Klohn Crippen Berger

Teck Metals Ltd.

Pinchi Lake Mine Tailings Storage Facility

2021 Annual Facility Performance Review

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October 2021

Klohn Crippen Berger

October 20, 2021

Teck Metals Ltd.
Kimberley Operations
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Kimberley, British Columbia
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Ms. Michelle Unger
Mine Manager

Dear Ms. Unger:

Pinchi Mine Lake Tailings Storage Facility
2021 Annual Facility Performance Review

We are pleased to submit the 2021 Annual Facility Performance Review of 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

PT/DK:jc

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Teck Metals Ltd.

Pinchi Lake Mine Tailings Storage Facility

2021 Annual Facility Performance Review

EXECUTIVE SUMMARY

This report presents the 2021 Annual Facility Performance Review for Teck Metals Ltd.'s (Teck) Pinchi Lake Mine Tailings Storage Facility (TSF) by Klohn Crippen Berger Ltd. (KCB). This report was prepared to fulfill the requirements of a Dam Safety Inspection (DSI) in the Health, Safety and Reclamation Code for Mines in British Columbia (HSRC) (MEM 2016, EMLI 2021). It is also an essential document per the Global Industry Standard on Tailings Management (GISTM) which was released in August 2020. The annual inspection of the TSF facilities was conducted in June 2021 by the Engineer of Record, Daniel Klassen, of KCB. Routine inspections were carried out in November 2020 and May 2021 by the Site Surveillance Officer, Mark Pokorski, of EcoFor.

This summary section is provided in accordance with the HSRC, and Teck's "Guideline for Tailings and Water Retaining Structures" (Teck 2019).

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 embankment: 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

KCB understands that Teck's long-term goal for all tailings facilities, where physically possible, is to reach landform status with all potential failure modes that could result in catastrophic release of tailings and/or water being reduced to non-credible. The long-term goal for the Pinchi TSF is to reduce the risk of all potential catastrophic failure modes to be non-credible based on Extreme consequence loading conditions. Evaluation of failure modes with respect to this goal is ongoing.

Key observations related to the potential hazards associated with the TSF are summarized as follows:

Earthquakes: The TSF is located in a region of low seismicity, with a peak ground acceleration of 0.04 g for the 2500-yr earthquake. There is lacustrine clay in the foundation of the TSF embankment that may be susceptible to cyclic softening if there was sufficient earthquake loading. Simplified deformation and post-earthquake stability analyses were performed and show that the TSF meets CDA guidelines for seismic stability (CDA 2014) and that the predicted seismic deformation is 10 cm, which indicates that the embankment and the overall TSF are expected to perform well under seismic loading (KCB 2017b). **Summary – no present concern and no long-term concern indicated.**

Surface Erosion: Ed Creek Diversion Channel was designed to convey the 1000-year flood event without erosion damage, but gradual weathering and breakage of the riprap has reduced its capacity. A portion of the channel is approximately 10 m from the TSF Embankment, and damage to the riprap during an extreme flood event could initiate gradual erosion of the channel towards the embankment. This is addressed through surveillance and maintenance, and erosion would not be allowed to progress to the point where it could undermine the toe of the embankment. Options for remediating the channel are also being investigated, including replacing the riprap and possibly realigning the channel away from the TSF. **Summary – no present concern; further evaluation recommended to address possible concerns over the long term.**

Potential Consequence of Failure

The CDA Dam Safety Guidelines provide a dam classification scheme based on the potential consequences of a hypothetical failure that can be used to provide guidance on the standard of care expected of dam owners and designers. Consequence of a hypothetical failure is not related to the likelihood of a failure, but rather the potential impact resulting from a failure if it did occur. The downstream potential consequence of the TSF was reviewed in 2012 after the completion of the reclamation/closure works, and based on the CDA (2007) scheme the TSF was noted to have a **Significant** potential consequence. 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 TSF's potential consequence.

Summary of Key Observations and Significant Changes

There has been no construction or any other significant changes to the TSF or associated water management infrastructure since the 2010/2011 closure works were completed.

There are six vibrating wire piezometers at three locations around the embankment 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 piezometer readings in 2021, and the quantifiable performance objectives (QPOs) were met. Piezometer readings show seasonal fluctuations between spring and summer/fall. Survey monuments were last read in December 2016, and the readings were below the alert criteria and did not show ongoing movements. There is normally no storage of water in the TSF and no instrumentation for water level or flow monitoring.

Overall, the TSF Embankment is in good condition with no significant changes observed, which indicates no changes to stability. A stability assessment of the TSF was performed in 2017, which concluded that the facility meets industry standard static and seismic stability design criteria (KCB 2017b).

A small beaver dam was observed downstream of the TSF Embankment east leg in a local drainage channel. This is not a safety concern for the TSF, but the beaver dam should be removed to discourage beaver activity in the area.

OMS Manual and EPRP

The OMS Manual and the Emergency Preparedness and Response Plan (EPRP) for the Pinchi Lake Mine TSF were revised in 2019 (KCB 2019b), and the EPRP was included as an appendix of the EPRP at

that time. Subsequently, the EPRP for the TSF was incorporated into the site-wide Mine Emergency Response Plan (Teck 2020). An update to the OMS Manual is in progress to remove the superseded EPRP and prevent duplication in the documentation of emergency response for the TSF.

Dam Safety Review

A Dam Safety Review (DSR) of the Pinchi Lake Mine TSF and associated water infrastructure was performed by SRK in 2018 (SRK 2020). There was appropriate engagement and input from the Engineer of Record. The report is being finalized. The HSRC (MEM 2016, EMLI 2021) 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 not later than 2023.

Summary of Recommendations

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

Priority 1	A high probability or actual TSF 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 TSF 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 TSF 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 TSF safety issue and are therefore considered “best practice” issues rather than urgent, TSF safety items.

Summary of Deficiencies and Recommendations

Structure	ID No.	Deficiency or Non Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Previous Recommendations Ongoing						
Ed Creek Diversion Channel	2019-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering.	OMS Manual	An options assessment and conceptual design should be completed for upgrading the channel to meet erosion protection requirements. Since failure of the riprap would not immediately affect the embankment, the risk to the embankment in the interim is effectively managed through inspections and maintenance as per the OMS Manual, and there is no immediate concern for embankment safety.	3	CLOSED - Initial options assessment complete.
TSF	2020-01	The TSF breach assessment performed in 2012 did not assess the credibility of the failure modes considered.	HSRC	A failure modes evaluation should be completed to determine whether there are any credible failure modes, and if so, would they result in uncontrolled release of tailings and water.	3	End of 2021. In progress.
Ed Creek Diversion Channel	2020-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering	OMS Manual	Select one or two preferred options for upgrading/replacing the existing Ed Creek Diversion Channel that will be advanced to a feasibility level design.	3	Q3 2022. In progress – additional options are being considered prior to feasibility design.
TSF	2020-03	The OMS Manual includes a superseded version of the EPRP as an appendix.	HSRC	The OMS Manual should be updated to reference the Mine Emergency Response Plan.	3	End of 2021. In progress.
2021 Recommendations						
TSF	2021-01	A small beaver dam (0.8 m high) was observed in the ditch that runs parallel to the toe of the east leg of the TSF Embankment.	OMS Manual	Remove beaver dam from the toe of the east leg of the TSF Embankment to discourage beaver activity in the area.	4	End of 2022
TSF	2021-02	Some survey monuments appear to have been removed.	OMS Manual	Check the condition of the survey monuments to confirm which ones are still active. Confirm need for continued monitoring.	4	End of 2022

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CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Teck Metals Ltd. (Client) for the specific application to the 2021 Annual Facility Performance Review, and it may not be relied upon by any other party without KCB's written consent.

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2. The Executive Summary is a selection of key elements of the report. It does not include details needed for the proper application of the findings and recommendations in the report.
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5. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

1 INTRODUCTION

1.1 Purpose, Scope of Work and Methodology

This report presents the 2021 Annual Facility Performance Review (AFPR) for Teck Metals Ltd.'s Pinchi Lake Mine Tailings Storage Facility (TSF) by Klohn Crippen Berger Ltd. (KCB). This report was prepared to fulfill the requirements of a Dam Safety Inspection (DSI) in the Health, Safety and Reclamation Code for Mines in British Columbia (HSRC) (MEM 2016, EMLI 2021). It is also an essential document per the Global Industry Standard on Tailings Management (GISTM) which was released in August 2020. The following activities were undertaken by KCB:

- Site inspections by Mr. Daniel Klassen, P.Eng. (the Engineer of Record) and Mr. Paul Takayesu, E.I.T. on June 15, 2021.
- Review and update of the list of outstanding recommendations from the previous annual performance reports.
- Review instrumentation and confirm that readings are within acceptable limits.

KCB was accompanied by Mr. Jason McBain, P.Eng. (Teck), Mr. Mark Pokorski, R.P.Bio. (Ecofor Consulting Ltd.) and Ms. Maria Case (Ecofor Consulting Ltd.). Mr. Pokorski conducted the spring inspection of the TSF and associated facilities. Ms. Case is training to provide backup to Mr. Pokorski.

The inspection was conducted and this report prepared in accordance with the Teck Guideline for Tailings and Water Retaining Structures (Teck 2019).

The AFPR is issued before the end of the calendar year, so the period considered for climate data and instrumentation is from September 2020 to August 2021.

1.2 Regulatory Requirements

This inspection report addresses the performance of the TSF and associated water management infrastructure in accordance with the HSRC and the Permit Amendment Approving Closure Plan (Permit No. M-5) dated July 12, 2010.

1.3 Roles and Responsibilities

The HSRC describes and defines responsibilities for several key roles for a TSF (MEM 2016). For Pinchi TSF the following personnel fill these roles:

- Mine Manager: Ms. Michelle Unger of Teck;
- Responsible Tailings Facility Engineer (RTFE) (equivalent to the TSF Qualified Person role defined in the HSRC): Mr. Jason McBain, P.Eng., of Teck; and
- Engineer of Record (EOR): Mr. Daniel Klassen, P.Eng., of KCB assumed the EOR role on March 1, 2021. The previous EOR, Mr. Bob Chambers, P.Eng., also of KCB, continues to be involved on the project.

1.4 Facility Description

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

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

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

The Pinchi Lake Mine TSF was constructed in 1967 and utilized between 1967 and 1975. The TSF is a side-hill impoundment covering approximately 24 ha and contained on three sides by an embankment. Approximately one million cubic metres of tailings are stored in the TSF. The TSF Embankment is approximately 1300 m long, and 3 m to 15 m high. The original embankment was designed and constructed in the late 1960s, and was raised in 1975 as shown in the historical drawing presented in Appendix IV. The embankment was originally a homogeneous embankment 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 embankment 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 IV (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 TSF Embankment as shown in the drawing in Appendix IV. The decant box and the Emergency 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 that summarizes key information 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 design/construction chronology was as follows:

- 1967 engineering of the facility (Stage 1) by Ripley, Klohn and Leonoff;
- 1967 construction with inspection by Kootenay Engineering and Tara Engineering Laboratories conducting 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 embankment raise (Stage 2);
- 1975 letter by Golder Associates approving design drawings for a reduced embankment 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 TSF Embankment for use as cover material for the tailings; and
- constructed the TSF Closure Spillway.

In addition to trimming the TSF embankment 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 Area A is located downstream of the south leg of the TSF Embankment; and, Borrow Areas B and C are located upstream of the TSF.

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 – FALL 2020 TO SUMMER 2021

The TSF is a closed facility and does not require operational intervention. Scheduled and event driven inspections and maintenance work are 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 (KCB 2019b).

The Site Surveillance Officer, Mr. Mark Pokorski, carries out inspections of the facility twice per year: one in the spring after freshet, and one in the fall. The 2020 fall inspection was carried out on November 9, 2020, and the 2021 spring inspection was carried out on May 26, 2021. These inspections did not identify any TSF safety issues.

An annual inspection of the TSF is conducted by the Engineer of Record; this inspection occurred on June 15, 2021.

Apart from these routine inspections, there were no other site activities over the last year.

