Klohn Crippen Berger

Teck Metals Ltd.

Pinchi Lake Mine Tailings Storage Facility

2017 Dam Safety Inspection

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March 14, 2018

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
2017 Dam Safety Inspection

We are pleased to submit the 2017 Dam Safety Inspection Report on the Pinchi Lake Mine Tailings Storage Facility.

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: jcp

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Teck Metals Ltd.

Pinchi Lake Mine Tailings Storage Facility

2017 Dam Safety Inspection

EXECUTIVE SUMMARY

This report presents the 2017 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 August 2017 by the Engineer of Record, Bob Chambers, of KCB. Routine inspections were carried out in April 2017 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 0.044 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

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 during 2017 and there have been no significant changes to the TSF or associated water management infrastructure since the 2016 DSI. During 2017, woody debris blocking the inlets of the Ed Creek culverts at Pinchi Lake Road was removed, and vegetation was cleared from the Ed Creek Diversion Channel and the Spillway Downstream Channel.

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 instrumentation in 2017, 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.

Tension 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. Apart from one reading in April 2017, which showed an increase of 14 mm, the readings have shown either minor fluctuations with no net change over time, or a decrease (narrowing of the cracks) over time. The cracks in the area where the readings increased have shown no indication of widening, and the readings before and after the April 2017 reading did not indicate movement, so it is likely that the rods were disturbed and the reading does not represent real slope movements. The readings currently do not give any cause for concern. Measurement of the rods and inspection of this slope are included in the regular surveillance described in the OMS Manual and will continue.

There were no significant changes to the stability of the dam in 2017, which means the dam is in a good state of repair. 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 (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) and a revision is currently in progress.

Dam Safety Review

A Dam Safety Review (DSR) of the Pinchi Lake Mine TSF was completed in 2013 (Golder 2014). The Health, Safety and Reclamation Code (MEM 2016, 2017) requires that all tailings storage facilities undergo a DSR every 5 years at minimum. To comply with the HSRC, the next DSR should be carried out in 2018.

Summary of Recommendations

The deficiencies and recommendations related to dam safety are summarized in the following table. None of the issues are high priorities. The level of priority is 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.

Year-No.	Description/Recommendation	Priority	Recommended Deadline/Status
Recommendations from Previous DSIs			
2014-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering. 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 2019
2015-03	Inspect area along the left bank of the Ed Creek Diversion Channel (Location 9 in Figure 4.1) where depression has been observed in the riprap surface, and replace riprap if deemed necessary.	3	CLOSED - Riprap replacement can be done with the rest of the channel per recommendation 2014-02

Year-No.	Description/Recommendation	Priority	Recommended Deadline/Status
2016-01	Develop a vegetation clearing plan as part of ongoing maintenance program.	3	CLOSED - Completed in December 2017
2016-03	Clear vegetation from the Ed Creek Diversion Channel.	3	CLOSED - Completed in October 2017
2016-04	Clear the debris and vegetation upstream of the Pinchi Lake Road culverts.	3	CLOSED - Completed on April 4, 2017
2016-05	Review the stability of the Tailings Dam, taking into account the new earthquake design criterion from HSRC (2016) and the findings of the 2016 foundation investigation.	3	CLOSED - Stability assessment completed November 17, 2017
Recommendations from 2017 DSI			
2017-01	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	Complete by November 1, 2018

With the exception of the cracks in the Borrow Area A slope, excessive vegetation in the Ed Creek Diversion Channel and the Spillway Downstream Channel (both of which have since been cleared), and the undersized and deteriorating riprap in the Ed Creek Diversion Channel, the Pinchi Lake Mine Tailings Storage Facility appears to be in good condition and there are no major concerns related to dam safety.

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1 INTRODUCTION

1.1 Purpose, Scope of Work and Methodology

This report presents the 2017 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 Bob Chambers, P.Eng. (the Engineer of Record) and Daniel Klassen, P.Eng. on August 30, 2017.
- Review and update of the list of outstanding recommendations from the previous annual reviews.
- 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 2017 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, 2017), 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 (KCB 2013).

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 upslope 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 2017

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 & 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. An annual inspection of the TSF is conducted by the Engineer of Record usually in late summer or early fall. 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 April 4, 2017, woody debris that was blocking the inlets of the Ed Creek culverts at Pinchi Lake Road was removed by Mr. Mark Pokorski of EcoFor. Vegetation was cleared from the Ed Creek Diversion Channel and the Spillway Downstream Channel in October 2017. Apart from these maintenance activities and routine inspections, there were no other site activities during 2017.

3 CLIMATE DATA AND WATER BALANCE DURING 2017

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, 2016 to Aug. 31, 2017 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 so are too incomplete to be useful for calculating monthly totals.

The climate data shows that temperatures during the period examined were close to average conditions. The precipitation data shows drier than average conditions from November to February (25 mm, 29 mm, 16 mm and 16 mm precipitation versus 45 mm, 43 mm, 48 mm and 30 mm normal for those months), and in July and August (22 mm and 17 mm precipitation versus 51 mm and 45 mm normal for those months), and the total precipitation over the one-year period (334 mm) was less than the climate normal (487 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 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.

Table 3.1 Fort St. James (No. 1092975) Temperatures and Precipitation – Sep. 2016 to Aug. 2017 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. 2016 – Aug. 2017													
Temperature													
Daily Average (°C)	10.2	3.3	2.1	-11.6	-8.8	-7.5	-2.2	4.7	11.4	13.7	15.2	16.3	3.8
Daily Maximum (°C)	15.8	6.1	5.3	-6.7	-4.7	-3.0	3.0	10.2	17.6	19.5	21.4	22.9	8.9
Daily Minimum (°C)	4.6	0.4	-1.0	-16.5	-12.9	-12.0	-7.3	-0.8	4.7	8.0	9.0	9.7	-1.2
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)	35.3	35.2	25.0	29.4	15.7	15.9	26.7	32.3	38.5	40.3	22.3	16.9	333.5
No. of days of missing data	1	2	5	0	1	0	0	0	5	0	0	0	14

4 SITE OBSERVATIONS – AUGUST 2017

4.1 Visual Inspection

The following areas were inspected during the August 30, 2017 site visit:

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

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

Impoundment Area

- There was no flowing or standing water in the Tailings Impoundment at the time of inspection.
- The soil cover on the tailings appeared to have good growth of grass (Photos II-2 and II-4 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 4 in Figure 4.1). 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 3 in Figure 4.1; Photo II-20). The riprap appears to be performing well.

- The area around the backfilled decant inlet box is overgrown with grass as expected. The invert of the decant pipe is approximately 2 m higher than the Closure Spillway; therefore, no discharge of water from the Tailings Impoundment via the decant is expected.
- The West Ditch, which carries local surface runoff from the west abutment of the Tailings Dam, is covered with vegetation (Photo II-26). There were no signs of erosion of the ditch. The invert of the ditch is approximately 4 m higher than the Closure Spillway; therefore, no discharge of water from the Tailings Impoundment via the ditch is expected.

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 were observed on the dam crest along the southwest leg and south leg of the Tailings Dam (Location 5 in Figure 4.1; Photo II-10). Similar cracks were observed in these areas during the 2015 inspection, but the cracks were not visible in 2016. 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, and may have reopened due to dry conditions over the summer (see Section 3.1). The cracks are not considered to be a dam safety issue.
- Vegetation on the dam slopes includes tall grasses, bushes, and small trees (Photos II-5 to II-8, II-11 to II-15, and II-17). The vegetation is not currently considered to be a dam safety concern, but it may be prudent to clear it before the trees become more difficult to remove. A vegetation clearing plan was developed in December 2017, which provides criteria for when and where clearing and herbicide treatment are required.
- The ground at the downstream toe of the southwest leg of the Tailings Dam was observed to be damp, and there is increased growth of vegetation in this zone (Photos II-13 and II-14). No flowing or standing water was observed.

Closure Spillway

- There was no flow or standing water in the Closure Spillway channel at the time of inspection, apart from a small pond below the riprap surface at the downstream end of the riprap, which was only visible at close range.
- The riprap along the entire Closure Spillway channel appeared to be in good condition (Photos II-18 to II-25). 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-24).
- There is a small slump in the slope above the riprap on the right (north) side of the spillway channel (Location 2 in Figure 4.1). The slump was covered with vegetation during the 2017 inspection and was very difficult to see, although the head scarp was visible from close range (Photo II-23). There were no noticeable changes in the slump area since the 2016 inspection and the slump is not expected to impact the Tailings Dam.

- At the time of the inspection, the lower reach of the Spillway Downstream Channel (along the former Emergency Spills Lagoon) had excessive vegetation that would affect the flow capacity of the channel (Photo II-30). The vegetation was also excessive upstream of the culvert in the middle reach of the channel (Location 1 in Figure 4.1; Photo II-28). Teck reported that vegetation was cleared from these areas in October 2017.

4.1.2 Borrow Area A Slope

- Tension cracks were observed in 2013 on the slope of Borrow Area A, downslope of the Tailings Dam (Location 6 in Figure 4.1). The locations of the tension cracks are shown in plan and on the cross-sections in the figures presented in Appendix IV. The cracks were difficult to see during this inspection due to heavy growth of vegetation on the slope (Photos II-31 to II-32). No notable changes were observed since the 2016 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.
- Four small seepage areas were identified in July 2011 on the slope of Borrow Area A (Location 7 in Figure 4.1). The surveyed locations of these seeps are shown in Figure 1.2, and in the figures presented in Appendix V. 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 seepage water. During the August 2017 inspection, the ground in the toe area was barely damp, except in the northeast corner of the borrow area where the ground was wet but no seepage was observed (Photo II-33).

4.1.3 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 Photo II-46) at the time of the inspection. Teck reported that this vegetation was cleared in October 2017.
- The Ed Creek Diversion Channel had heavy growth of vegetation at the time of the inspection (Photos II-37, II-39 to II-42, and II-44). Teck reported that this 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. The riprap along a small section of the channel (Location 8 in Figure 4.1; Photo II-41), where a depression had formed in the riprap surface, was replaced in 2014. This riprap appeared to be in good condition.

