rods can be discontinued until there is a noticeable change in the condition of the slope.

The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering. A failure of the Diversion Channel could potentially affect the Tailings Dam. Measures to re-establish the required erosion protection along the channel, such as replacement of the riprap or other suitable alternatives, should be undertaken. The previous recommendation was to carry out this work by the end of 2019. Teck is actively investigating options to remediate the channel, and may require additional studies to assess the long-term implications of each option in terms of risk, cost, and maintenance requirements. A failure of the riprap in the channel would not immediately affect the Tailings Dam, and there would be time to halt the erosion of the natural glacial till soils in the right bank before it could impact the dam. Therefore, we think it is appropriate to extend the deadline for replacing the erosion protection until the end of 2022.

Inspections were carried out in May 2018 by the Site Surveillance Officer, and June 2018 by the Engineer of Record. Maintenance activities in 2018 included clearing of vegetation from around the inlets of the Ed Creek culverts at Pinchi Lake Road.

Climate data from the nearest climate station for the period from Sep. 1, 2017 to Aug. 31, 2018 showed temperatures were close to average conditions (based on 1981 to 2010 climate normals), but there was less precipitation than average. Since the water balance is based on annual average climate data, there is no storage of water in the TSF, and inflows are limited to direct precipitation and stormwater runoff from upslope, updating the water balance on an annual basis is deemed to be unnecessary.

The downstream consequence classification of the TSF was reviewed in 2012 after the completion of the reclamation/closure works, and the dam was classified as Significant. There have been no material changes to the TSF or the upstream and downstream conditions since the previous review; therefore, there is no change in the dam classification.

The OMS Manual and the EPRP were updated in 2017.

Table 6.1 Summary of Deficiencies and Recommendations

Structure	ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Ed Creek Diversion Channel	2014-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering.	HSRC	Measures to re-establish the required erosion protection along the channel should be undertaken. This may include the replacement of the riprap or other suitable alternative(s). As this work may take some time to undertake, in the interim, the channel should be inspected twice per year and the riprap along selected sections of the channel should be replaced when deemed necessary.	3	End of 2022
Pinchi Lake Road Culverts	2017-01	Excessive vegetation around inlets	OMS Manual	Clear dead vegetation and debris from upstream of the Pinchi Lake Road culverts to a distance of 6 m upstream of the inlet. Clear or trim living vegetation overhanging the area immediately upstream of the inlet. Until this work is completed, perform weekly inspections starting the first week of April 2018. Increase inspection frequency to twice per week when daytime temperatures regularly exceed 10°C.	3	CLOSED - Vegetation cleared from around inlet on March 29, 2018.
TSF	2018-01	N/A	OMS Manual	Remove the West Ditch from regular surveillance in the 2019 DSI and in the next update of the OMS Manual.	4	End of 2019
Borrow Area A	2018-02	N/A	OMS Manual	Discontinue Borrow Area A monitoring rod measurements and remove from the 2019 DSI and the next update of the OMS Manual.	4	End of 2019

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 Metals Ltd. (Client) for the specific application to the Pinchi Lake Mine project. 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.

KLOHN CRIPPEN BERGER LTD.

Daniel Klassen, P.Eng.
Project Manager

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

REFERENCES

Canadian Dam Association (CDA). 2007. “Dam Safety Guidelines 2007”.

Canadian Dam Association (CDA). 2013. “Dam Safety Guidelines 2007 (Revised 2013)”.

Canadian Dam Association (CDA). 2014. “Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams”.

Federal Emergency Management Agency (FEMA). 2005. “Technical Manual for Dam Owners – Impacts of Plants on Earthen Dams”. September.

Golder Associates. 2014. “Pinchi Lake Mine – 2013 Dam Safety Review”, April 17.

Hynes-Griffin M. E. and Franklin A. G. 1984. “Rationalizing the Seismic Coefficient Method”. US Army Corps of Engineers. July.

Klohn Crippen Berger (KCB) 2009a. “Pinchi Lake Tailings Facility – 2008 Annual Review”, May 6.

Klohn Crippen Berger (KCB). 2009b. “Pinchi Lake Mine Tailings Facility - Closure Spillway Design”, July 3.

Klohn Crippen Berger (KCB). 2012. “Pinchi Lake Mine Post-Reclamation Monitoring Requirements”, April 20.

Klohn Crippen Berger (KCB). 2014. “Pinchi Lake Mine Tailings Storage Facility – 2014 Dam Safety Inspection”, November 27.

Klohn Crippen Berger (KCB). 2015. “Pinchi Lake Mine Tailings Storage Facility – Response to MEM Memorandum dated February 3, 2015”, June 30.

Klohn Crippen Berger (KCB). 2017a. “Pinchi Lake Mine Tailings Storage Facility – 2016 Dam Safety Inspection”, February 9.

Klohn Crippen Berger (KCB). 2017b. “Pinchi Lake Mine Tailings Storage Facility – Operation, Maintenance and Surveillance Manual & Emergency Preparedness Plan – Revision 2”, March 7.

Klohn Crippen Berger (KCB). 2017c. “Pinchi Lake Mine – TSF Stability Assessment”, November 17.

Klohn Crippen Berger (KCB). 2017d. “Pinchi Lake Mine Tailings Storage Facility – 2016 Foundation Investigation”, December 20.

Ministry of Energy, Mines and Petroleum Resources (MEMPR). 2008. “Health, Safety and Reclamation Code for Mines in British Columbia”.

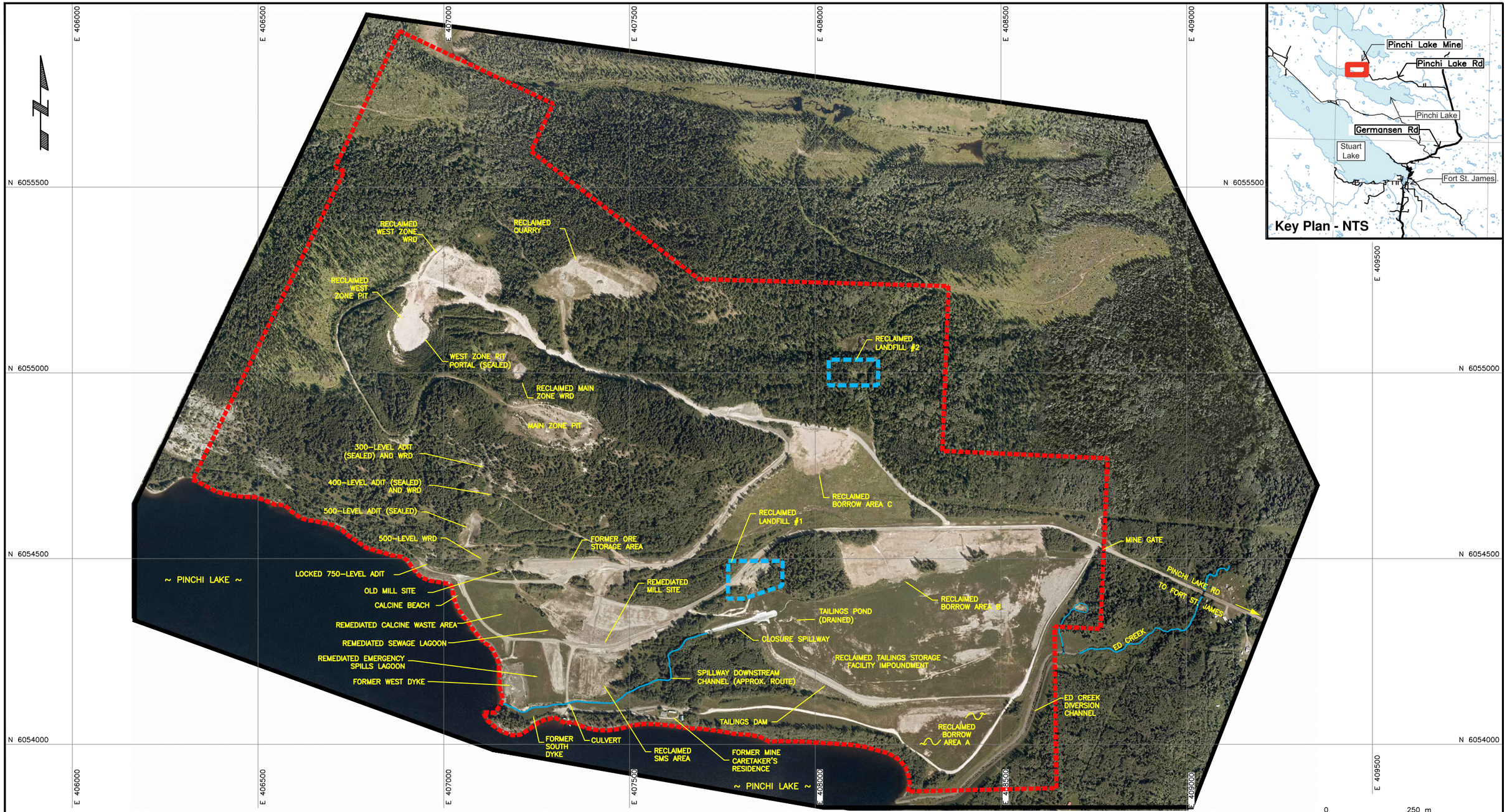
Ministry of Energy and Mines (MEM). 2016. “Guidance Document – Health, Safety and Reclamation Code for Mines in British Columbia”, July 20.

Ministry of Energy and Mines (MEM). 2017. “Health, Safety and Reclamation Code for Mines in British Columbia”, February 28.

Spectrum Resource Group Inc. (Spectrum). 2017. “Pinchi Lake Mine – Site Integrated Vegetation Management Plan.” December 12.

Teck Resources Ltd. (Teck). 2014. “Guideline for Tailings and Water Related Structures”, November 2014.

FIGURES



LEGEND

- PROPERTY BOUNDARY
- WRD — WASTE ROCK DUMP

NOTES

1. ORTHOPHOTO IMAGE TAKEN IN 2013 (PROVIDED BY TECK).
2. NAD83, UTM ZONE 10.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED FEB. 2019

SCALE 0 250 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2018 DAM SAFETY INSPECTION