3 CLIMATE DATA AND WATER BALANCE DURING 2021

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 compares the recorded monthly temperatures and precipitation from Sep. 1, 2020 to Aug. 31, 2021 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 not available at this or any other nearby stations with recent data. Daily average temperatures during the reporting period were generally higher than average conditions (by about 2°C), and precipitation was generally lower than normal, apart from an unusually wet month in October 2020.

Table 3.1 Fort St. James (No. 1092975) Temperatures and Precipitation – September 2020 to August 2021 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
September 2020 – August 2021													
Temperature													
Daily Average (°C)	12.1	3.1	-0.9	-2.3	-4.6	-9.6	1.3	4.6	9.5	16.1	17.8	16.6	5
Daily Maximum (°C)	17.5	7.1	2.5	0.7	-0.8	-4.7	6.2	10.2	15.3	22.3	24.0	22.3	10
Daily Minimum (°C)	6.8	-1.0	-4.3	-5.4	-8.4	-14.4	-3.6	-1.1	3.8	9.9	11.5	10.9	0
Precipitation													
Rainfall (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Snowfall (cm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Precipitation (mm)	0.8	72.6	39.8	12.7	17.8	18.2	7.4	12.8	46.2	23.0	33.5	19.6	305
No. of days of missing data	1	0	0	1	0	0	0	0	0	0	0	2	4

3.2 Water Balance

The HSRC (MEM 2016, EMLI 2021) calls for a water balance review in the annual inspection report. 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 water ponding behind the spillway, except in small local depressions in the tailings cover. Because inflow to the impoundment is limited to direct precipitation and stormwater runoff from small catchments upslope of the TSF, an annual water balance review is deemed to be unnecessary. However, a water balance was prepared in 2019 based on average precipitation from 1998 to 2017 at Fort St. James (Environment Canada climate station no. 1092970). The water balance is included in Appendix V; the average discharge through the spillway was estimated to be 0.5 L/s.

3.3 Water Quality

The surface water quality discharging from the TSF is monitored annually under effluent permit PE-224. The groundwater quality at Pinchi Lake Mine is monitored under the Contaminated Sites Regulation (B.C. Reg. 375/96). Both surface and groundwater quality are reported by Teck to B.C. Ministry of Environment and B.C. Ministry of Energy, Mines & Petroleum Resources.

4 SITE OBSERVATIONS – JUNE 2021

4.1 Visual Inspection

The following areas were inspected during the June 15, 2021 site visit:

- Tailings Storage Facility:
  - Tailings Impoundment (drained and covered with soil);
  - TSF Embankment; and
  - Closure Spillway.
- Borrow Area A Slope;
- Ed Creek:
  - Ed Creek Diversion Channel; and
  - Ed Creek culverts under Pinchi Lake Road.

Weather during the site visit was partly cloudy with sun and about 18°C. Rain was observed in Fort St. James in the morning on the day of the site visit. Site observations and recommendations are presented in the following sub-sections and observation locations are identified in Figure 4.1. Selected photographs taken during the inspection are presented in Appendix II, and inspection forms are presented in Appendix III.

4.1.1 Tailings Storage Facility

Tailings Impoundment

- There was minimal flowing or standing water in the Tailings Impoundment at the time of inspection, apart from a small pond on the south side of the Closure Spillway (about 1 m wide).
- The soil cover on the tailings is covered in grass (Photos II-5 and II-7 in Appendix II). A detailed inspection of the cover was not conducted but observations from the embankment crest did not identify any signs of erosion, large ponds, or deformation of the cover.
- In 2014, Teck placed riprap at a location on the cover where flow was observed entering the Closure Spillway (Location 2 in Figure 4.1; Photos II-16 to II-17). The riprap appears to be performing well.

TSF Embankment

- The embankment crest, and upstream and downstream slopes of the TSF Embankment appeared to be in good condition.
- No cracks were observed on the embankment crest. Longitudinal cracks were previously observed on the crest of the southwest leg of the TSF Embankment in 2015, 2017, 2018, and 2019, but these were not visible at the time of the inspection. The cracks are likely surficial

features related to drying of the embankment crest surface and are not a TSF safety concern. As noted above, rain was observed in Fort St. James in the morning on the day of the site inspection; thus, the surface of the embankment crest was likely moist and this may be why the cracks were not observed.

- The embankment slopes were covered with grasses and small shrubs. Some bushes have regrown on the east leg downstream slope since this area was cleared in fall 2019, and are exceeding 1.5 m height in some areas (see Photo II-1 and Photo II-13). This does not present an immediate concern for embankment safety, but note that the vegetation management plan recommends clearing vegetation greater than 1.5 m height from the embankment slopes (Spectrum 2017).
- A pond was observed in the trees near the toe of the east leg of the TSF Embankment (see Figure 1.2 for location; Photo II-2) as in previous inspections. This pond is located near a drainage channel that was shown on historical drawings of the TSF (see Appendix IV) and labelled "runoff channel." The channel ran parallel to the main Ed Creek channel, and apparently once joined up with Ed Creek just inside the TSF. The pond appears to collect local runoff, and it drains through a channel to the south and through a culvert into Ed Creek Diversion Channel. The pond level was slightly higher than in previous inspections due to the beaver dam noted below.
- A small beaver dam (0.8 m high) was observed in the channel south of the pond described above (Location 7, Photo II-47). Although this beaver dam is not currently an embankment safety issue, it is prudent to remove it to discourage beaver activity in the area.

Recommendation/Action:

Remove beaver dam from the toe of the east leg of the TSF Embankment.

- Apart from the pond noted above, the ground at the downstream toe of the embankment was dry and no ponded water or seepage were observed.

Closure Spillway

- There was no flow or standing water in the Closure Spillway channel; there was a 28 cm deep pond at the downstream end of the riprap (Photo II-24).
- The riprap along the entire Closure Spillway channel appeared to be in good condition (Photos II-16 to II-22, and II-24). The spillway has likely not experienced any high flood discharges since it was constructed. Vegetation growth in the channel was minimal, with only a few small shrubs (Photo II-22).
- A small slump in the slope above the riprap on the right (north) side of the spillway channel has been noted in inspections since 2014 (Location 1 in Figure 4.1). The slump area was covered in grass and the head scarp was only visible at close range (Photo II-23). The upstream side of the slump is about 90 m downstream of the embankment centreline. The condition of the slump has not noticeably changed in the last seven years, and it is not expected to impact the TSF Embankment or the performance of the Closure Spillway.

- The Outlet Channel was observed at the culvert crossing on the road adjacent to the Emergency Spills Lagoon (Photos II-25 to II-28). The middle reach upstream of the culvert appeared to be in good condition. There was grass growing in front of the culvert inlet, partially blocking it. There was some flow into the culvert and was measured at 5 cm above the invert (Photo II-26). The outlet of the culvert was mostly clear of vegetation (with no immediate obstructions), but there was water ponding locally at the outlet to 19 cm above the invert (Photo II-27). The culvert is not related to TSF safety but clearing of the inlet may be prudent to restore its normal flow capacity. The lower reach of the Outlet Channel appeared to be in good condition, although there were some larger bushes growing that were about 1.5 m high (Photo II-28).

4.1.2 Borrow Area A Slope

- Borrow Area A is located near the south leg of the TSF Embankment. The slope, which is about 10 m downstream of the toe, appeared to be in good condition (Photos II-29, II-31 and II-33).
- Cracks were observed on the slope from 2013 to 2017 (Location 3 in Figure 4.1) and 2020 (Location 4 in Figure 4.1). Measurements of crack movements were taken from 2015 to 2018 using metal rods installed on either side of the cracks (Photo II-30), but these measurements showed no ongoing movements and were discontinued in 2019. The cracks are no longer visible due to vegetation growth, and are not a TSF safety concern. Nevertheless, this area will continue to be monitored during routine inspections as per the OMS Manual.
- A few small areas of wet ground and ponding were observed starting in the northeast corner of the borrow area and moving slightly downhill to the west along the toe of the slope for 150 m (Location 5 in Figure 4.1; Photo II-32). The largest pond was about 0.5 m wide and a few centimetres deep. Similar wet areas have been observed since 2011, and they are believed to be associated with groundwater unrelated to the TSF. Outside of these wet areas, the ground on the slope and along the toe was dry.

4.1.3 Ed Creek

Ed Creek Diversion Channel

- Vegetation growth at the base of Ed Creek Diversion Channel is over 2 m high in some areas (Photos II-34, and II-36 to II-43). This is not currently considered to be a TSF safety concern. However, the vegetation management plan recommends vegetation clearing prior to vegetation exceeding 1.5 m in height (Spectrum 2017).
- Previous annual performance reports have noted that the riprap along some areas of the Ed Creek Diversion Channel is weathering and breaking up (Photo II-35). The condition of the riprap appeared similar to previous inspections. Degradation of the riprap is discussed further in Section 5.5.
- The riprap along a small section of the channel (Location 6 in Figure 4.1; Photo II-39), where a depression had formed in the riprap surface, was replaced in 2014. This riprap appeared to be in good condition.

- The 460 mm diameter HDPE culvert on the north bank of the Ed Creek Diversion Channel had some minor vegetation growing in front of the inlet (see Figure 1.2 for culvert location, and Photos II-44 and II-45). This is not a TSF safety concern. The culvert was flowing with a depth of 3 cm above the invert.

Ed Creek Culverts Under Pinchi Lake Road

- There are two culverts on Ed Creek under Pinchi Lake Road approximately 300 m east of the mine gate (see Figure 1.2 for location and refer to Photos II-48 to II-51). Flow was observed in both culverts, with a water depth of 110 mm at the east culvert inlet and a water depth of 70 mm at the west culvert inlet.
- There was no vegetation in front of the culvert inlets. However, there was a small log partially blocking a portion of the west culvert (Photo II-49), which is not an immediate concern.

4.2 Instrumentation Review

4.2.1 TSF Embankment Instrumentation

There are six vibrating wire piezometers at three locations around the embankment (four piezometers at the toe, two at the crest) as shown in Figure 1.2; these piezometers are read twice per year at minimum. Quantifiable Performance Objectives (QPOs) for the piezometers are defined as threshold piezometric elevations, and these are given in Appendix VI.

Piezometer readings taken in fall 2020 and spring 2021 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 embankment, and 10 m below the crest at the highest embankment section. Piezometer readings are shown as elevations versus time in Figure 4.2. The readings in the piezometers at the embankment toe (DH16-01-VWP1,2 and DH16-03-VWP1,2) show seasonal fluctuations up to 2 m, with higher readings in the spring and lower readings in the fall. The piezometers installed below the embankment crest (DH16-02-VWP1,2) have shown less variation in the readings after an initial period of stabilization following installation. The piezometers at the toe of the west leg (DH16-01-VWP1,2) showed an upward gradient of up to 0.1, while the other piezometers showed negligible gradients.

Table 4.1 Fall 2020 and Spring 2021 Piezometer Readings

Piezometer ID	Piezometric Elevation (m)			Depth Below Ground (m)	
	Threshold Value	Nov. 9, 2020	May 6, 2021	Nov. 9, 2020	May 6, 2021
DH16-01-VWP1	736.1	734.4	735.1	1.7	1.0
DH16-01-VWP2	736.1	733.9	734.3	2.2	1.8
DH16-02-VWP1	738.5	732.4	732.8	9.6	9.2
DH16-02-VWP2	738.5	732.7	733.0	9.3	9.0
DH16-03-VWP1	737.0	735.2	735.4	2.7	2.5
DH16-03-VWP2	737.0	735.1	735.3	2.8	2.6

Prior to the 2010/2011 closure works, a piezometer located 10 m from DH16-02-VWP1,2 showed typical readings of around El. 733.5 m, which is 0.5 m higher than the May 6, 2021 reading. This suggests the piezometric levels in the embankment have gone down compared to the condition before the pond was drained.

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 from the decant system was measured. Water is now released through the Closure Spillway but, given that the spillway channel is lined with large riprap, most of the low flows pass through the riprap, making it difficult to measure flow.

4.2.3 Survey Monuments

Survey monuments were installed on the TSF Embankment crest in 1998; however, some monuments were destroyed over the years. New survey monuments 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 VI.

Readings were last taken in December 2016, and the readings met the QPOs and did not show ongoing movements (KCB 2017a). The survey monuments are to be read every ten years, so the next readings will be in 2026.