  Riprap along the right bank of the channel upstream of Sta. 0+210 appears to be deteriorating more than other reaches of the channel. A depression in the riprap surface was noted in the 2015 inspection along a section of the channel identified as Location 9 in Figure 4.1 (Photos II-42 and II-43). The condition at this location during the 2017

inspection was similar to recent years. This area does not require immediate repair and can be dealt with as part of the erosion protection replacement for the entire channel. The existing recommendation (No. 2015-03) to inspect the depression is now considered closed.

A 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. The recommendation from 2014 to re-establish erosion protection still stands, and Teck have been investigating erosion protection options for the channel.

- There are two culverts on Ed Creek under Pinchi Lake Road east of the mine gate (see Figure 1.2 for location). Debris was cleared from the inlet of the culverts in April 2017. Although 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-47 and II-48). 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 will continued to be monitored in future inspections.

Recommendation/Action:

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.

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. 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 2017 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) show a decrease in readings since October 2016, possibly because the piezometers had 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 1.4 m higher than the August 2017 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 2017 Piezometer Readings

Piezometer ID	Piezometric Elevation (m)			Depth Below Ground (m)	
	Threshold Value	April 21, 2017	August 30, 2017	April 21, 2017	August 30, 2017
DH16-01-VWP1	736.1	735.3	733.8	0.8	2.3
DH16-01-VWP2	736.1	734.5	733.7	1.6	2.4
DH16-02-VWP1	738.5	No reading	732.1	No reading	9.9
DH16-02-VWP2	738.5	732.4	732.2	9.6	9.8
DH16-03-VWP1	737.0	735.7	734.7	2.2	3.2
DH16-03-VWP2	737.0	735.5	734.5	2.4	3.4

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 the discharge.

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 Tension 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.

Location 403 showed an increase of 14 mm from Sep. 2016 to Apr. 2017, indicating widening of the cracks. However, the cracks themselves were difficult to see (see Photos II-31 and II-32 in Appendix II) and did not show any indication of widening. Also, the readings before and after the April 2017 reading did not indicate movement, so it is likely that the rods were disturbed and the reading does not represent real slope movements. Locations 103 and 203 show minor fluctuations in the readings with no net change over time. Location 103A has decreased (narrowing of the cracks) over time. The readings currently do not give any cause for concern. Readings should continue to be taken during inspections as described in the OMS Manual to determine whether these trends will continue.

Table 4.2 Borrow Area A Tension 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
103	402	401 (-1)	403 (+2)	400 (-3)	402 (+2)	401 (-1)
103A	450	436 (-14)	438 (+2)	427 (-11)	431 (+4)	428 (-3)
203	359	354 (-5)	358 (+4)	355 (-3)	359 (+4)	360 (+1)
403	357	351 (-6)	350 (-1)	349 (-1)	363 (+14)	364 (+1)

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).

The Health, Safety and Reclamation Code (MEM 2016, 2017) requires that all tailings storage facilities undergo a DSR every 5 years at minimum. To comply with the HSRC, the next DSR should be carried out in 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 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].

- **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

[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.

[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.

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 cause erosion on 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 did 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 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

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

[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.

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 guidelines; therefore, there is no change in the Tailings Dam classification.

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 of the pond, resulting in a decrease in phreatic levels within the dam (as discussed in Section 4.2.1); and
- trimming of 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 tension 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.

Clearing of vegetation from earthen dams is generally recognized as a best management practice (FEMA 2005). Periodic removal of vegetation from the crest and slopes of the dam is important to prevent large root systems from developing. Water conveyance structures including the Closure Spillway, Ed Creek Diversion Channel, and ditches should also be cleared periodically or they will not operate to design capacity.

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) and a revision is currently in progress.

6 CONCLUSIONS AND RECOMMENDATIONS

The deficiencies and recommendations from previous years and from the 2017 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.

With the exception of the cracks in the Borrow Area A slope, excessive vegetation in the Ed Creek Diversion Channel and the Spillway Downstream Channel (both of which have since been cleared), and the undersized and deteriorating riprap in the Ed Creek Diversion Channel, the Pinchi Lake Mine Tailings Storage Facility 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 2017.

The tension cracks on the slope of Borrow Area A have not been widening over time, and are not expected to affect the stability of the Tailings Dam; however, the borrow area slope should continue to be monitored for further development of cracks, seeps and movement as described in the OMS Manual.

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 by the end of 2019.

Inspections were carried out in April 2017 by the Site Surveillance Officer, and August 2017 by the Engineer of Record. Maintenance activities in 2017 included removal of woody debris blocking the inlets of the Ed Creek culverts at Pinchi Lake Road, and clearing of vegetation from the Ed Creek Diversion Channel and the Spillway Downstream Channel.

Climate data from the nearest climate station for the period from Sep. 1, 2016 to Aug. 31, 2017 showed temperatures were close to average conditions (based on 1981 to 2010 climate normals), but there was less precipitation than average. There is no storage of water in the TSF, and inflows are limited to direct precipitation and stormwater runoff from upslope, so an annual water balance review 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 and a revision is currently in progress.

Table 6.1 Summary of Deficiencies and Recommendations

Year-No.	Description/Recommendation	Priority	Recommended Deadline/Status
Recommendations from Previous DSIs			
2014-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering. 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 2019
2015-03	Inspect area along the right bank of the Ed Creek Diversion Channel (Location 9 in Figure 4.1) where depression has been observed in the riprap surface, and replace riprap if deemed necessary.	3	CLOSED - Riprap replacement can be done with the rest of the channel per recommendation 2014-02
2016-01	Develop a vegetation clearing plan as part of ongoing maintenance program.	3	CLOSED - Completed in December 2017
2016-03	Clear vegetation from the Ed Creek Diversion Channel.	3	CLOSED - Completed in October 2017
2016-04	Clear the debris and vegetation upstream of the Pinchi Lake Road culverts.	3	CLOSED - Completed on April 4, 2017.
2016-05	Review the stability of the Tailings Dam, taking into account the new earthquake design criterion from HSRC (2016) and the findings of the 2016 foundation investigation.	3	CLOSED - Stability assessment completed November 17, 2017
Recommendations from 2017 DSI			
2017-01	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	Complete by November 1, 2018

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.

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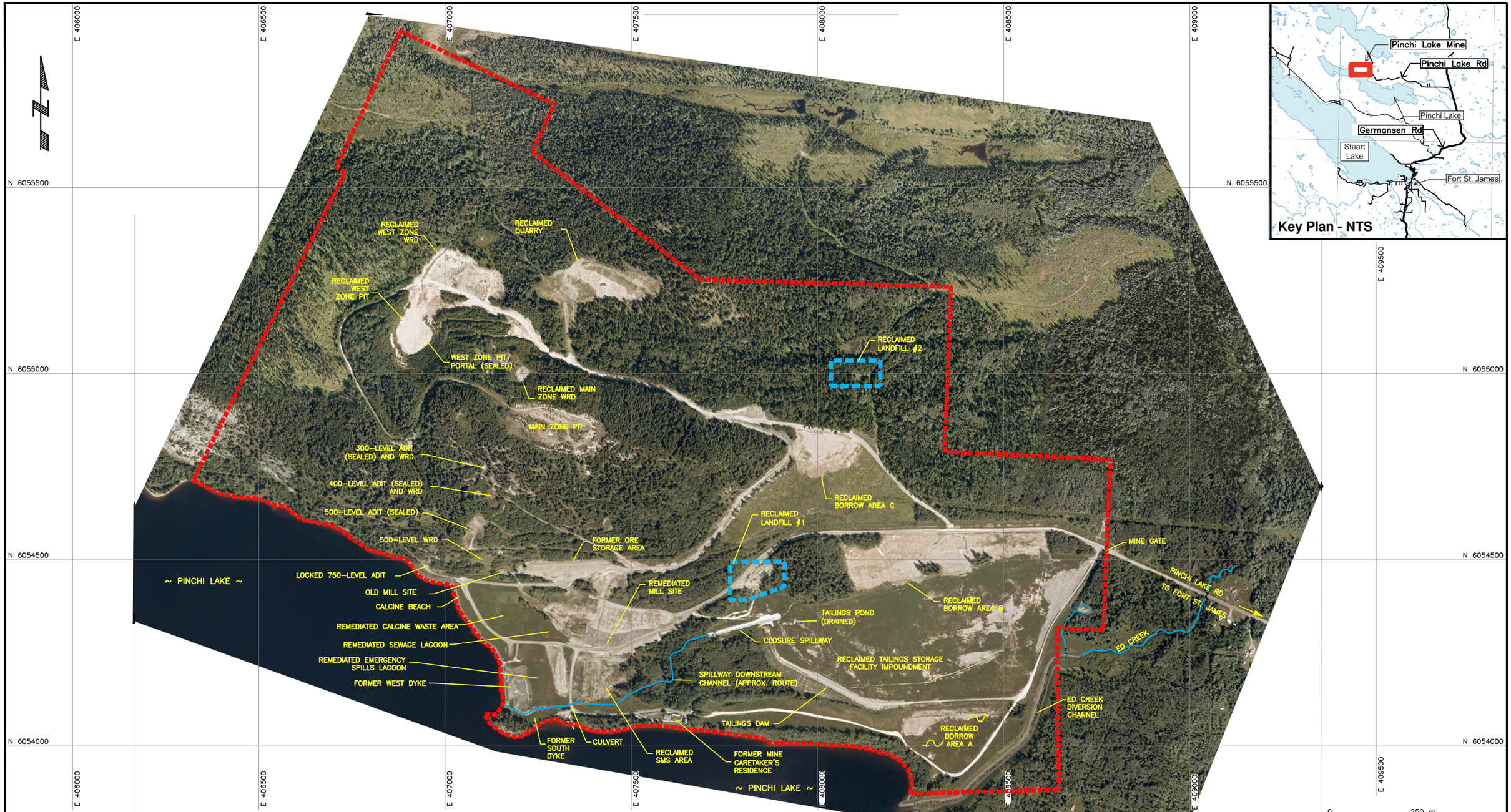
FIGURES