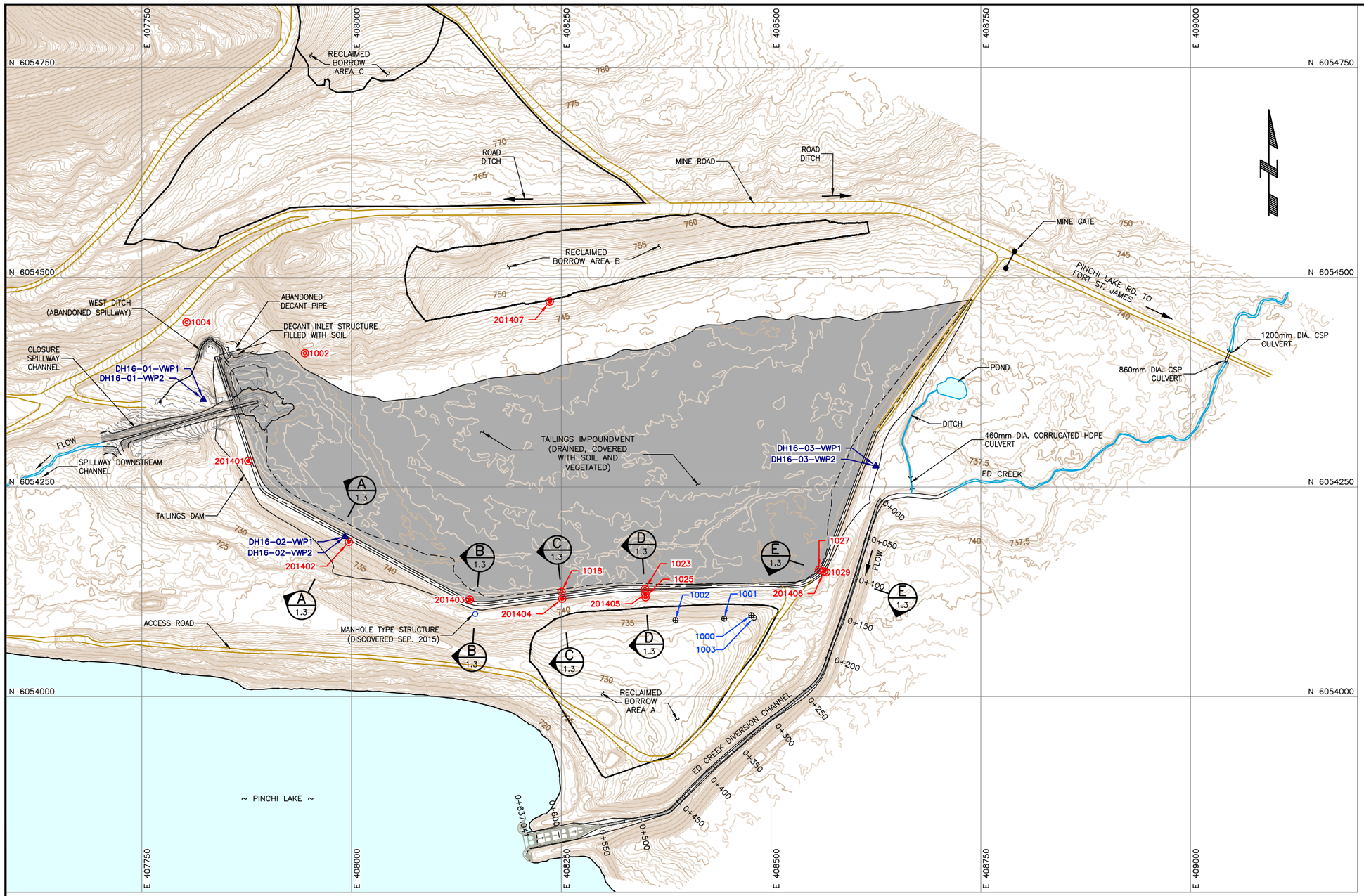
TITLE: MINE SITE PLAN

PROJECT No. M07728 A33

FIG. No. 1.1

KCB-R-MLB

Time: 14:39:51
Date: 11/19/2018
Scale: 1:2.5849(PS)
Drawing File: \\nt.klohn.com\ProData\M\VCR\M07728A33-TML-Pinchi Lake 2018 Services\400 Drawings\CAD\DSI\Fig1.1 - MineSitePlan.dwg (persyem)
Xref File(s): Pinchi-2013_20cm_R
Image File(s): Pinchi-2013_20cm_R



SEEPAGE POINT	
NAME	GROUND ELEVATION (m)
1000	737.0
1001	734.3
1002	734.2
1003	736.9

LEGEND

- 1000 SEEPAGE NOTED IN 2012
- 1998 SURVEY MONUMENT
- 2014 SURVEY MONUMENT
- 2016 VIBRATING WIRE PIEZOMETER

NOTES

1. GENERAL SITE TOPOGRAPHY IS BASED ON SEPTEMBER 2012 LIDAR SURVEY BY McELHANNEY ENGINEERING. TOPOGRAPHY FOR SPILLWAY CHANNEL IS BASED ON JUNE 2011 GROUND SURVEY.
2. COORDINATES ARE NAD83, UTM ZONE 10.

SCALE 0 100 m

REFERENCE DRAWINGS:
CHAINAGE FOR ED CREEK DIVERSION CHANNEL IS FROM KLOHN CRIPPEN DWG No. D-6101.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED FEB. 2019

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2018 DAM SAFETY INSPECTION

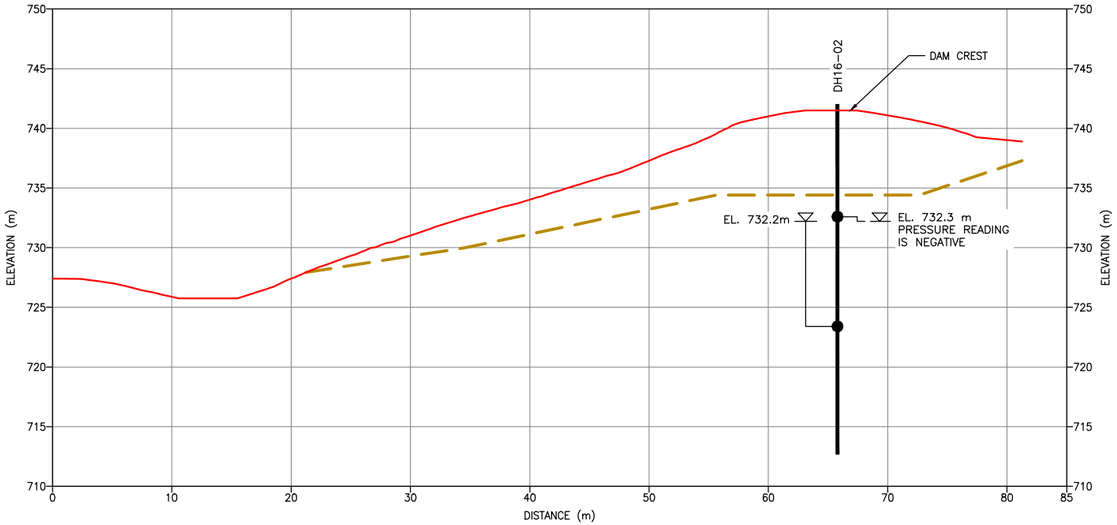
TITLE: TAILINGS STORAGE FACILITY PLAN

PROJECT No. M07728 A33

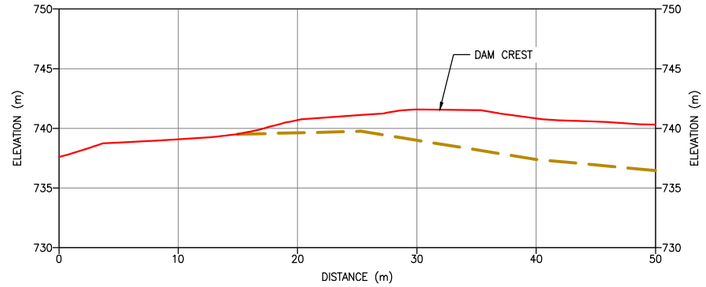
FIG. No. 1.2

KCB-R-MLB

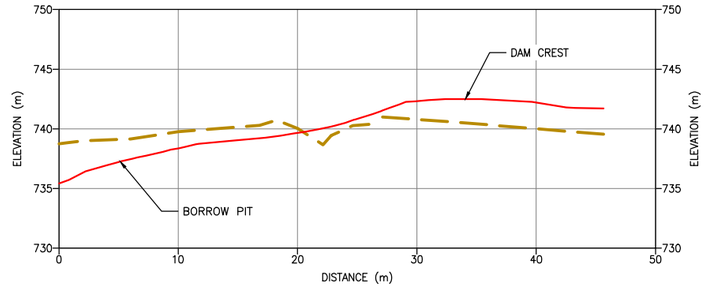
Time: 13:58:32
Date: 11/19/2018
Scale: 1:2.5849(PS)
Drawing File: \\int.klohn.com\ProData\M\VCR\M07728A33-TML-Pinchi Lake 2018 Services\400 Drawings\CAD\DSI\Fig1.2 - TSF-Plan.dwg (persyem)
Xref File(s): BM-Pinchi-10July13_ACAD-Pinchi_Lake_407700E_6053000N12
Image File(s):



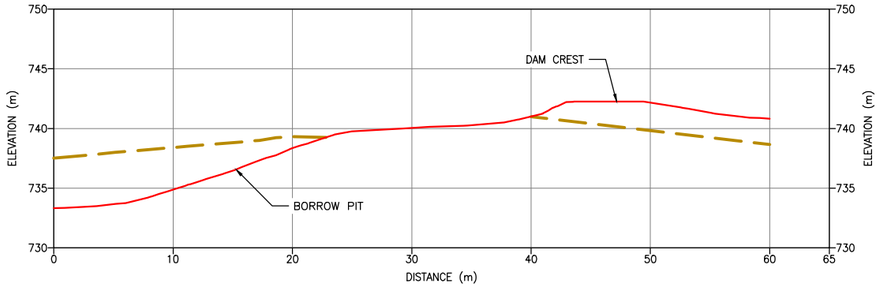
SECTION A 1.2



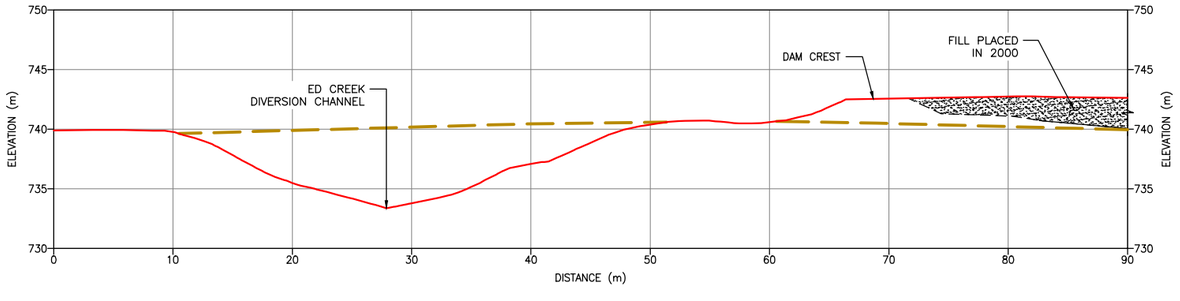
SECTION B 1.2



SECTION D 1.2



SECTION C 1.2



SECTION E 1.2

DAM HEIGHT AND SLOPE			OVERALL SLOPE (NOTE 2)
SECTION	DAM HEIGHT (m)	SLOPE OF D/S FACE	
A	14.0	2.7H:1V	2.7H:1V
B	2.5	2.7H:1V	2.4H:1V
C	1.8	2.3H:1V	4.5H:1V
D	1.5	2.0H:1V	4.3H:1V
E	1.8	4.3H:1V	4.3H:1V

LEGEND:

- PIEZOMETER TIP/SCREEN
- 723.4 m — JUN. 13, 2018 READING (m)
- ORIGINAL GROUND SURFACE PRE-1967
- GROUND SURFACE AFTER 2010/11 RECLAMATION/CLOSURE WORKS (SEP. 2012 LIDAR SURVEY)

NOTES:

1. ORIGINAL GROUND SURFACE HAS BEEN EXTRACTED FROM DWG. PLM-D-3, REV.1 AND IS APPROXIMATE.
2. OVERALL SLOPE IS MEASURED FROM DOWNSTREAM EDGE OF DAM CREST TO TOE OF NATURAL GROUND SLOPE (SECTIONS A AND B), TOE OF BORROW PIT SLOPE (SECTIONS C AND D) OR BASE OF ED CREEK DIVERSION CHANNEL (SECTION E).

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED FEB. 2019

SCALE 0 10 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2018 DAM SAFETY INSPECTION