During the 2021 inspection, the condition of survey monument 1025 was investigated by following a handheld GPS to its last known coordinates. At the approximate location, a hole filled with gravel was discovered at the toe of the south leg of the embankment. This is similar to a hole that was discovered in 2018 at the approximate location of survey monument 1018 (KCB 2019a), that was considered a safety hazard and later filled with gravel by the Site Surveillance Officer. Both of these monuments were surveyed in 2016, so it's not clear why they were subsequently removed or by whom.

Recommendation/Action:

Check the condition of the survey monuments to confirm which ones are still active.

5 TSF SAFETY ASSESSMENT

5.1 Design Basis Review

The relevant design criteria from CDA (2014) and HSRC (MEM 2016, EMLI 2021) 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. Teck is also evaluating the facility against more conservative design criteria, as described in Section 5.3.

Table 5.1 Comparison of CDA and HSRC Design Criteria for TSFs with Significant Potential Consequence

Parameter	CDA (2014)		HSRC (MEM 2016, EMLI 2021)
	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 performed by SRK in 2018. There was appropriate engagement and input from the Engineer of Record. The report is being finalized.

The HSRC (MEM 2016, EMLI 2021) 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 no later than 2023.

5.3 Failure Modes Review

KCB understands that Teck's long-term goal for all tailings facilities, where physically possible, is to reach landform status with all potential failure modes that could result in catastrophic release of tailings and/or water being reduced to non-credible. The long-term goal for the Pinchi TSF is to reduce the risk of all potential catastrophic failure modes to be non-credible based on Extreme consequence loading conditions. Evaluation of failure modes with respect to this goal is ongoing.

A summary of the current conditions is provided below to describe the safeguards that are in place and the justification that these failure modes are well-managed for the Pinchi TSF.

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

- **Overtopping:** There is no permanent pond in the TSF, and the Closure Spillway is designed to convey flood flows passively without developing a large pond in the TSF. A hydrotechnical review of the Closure Spillway found that the freeboard in the TSF during the 1/3 between 1000-year and PMF event is over 4 m (KCB 2019c). The spillway and freeboard are effective controls to manage overtopping risks.
- **Internal Erosion and Piping:** The embankment 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 2015b). However, the observed performance of the embankment, 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 embankment 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 embankment have reduced, and this is reflected in lower piezometer readings in the embankment compared to the pre-2010 readings, as discussed in Section 4.2.1. Checking the embankment toe for seepage is included in the scheduled surveillance in the OMS Manual (KCB 2019b).
- **Slope Instability:** A stability assessment of the TSF was completed in 2017 (KCB 2017b) 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 embankment is generally more favourable for stability now than it was during operations due to the draining of the pond and trimming of the embankment crest in some areas. Survey monuments on the embankment crest have not shown ongoing movements (Section 4.2.3).
- **Foundation Irregularities:** A drilling and laboratory testing program was carried out in 2016 to confirm whether silt or clay soils are present beneath the embankment and to characterize their geotechnical properties (KCB 2017c). The investigation identified lacustrine clay below the west leg and the east leg of the embankment, but the drill hole at the southwest leg of the embankment, where the embankment is highest, did not encounter lacustrine clay. The Borrow Area A slope has exposed foundation soils near the south leg of the embankment 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 stability criteria were met.
- **Surface Erosion:** There are no significant erosion features on the crest or slopes of the embankment. Surface runoff from the impoundment drains towards the closure spillway and will not erode the embankment surface. The embankment surface is vegetated and well protected against surface erosion. The downstream slope of the embankment includes coarse

rockfill, so any erosion channels that form would be self-armouring and unlikely to rapidly erode through the embankment.

Ed Creek Diversion Channel was designed to convey the 1000-year flood event without erosion damage, but gradual weathering and breakage of the riprap has reduced its capacity. A portion of the channel is approximately 10 m from the TSF Embankment, and damage to the riprap during an extreme flood event could initiate gradual erosion of the channel towards the embankment. This is addressed through surveillance and maintenance, and erosion would not be allowed to progress to the point where it could undermine the toe of the embankment. Options for remediating the channel are also being investigated, including replacing the riprap and possibly realigning the channel away from the TSF.

- **Earthquakes:** The TSF is located in a region of low seismic activity, and the estimated seismic ground motions are small, with a peak ground acceleration (PGA) of 0.04 g for the 1/2500 AEP earthquake event for Site Class B/C (KCB 2020b). A simplified deformation analysis was performed as part of the stability assessment (KCB 2017b) using the Hynes-Griffin and Franklin (1984) method, and the predicted deformation was 10 cm, which indicates that the embankment and the overall TSF are expected to perform well under seismic loading. 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.

5.4 Potential Consequence of Failure

The CDA Dam Safety Guidelines (CDA 2007, 2013) provide a dam classification scheme based on the potential consequences of a hypothetical failure that can be used to provide guidance on the standard of care expected of dam owners and designers. Consequence of a hypothetical failure is not related to the likelihood of a failure, but rather the potential impact resulting from a failure if it did occur. The downstream potential consequence of the TSF was reviewed in 2012 with respect to the criteria presented in the 2007 CDA Dam Safety Guidelines (CDA 2007), and the HSRC. Details of the potential consequence review are presented in Pinchi Lake Mine Post-Reclamation Monitoring Requirements (KCB 2012), and the results are summarized below.

CDA Potential Consequence

KCB (2012) stated that the area downstream of the embankment 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 TSF Embankment, releases from the impoundment could enter Pinchi Lake. The TSF was identified as Low for economic and cultural losses, and Significant for loss of life and environmental losses. Therefore, the TSF's potential consequence was noted as Significant.

The 2012 potential consequence review included a simplified TSF breach assessment to estimate the peak discharge, tailings outflow volume and tailings runout distance for hypothetical sunny-day and rainy-day failure scenarios. These hypothetical scenarios were not evaluated to confirm that they are credible failure modes. An evaluation of credible failure modes for the TSF is in progress, and the need for updates to the TSF breach assessment will be reviewed after this is completed.

HSRC Potential Consequence

All tailings storage facilities are required to have the potential consequence determined by the Engineer of Record in accordance with the CDA Dam Safety Guidelines (CDA 2013), as described above, and design criteria are given in the Code based on the potential consequence. Design criteria that are relevant to the Pinchi TSF are described in Section 5.1.

5.5 Physical Performance

5.5.1 Geotechnical Performance

The embankment 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 embankment, including:

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

Borrow Area A was excavated about 10 m from the toe of the south leg of the TSF Embankment during the closure works, and is therefore relevant to performance of the embankment. Longitudinal cracks were identified on the north slope of Borrow Area A in August 2013. The stability of the overall slope (which includes the TSF Embankment) was reviewed in 2017 under static and seismic loadings, and was found to meet the design criteria summarized in Table 5.1 (KCB 2017b). However, localized slumping of the borrow area slope could occur and may impact the TSF Embankment 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 2019b).

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

5.5.2 Hydrotechnical Performance

Closure Spillway

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.

The Closure Spillway was designed to route the 24-hour 1000-year rainfall plus 100-year snowmelt event (KCB 2009). This design was adequate to meet CDA (2007) criteria, which specified the 1000-year flood event as the criteria for a Significant dam. CDA (2014) increased the criteria for TSFs with a Significant potential consequence in the Passive Care phase of closure to 1/3 between the 1000-year event and the Probable Maximum Flood (PMF), and HSRC (MEM 2016) set the criteria in all phases of the mine life to 1/3 between the 975-year event and the PMF (see Table 5.1 for a summary of the revised criteria). However, the HSRC states that the revised criteria do not apply when the Chief Inspector has received a permit application before the date when the criteria came into force, which is the case for the Closure Spillway. Nevertheless, an evaluation of the spillway capacity with respect to Closure – Passive Care criteria was completed (KCB 2019c), and this showed that the spillway can convey the higher design flows without overtopping, but the spillway channel riprap downstream of the embankment toe would likely be damaged in the process. The extent of erosion expected in this scenario is being investigated. Options for upgrading the spillway are also being investigated.

Ed Creek Diversion Channel

Ed Creek Diversion Channel was designed to convey the 1000-year flood event without erosion damage. The right bank of the channel near the TSF Embankment was also designed to contain the PMF with some erosion damage. Observations of the riprap since the original construction in 2000 have shown that the riprap is gradually weathering and breaking down. Test pits in 2014 confirmed that the in-place riprap is undersized compared to the original design (KCB 2015a). Observations show that the degradation of the riprap is happening slowly, and the channel could still convey large flood flows, though not to the level of the original design. There is the potential for an extreme flood event to initiate erosion of the channel. Part of the channel is located approximately 10 m from the TSF Embankment, and erosion in this area, if left unchecked, could eventually erode the glacial till soils in the right bank and undermine the embankment toe. The channel is inspected twice per year and after large precipitation events, so this risk is appropriately managed through surveillance and maintenance that are carried out as per the OMS Manual. However, a long-term solution remains the recommendation, first made in 2014, for Teck to re-establish erosion protection. An options assessment and conceptual design was completed in 2020 for upgrading the channel to meet erosion protection requirements (KCB 2020a). An additional study is in progress to investigate the option of a natural channel design that relies on bed material transport and vegetated banks to control erosion, instead of riprap.

Vegetation Control

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

5.6 Operational Performance

The Pinchi Lake Mine TSF has been closed for about 45 years and, as indicated in Section 2, there are no operational requirements.

5.7 OMS Manual and EPRP Review

The OMS Manual and the Emergency Preparedness and Response Plan (EPRP) for the Pinchi Lake Mine TSF were revised in 2019 (KCB 2019b), and the EPRP was included as an appendix of the EPRP at that time. Subsequently, the EPRP for the TSF was incorporated into the site-wide Mine Emergency Response Plan (Teck 2020). An update to the OMS Manual is in progress to remove the superseded EPRP and prevent duplication in the documentation of emergency response for the TSF.

6 CONCLUSIONS AND RECOMMENDATIONS

The deficiencies and recommendations from previous years and from the 2021 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 TSF 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 TSF 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 TSF safety issues.

Priority 4 Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks.

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

Inspections were carried out in October 2020 and May 2021 by the Site Surveillance Officer, and in June 2021 by the Engineer of Record.

There were no threshold exceedances in the piezometers in 2021.

The riprap along the Ed Creek Diversion Channel is undersized and is gradually weathering and breaking down. This has reduced the capacity of the channel to convey large flood flows without erosion damage compared to the original design. Part of the channel is located approximately 10 m from the TSF Embankment, and erosion in this area, if left unchecked, could eventually erode the glacial till soils in the right bank and undermine the embankment toe. The channel is inspected twice per year and after large precipitation events, so this risk is appropriately managed through surveillance and maintenance that are carried out as per the OMS Manual.

Climate data from the nearest climate station from Sep. 1, 2020 to Aug. 31, 2021 showed temperatures were above average and precipitation was below average (based on 1981 to 2010 climate normals). Since the water balance is based on annual average climate data, there is no water storage in the TSF, and inflows are limited to direct precipitation and stormwater runoff from upslope, updating the water balance on an annual basis is deemed to be unnecessary.

The downstream potential consequence of the TSF was reviewed in 2012 after the completion of the reclamation/closure works, and the TSF was noted to have a Significant potential consequence 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; therefore, there is no change in the TSF's potential consequence.

An update to the OMS Manual is in progress. The EPRP is incorporated into the site-wide Mine Emergency Response Plan (MERP).