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 MAR. 2018

SCALE 0 250 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2017 DAM SAFETY INSPECTION

TITLE: MINE SITE PLAN

PROJECT No. M07728 A32

FIG. No. 1.1

KCB-R-MLB

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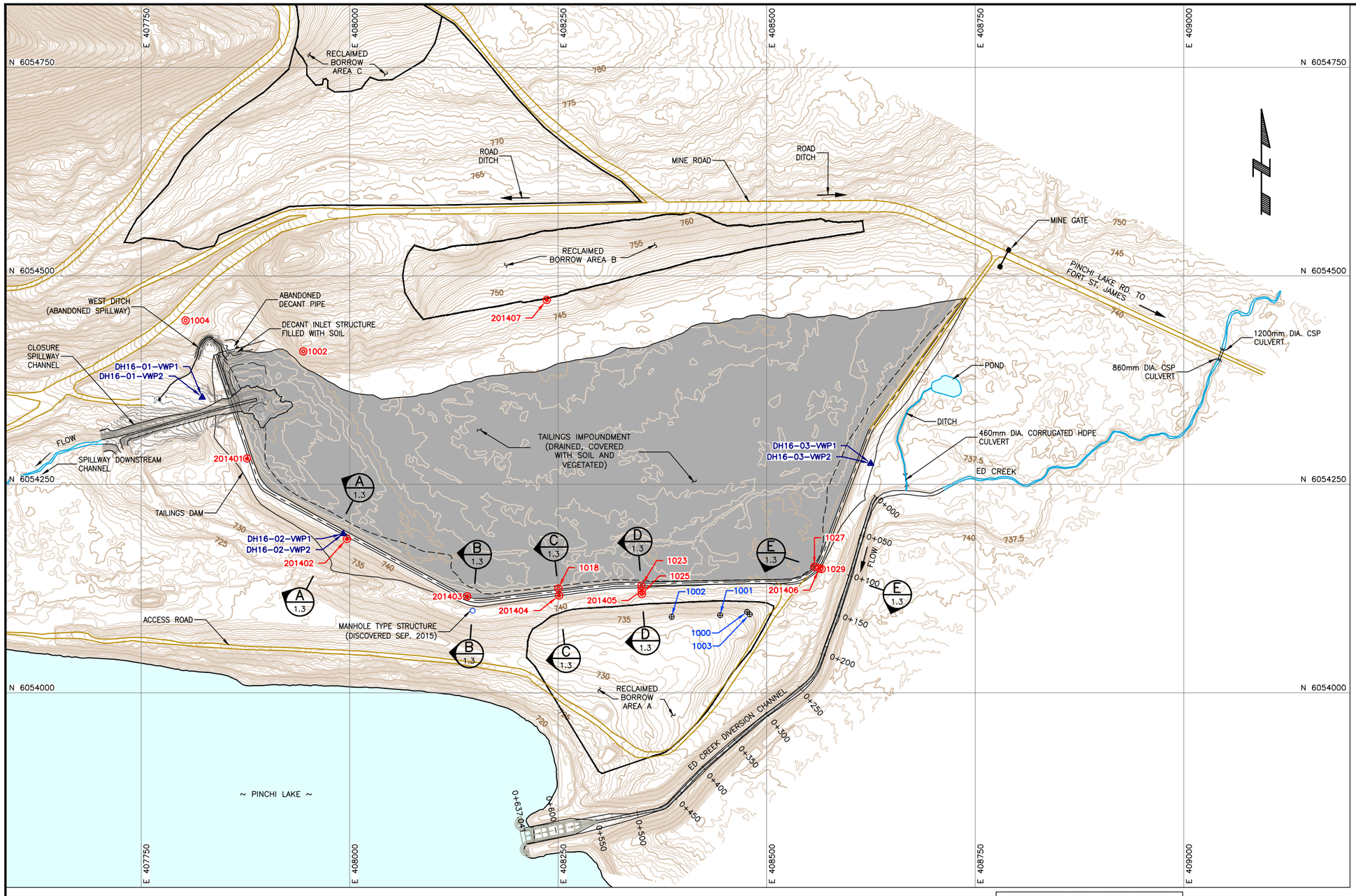

SEEPAGE POINT	
NAME	GROUND ELEVATION (m)
1000	737.0
1001	734.3
1002	734.2
1003	736.9

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.

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 MAR. 2018

SCALE 0 100 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2017 DAM SAFETY INSPECTION

TITLE: TAILINGS STORAGE FACILITY PLAN

PROJECT No. M07728 A32

FIG. No. 1.2

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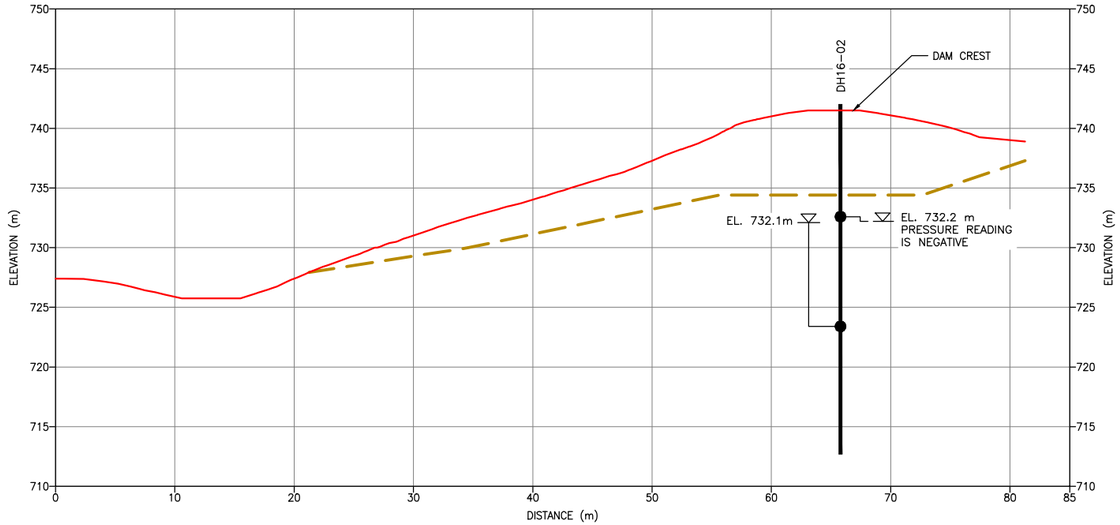

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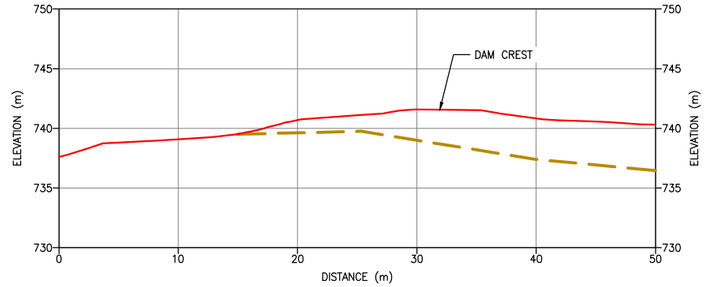

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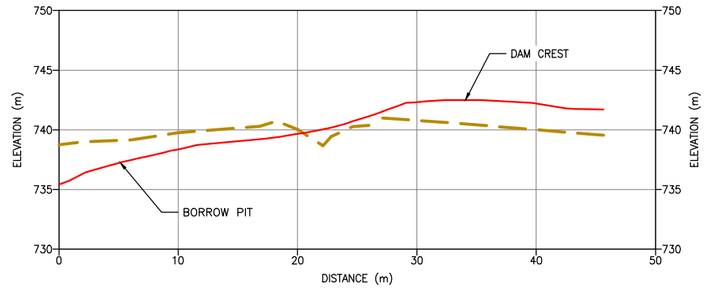

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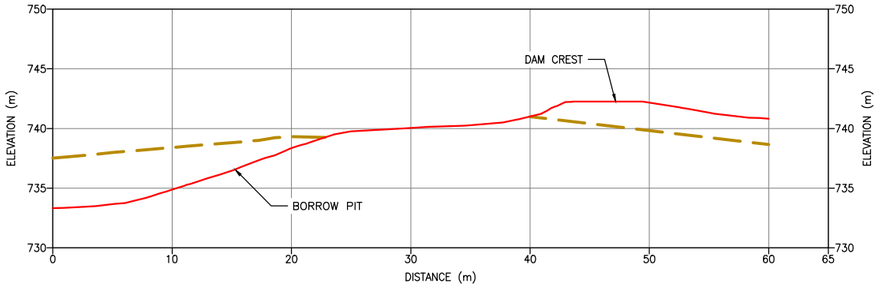
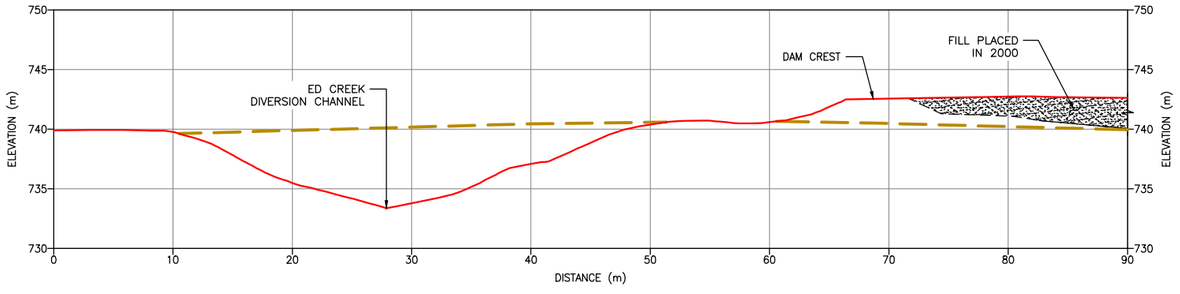