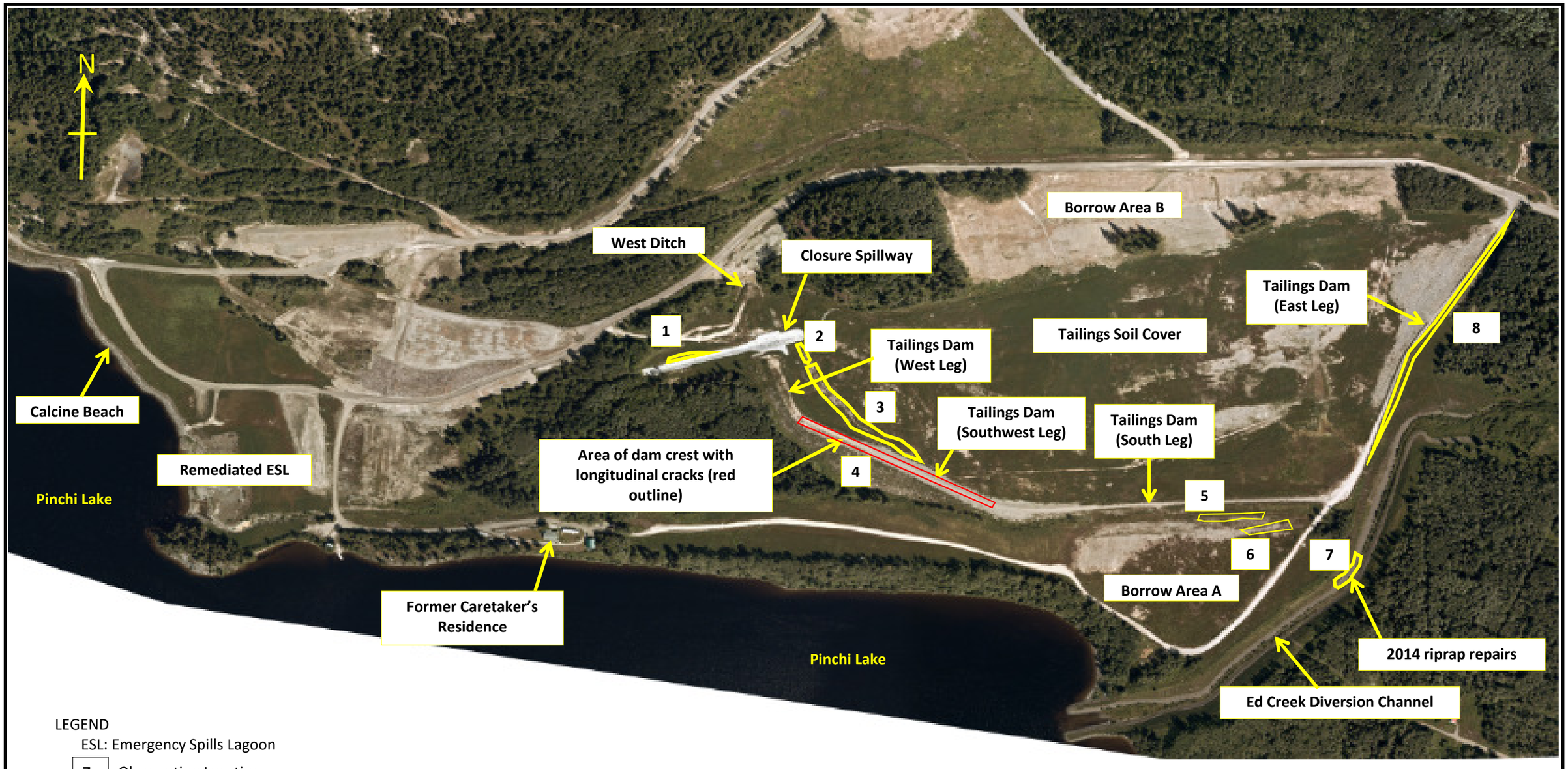
TITLE: TAILINGS STORAGE FACILITY
DAM CROSS SECTIONS

PROJECT No. M07728 A33

FIG. No. 1.3

KCB-R-MLB

Time: 13:58:27
Date: 11/19/2018
Scale: 1:2.5849(PS)
Drawing File: \\nt.klohn.com\ProjData\M\VCR\M07728A33-TML-Pinchi Lake 2018 Services\400 Drawings\CAD\DSI\Fig1.3 - Sections.dwg (persyem)
Xref File(s):
Image File(s): Teckcominco-color-logo



LEGEND

ESL: Emergency Spills Lagoon

7 Observation Location

Not to Scale

NOTES:

1. All Locations shown are approximate.

CLIENT: Teck

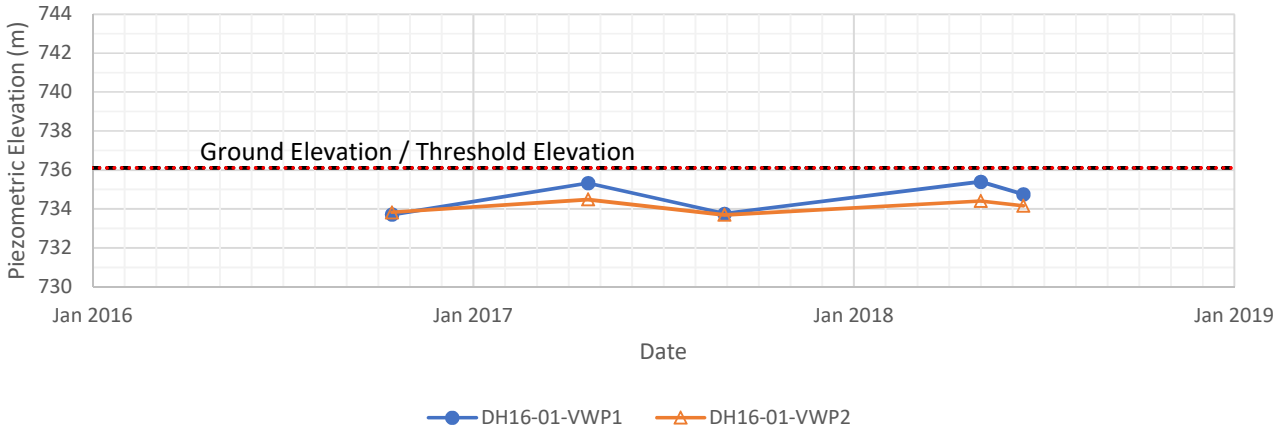
Klohn Crippen Berger

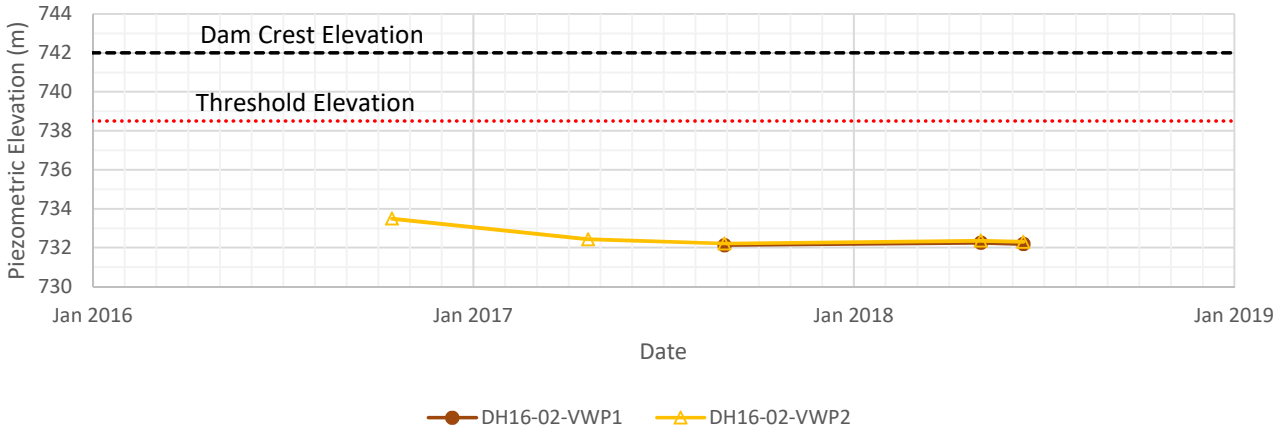
PROJECT: PINCHI LAKE MINE TSF
2018 DAM SAFETY INSPECTION

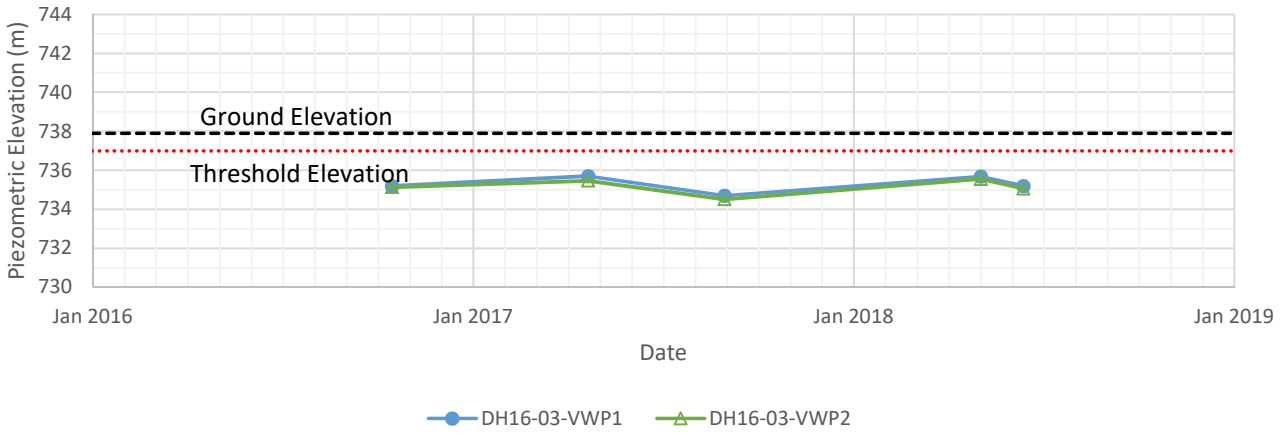
TITLE: JUNE 2018 OBSERVATION LOCATIONS

PROJECT No. M07728A33

FIG No. 4.1







CLIENT Teck

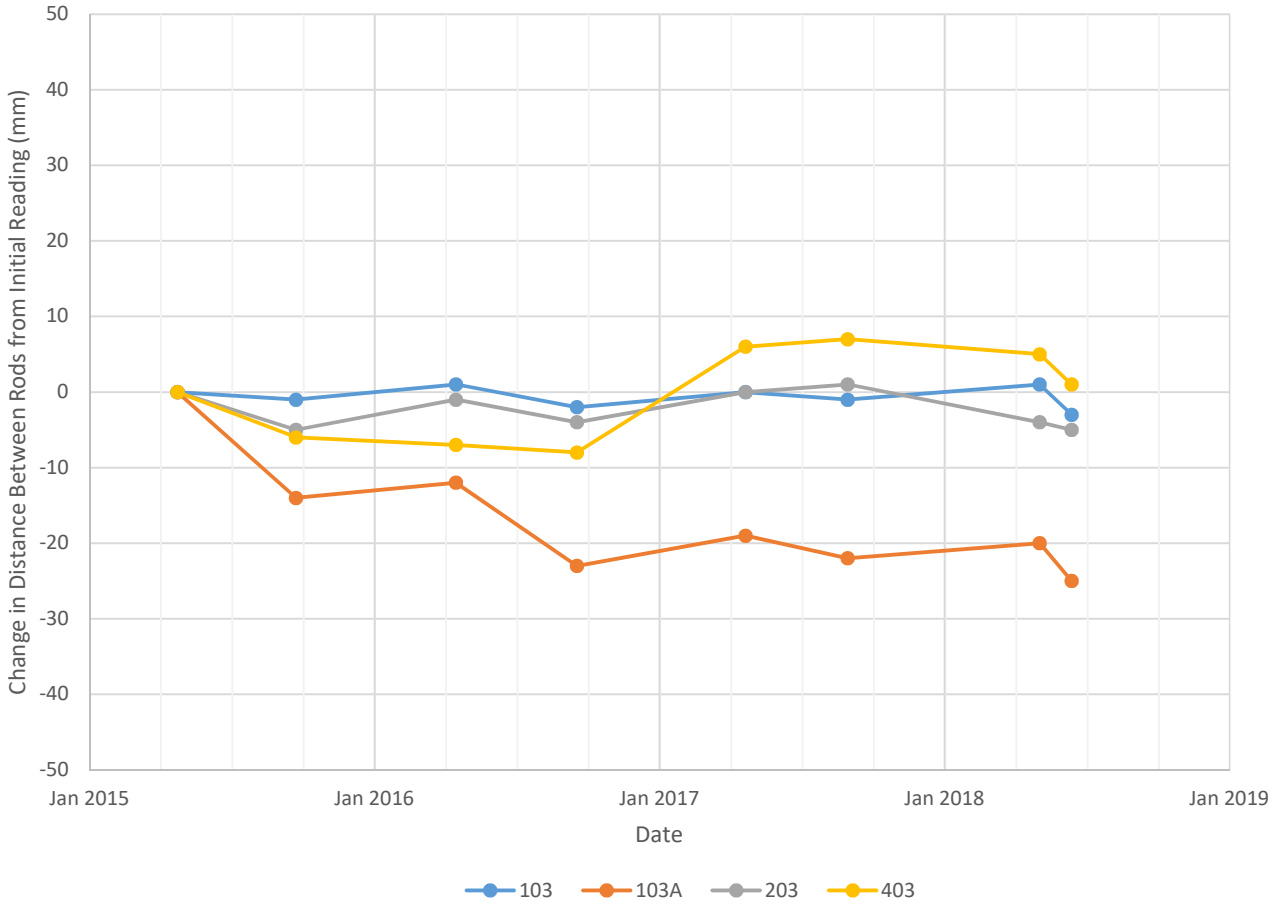
Klohn Crippen Berger

PROJECT PINCHI LAKE MINE TSF
2018 DAM SAFETY INSPECTION

TITLE PIEZOMETER READINGS

PROJECT No. M07728A33

FIG No. 4.2



NOTE:
1. Negative values indicate the rods have moved closer together.