Table 6.1 Summary of Deficiencies and Recommendations

Structure	ID No.	Deficiency or Non Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline/Status
Previous Recommendations Ongoing						
Ed Creek Diversion Channel	2019-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering.	OMS Manual	An options assessment and conceptual design should be completed for upgrading the channel to meet erosion protection requirements. Since failure of the riprap would not immediately affect the embankment, the risk to the embankment in the interim is effectively managed through inspections and maintenance as per the OMS Manual, and there is no immediate concern for embankment safety.	3	CLOSED - Initial options assessment complete.
TSF	2020-01	The TSF breach assessment performed in 2012 did not assess the credibility of the failure modes considered.	HSRC	A failure modes evaluation should be completed to determine whether there are any credible failure modes, and if so, would they result in uncontrolled release of tailings and water.	3	End of 2021. In progress.
Ed Creek Diversion Channel	2020-02	The riprap along the Ed Creek Diversion Channel is undersized and is deteriorating due to weathering	OMS Manual	Select one or two preferred options for upgrading/replacing the existing Ed Creek Diversion Channel that will be advanced to a feasibility level design.	3	Q3 2022. In progress – additional options are being considered prior to feasibility design.
TSF	2020-03	The OMS Manual includes a superseded version of the EPRP as an appendix.	HSRC	The OMS Manual should be updated to reference the Mine Emergency Response Plan.	3	End of 2021. In progress.
2021 Recommendations						
TSF	2021-01	A small beaver dam (0.8 m high) was observed in the ditch that runs parallel to the toe of the east leg of the TSF Embankment.	OMS Manual	Remove beaver dam from the toe of the east leg of the TSF Embankment to discourage beaver activity in the area.	4	End of 2022
TSF	2021-02	Some survey monuments appear to have been removed.	OMS Manual	Check the condition of the survey monuments to confirm which ones are still active.	4	End of 2022

7 CLOSING

We thank you for the opportunity to work on this project. Should you have any questions, please do not hesitate to contact the undersigned.

KLOHN CRIPPEN BERGER LTD.

Daniel Klassen, P.Eng.
Geotechnical Engineer

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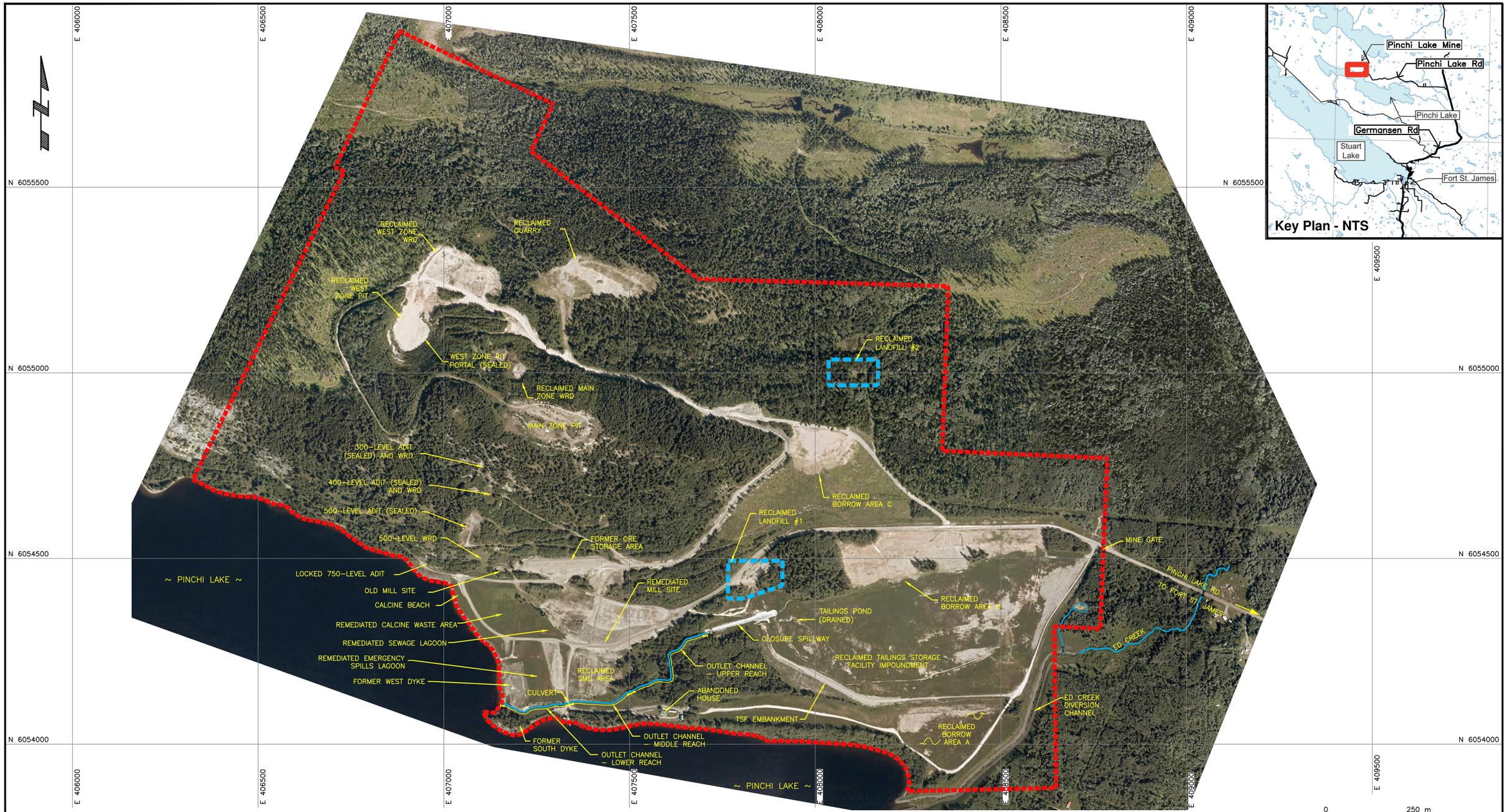
FIGURES



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TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED OCTOBER 2021

LEGEND

PROPERTY BOUNDARY

WRD WASTE ROCK DUMP

NOTES

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

NOT FOR CONSTRUCTION

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2021 ANNUAL FACILITY PERFORMANCE REVIEW

TITLE: MINE SITE PLAN

PROJECT No. M07728 A37

FIG. No. 1.1

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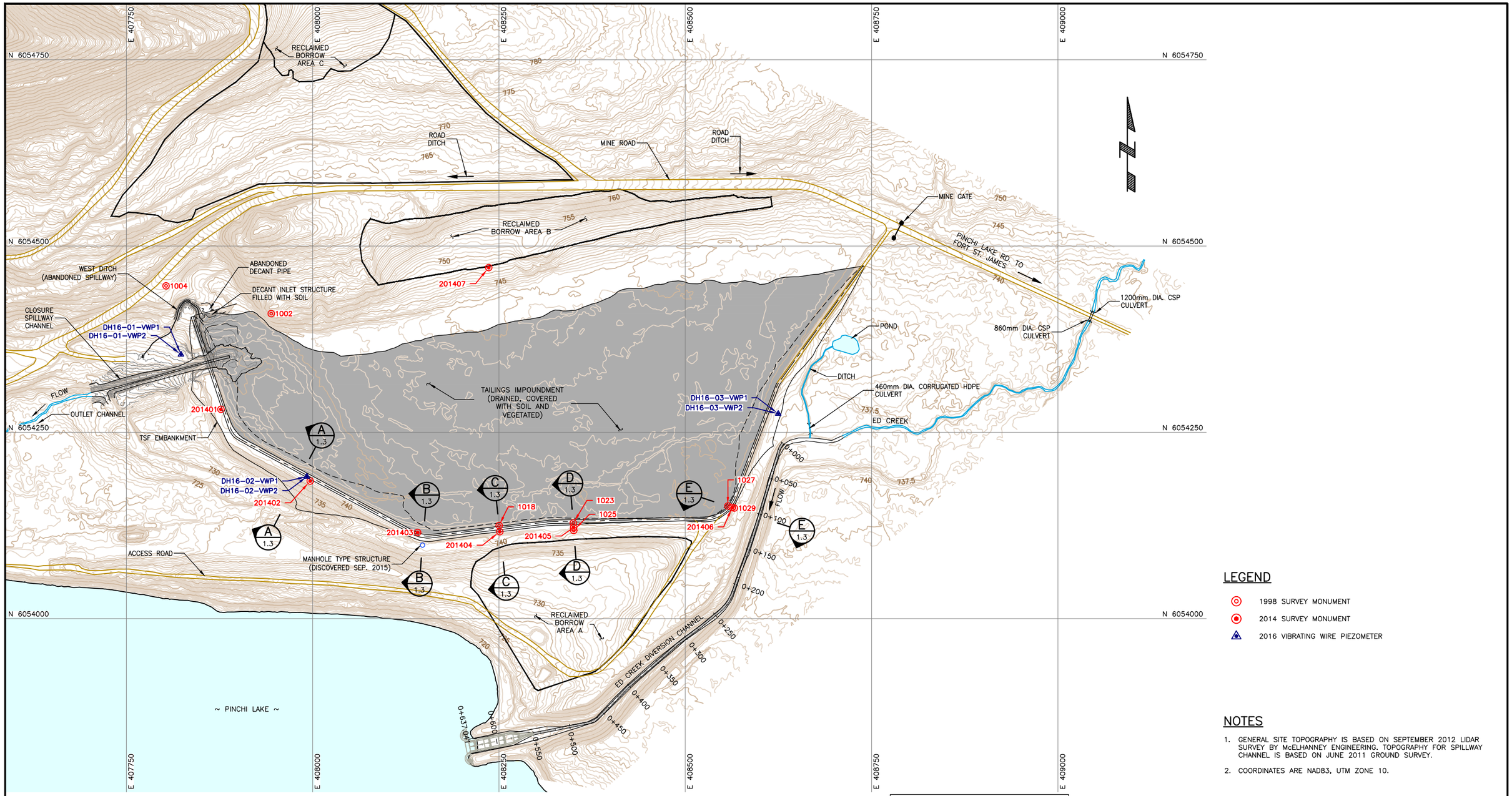

LEGEND

- 1998 SURVEY MONUMENT
- 2014 SURVEY MONUMENT
- 2016 VIBRATING WIRE PIEZOMETER

NOTES

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

SCALE 0 100 m

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

NOT FOR CONTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED OCTOBER 2021

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2021 ANNUAL FACILITY PERFORMANCE REVIEW

TITLE: TAILINGS STORAGE FACILITY PLAN

PROJECT No. M07728 A37

FIG. No. 1.2

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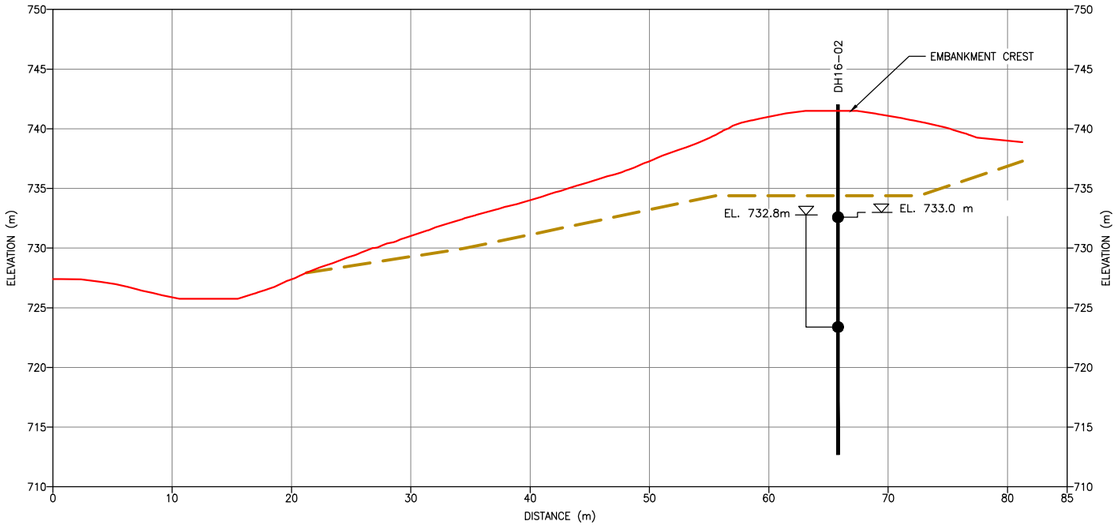
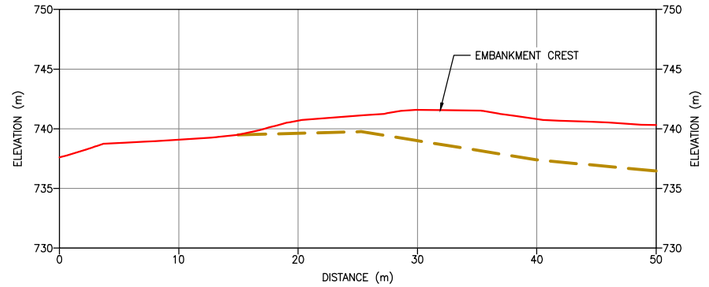