SECTION C 1.2



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 — AUG. 30. 2017 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 MAR. 2018

SCALE 0 10 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2017 DAM SAFETY INSPECTION

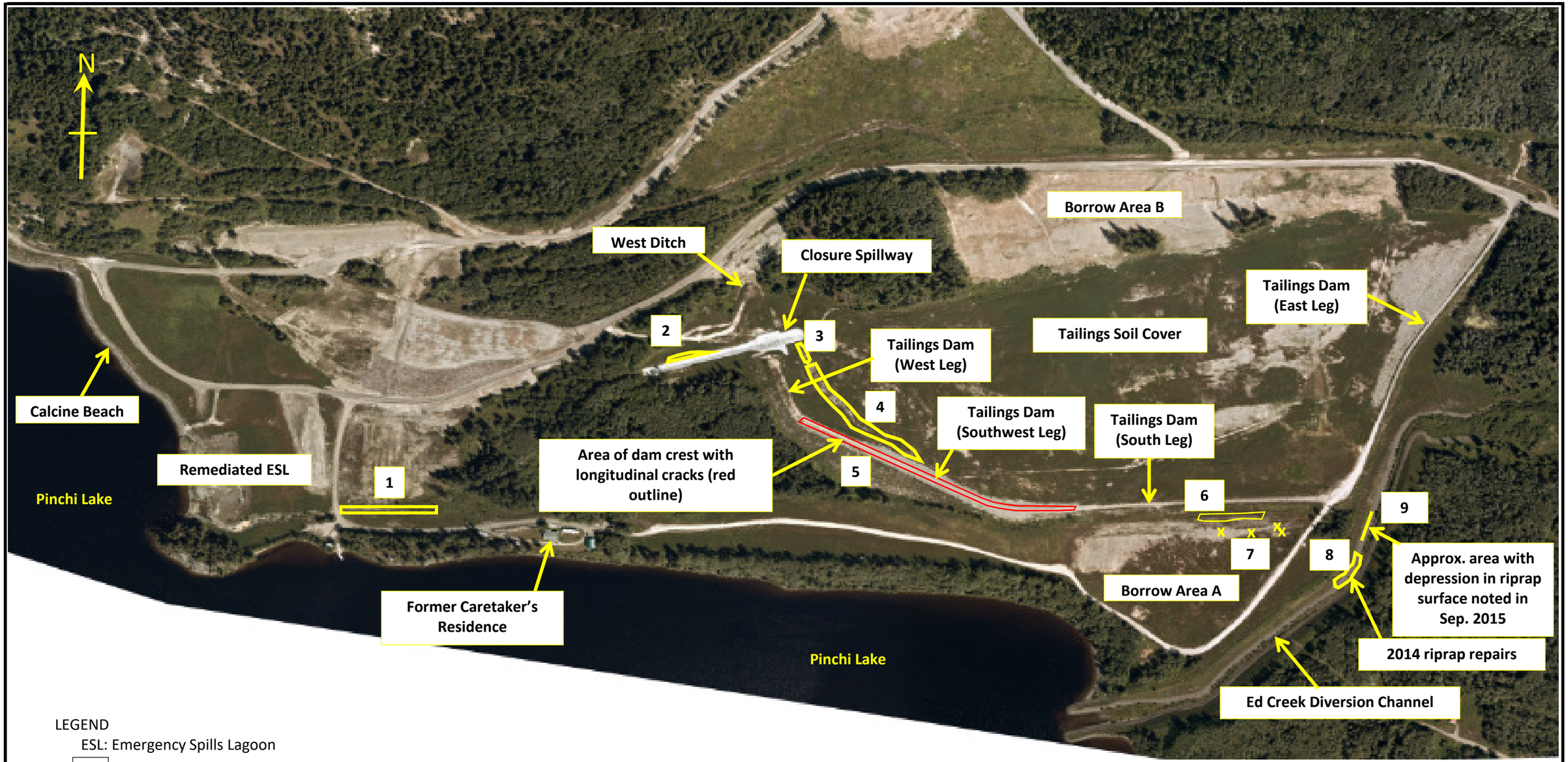
TITLE: TAILINGS STORAGE FACILITY
DAM CROSS SECTIONS

PROJECT No. M07728 A32

FIG. No. 1.3

KCB-R-MLB

Time: 13:29:23
Date: 9/22/2017
Scale: 1:2.5849(PS)
Drawing File: \\vcr-fs-v\ProData\W\VCR\M07728A32-TML-Pinchi Lake 2017 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

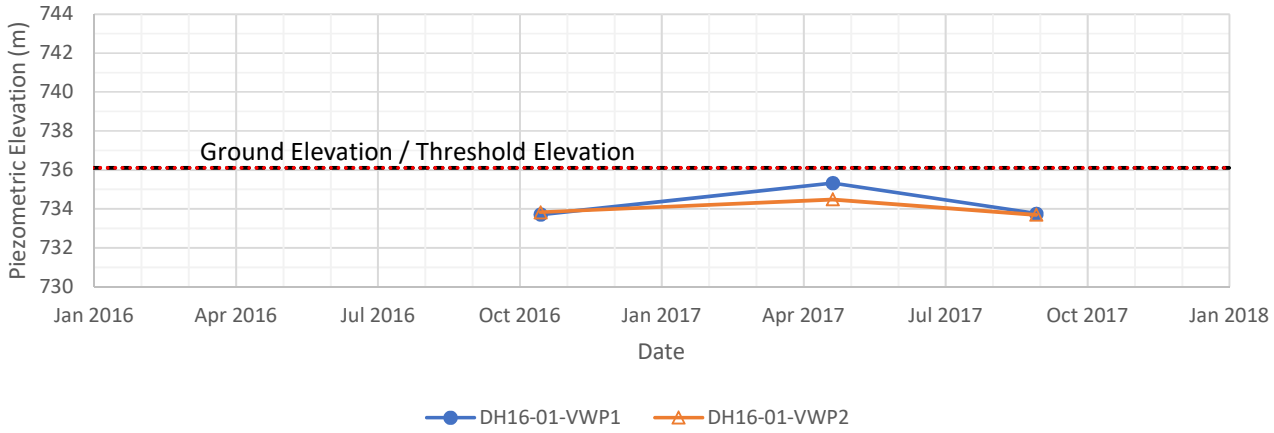
Klohn Crippen Berger

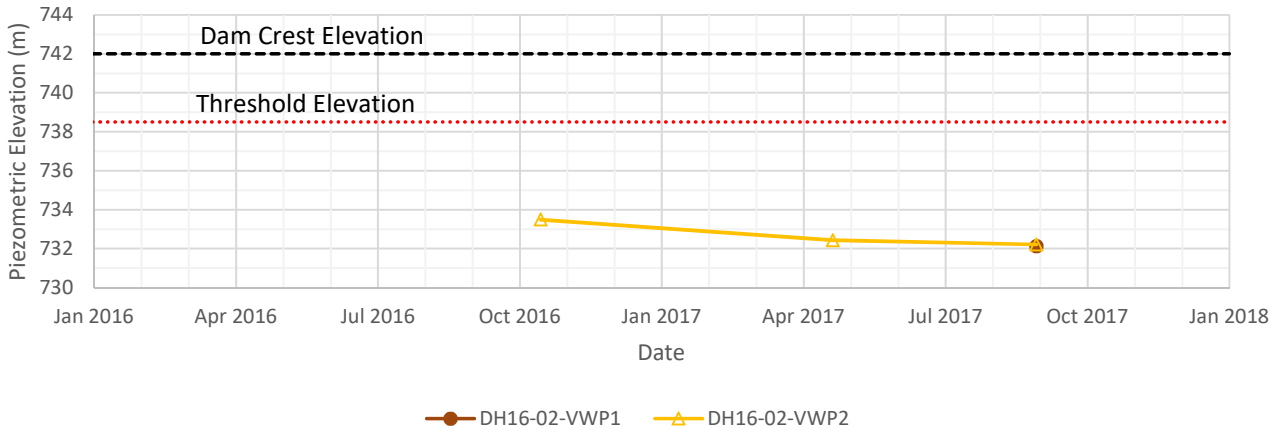
PROJECT: PINCHI LAKE MINE TSF
2017 DAM SAFETY INSPECTION

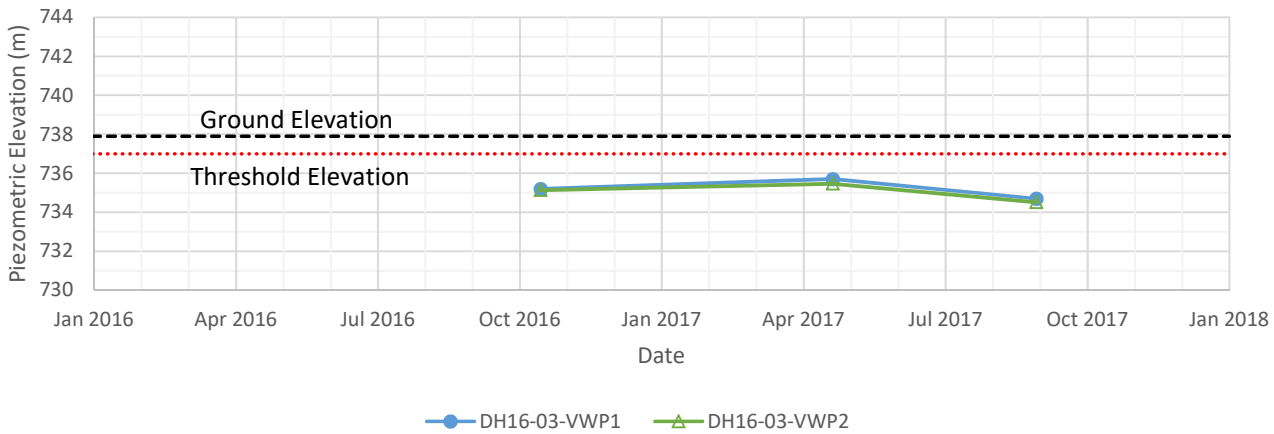
TITLE: AUGUST 2017 OBSERVATION LOCATIONS

PROJECT No. M07728A32

FIG No. 4.1







NOTES:
1. DH16-02-VWP1 was previously giving no reading, but a damaged spot in the cable was located during the Aug. 30, 2017 reading. The cable was cut below the damaged spot and the instrument now appears to be functioning properly.