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2018 DAM SAFETY INSPECTION

TITLE: BORROW AREA A
ROD MEASUREMENTS

PROJECT No. M07728A33

FIG No. 4.3

APPENDIX I

Facility Data Sheet

Appendix I
Facility Data Sheet

PINCHI LAKE MINE TSF DAM
PHYSICAL DESCRIPTION

Dam Type	Earthfill
Maximum Dam Height	15 m
Dam Length	1300 m
Dam Crest Width	6 m to 8 m May be wider in some areas.
Impoundment Area	21 ha (surface area of covered tailings)
Volume of Tailings	1 million m^3 approximate
Reservoir Capacity	This is a “dry” tailings impoundment. There is no storage of water and the impoundment is normally dry.
Consequence Classification	Significant
Inflow Design Flood (IDF)	1/3 between 1/1000 and PMF (based on consequence classification of Significant)
Design Earthquake	1/2475 annual exceedance probability (based on consequence classification of Significant)
Spillway Capacity	Spillway has capacity to route IDF with > 4 m freeboard in the impoundment, and 0.4 m in the spillway channel. However, riprap from the dam centreline to the downstream end of the channel is undersized for the IDF and may be damaged. Estimated peak spillway discharge = 7 m^3/s
Catchment Area	55 ha
Access to Dam	Vehicle access to the mine from Fort St. James is 25 km north along Germansen Road, and then 20 km west along Pinchi Lake Road. Both roads are gravel surfaced. The access road into the mine site is gated. The mine site can also be reached by water over Pinchi Lake. The lake usually has ice cover from November to mid-April.

APPENDIX II

June 2018 Photographs

Appendix II
June 2018 Photographs

Photo II-1 Tailings Dam – east leg, looking south. Note vegetation on dam slope.

Photo II-2 Tailings Dam – east leg, looking north. Note vegetation on dam slope.

Photo II-3 Tailings Dam – east leg, looking downstream from crest. Note vegetation on dam slope.

Photo II-4 Tailings Dam – east leg, looking upstream from toe. Note vegetation on dam slope.

Photo II-5 Tailings Dam – pond near toe of east leg.

Photo II-6 Tailings Dam – east leg, looking north. Note vegetation on dam slope.

Photo II-7 Tailings Dam – east leg, looking north.

Photo II-8 Tailings Dam – east leg, looking south. Note vegetation on dam slope.

Photo II-9 Tailings Dam – east leg, looking west at the covered tailings surface.

Photo II-10 Tailings Dam – south leg, looking east from mid-point towards Ed Creek.

Photo II-11 Tailings Dam – south leg, looking north at the covered tailings surface.

Photo II-12 Tailings Dam – south leg, looking west along downstream slope.

Photo II-13 Tailings Dam – hole at former survey monument location 1018 on upstream side of crest at south leg.

Photo II-14 Tailings Dam – southwest leg, looking northwest along the crest.

Photo II-15 Tailings Dam – southwest leg, looking northwest along the downstream slope.

Photo II-16 Tailings Dam – southwest leg, looking southeast along the downstream slope.

Photo II-17 Tailings Dam – southwest leg, looking downstream from the crest.

Photo II-18 Tailings Dam – southwest leg, crack on dam crest in tire track.

Photo II-19 **Tailings Dam – southwest leg, surface runoff channel in tailings cover upstream of dam.**

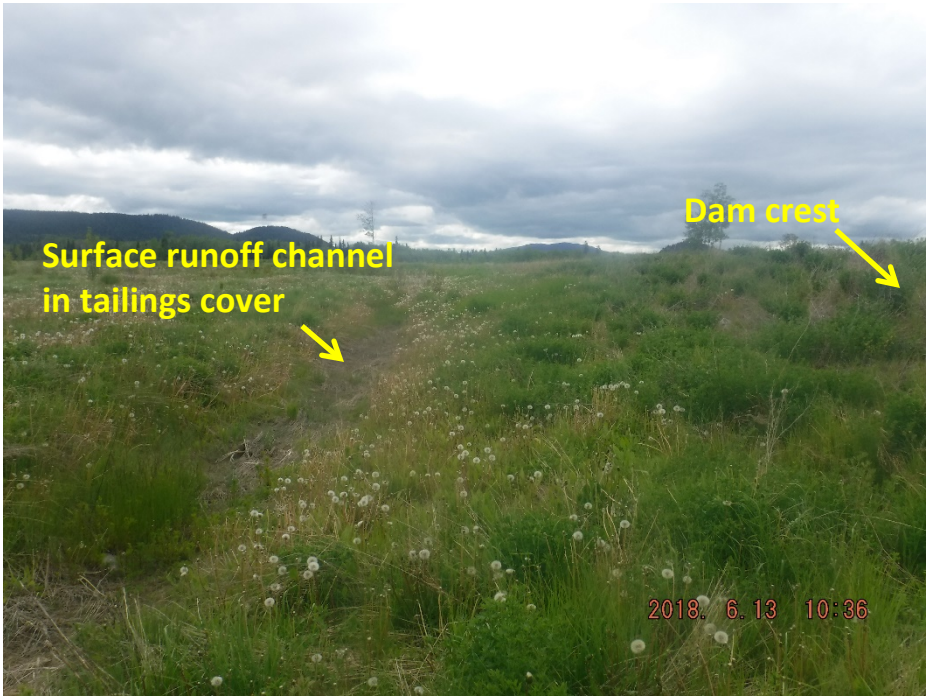


Photo II-20 **Tailings Dam – southwest leg, surface runoff channel in tailings cover upstream of dam.**

Photo II-21 Tailings Dam – southwest leg, looking southeast along dam toe.

Photo II-22 Tailings Dam – southwest leg, looking upstream from dam toe.

Photo II-23 Tailings Dam – southwest leg, looking northwest along dam slope towards corner with west leg.

Photo II-24 Tailings Dam – west leg, looking south along downstream slope.

Photo II-25 Tailings Dam – west leg, looking south along upstream slope. Covered tailings surface is on the left.

Photo II-26 Tailings Dam – west leg, looking north along dam slope towards Closure Spillway.

Photo II-27 Tailings Dam – west leg, looking south along dam slope.

Photo II-28 Closure Spillway – inlet apron.

Photo II-29 **Downstream end of surface runoff channel where it discharges to the Closure Spillway, showing riprap which was placed in 2014.**

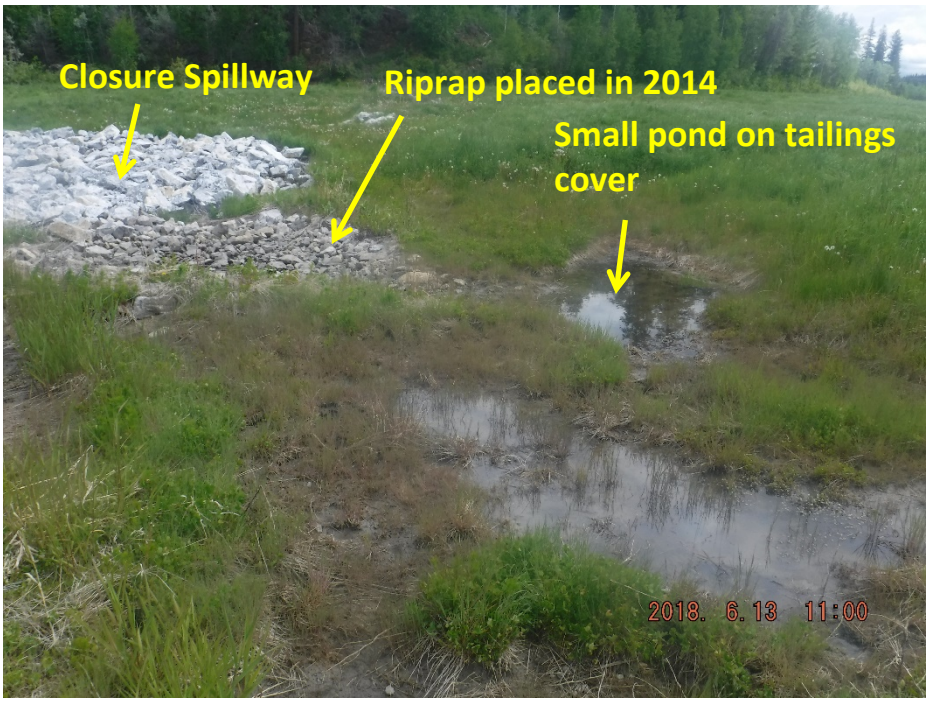


Photo II-30 **Downstream end of surface runoff channel in tailings cover, looking southeast from Closure Spillway.**

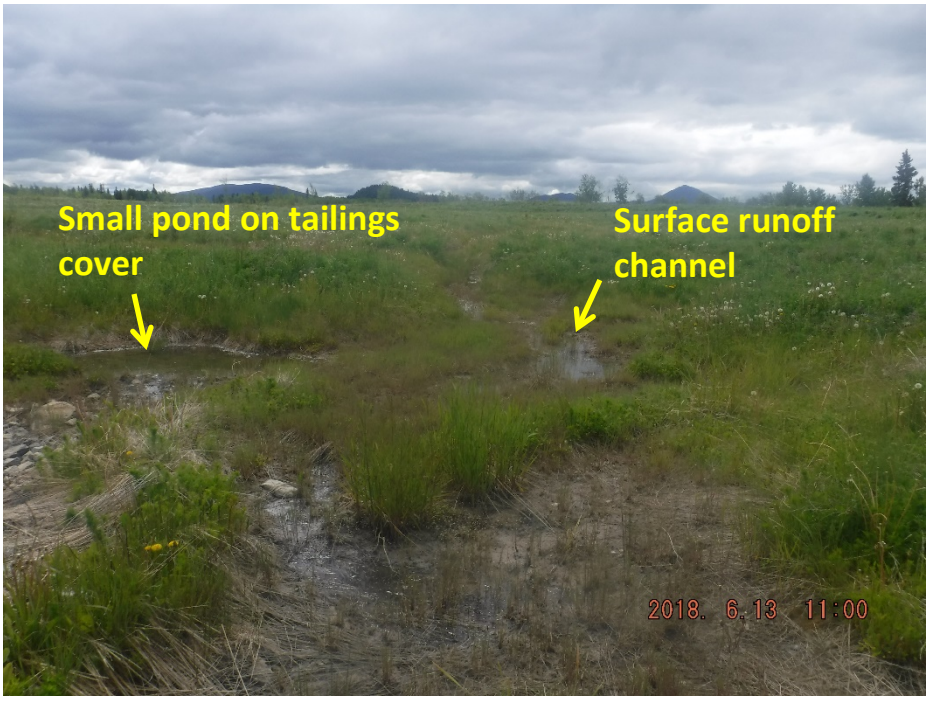


Photo II-31 Closure Spillway – looking downstream from inlet.

Photo II-32 Closure Spillway – looking south from dam crest

Photo II-33 Closure Spillway – looking upstream from dam toe area.

Photo II-34 Closure Spillway – looking downstream.

Photo II-35 Closure Spillway – head scarp of slump above right bank, 90 m downstream of centreline

Photo II-36 Closure Spillway – looking upstream from downstream end of riprap.

Photo II-37 Closure Spillway – pond at downstream end of riprap.

Photo II-38 West Ditch – looking northeast. Note small pond in base of ditch.

Photo II-39 Spillway Downstream Channel – inlet to culvert beneath road to former caretaker's house.

Photo II-40 Spillway Downstream Channel – Middle Reach, looking upstream from culvert beneath road to former caretaker's house.

Photo II-41 Spillway Downstream Channel – outlet of culvert beneath road to former caretaker's house.

Photo II-42 Spillway Downstream Channel – Lower Reach, looking downstream from culvert beneath road to former caretaker's house.

Photo II-43 Borrow Area A – looking west from access road.

Photo II-44 Borrow Area A – tension crack monitoring rod location 103.

Photo II-45 Borrow Area A – looking east along the slope.

Photo II-46 Borrow Area A – wet ground in northeast corner,

Photo II-47 Borrow Area A – wet ground in northeast corner. No flowing water was observed.

Photo II-48 Borrow Area A – looking northwest from south end.

Photo II-49 Road ditch above tailings impoundment, looking east.