SECTION A 1.2



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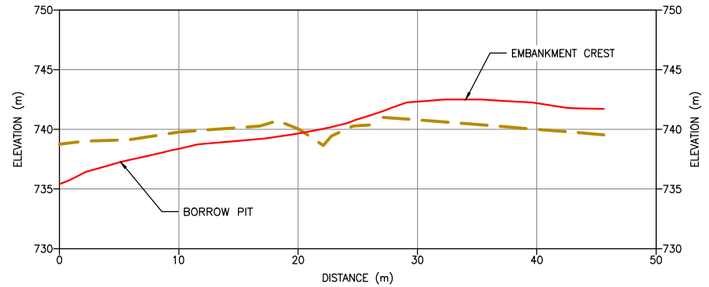

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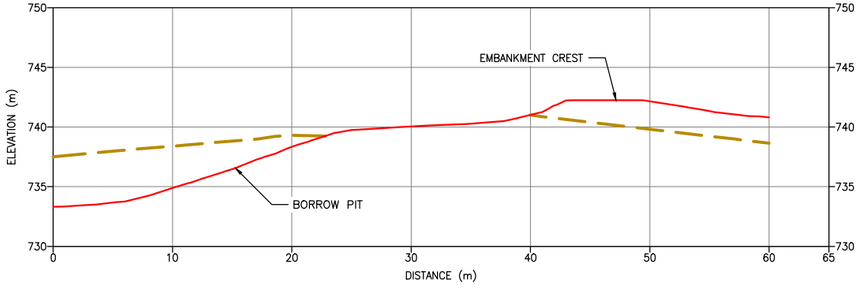

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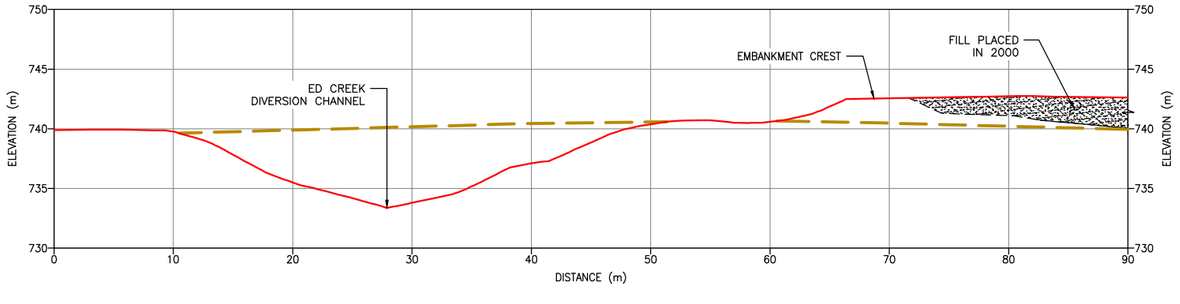

SECTION E 1.2

EMBANKMENT HEIGHT AND SLOPE			OVERALL SLOPE (NOTE 2)
SECTION	EMBANKMENT 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
- 732.8 m — MAY 06, 2021 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 EMBANKMENT 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 OCTOBER 2021

SCALE 0 10 m

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF
2021 ANNUAL FACILITY PERFORMANCE REVIEW

TITLE: TAILINGS STORAGE FACILITY
EMBANKMENT CROSS SECTIONS

PROJECT No. M07728 A37

FIG. No. 1.3

KCB-R-MLB

Time: 11:58:14
Date: 10/19/2021
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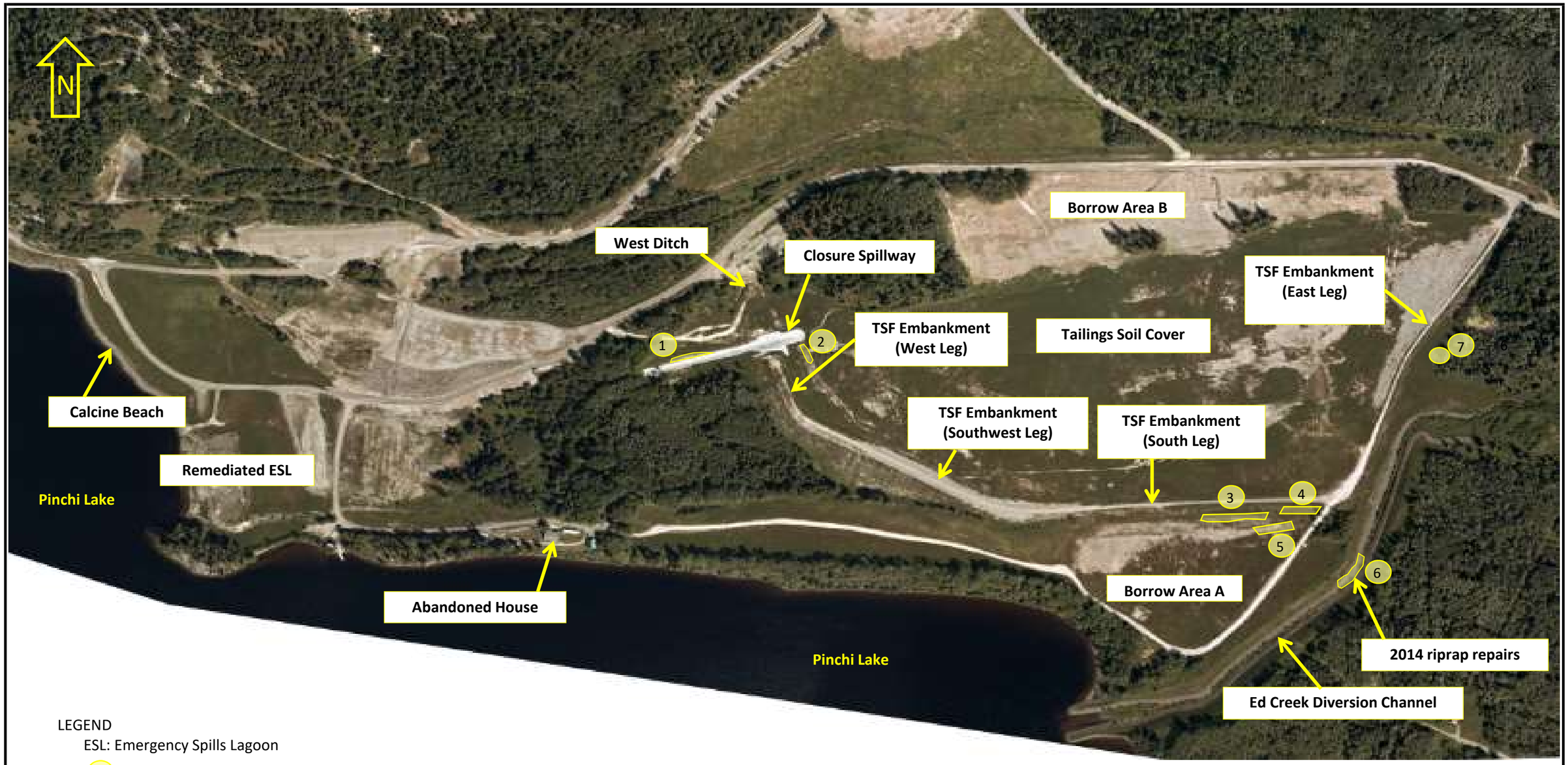
Drawing File: Z:\M\VCR\M07728A37-TML-Pinchi Lake 2021 Services\400 Drawings\CAD\05-FIGURES\2021 Annual Summary of TSF Performance\Fig1.3 - Sections.dwg (ssingh)
Xref File(s):
Image File(s): Teckcominco-color-logo



LEGEND

ESL: Emergency Spills Lagoon

3 Observation Location

Not to Scale

NOTES:

1. All Locations shown are approximate.

TO BE READ WITH KCB REPORT DATED: OCTOBER 2021

CLIENT: Teck

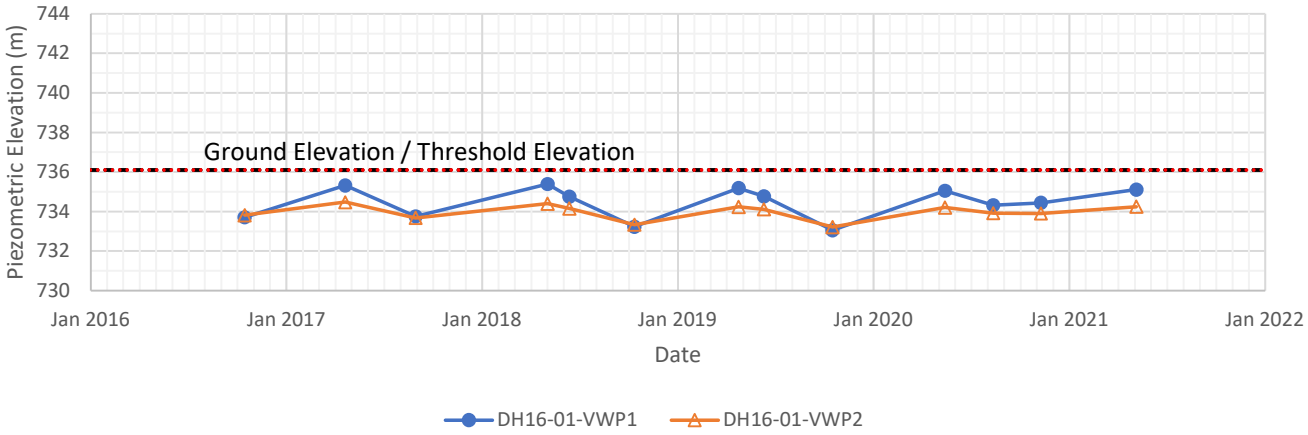
Klohn Crippen Berger

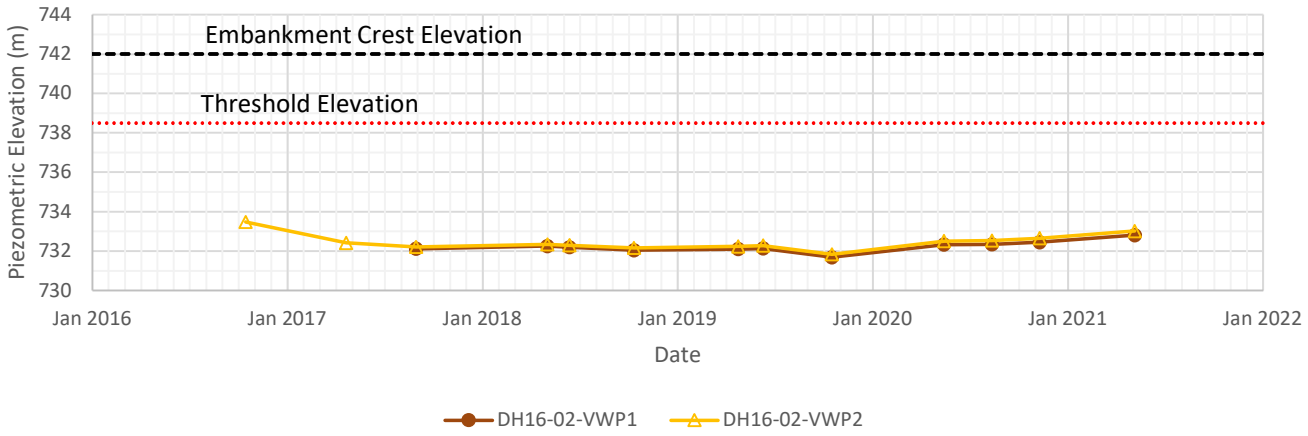
PROJECT: PINCHI LAKE MINE TSF
2021 ANNUAL FACILITY PERFORMANCE REVIEW

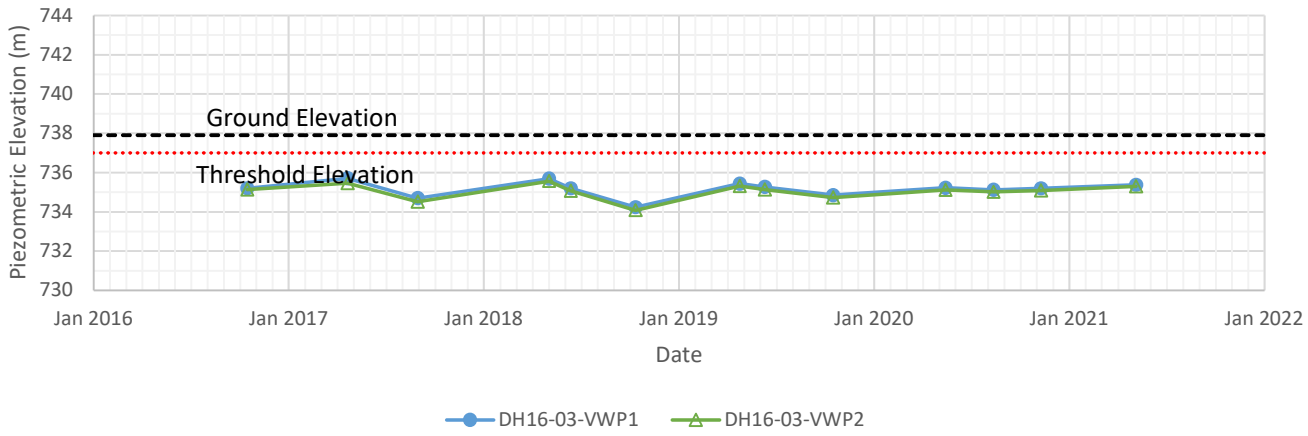
TITLE: JUNE 2021 OBSERVATION LOCATIONS

PROJECT No. M07728A37

FIG No. 4.1







TO BE READ WITH KCB REPORT DATED: OCTOBER 2021

CLIENT: Teck

Klohn Crippen Berger

PROJECT: PINCHI LAKE MINE TSF - 2021 ANNUAL FACILITY PERFORMANCE REVIEW

TITLE: PIEZOMETER READINGS

PROJECT No. M07728A37

FIG No. 4.2

APPENDIX I

Facility Data Sheet

Appendix I
Facility Data Sheet

PINCHI LAKE MINE TSF EMBANKMENT

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 0.5 m in the spillway channel. However, riprap from the embankment toe 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 Embankment	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 and locked. The mine site can also be reached by water over Pinchi Lake. The lake usually has ice cover from November to mid-April.

APPENDIX II

June 2021 Photographs

Appendix II
June 2021 Photographs

Photo II-1 TSF Embankment – East leg, looking south. Note vegetation.

Photo II-2 TSF Embankment – Pond near toe of east leg.

Photo II-3 TSF Embankment – East leg looking south.

Photo II-4 TSF Embankment – East leg, looking north.

Photo II-5 TSF Embankment – East leg, looking west at the covered tailings surface

Photo II-6 TSF Embankment – South leg, looking east

Photo II-7 TSF Embankment – South leg, looking north at the covered tailings surface.

Photo II-8 TSF Embankment – South leg, looking west.

Photo II-9 TSF Embankment – Southwest leg, looking northwest along the crest.

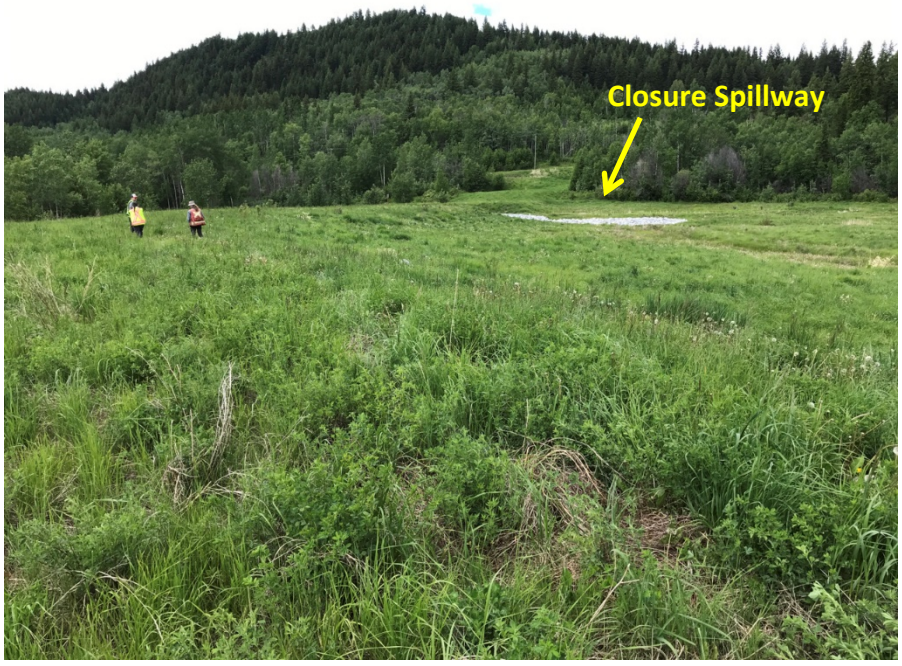


Photo II-10 TSF Embankment – Southwest leg, looking southeast along downstream slope.

Photo II-11 TSF Embankment – Southwest leg, looking downstream from the crest.

Photo II-12 TSF Embankment – Southwest leg, looking northwest along the downstream slope.

Photo II-13 TSF Embankment – West leg, looking south along downstream slope.

Photo II-14 TSF Embankment – West leg, looking north along upstream slope.

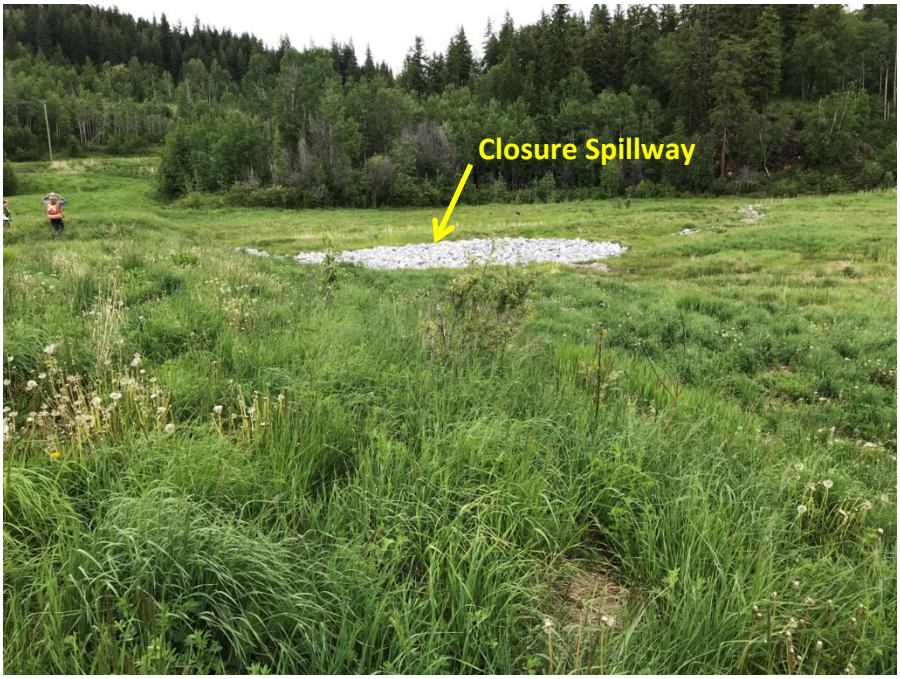


Photo II-15 TSF Embankment – West leg, looking north from downstream slope.

Photo II-16 Closure Spillway – Inlet apron.

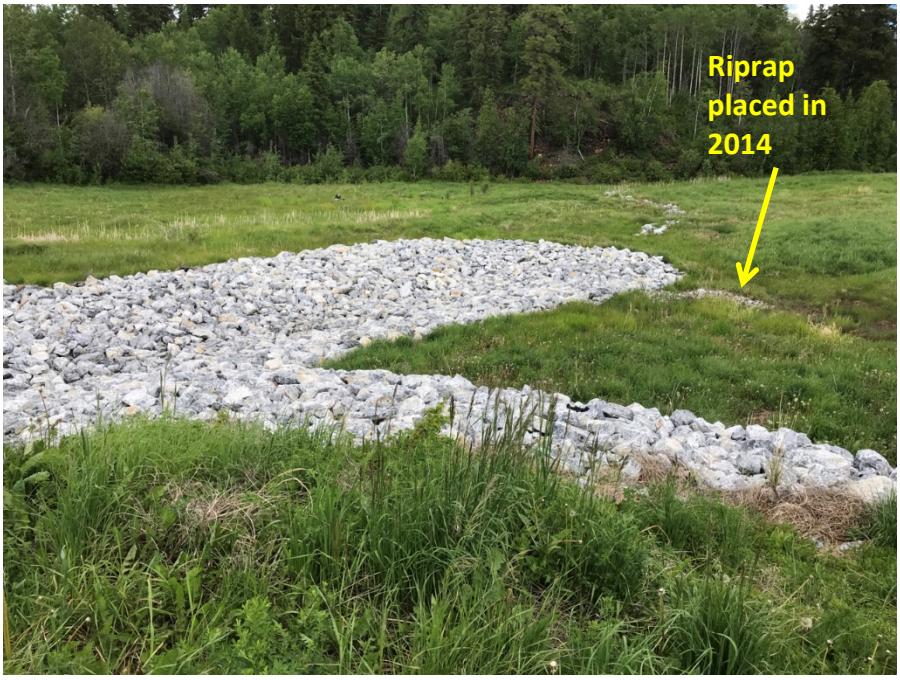


Photo II-17 Closure Spillway – small pond at inlet to spillway.

Photo II-18 Closure Spillway – Channel section through the TSF Embankment.

Photo II-19 Closure Spillway – looking downstream from embankment crest.

Photo II-20 Spillway inlet looking downstream.

Photo II-21 Closure Spillway – looking downstream.

Photo II-22 Closure Spillway – looking into channel from right bank.

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

Photo II-24 Closure spillway – Pond at downstream end of riprap.

Photo II-25 Outlet Channel – Middle Reach, looking upstream from road between the South of Mill Site (SMS) and Emergency Spills Lagoon (ESL) areas.

Photo II-26 Outlet Channel – Culvert inlet beneath road between the SMS and ESL areas.

Photo II-27 Outlet Channel – Culvert outlet beneath road between the SMS and ESL areas.

Photo II-28 Outlet Channel – Lower Reach, looking downstream.

Photo II-29 Borrow Area A – Looking west from eastern part of Borrow Area A.

Photo II-30 Borrow Area A – crack monitoring rod location 103 (crack not visible).

Photo II-31 Borrow Area A – Looking east along the slope.

Photo II-32 Borrow Area A – Wet ground and ponding in northeast corner.

Photo II-33 Borrow Area A – Looking south along the embankment slope.

Photo II-34 Ed Creek Diversion Channel – Looking downstream at outlet at Pinchi Lake.

Photo II-35 Ed Creek Diversion Channel – Riprap on right bank, showing weathering and breakage.

Photo II-36 Ed Creek Diversion Channel – looking upstream from near end of channel.

Photo II-37 Ed Creek Diversion Channel – looking downstream from between second and third bends.

Photo II-38 Ed Creek Diversion Channel – Vegetation in channel.

Photo II-39 Ed Creek Diversion Channel – looking upstream from near second bend. Light coloured area of riprap was replaced in 2014 and is in good condition.

Photo II-40 Ed Creek Diversion Channel – looking downstream from between first and second bends.

Photo II-41 Ed Creek Diversion Channel – looking upstream from between first and second bends.

Photo II-42 Ed Creek Diversion Channel – Looking downstream from near first bend.

Photo II-43 Ed Creek Diversion Channel – Looking upstream from just before first bend.

Photo II-44 Outlet of 460 mm culvert on north bank of Ed Creek Diversion Channel.