CLIENT: Teck

Klohn Crippen Berger

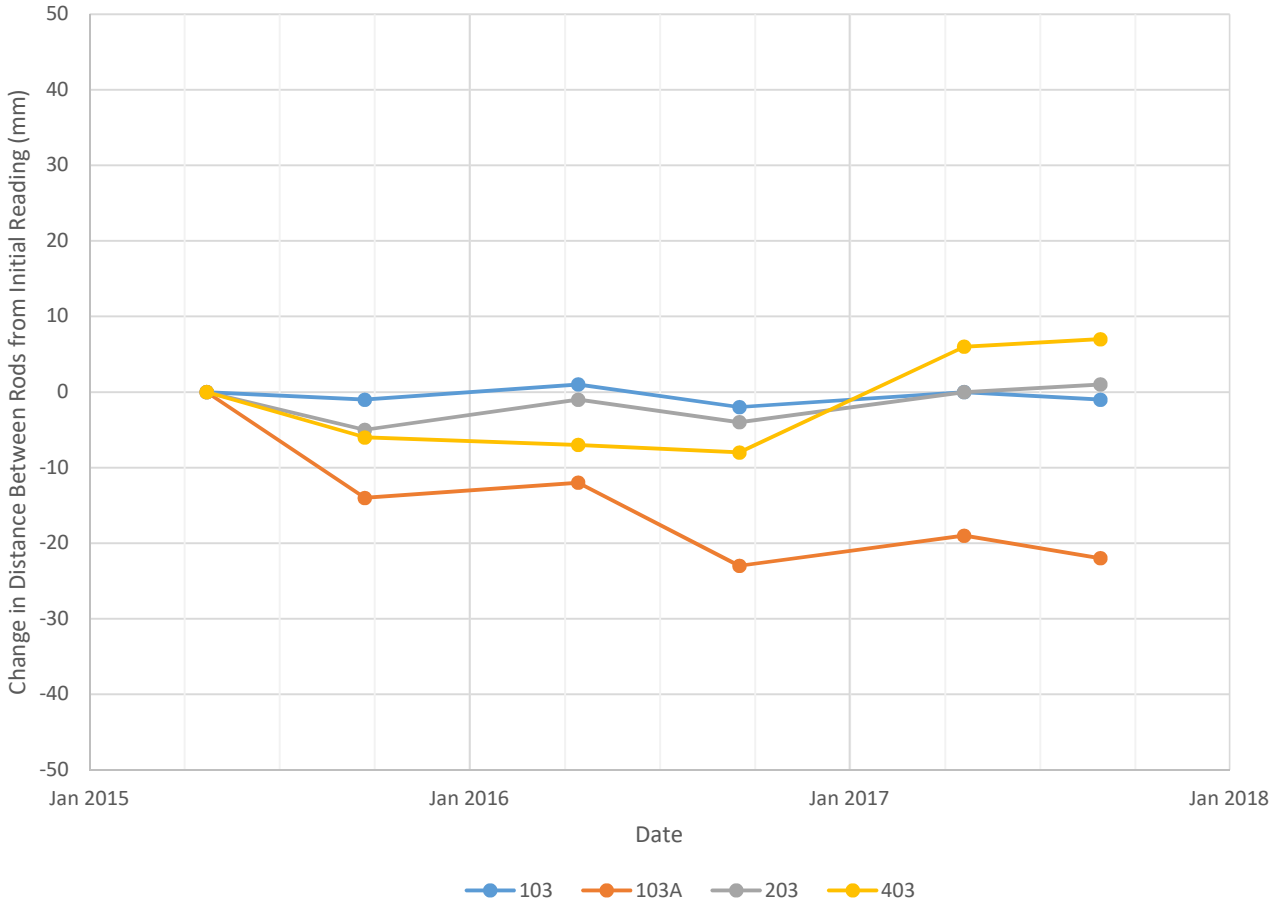
PROJECT: PINCHI LAKE MINE TSF
2017 DAM SAFETY INSPECTION

TITLE: PIEZOMETER READINGS

PROJECT No. M07728A32

FIG No. 4.2

Date & Time: 2018-03-12 11:15
Figure File: \\vcr-fs-v\Proj\Data\M\VCR\M07728A32-TML-Pinchi Lake 2017 Services\300 Design\320 Instrumentation\[Figure - VW piezos.xlsx]Figure



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

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2017 DAM SAFETY INSPECTION

TITLE: BORROW AREA A
ROD MEASUREMENTS

PROJECT No. M07728A32

FIG No. 4.3

Date & Time: 2017-09-19 13:14
Figure File: \\vcr-fs-v\Proj\Data\M\VCR\M07728A32-TML-Pinchi Lake 2017 Services\300 Design\320 Instrumentation\[Pinchi VW piezos.xlsx]Figure

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

August 2017 Photographs

Appendix II
August 2017 Photographs

Photo II-1 Tailings Dam – East Leg, looking north towards the mine gate.

Photo II-2 Tailings Dam – East Leg, looking west at the covered tailings surface.

Photo II-3 Tailings Dam – South Leg, looking east from mid-point towards Ed Creek.

Photo II-4 Tailings Dam – South Leg, looking north at the covered tailings surface.

Photo II-5 Tailings Dam – South Leg, looking west along downstream slope.

Photo II-6 Tailings Dam – South Leg, looking east along toe towards Borrow Area A.

Photo II-7 Tailings Dam – South Leg, looking up the slope from the toe area.

Photo II-8 Tailings Dam – Southwest Leg, looking southeast along downstream slope.

Photo II-9 Tailings Dam – Southwest Leg, looking northwest towards Closure Spillway.

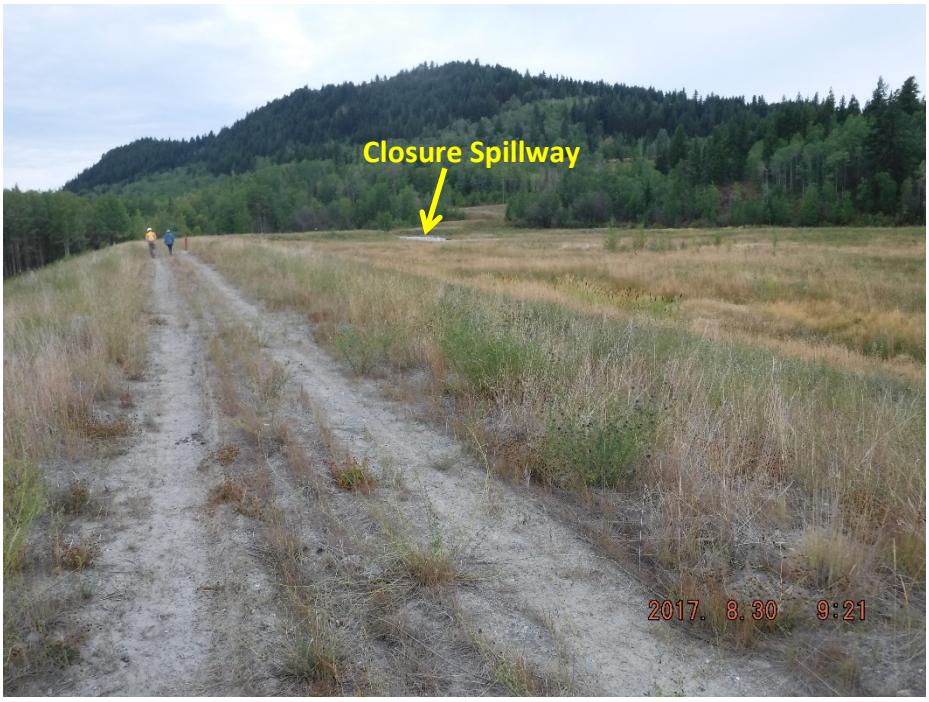


Photo II-10 Tailings Dam – Southwest Leg, crack on dam crest in tire track.

Photo II-11 Tailings Dam – Southwest Leg, looking southeast along downstream slope.

Photo II-12 Tailings Dam – Southwest Leg, looking downslope towards the toe.

Photo II-13 Tailings Dam – Southwest Leg, looking northwest along dam slope towards corner with West Leg.

Photo II-14 Tailings Dam – Southwest Leg, looking northwest along dam slope from toe area.

Photo II-15 Tailings Dam – West Leg, looking north along dam slope towards Closure Spillway.

Photo II-16 Tailings Dam – West Leg, looking south along dam crest.

Photo II-17 Tailings Dam – West Leg, looking north along toe.

Photo II-18 Closure Spillway, inlet apron.

Photo II-19 Closure Spillway – Looking downstream from inlet area.

Photo II-20 Downstream end of surface runoff channel where it discharges to the Closure Spillway, showing riprap which was placed in 2014.

Photo II-21 Closure Spillway, looking upstream from dam toe area.

Photo II-22 Closure Spillway, looking downstream.

Photo II-23 Closure Spillway – head scarp of slump above right bank

Photo II-24 Closure Spillway – looking upstream from near downstream end of channel. Some minor regrowth of vegetation has occurred in this area.

Photo II-25 Closure Spillway – looking downstream towards end of riprap-lined portion of channel.

Photo II-26 West Ditch – looking northeast from base of ditch.

Photo II-27 Spillway Downstream Channel – inlet to culvert beneath road to caretaker's house.