Photo II-50 Road ditch above tailings impoundment, looking west.

Photo II-51 Ed Creek Diversion Channel – outlet at Pinchi Lake.

Photo II-52 Ed Creek Diversion Channel – looking upstream from near outlet.

Photo II-53 Ed Creek Diversion Channel – Riprap on right bank, showing weathering and breakage.

Photo II-54 Ed Creek Diversion Channel – looking upstream from near third bend. Flow depth in channel is 20 cm.

Photo II-55 **Ed Creek Diversion Channel – looking upstream from between second and third bends.**

Photo II-56 **Ed Creek Diversion Channel – looking downstream from near second bend. Light-coloured area of riprap was replaced in 2014, and is in good condition.**

Photo II-57 Ed Creek Diversion Channel – looking downstream from between first and second bends.

Photo II-58 Ed Creek Diversion Channel – looking upstream from between first and second bends.

Photo II-59 Ed Creek Diversion Channel – looking downstream from near first bend.

Photo II-60 Ed Creek Diversion Channel – looking upstream towards first bend.

Photo II-61 Outlet of 460 mm culvert on north bank of Ed Creek Diversion Channel.

Photo II-62 Inlet of 460 mm culvert on north bank of Ed Creek Diversion Channel. There is vegetation upstream of the inlet that could block the channel during flood conditions.

Photo II-63 Drainage ditch between pond area at the toe of the east leg of the Tailings Dam and Ed Creek Diversion Channel. Looking upstream from culvert shown in Photo II-62.

Photo II-64 Inlets of Ed Creek culverts under Pinchi Lake Road.

Photo II-65 Inlet of east culvert under Pinchi Lake Road.

Photo II-66 Outlets of Ed Creek culverts under Pinchi Lake Road.

APPENDIX III

June 2018 Inspection Forms

1. Tailings Dam and Tailings Impoundment
2. Closure Spillway
3. Spillway Downstream Channel
4. West Ditch
5. Road Ditch Above Tailings Impoundment
6. Borrow Area A
7. Ed Creek Diversion Channel
8. Ed Creek Culverts at Pinchi Lake Road

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

TAILINGS DAM AND TAILINGS IMPOUNDMENT

Date: _June 13, 2018_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____ Pond Water Level: _No Standing Water_____

Weather: _Cloudy, 13°C_____

Is there any apparent …..	Yes	No	Comments
Cracks			
• Embankment cracks on the dam crest?	X		See comment 1 below
o Enlargement of cracks or new cracks in SW leg and S leg of dam (first observed in 2015)?		X	Cracks similar to those observed in 2017, but fewer of them
• Embankment cracks on the u/s slope?		X	
• Embankment cracks on the d/s slope?		X	
Vegetation Growth and Debris			
• Excessive tree or shrub growth on embankment?		X	
• Debris in tailings impoundment?		X	
Other Structural Problem			
• Settlement or erosion on the dam crest?		X	
• Slough, slides, bulges or erosion on u/s slope of dam?		X	
• Slough, slides, bulges or erosion on d/s slope of dam?		X	
• Sinkhole on dam crest?		X	
• Sinkhole on u/s slope of dam?		X	See comment 2 below
• Sinkhole on d/s slope of dam?		X	
• Sinkhole in tailings pond till cover?		X	
• Erosion of flow channels in tailings pond till cover?	X		See comment 3 below
Ponding / Seepage			
• Evidence of water ponding on dam crest?		X	
• Wet areas or seepage on d/s slope or toe of dam?		X	
• Evidence of water ponding at d/s toe of dam?	X		See comment 4 below
• Wet areas or seepage along d/s abutments?		X	
Animal Activity			
• Rodent burrows in dam embankment?		X	
• Beaver dam in Tailings Pond?		X	
Dam Crest at South-East Corner of TSF			
• Evidence of water ponding on dam crest?		X	
• Erosion on dam crest of d/s slope of dam?		X	
• Has there been any settlement of dam crest?		X	

Additional comments:

1. Longitudinal cracks were observed on the dam crest on the southwest leg, up to 5 m long, 20 mm wide, and a tape measure could be pushed in 25 cm deep. The cracks were often located in or close to

	tire tracks. Note that similar cracks were observed at both the south and southwest legs in 2017, with similar dimensions, but fewer cracks were observed during the June 2018 inspection. The cracks are believed to have been formed by loosening and drying of the soil as part of the reclamation and seeding, and are not considered to be a dam safety issue.
2.	A 50 cm diameter by 60 cm deep hole was discovered on the upstream side of the crest next to a stake marked 1018. This appears to be the location of a survey monument that was removed. It is not known when or why this was removed.
3.	No evidence of recently eroded flow channels. Existing channels are vegetated and unlikely to erode under normal weather conditions.
4.	A pond is located near the toe of the east leg of the dam, which drains to the south through a culvert into Ed Creek Diversion Channel. This pond has been observed in previous inspections, and appears to be related to local runoff. No other ponds were observed near the dam toe.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

CLOSURE SPILLWAY

Date: _June 13, 2018_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 13°C_____

Is the spillway flowing? _____No_____(yes / no) If yes, give approx. flow depth: _____ mm

Is the flow above the riprap? ____No_____(yes / no) If yes, give approx. flow depth above riprap: _____ mm

Is there any apparent …..	**Yes**	**No**	**Comments**
Vegetation Growth and Debris			
• Excessive tree or shrub growth along the channel?		X	A few small shrubs
• Debris in the channel?		X	
Riprap			
• Displaced or broken down riprap in channel bottom?		X	
• Displaced or broken down riprap along the right bank?		X	
• Displaced or broken down riprap along the left bank?		X	
Erosion, cracks, slough, slides or bulges			
• Along the bottom of channel?		X	
• Along the right bank of channel?		X	
o Any signs of recent movement of slump on right bank?		X	Appears unchanged from previous inspections
• Along the left bank of channel?		X	
Seepage			
• Seepage into the channel from right side slope?		X	
• Seepage into the channel from left side slope?		X	
Animal Activity			
• Beaver dam in spillway channel?		X	
• Any other animal activity?		X	

NOTE: left and right banks are looking downstream along the channel.

Additional comments:

Small pond on south side of riprap apron at intake. No flow.

30 cm deep pond at the downstream end of the spillway. No flow.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

SPILLWAY DOWNSTREAM CHANNEL

Date: _June 13, 2018__ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 17°C_____

Is there flow in the channel? _____yes_____ (yes / no)

Give location of flow: _Culvert inlet_____ Give approx. flow depth: __10__ mm

Is there any apparent …..	Yes	No	Comments
Middle Reach*			
• Debris in the channel?			See comment 1 below
• Erosion in the channel?			See comment 1 below
• Beaver activity in channel?			See comment 1 below
Culvert under Road to Caretaker's Residence			
• Blockage of culvert inlet or outlet?		X	
• Structural damage or deformation of culvert pipe?		X	
• Displaced or broken down riprap?		X	
Lower Reach (along former Emergency Spills Lagoon)			
• Excessive tree or shrub growth in the channel?		X	
• Debris in the channel?		X	
• Erosion in the channel?		X	
• Displaced or broken down riprap in channel?		X	
• Beaver activity in channel?		X	

*NOTE: Middle reach of Spillway Downstream Channel is the flow route from the end of the riprap lined Closure Spillway channel to the culvert under the road to the Caretaker's residence.

Additional comments:

1. Only the upper and lower ends of the middle reach of Spillway Diversion Channel were inspected. This reach follows natural channels, and has dense tree and bush growth and debris such as windfalls.
2. Lower reach is backed up due to a high lake level. Water is 15 cm above invert of culvert at the outlet.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

WEST DITCH

Date: _June 13, 2018_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 13°C_____

Is there flow in the channel? ____no_____ (yes / no) Give approx. flow depth: _____ mm

Is there any apparent …..	Yes	No	Comments
West Ditch			
• Excessive tree or shrub growth in the channel?		X	
• Debris in the channel?		X	
• Erosion in the channel?		X	
• Beaver activity in the channel?		X	

Additional comments:

Shallow water ponded along ~7 m length of channel.
Channel is covered with vegetation and is unlikely to erode under normal weather conditions.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ROAD DITCH ABOVE TAILINGS IMPOUNDMENT

Date: __June 13, 2018_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 17°C_____

Is there flow in the channel? ____no_____ (yes / no)

Give location of flow: _____ Give approx. flow depth: _____ mm

Is there any apparent …..	Yes	No	Comments
Road Ditch			
• Excessive tree or shrub growth in the channel?		X	Primarily grass with some localized cattails
• Debris in the channel?		X	
• Erosion in the channel?		X	
• Beaver activity in the channel?		X	

Additional comments:

Standing water ~5 cm deep in some areas

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

BORROW AREA A

Date: _June 13, 2018_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 13°C_____

Is there any apparent …..	**Yes**	**No**	**Comments**
Cracks			
• Cracks on ground between borrow pit and toe of dam?		X	
• Cracks on borrow pit slope?		X	See comment 1 below
Other Structural Problems			
• Sloughs, slides, bulges or erosion on borrow pit slope?		X	
Ponding / Seepage			
• Wet areas or seepage on borrow pit slope?		X	
• Wet areas or seepage at toe of borrow pit slope?	X		See comment 2 below
• Evidence of water ponding within borrow area?		X	
Animal Activity			
• Rodent burrows in borrow pit slope?		X	

Measurements Between Metal Rods at Borrow Area A Tension Cracks

Rod Pair #	Distance Between Rods (mm)			
	Measurement #1	Measurement #2	Measurement #3	Average
103 (west side)	399	399	398	399
103A	424	426	425	425
203	354	354	354	354
403 (east side)	358	357	358	358

Additional comments:

1. Cracks have been observed on the borrow pit slope since 2013. The cracks have filled in with vegetation and were not clearly visible during the inspection.
2. A wet area was observed starting in the northeast corner of the borrow area and continuing 60 m west along the toe of the slope. No flowing water was observed.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ED CREEK DIVERSION CHANNEL

Date: _June 13, 2018_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 17°C_____

Is there flow in the channel? _____yes_____ (yes / no)

Give location of flow: _Base of channel_____ Give approx. flow depth: __200__ mm

Is there any apparent …..	**Yes**	**No**	**Comments**
Vegetation Growth and Debris			
• Excessive tree or shrub growth along the channel?		X	
• Debris in the channel?		X	
Riprap			
• Displaced or broken down riprap in channel bottom?	X		See comment 1 below
• Displaced or broken down riprap along the right bank?	X		See comment 1 below
• Displaced or broken down riprap along the left bank?	X		See comment 1 below
Erosion, cracks, slough, slides or bulges			
• Along the bottom of channel?		X	
• Along the right bank of channel?		X	
• Along the left bank of channel?		X	
Seepage			
• Seepage into the channel from right side slope?		X	
• Seepage into the channel from left side slope?		X	
Animal Activity			
• Beaver dam in spillway channel?		X	
• Any other animal activity?		X	

NOTE: left and right banks are looking downstream along the channel.