Photo II-45 Inlet of 460 mm culvert on north bank of Ed Creek Diversion Channel. There is minor vegetation upstream of the inlet.

Photo II-46 Ed Creek Diversion Channel – Ditch upstream of culvert inlet and Ed Creek Diversion Channel.

Photo II-47 Lookup upstream at small beaver dam and pond near East Leg toe.

Photo II-48 Inlet of Ed Creek culverts under Pinchi Lake Road.

Photo II-49 Small log partially blocking invert of west culvert under Pinchi Lake Road.

Photo II-50 Looking upstream from inlet of Ed Creek culverts under Pinchi Lake Road.

Photo II-51 Outlet of Ed Creek culverts under Pinchi Lake Road.

APPENDIX III

June 2021 Inspection Forms

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

TSF EMBANKMENT AND TAILINGS IMPOUNDMENT

Date: _June 15, 2021_____ Inspected By: _D. Klassen, P Takayesu

Time: _12:40 pm to 2:00 pm Pond Water Level: _Small shallow pond near spillway inlet_

Weather: Mix of sun and clouds, 18°_____

Is there any apparent …..	Yes	No	Comments
Cracks			
• Embankment cracks on the embankment crest?		X	
○ Enlargement of cracks or new cracks in SW leg and S leg of embankment (first observed in 2015)?		X	Not visible, see comment 1
• Embankment cracks on the u/s slope?		X	
• Embankment cracks on the d/s slope?		X	
Vegetation Growth and Debris			
• Excessive tree or shrub growth on embankment?		X	Plants > 1.5 m high on east leg d/s slope, but not excessive
• Debris in tailings impoundment?		X	
Other Structural Problem			
• Settlement or erosion on the embankment crest?		X	
• Slough, slides, bulges or erosion on u/s slope of embankment?		X	
• Slough, slides, bulges or erosion on d/s slope of embankment?		X	
• Sinkhole on embankment crest?		X	
• Sinkhole on u/s slope of embankment?		X	
• Sinkhole on d/s slope of embankment?		X	
• Sinkhole in tailings pond till cover?		X	
• Erosion of flow channels in tailings pond till cover?		X	
Ponding / Seepage			
• Evidence of water ponding on embankment crest?		X	
• Wet areas or seepage on d/s slope or toe of embankment?		X	
• Evidence of water ponding at d/s toe of embankment?	X		See comment 2 below
• Wet areas or seepage along d/s abutments?		X	
Animal Activity			
• Rodent burrows in embankment?		X	
• Beaver dam in Tailings Pond?		X	Beaver activity noted downstream of east leg toe, see note 3.

Additional comments:

1. Cracks have been observed in this area for several years and are believed to been formed by loosening and drying of the soil as part of the reclamation and seeding and are not considered to be a TSF safety

	issue. These cracks were not visible during the 2021 inspection.
2.	A pond is located near the toe of the east leg of the embankment, which drains to the south through a culvert into Ed Creek Diversion Channel. This pond has been observed in previous inspections and appears to be related to local runoff. The pond level was higher than normal due to the beaver embankment described in note 3. No other ponds were observed near the embankment toe.
3.	A beaver embankment is present downstream of the east leg of the embankment, in a ditch that leads from the pond area at the embankment toe south towards the culvert at the right bank of Ed Creek Diversion Channel (see Figure 4.1 in the main text for location). The embankment is 80 cm high.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

CLOSURE SPILLWAY

Date: _June 15, 2021_____ Inspected By: _D. Klassen, P. Takayesu_____

Time: _2:00 PM_____

Weather: Mix of sun and clouds, 18°_____

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	
○ Any signs of recent movement of slump on right bank?		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 embankment in spillway channel?		X	
• Any other animal activity?		X	

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

Additional comments:

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

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

OUTLET CHANNEL

Date: June 15, 2021_____ Inspected By: _D. Klassen, P. Takayesu

Time: _4:30 PM_____

Weather: _Mix of sun and clouds, 18°_____

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 (along reclaimed SMS area)*			
• Debris in the channel?		X	
• Erosion in the channel?		X	
• Beaver activity in channel?		X	
Culvert under road between SMS and ESL			
• Blockage of culvert inlet or outlet?	X		See note 1
• 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 Outlet Channel is the flow route along the reclaimed South of Mill Site (SMS) area, from the edge of the trees to the culvert under the road between the SMS and the remediated Emergency Spills Lagoon (ESL). Lower Reach extends from the culvert to Pinchi Lake. Upper Reach is densely vegetated and is not inspected.

Additional comments:

1. Grass growing in front of inlet, partially blocking it. Water ponding locally at the culvert, 5 cm above the invert of the culvert, and 19 cm deep immediately downstream of the culvert. The channel downstream of this is dry until it reaches the lake.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ROAD DITCH ABOVE TAILINGS IMPOUNDMENT

Date: _June 15, 2021 Inspected By: _D. Klassen, P. Takayesu_____

Time: _4:00 PM_____

Weather: _Mix of sun and clouds, 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		Trees growing in ditch near bottom of hill close to the mine gate
• 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: _June 15, 2021_____ Inspected By: _D. Klassen, P. Takayesu_____

Time: _3:00 PM_____

Weather: _Sun and cloud, 18°C

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

Additional comments:

1. A few small areas of wet ground or ponds (< 0.5 m diameter) were observed between the northeast corner of the borrow area and 150 m to the west. There was no flowing water.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ED CREEK DIVERSION CHANNEL

Date: _June 15, 2021_____ Inspected By: _D. Klassen, P. Takayesu_____

Time: _3:30 PM_____

Weather: _Sun and cloud, 18°C

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

Give location of flow: _Base of channel_____ Give approx. flow depth: _190__ 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 embankment in spillway channel?		X	
• Any other animal activity?		X	

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

Additional comments:

1. Vegetation was observed throughout the base of the channel, including tall grasses and some bushes greater than 2 m height.
2. As noted during previous inspections, riprap along entire diversion channel is deteriorating. Visual inspection suggested there were no significant changes from the condition in recent years.

Pinchi Lake Mine Tailings Storage Facility
Inspection Checklist

ED CREEK CULVERTS AT PINCHI LAKE ROAD

Date: _June 15, 2021_____ Inspected By: _D. Klassen, P. Takayesu _____

Time: _12:00 PM_____

Weather: _Sun and cloud, 18°C

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

Give approx. water depth in channel at culvert inlet: _110___ 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	

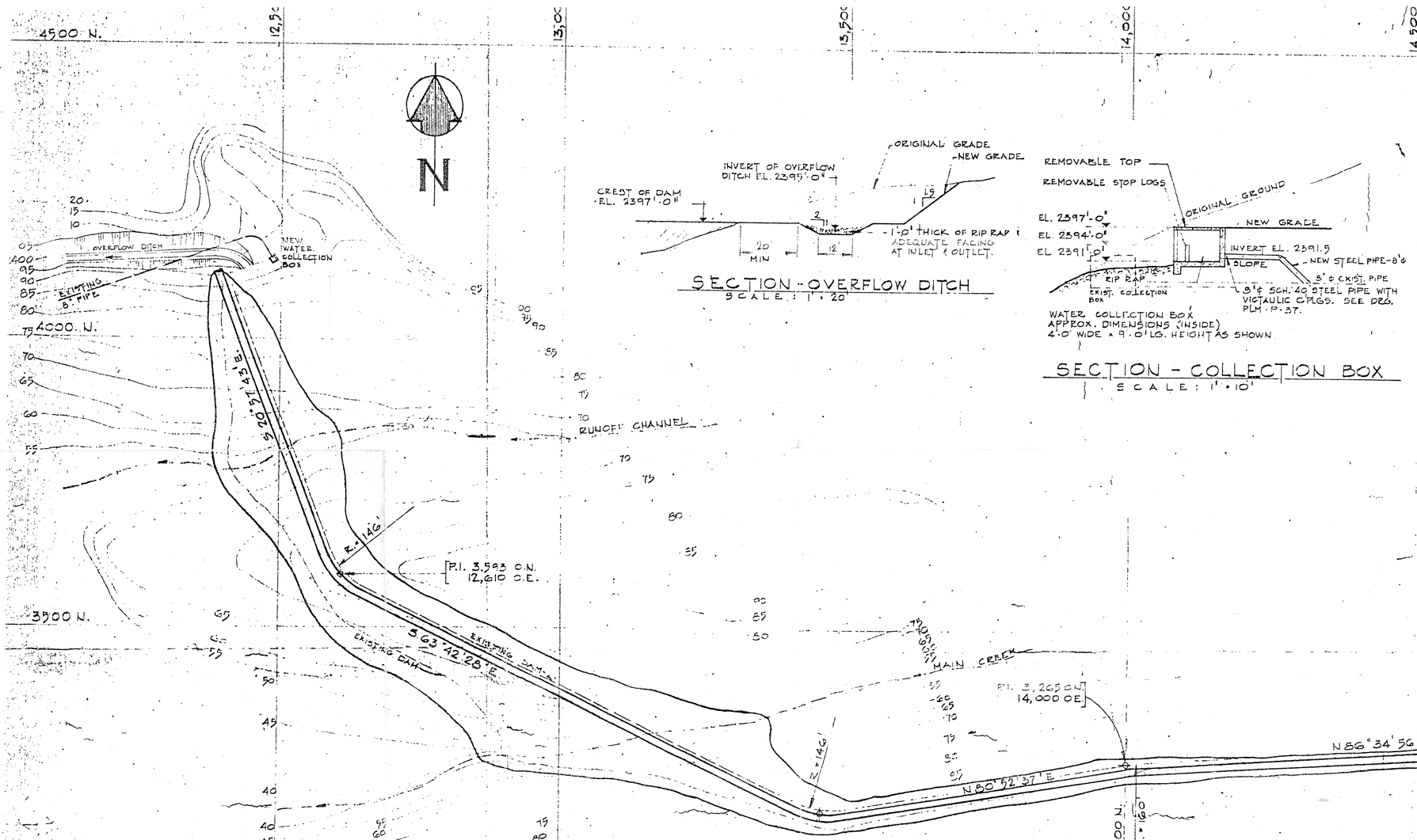
Additional comments:

Water depth at culvert inlet is for east culvert. West culvert has an approximate water depth of 70 mm and has a small log blocking a small portion of the opening.

APPENDIX IV

1975 Embankment Drawing

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



PLAN - TAILINGS DAM

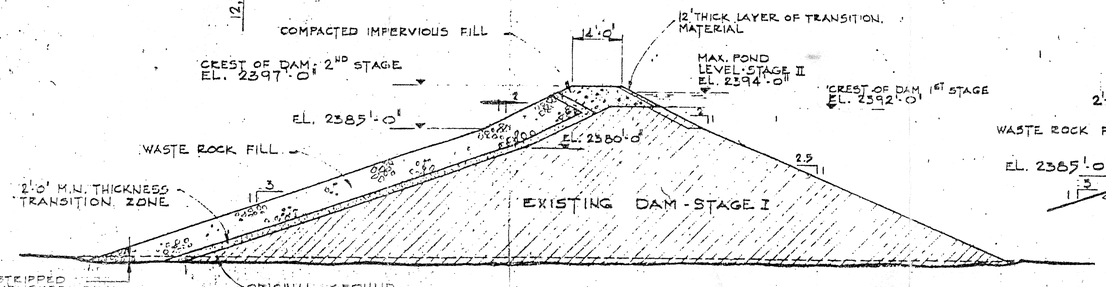
SCALE: 1" = 100'

SECTION - OVERFLOW DITCH

SCALE: 1" = 20'

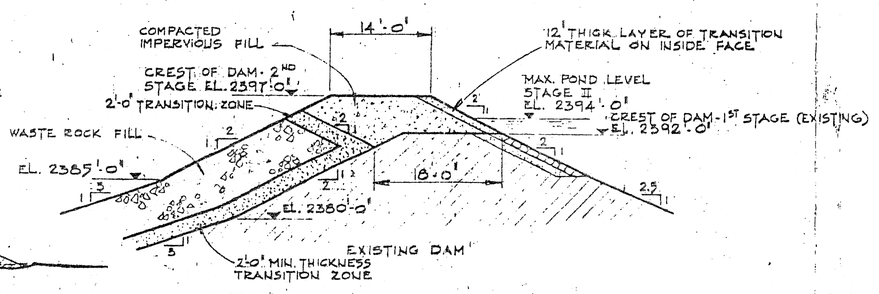
SECTION - COLLECTION BOX

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 V

Water Balance

Klohn Crippen Berger

September 10, 2019

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

Ms. Michelle Unger
Mine Manager

Dear Ms. Unger:

Pinchi Lake Mine Tailings Storage Facility
Water Balance

1 INTRODUCTION

This letter summarizes an update to the water balance completed by Klohn Crippen Berger Ltd. (KCB) in 2009 for 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, at an elevation of approximately 750 m. No tailings have been deposited in the facility since 1975 and closure reclamation works were completed in 2011.