Photo II-28 Spillway Downstream Channel – Middle Reach, looking upstream from culvert beneath road to caretaker's house.

Photo II-29 Spillway Downstream Channel, outlet of culvert beneath road to caretaker's house.

Photo II-30 Spillway Downstream Channel – Lower Reach, looking downstream from culvert beneath road to caretaker's house.

Photo II-31 Borrow Area A – tension crack monitoring rod location 403.

Photo II-32 Borrow Area A – tension crack on slope at monitoring rod location 403. Crack shows no sign of widening compared to previous inspections.

Photo II-33 Borrow Area A – wet ground in northeast corner. No flowing water was observed.

Photo II-34 Borrow Area A, looking north towards West Leg of Tailings Dam.

Photo II-35 Road ditch above tailings impoundment, looking west.

Photo II-36 Road ditch above tailings impoundment, looking east.

Photo II-37 Ed Creek Diversion Channel, outlet at Pinchi Lake.

Photo II-38 Ed Creek Diversion Channel – Riprap on right bank, showing weathering and breakage

Photo II-39 Ed Creek Diversion Channel, looking upstream from near third bend. Channel base is covered with thick vegetation.

Photo II-40 Ed Creek Diversion Channel, looking towards left bank from near third bend.

Photo II-41 **Ed Creek Diversion Channel – area on right bank where riprap was replaced in 2014. Riprap in this area is in good condition.**

Photo II-42 **Ed Creek Diversion Channel – looking upstream from near second bend towards depression in riprap surface (location 9 in Figure 4.1).**

Photo II-43 **Ed Creek Diversion Channel - Top of right bank where there is a depression in the riprap surface (location 9 in Figure 4.1), and riprap appears to be deteriorating more than other areas.**

Photo II-44 **Ed Creek Diversion Channel – Looking northeast at first bend near the upstream end of the channel.**

Photo II-45 Outlet of 460 mm culvert on north bank of Ed Creek Diversion Channel.

Photo II-46 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-47 **Inlets of Ed Creek culverts under Pinchi Lake Road. Vegetation is not currently blocking the inlet but could become mobilized during flood conditions.**

Photo II-48 **Ed Creek culverts under Pinchi Lake Road, looking at channel upstream of culverts. There is debris in the channel.**

Photo II-49 Outlets of Ed Creek culverts under Pinchi lake Road.

APPENDIX III

August 2017 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: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____ Pond Water Level: _No Standing Water_____

Weather: _Cloudy, 18°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 2015 (but not visible in 2016)
• Embankment cracks on the u/s slope?		X	Covered in tall grass – unlikely to see cracks
• Embankment cracks on the d/s slope?		X	Covered in tall grass – unlikely to see cracks
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	
• 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 2 below
Ponding / Seepage			
• Evidence of water ponding on dam crest?		X	
• Wet areas or seepage on d/s slope or toe of dam?		X	Damp ground near toe of southwest leg, but no free water or seepage observed
• Evidence of water ponding at d/s toe of dam?		X	
• 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 south and southwest legs. Cracks on the south leg were typically 1 to 3 m long and 5 mm wide. Cracks on the southwest leg were up to 7 m long, 20 mm wide, and a tape measure could be pushed in 30 to 35 cm deep. The cracks were often located in or close to tire tracks. Note that similar cracks were observed in these areas in 2015, with similar dimensions. 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. No evidence of recently eroded flow channels. Existing channels are vegetated and unlikely to erode under typical weather conditions.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

CLOSURE SPILLWAY

Date: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 18°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	Difficult to see due to vegetation, but head scarp is visible at close range.
• 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:

No water ponding at spillway entrance, and no sign of flow.

Very small amount of water ponding at the downstream end of the spillway, far below the riprap surface (less water than was observed in 2016). No flow.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

SPILLWAY DOWNSTREAM CHANNEL

Date: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 18°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
Middle Reach*			
• Debris in the channel?			See comments 1 and 2 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. There is excessive vegetation in the channel upstream of the road culvert.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

WEST DITCH

Date: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 18°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:

No water in the channel. Channel is covered with vegetation and is unlikely to erode under typical weather conditions.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ROAD DITCH ABOVE TAILINGS IMPOUNDMENT

Date: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 18°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, small trees
• Debris in the channel?		X	
• Erosion in the channel?		X	
• Beaver activity in the channel?		X	

Additional comments:

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

BORROW AREA A

Date: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 18°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		See comment 2 below
• Wet areas or seepage at toe of borrow pit slope?		X	Slightly damp in a few locations
• 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)	400	401	401	401
103A	428	428	427	428
203	360	360	361	360
403 (east side)	364	365	364	364

Additional comments:

1. Cracks have been observed on the borrow pit slope since 2013. The cracks were difficult to see because of vegetation, and were most clearly visible near measurement location 403.
2. A wet area was observed in the northeast corner of the borrow pit (likely at seepage point 1000 or 1003 as marked in 2012, but stake is no longer there so can't be sure which one). The greater quantity of vegetation immediately downslope suggests this area is typically wetter than the surrounding ground.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ED CREEK DIVERSION CHANNEL

Date: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 18°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
Vegetation Growth and Debris			
• Excessive tree or shrub growth along the channel?	X		See comment 1 below
• Debris in the channel?		X	
Riprap			
• Displaced or broken down riprap in channel bottom?	X		See comment 2 below
• Displaced or broken down riprap along the right bank?	X		See comment 2 below
• Displaced or broken down riprap along the left bank?	X		See comment 2 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. Vegetation in the channel was excessive in 2016 also, and there is a standing recommendation from the 2016 DSI report to clear the vegetation.
2. 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: _August 29, 2017_____ Inspected By: _B. Chambers, D. Klassen_____

Time: _____

Weather: _Cloudy, 18°C_____

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

Give approx. water depth in channel at culvert inlet: __5___ 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	
• Beaver activity in Ed Creek u/s or d/s of culvert?		X	

Additional comments:

Minor flow in the east culvert only

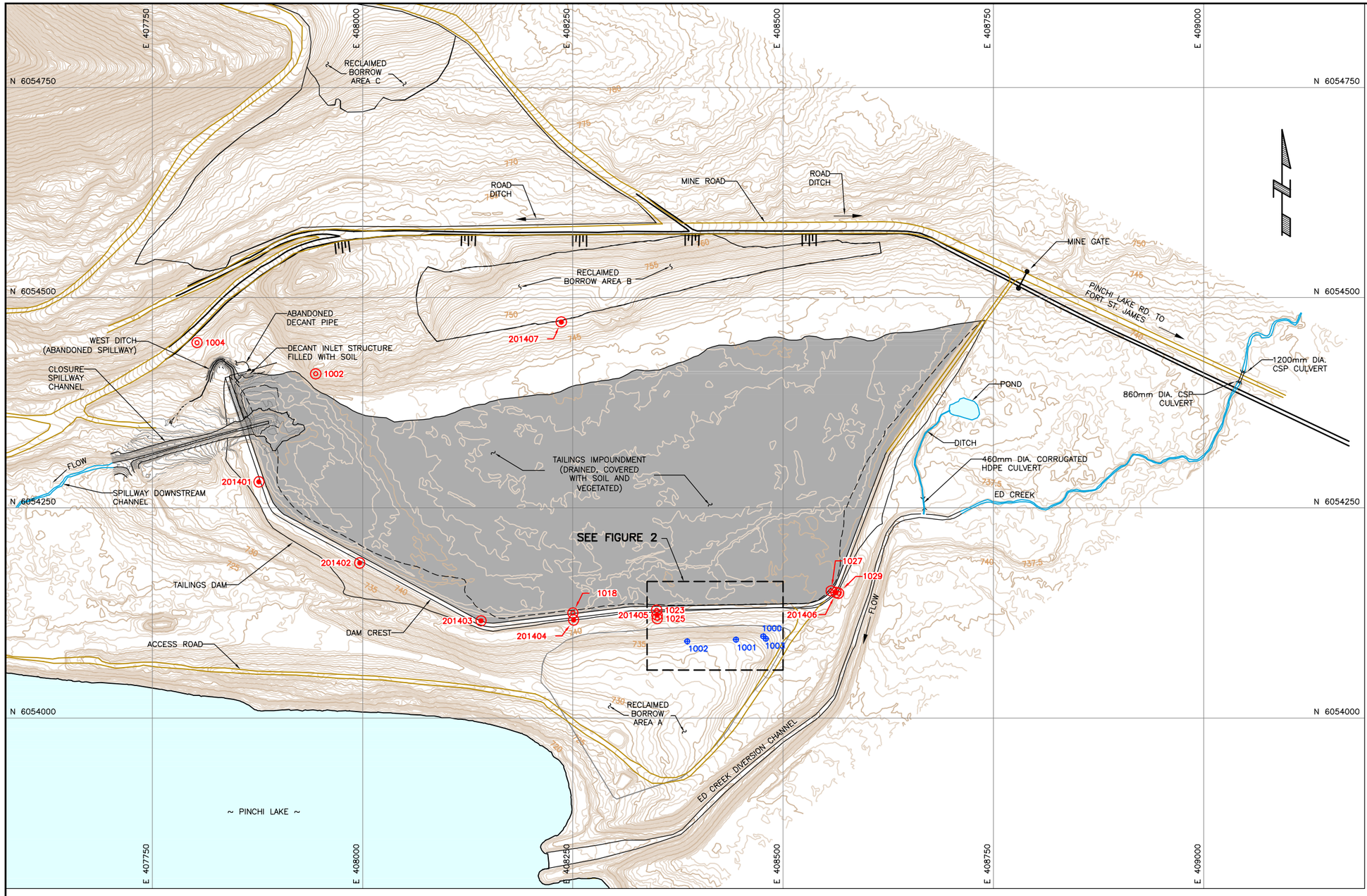
APPENDIX IV

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

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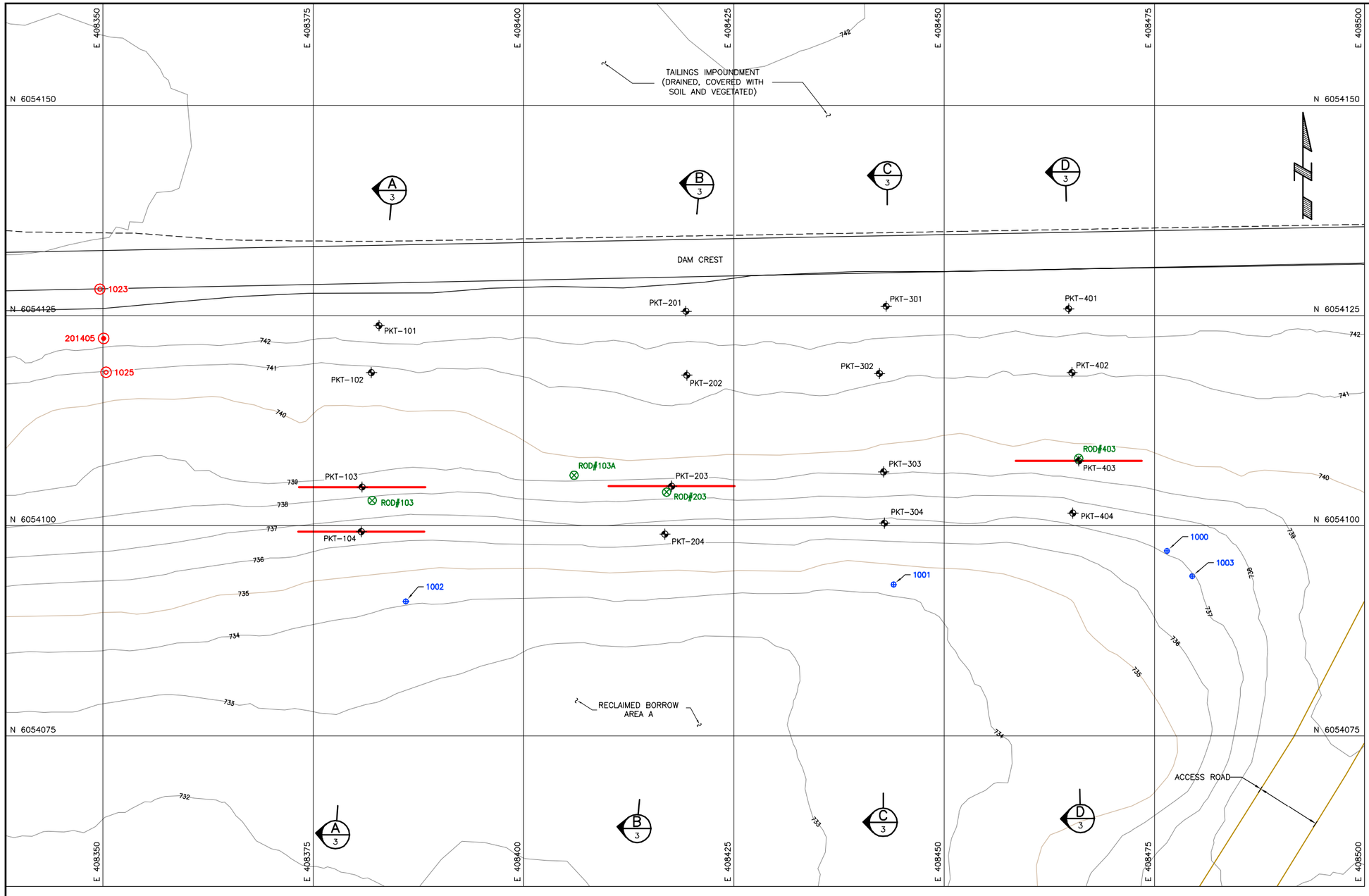

PLAN
(FOR LOCATION SEE FIG. 1)

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
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Drawing File: Z:\M\VCR\M07728A31-TML-Pinchi Lake 2016 Services\400 Drawings\TSF\Fig1-2-3 _ Location-Plan-Sections.dwg (perseym)
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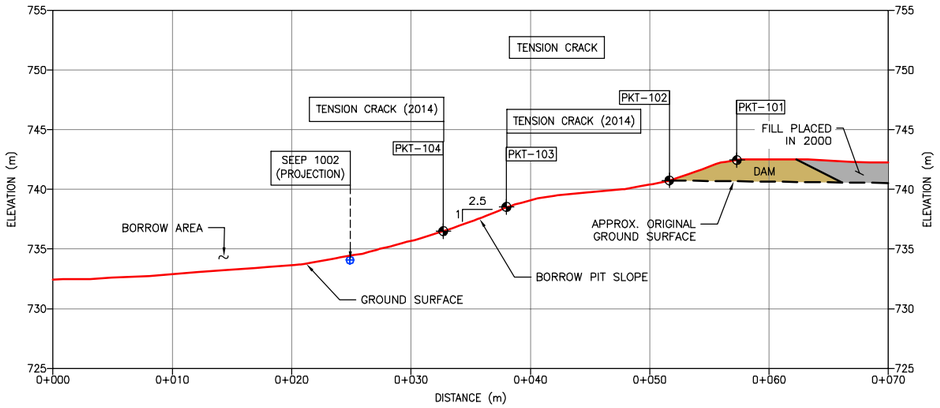
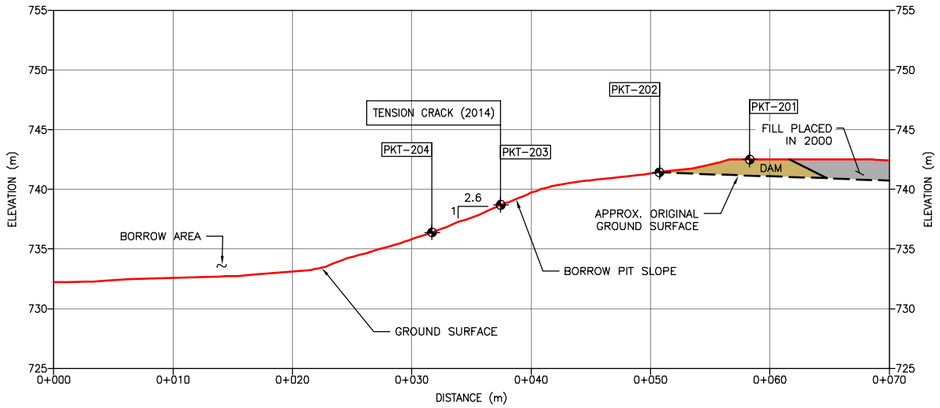
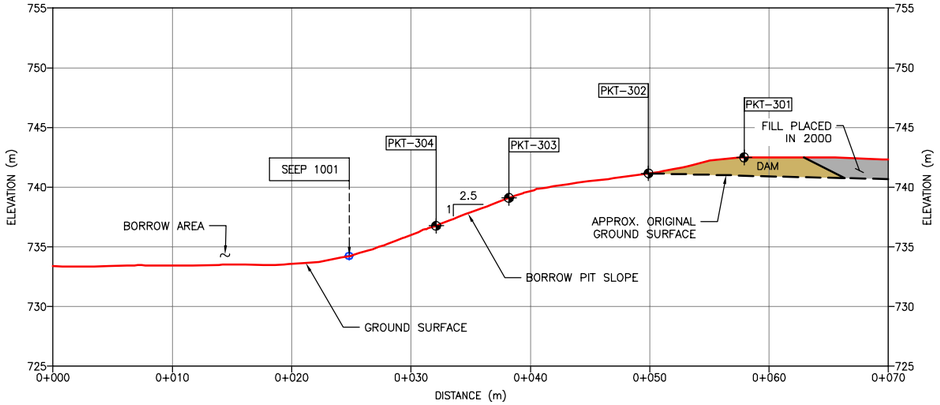