Additional comments:

1. As noted during previous inspections, riprap along entire diversion channel is deteriorating.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ED CREEK CULVERTS AT PINCHI LAKE ROAD

Date: _June 13, 2018_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 17°C_____

Is there flow in the culverts? _____yes_____ (yes / no)

Give approx. water depth in channel at culvert inlet: __50__ mm

Is there any apparent …..	Yes	No	Comments
Culverts Under Pinchi Lake Road			
• Excessive tree or shrub growth at inlet or outlet?		X	
• Blockage of culvert inlets or outlets?		X	
• Structural damage or deformation of culvert pipe?		X	
• Erosion in channel u/s or d/s of culvert?		X	See comment 1 below
• Beaver activity in Ed Creek u/s or d/s of culvert?		X	

Additional comments:

1. Left bank d/s of culvert is steep and is subject to ongoing erosion.

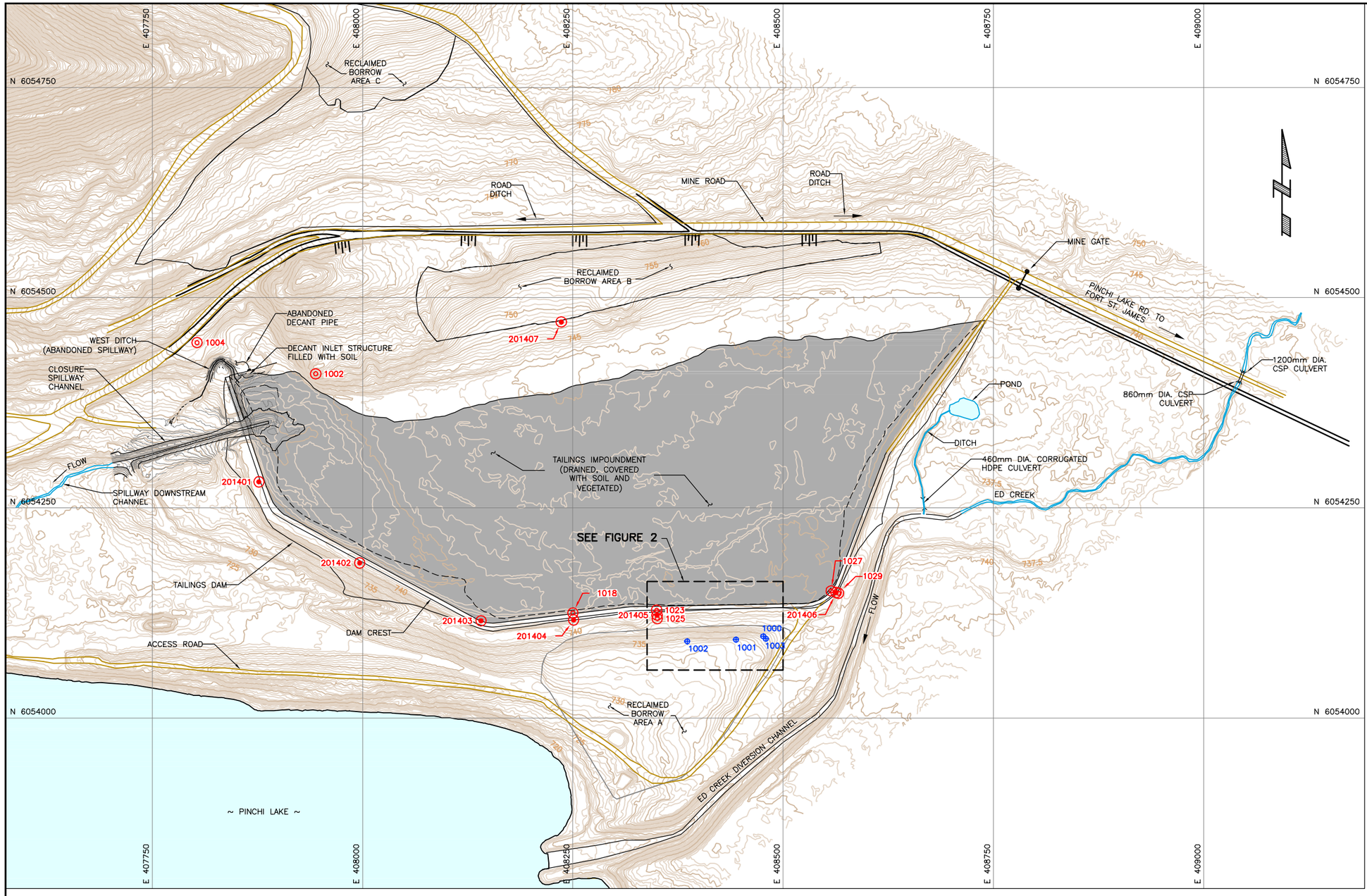
APPENDIX IV

Plan and Sections of Borrow Area A Slope

Figure 1 - Borrow Area A – Location Plan

Figure 2 - Borrow Area A – Survey Stake and Rod Locations – Plan

Figure 3 - Borrow Area A – Sections



LEGEND

- 1000 SEEPAGE NOTED IN 2012
- 1998 SURVEY MONUMENT
- 2014 SURVEY MONUMENT

NOTES

1. GENERAL SITE TOPOGRAPHY IS BASED ON SEPTEMBER 2012 LIDAR SURVEY BY McELHANNEY ENGINEERING. TOPOGRAPHY FOR SPILLWAY CHANNEL IS BASED ON JUNE 2011 GROUND SURVEY.
2. COORDINATES ARE NAD83, UTM ZONE 10.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED _____

SCALE 0 100 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF

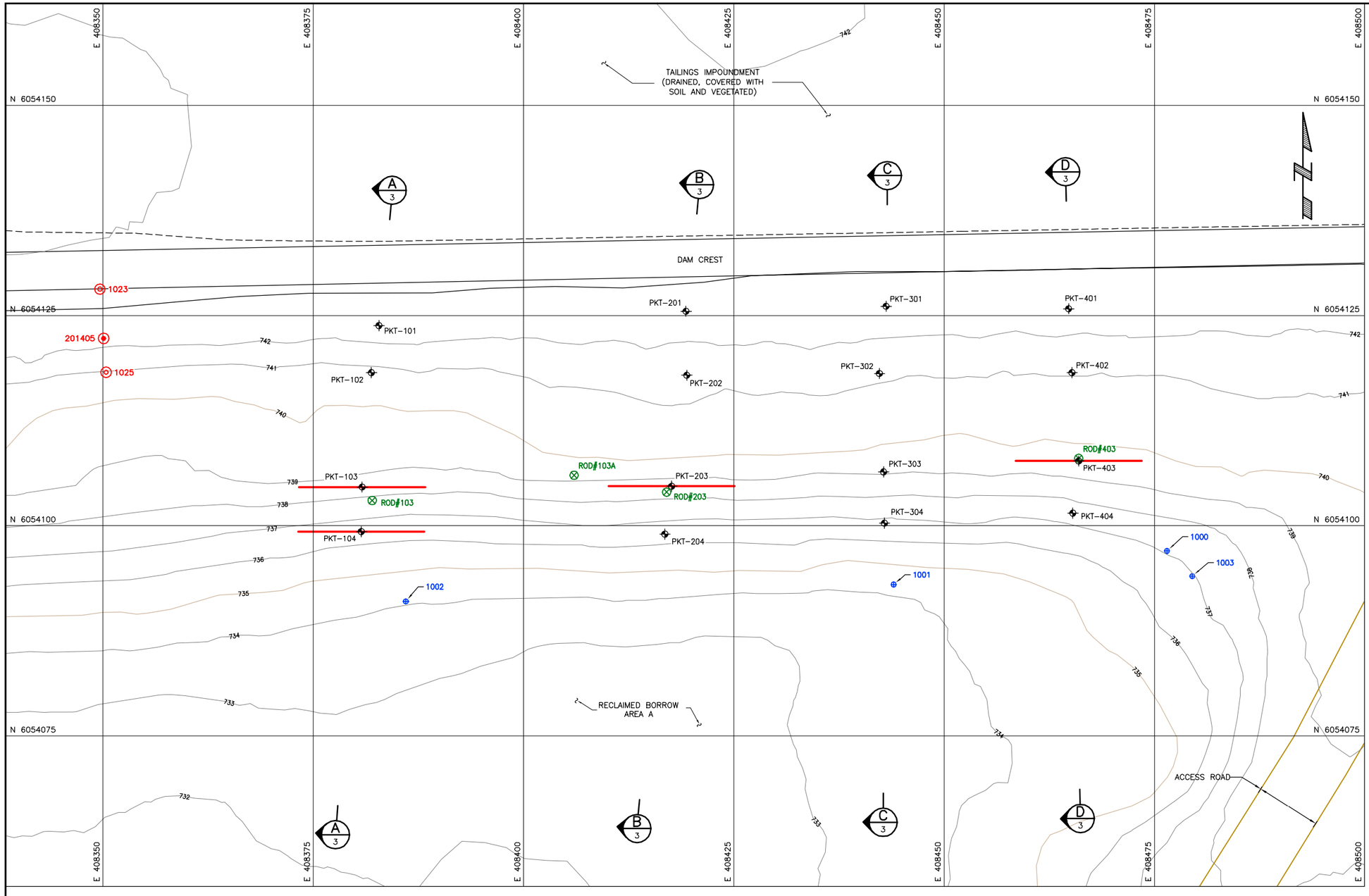
TITLE: BORROW AREA A LOCATION PLAN

PROJECT No. M07728 A31

FIG. No. 1

KCB-R-MLB

Time: 15:42:04
Date: 10/3/2016
Scale: 1:2.5849(PS)
Drawing File: Z:\M\VCR\M07728A31-TML-Pinchi Lake 2016 Services\400 Drawings\TSF\Fig1-2-3 _ Location-Plan-Sections.dwg (persyem)
Xref File(s): BM-Pinchi-10July13_ACAD-Pinchi_Lake_407700E_6053000Nv12
Image File(s):



PLAN
(FOR LOCATION SEE FIG. 1)

PKT COORDINATES			
NAME	NORTHING (m)	EASTING (m)	ELEVATION (m)
PKT-101	6054123.8	408382.8	742.7
PKT-102	6054118.2	408381.9	740.8
PKT-103	6054104.6	408380.8	738.7
PKT-104	6054099.3	408380.7	736.8
PKT-201	6054125.5	408419.3	742.9
PKT-202	6054117.9	408419.4	741.4
PKT-203	6054104.7	408417.6	738.7
PKT-204	6054099.0	408416.8	736.5
PKT-301	6054126.1	408443.1	742.8
PKT-302	6054118.1	408442.3	741.2
PKT-303	6054106.4	408442.8	739.1
PKT-304	6054100.3	408442.9	736.9
PKT-401	6054125.8	408464.8	742.7
PKT-402	6054118.2	408465.2	740.9
PKT-403	6054107.7	408466.0	739.8
PKT-404	6054101.5	408465.3	737.5

FROM JUNE 14, 2014 SURVEY BY FOCUS

ROD COORDINATES		
NAME	NORTHING (m)	EASTING (m)
ROD#103	6054103.0	408382.0
ROD#103A	6054106.0	408406.0
ROD#203	6054104.0	408417.0
ROD#403	6054108.0	408466.0

FROM HAND-HELD GPS MEASURED BY ECOFOR, APRIL 2015

LEGEND

- CRACKS OBSERVED JUNE 2014
- 1000 SEEPAGE NOTED IN 2012
- PKT-101 SURVEY STAKES 2014
- 1998 SURVEY MONUMENT
- 2014 SURVEY MONUMENT
- CRACK MONITORING ROD

NOTES

1. GENERAL SITE TOPOGRAPHY IS BASED ON SEPTEMBER 2012 LIDAR SURVEY BY McELHANNEY ENGINEERING. TOPOGRAPHY FOR SPILLWAY CHANNEL IS BASED ON JUNE 2011 GROUND SURVEY.
2. COORDINATES ARE NAD83, UTM ZONE 10.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED _____

SCALE 0 10 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF

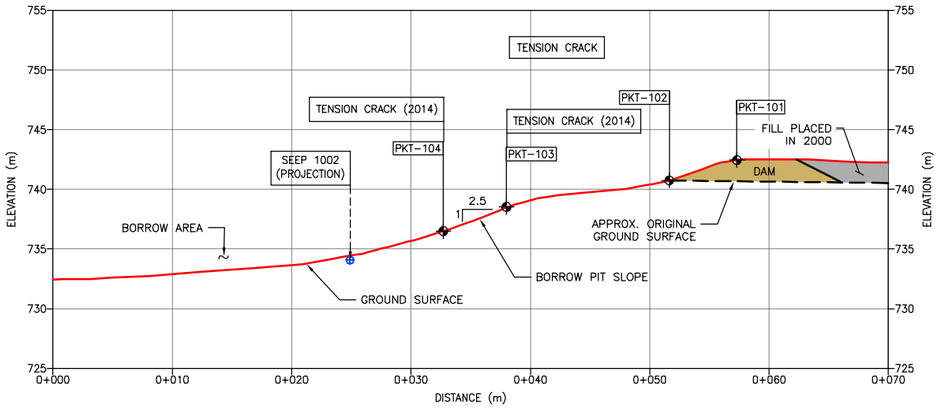
TITLE: BORROW AREA A
SURVEY STAKE AND ROD LOCATIONS
PLAN

PROJECT No. M07728 A31

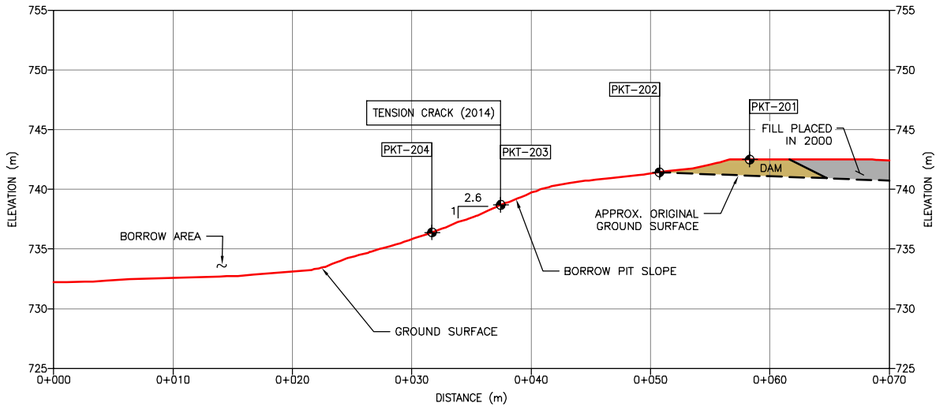
FIG. No. 2

KCB-R-MLB

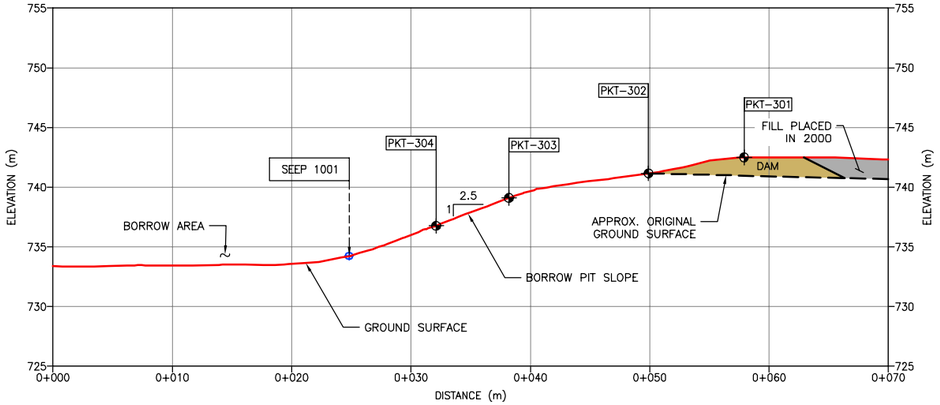
Time: 15:40:35
Date: 10/3/2016
Scale: 1:2.5849(PS)
Drawing File: Z:\M\VCR\M07728A31-TML-Pinchi Lake 2016 Services\400 Drawings\TSF\Fig1-2-3 _ Location-Plan-Sections.dwg (perseym)
Xref File(s): BM-Pinchi-10July13_ACAD-Pinchi_Lake_407706E_6053000Nv12
Image File(s):



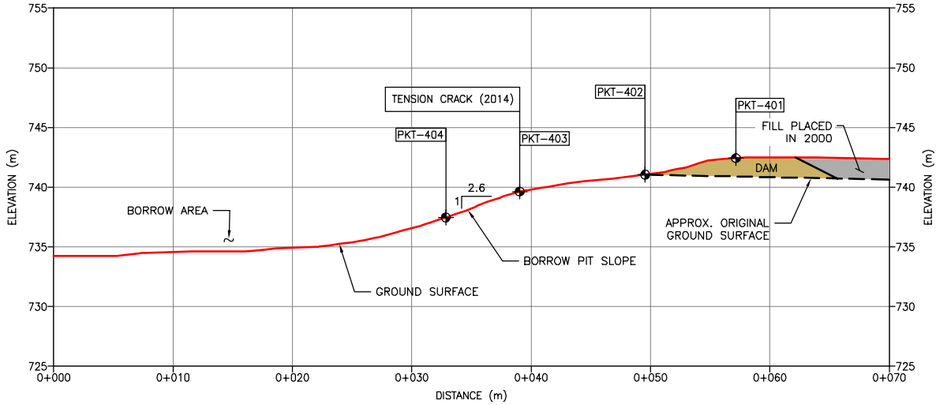
SECTION A 2



SECTION B 2



SECTION C 2



SECTION D 2

LEGEND

- GROUND SURFACE FROM JUNE 2014 SURVEY BY FOCUS
- PKT-101 SURVEY STAKES 2014
- 1000 SEEPAGE NOTED IN 2012

NOTES

1. DAM OUTLINE AND ORIGINAL GROUND SURFACE SHOWN ARE APPROXIMATE.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED _____

SCALE 0 10 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF

TITLE: BORROW AREA A SECTIONS

PROJECT No. M07728 A31

FIG. No. 3

KCB-R-WLB

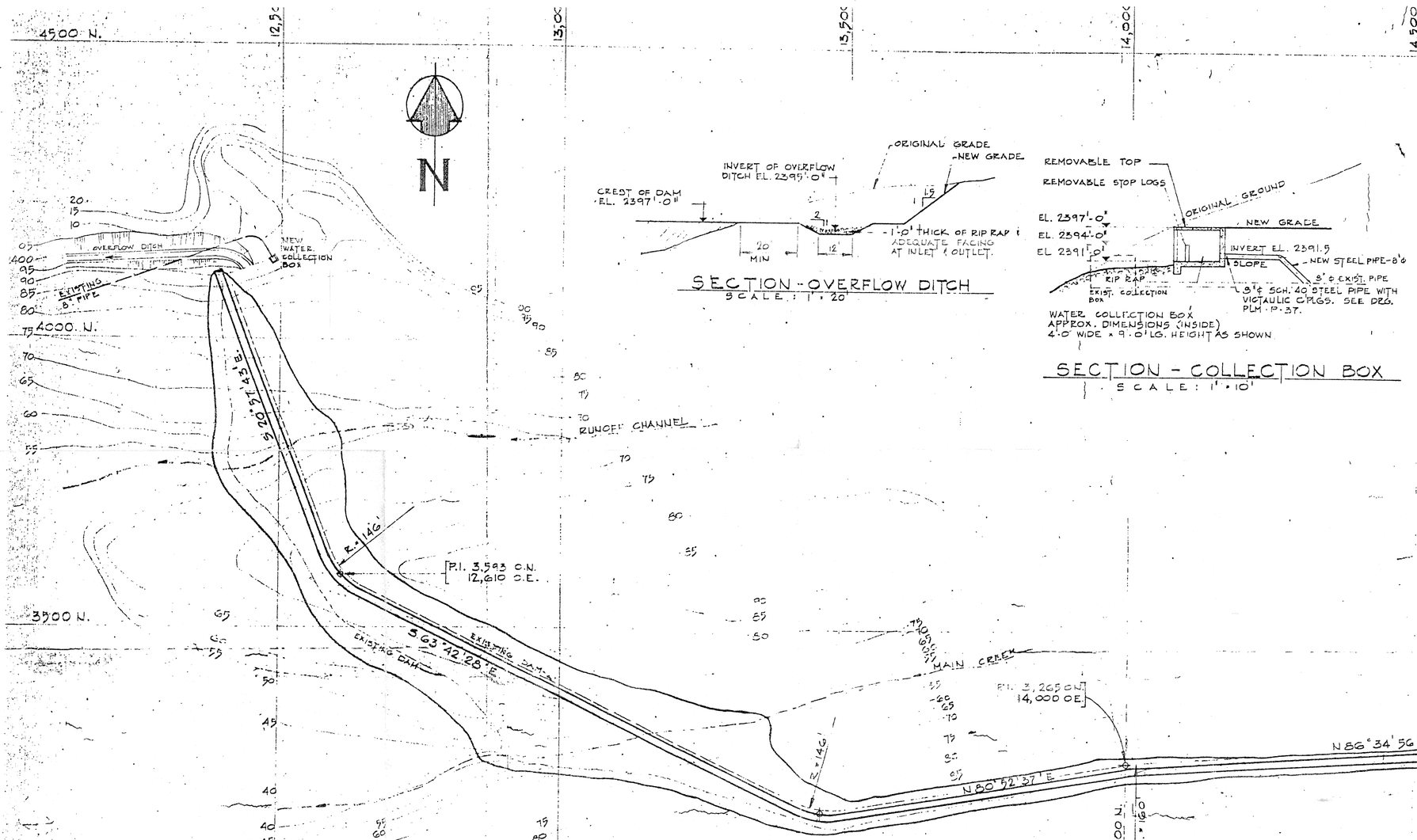
Time: 15:39:31
Date: 10/3/2016
Scale: 1:2.5849(PS)
Drawing File: Z:\VA\VCR\M07728A31-TML-Pinchi Lake 2016 Services\400 Drawings\TSF\Fig1-2-3 - Location-Plan-Sections.dwg (persyem)
Xref File(s): BM-Pinchi-10July13_ACAD-Pinchi_Lake_407700E_6053000N.r12
Image File(s):

APPENDIX V

1975 Tailings Dam Drawing

Dwg. PLM-D-514, Rev. 0 - Tailings Dam Extension 1975 – Plan & Sections

No.	Req'd	Description	Supplied or Made by	Date Ordered	Requisition No.



PLAN - TAILINGS DAM

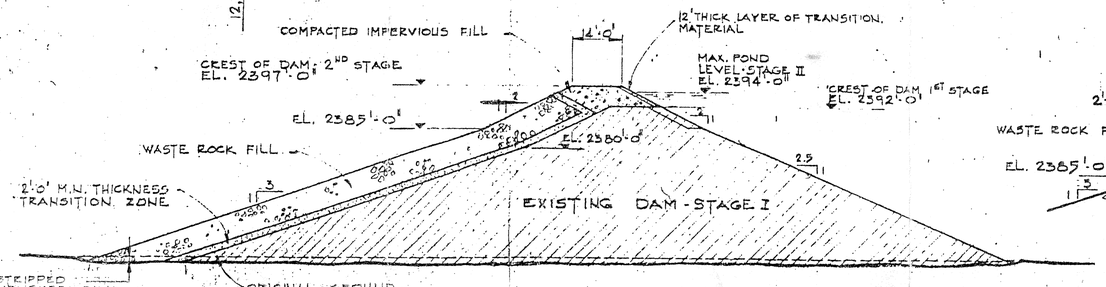
SCALE: 1" = 100'

SECTION - OVERFLOW DITCH

SCALE: 1" = 20'

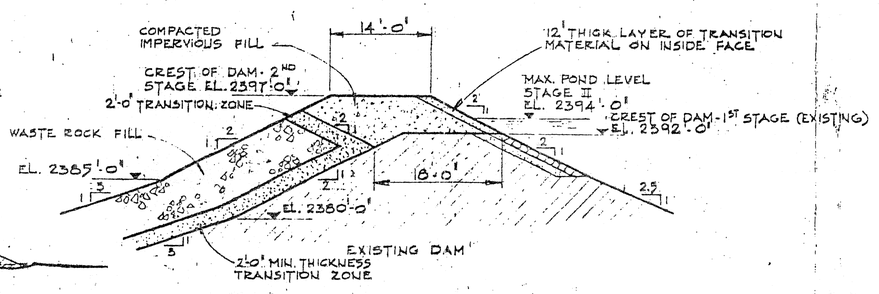
SECTION - COLLECTION BOX

SCALE: 1" = 10'



TYPICAL SECTION THRU DAM

SCALE: 1" = 20'



DETAIL - TOP OF DAM TYPICAL

SCALE: 1" = 10'

Job No. J-7710.003		PLM-P-37, TAILINGS DISPOSAL		Drawn by K. FRICKE	JAN. 14/75	Function MINES	Scale AS NOTED
Drawing No. PLM D 514	Revision 0			Checked by J.E. PRIME	FEB/7/75	Activity PINCHI LAKE MERCURY	Drawing No. PLM D 514
Issued to		Reference		Design Eng.		Section TAILINGS DAM EXTENSION - 1975	Revision 0
Issued to				Proj. Eng.	Approved	Job PLAN & SECTIONS	
			Revisions: No. Made by Date Approved Description			Engineering TRAIL, B.C.	Commoo

210-0650

APPENDIX VI

Water Balance

December 19, 2016

Teck Metals Ltd
Kimberley Operations
Bag 2000
Kimberley, British Columbia
V1A 3E1

Ms. Michelle Unger
Mine Manager

Dear Ms. Unger:

Pinchi Lake Mine Tailings Storage Facility
Water Management, Water Balance, and Quantifiable Performance Objectives

1 INTRODUCTION

This letter summarizes the available information on the water management, water balance and quantifiable performance objectives of the Pinchi Lake Mine Tailings Storage Facility (TSF).