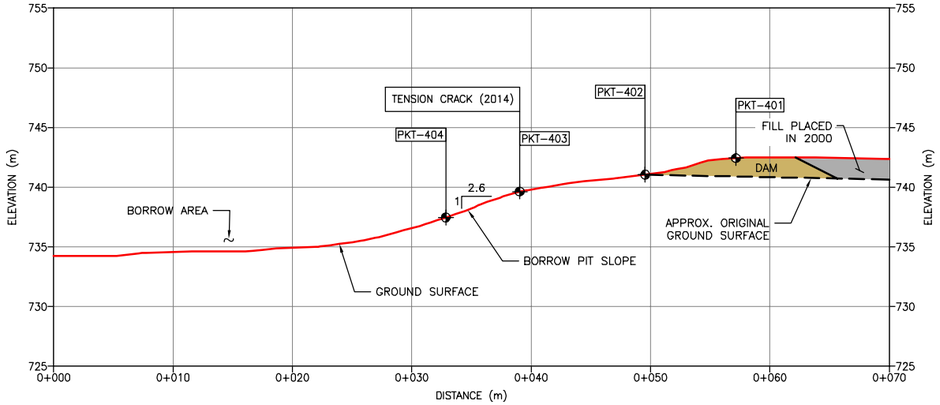
SECTION A 2



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

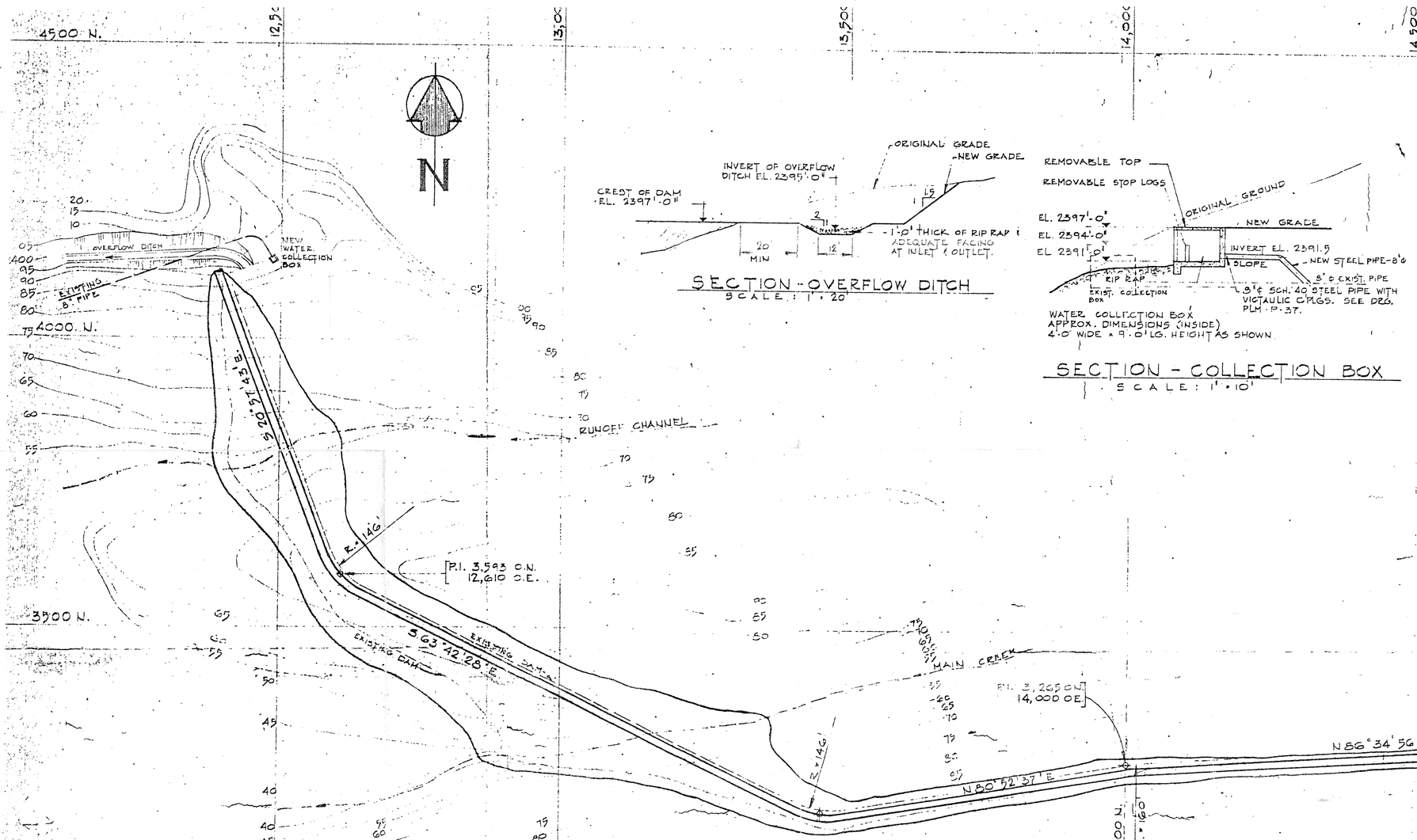
Time: 15:39:31
Date: 10/3/2016
Scale: 1:2.5849(PS)
Drawing File: Z:\VA\VCR\M07728A31-TML-Pinchi Lake 2016 Services\400 Drawings\TSF\Fig1-2-3 - Location-Plan-Sections.dwg (persyem)
Xref File(s): BM-Pinchi-10July13_ACAD-Pinchi_Lake_407700E_6053000N.r12
Image File(s):

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

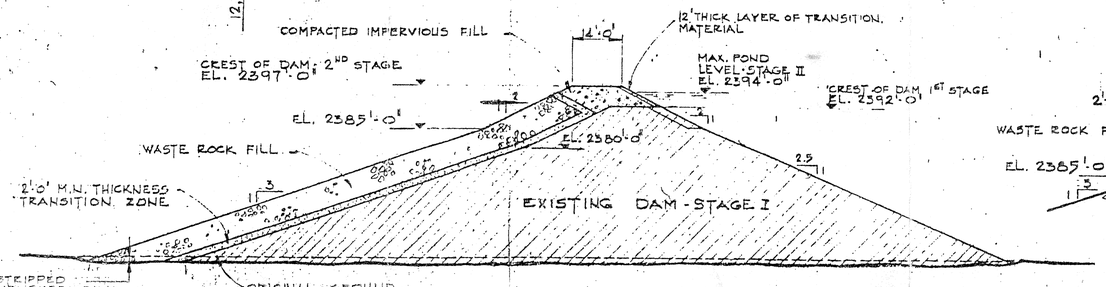
SCALE: 1" = 100'

SECTION - OVERFLOW DITCH

SCALE: 1" = 20'

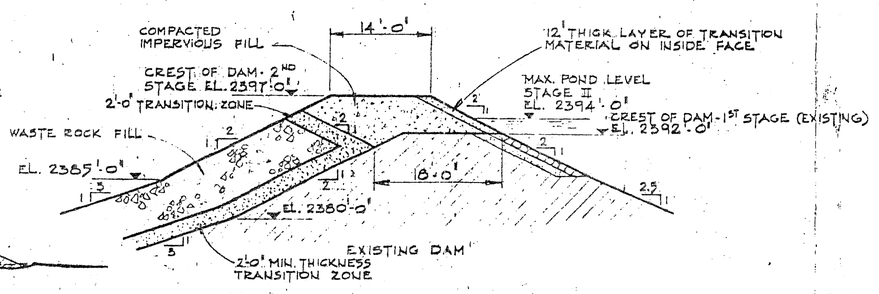
SECTION - COLLECTION BOX

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

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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

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Dec. 19/16

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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

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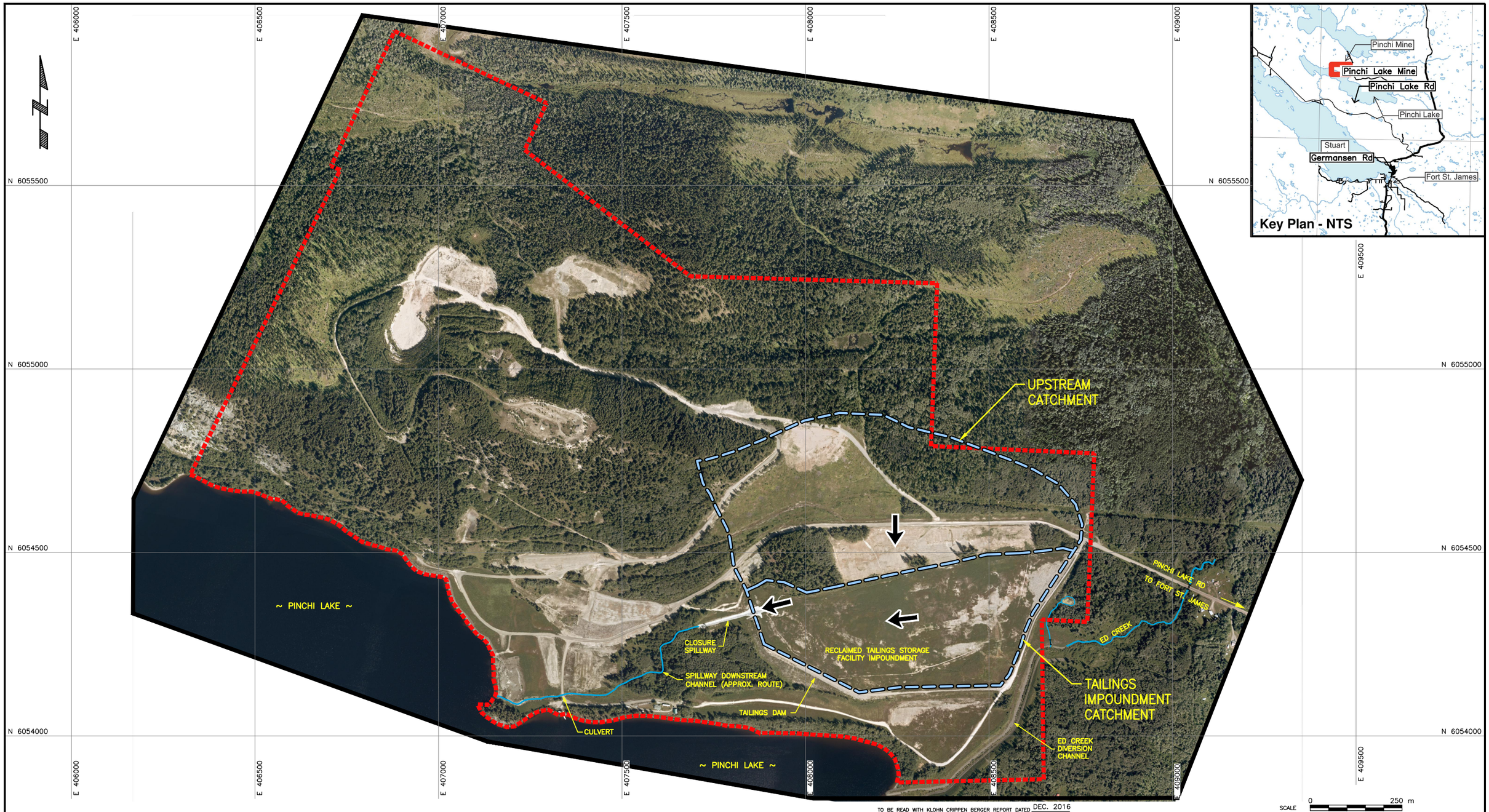
Klohn Crippen Berger (KCB). 2009b. "Pinchi Lake Mine Tailings Facility – Closure Spillway Design", July 3.

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

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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.

I-1 PIEZOMETERS

The threshold levels established for piezometers are based on stability analysis and are summarized in Table 1.1. Threshold level exceedances will be reviewed by the Engineer of Record, and further action will be advised based on subsequent engineering analysis.

Table 1.1 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

I-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; and
- 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.