The Pinchi Lake Mine TSF is located in central British Columbia on the north side of Pinchi Lake. No tailings have been deposited in the facility since 1975 and closure reclamation works were completed in 2011.

2 WATER MANAGEMENT

The Pinchi Lake Mine TSF is a closed facility, which has been converted to a "dry" impoundment. The tailings are covered by a minimum of 1 m of till material. The Closure Spillway is located in the area of the former supernatant pond. The spillway invert is set such that water would not be stored in the tailings impoundment under normal conditions. Water management for the TSF operates passively, provided that the Closure Spillway is maintained in a fully functioning condition (KCB 2014). Small ponds have been observed on the surface of the impoundment in spring, but ponds have not been observed directly adjacent to the dam face since the closure works were completed in 2011, and flow through the spillway channel has not been observed above the riprap.

The catchment that reports to the facility is 56.6 ha, as shown in Figure 1. This includes the natural catchment upstream of the road ditch, which is assumed to report to the tailings impoundment during large storm events.

The spillway is designed to route the 24-hour Probable Maximum Rainfall (PMR; 211 mm) + 100-year, 24-hour snowmelt (46 mm) with a peak flow rate of 10.7 m^3/s through the spillway. Additionally, it

Klohn Crippen Berger LTD. • 500 - 2955 Virtual Way • Vancouver BC V5M 4X6 • CANADA
604.669.3800 t • 604.669.3835 f • www.klohn.com

was designed to route the 1000-year, 24-hour rainfall (84 mm) + 100-year, 24-hour snowmelt with a minimum freeboard of 0.6 m, and a peak flow rate of 5.4 m^3/s through the spillway (KCB 2009b).

Teck is currently updating Pinchi's Effluent Discharge Permit PE-224, under the Environmental Management Act of BC Ministry of Environment. The permit regulates authorized discharge from the Pinchi Mine to the receiving environment. Drainage from the tailings impoundment and the mine site area downgradient of the pond flows via a drainage channel that flows during a brief period in spring. The discharge rate at the spillway varies according to snowpack and melt dynamics, but has not been recorded to exceed 14 L/s since 2010. Discharge is usually recorded between 7 L/s and 12 L/s during the peak flow period. No drainage has been identified at any other time of year.

3 WATER BALANCE

Pinchi Lake Mine is located northwest of three Environment Canada climate stations which are summarized in Table 3.1. These stations are slightly lower than the site elevation (approximately 740 masl) and precipitation at the facility may vary. Daily precipitation data at all of the stations is missing a large amount of records in 2015. As a result, precipitation from the Fort St James (1092970) 1981-2010 climate normal was used in the water balance.

Table 3.1 Climate Stations near the TSF

Station Name	Station ID	Distance and Direction from TSF	Station El. (masl)	2015 Precipitation (mm)	Daily Precipitation Data Coverage in 2015	1981-2010 Climate Normal Precipitation (mm)
Fort St James	1092970	21 km southeast	691	211.8	62%	487.1
Fort St James Auto	1092975	21 km southeast	688	355.0	87%	-
Vanderhoof	1098D90	69 km southeast	638	468.2	88%	489.2

The annual water balance for average climate conditions is shown in Table 3.2. The average discharge through the spillway is estimated to be 3.0 L/s, which is the net outflow based on the difference between the inflows and outflows.

Table 3.2 Average Annual TSF Water Balance

	Volume (m^3)	Flow Rate (L/s)	Basis/Assumption	Data Source
INFLOWS				
Direct Precipitation on Impoundment Surface	107,184	3.4	Impoundment Catchment: 18.5 ha, see Figure 1 Annual Average Precipitation: 487.1 mm	Annual Average Precipitation: Fort St James 1981-2010 Climate Normal (1092970; Environment Canada 2014)
Upstream Catchment Runoff	57,327	1.8	Runoff Coefficient = 0.34 Upstream Catchment = 38.1 ha, see Figure 1	Runoff coefficient calibrated to historical decant pipe flows (KCB 2009a)
Total Inflows	164,511	5.2		
OUTFLOWS				
Evaporation	-	-	Evapotranspiration is accounted for in the runoff coefficient which was calibrated to weir flows.	-
Seepage	69,427	2.2	Seepage through tailings based on tailings permeability of $1x10^{-8}$ m/s	(KCB 2009a)
Spillway Discharge	95,085	3.0	Calculated	-
Total Outflows	164,511	5.2		

4 QUANTIFIABLE PERFORMANCE OBJECTIVES

There are eleven survey monitoring stations on the dam crest for monitoring dam displacements. Quantifiable performance objectives (QPOs) are defined in the OMS Manual (KCB 2014) for these monuments as summarized below:

- Incremental vertical and horizontal displacements over one year, perpendicular to the dam alignment, should be less than 50 mm.
- An engineering assessment is required for a continuing trend of movement if cumulative displacements of the dam in a credible (i.e., plausible) direction exceed 100 mm.

5 CLOSING

This letter is an instrument of service of Klohn Crippen Berger Ltd. The letter has been prepared for the exclusive use of Teck Metals Ltd. (Client) for the specific application to the Pinchi Lake Mine project. The letter's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this letter, 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.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Jaclyn Bowman, EIT
Environmental Engineer

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. R. KLASSEN
39699

Dec. 19/16

Daniel Klassen, P.Eng.
Project Manager

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
R. W. CHAMBERS

19 DEC 2016

Robert W. Chambers, P.Eng.
Engineer of Record
Vice President Mining Environmental Group, Principal

DK/JB:jcp/dl

Attachment: Figure 1 - TSF Catchment Area

REFERENCES

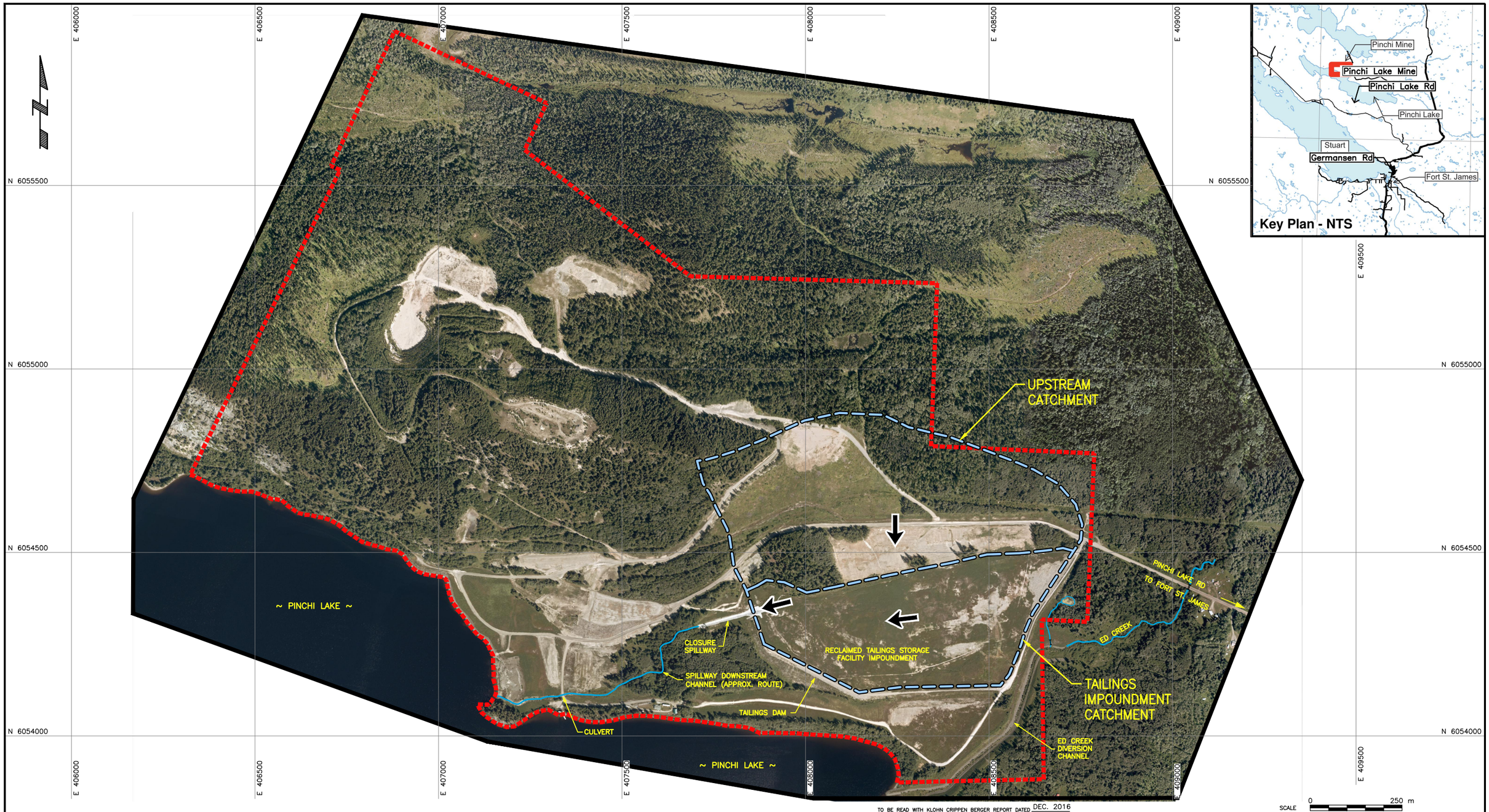
Environment Canada. 2014. Canadian Climate Normals 1981-2010, Fort St James, British Columbia. Accessed November 15, 2016. http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=fort+st+james&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=588&dispBack=1

Environment Canada. 2014. Canadian Climate Normals 1981-2010, Vanderhoof, British Columbia. Accessed November 16, 2016. http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=655&autofwd=1

Klohn Crippen Berger (KCB). 2009a. "Pinchi Lake Tailings Facility 2008 Annual Review", May 6.

Klohn Crippen Berger (KCB). 2009b. "Pinchi Lake Mine Tailings Facility – Closure Spillway Design", July 3.

Klohn Crippen Berger (KCB). 2014. "Pinchi Lake Mine Tailings Storage Facility - Operation, Maintenance and Surveillance Manual & Emergency Preparedness Plan", April 4.



LEGEND

- PROPERTY BOUNDARY
- FLOW DIRECTION

NOTES

1. ORTHOPHOTO IMAGE TAKEN IN 2013 (PROVIDED BY TECK).
2. NAD83, UTM ZONE 10.

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED DEC. 2016

SCALE 0 250 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF

TITLE: TAILINGS IMPOUNDMENT CATCHMENT AREAS

PROJECT No. M07728 A31

FIG. No. 1

KCB-R-MLB

Time: 16:20:10
Date: 12/15/2016
Scale: 1:2,500 (22"x34")
Drawing File: \\vn1.klohn.com\ProjData\MT\VCR\M07728A31-TML-Pinchi Lake 2016 Services\400 Drawings\Water Balance Letter\Fig-01.dwg (jbokic)
Xref File(s):
Image File(s): Pinchi-2013-20cm_R

APPENDIX VII

Quantifiable Performance Objectives

Appendix VII
Quantifiable Performance Objectives

Quantifiable Performance Objectives for the Pinchi Lake Mine Tailings Storage Facility are as follows.

VII-1 PIEZOMETERS

The threshold levels established for piezometers are based on stability analysis and are summarized in Table VII-1. Threshold level exceedances will be reviewed by the Engineer of Record, and further action will be advised based on subsequent engineering analysis.

Table VII-1 Threshold Levels for Piezometers

Piezometer ID	Serial #	Threshold Value (Piezometric Elevation in metres)
DH16-01-VWP1	VW38610	736.1
DH16-01-VWP2	VW38611	736.1
DH16-02-VWP1	VW38608	738.5
DH16-02-VWP2	VW38609	738.5
DH16-03-VWP1	VW38606	737.0
DH16-03-VWP2	VW38607	737.0

VII-2 SURVEY MONUMENTS

Alert criteria for displacement of survey monuments on the dam are as follows:

- Vertical displacements over one year greater than 50 mm.
- Horizontal displacements over one year, perpendicular to the dam alignment, greater than 50 mm.
- An engineering assessment is required for a continuing trend of movement if cumulative displacements of the dam in a credible (i.e., plausible) direction exceed 100 mm, relative to the baseline readings.