2 METHODOLOGY

The previous Pinchi Lake Mine TSF water balance (KCB 2009) included a small (0.4 ha) pond near the outlet of the TSF where water levels and discharge (through a decant structure) had been measured since 1997. The last year of measurement at the TSF outlet occurred in 2008, just prior to reclamation and closure of the TSF that saw: the pond drained; the decant structure and emergency spillway replaced with the current riprap closure spillway; and the tailings covered with glacial till and vegetated.

The water balance was modelled in GoldSim® as a single catchment area reporting to the spillway. Snow accumulation and snowmelt were estimated using daily precipitation and temperature data. Snow accumulation was validated using regional snow course data. Runoff, seepage loss and evaporation loss in the catchment were estimated using a soil moisture accounting (SMA) model[1].

[1] A model that uses daily precipitation, temperature, soil moisture, and soil permeability of a catchment to estimate the amount of water that enters, is stored in, and leaves the catchment.

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The surface soil storage and seepage rate were calibrated to water level and flow measurements taken in 2007 and 2008 (assuming the small pond present in 2008), or the “pre-cover scenario”.

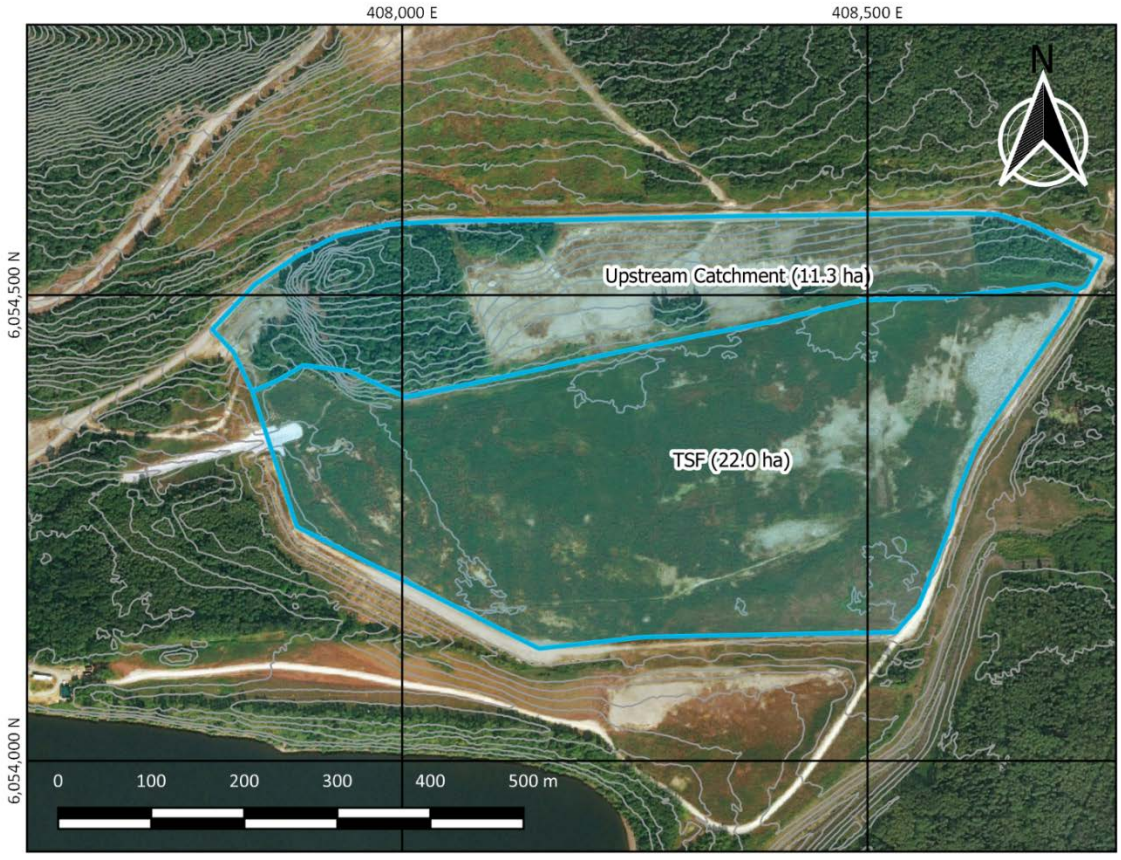
For this 2019 assessment, the GoldSim model was updated to reflect current closure conditions, or the “post-cover scenario”, by removing the free water pond and increasing soil storage to account for the vegetated glacial till closure cover. The updated model was then run using the past 20 years of climate data (1998 to 2017) to estimate monthly average flows. Modelled runoff volumes in April and May were compared to estimated runoff volumes from flow measurements in 2011 and 2012 to provide a level of confidence in the results. However, there is not enough data to calibrate the post-cover scenario.

2.1 Input Data

2.1.1 Catchment Areas

Approximately 22.0 ha of past tailings deposition area and 11.3 ha of upstream catchment report to the closure spillway (Figure 2.1). The upstream catchment assumes the ditch beside the access road operates during normal conditions. Note that this upstream catchment area is less than what was used in the assessment of the TSF spillway capacity because that assessment assumed the road upstream of the TSF is breached during the Inflow Design Flood (IDF).

Figure 2.1 TSF Water Balance Catchment Areas



2.1.2 Climate

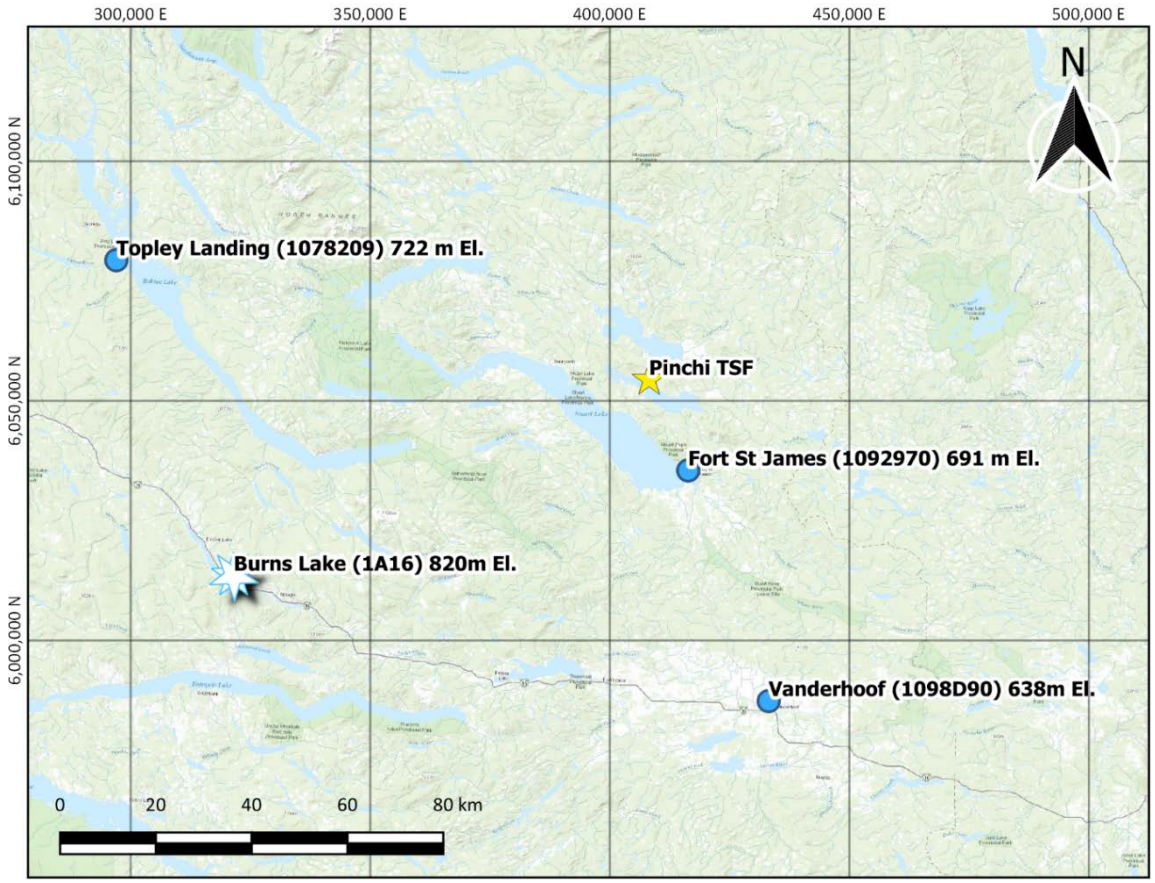
Regional Environment Canada climate stations with parameters of interest, along with period of record and elevation, are listed in Table 2.1 and shown in Figure 2.2.

Snowpack and snowmelt are estimated based on precipitation and temperature data; however, measurements of snowpack are needed to validate these estimates. Snow course is measured in the spring at Burns Lake, 100 km southwest of site, at an elevation 820 m, similar to Pinchi TSF (750 m).

Table 2.1 Regional Climate Stations

Station Name	Station ID	Period of Record	Elevation (m)	Distance from Site	Parameters of Interest
Fort St James	1092970	1895 to 2018	691	20 km southeast	Precipitation, Temperature
Fort St James Auto	1092975	2013 to 2018	688	20 km southeast	Precipitation, Temperature
Vanderhoof	1098D90	1980 to 2018	638	70 km southeast	Precipitation, Temperature
Topley Landing	1078209	1962 to 2017	722	110 km northwest	Lake Evaporation
Burns Lake	1A16	1970 to 2018	820	100 km southwest	Snow Course

Figure 2.2 Regional Climate Station Locations



Note: Fort St. James and Fort St James Auto stations are in the same location on this map.

Precipitation and temperature are inputs to the Pinchi Lake TSF water balance. These parameters were taken first from the Fort St James station due its proximity to site, with gaps filled in with data from Vanderhoof. To account for Pinchi Lake TSF being at a higher elevation, precipitation data from these stations was increased by 3%[2] and temperature data was decreased by 0.3°C[3].

Lake evaporation, or potential evapotranspiration (PET), is measured at Topley Landing from May to September and was used to estimate actual evapotranspiration (AET) losses from the pond and catchment.

Monthly averages of the 1998 to 2017 climate data inputs used in the GoldSim model are presented in Table 2.2.

Table 2.2 1998 to 2017 Monthly Climate Averages

Period	Precipitation (mm)	Rain[1] (mm)	Snow[1] (mm)	PET[2] (mm)
January	45	2	43	3
February	28	2	27	6
March	27	7	19	23
April	26	21	5	48
May	40	40	1	80
June	47	47	0	92
July	49	49	0	98
August	43	43	0	84
September	40	40	1	48
October	52	37	15	20
November	42	7	34	6
December	41	1	40	2
Annual Totals	**480**	**295**	**185**	**509**
Percent of Precipitation	**100%**	**62%**	**38%**	

Notes:
1. Estimated from precipitation data based on temperature.
2. PET is estimated from October to April, when data from Topley Landing is not available.

2.1.3 Surface Storage

Based on the recorded data, discharge from the TSF spillway normally occurs only during freshet indicating that there is enough surface depression, vegetation and upper soil moisture storage to contain most rain events. An initial estimate of these storages for the pre-cover model calibration (i.e., 2007/2008 condition) is 80 mm, broken down as follows:

- 65 mm of soil moisture storage in a dry antecedent moisture condition (AMC) based on:
  - 0.221 water content at wilting point (i.e. dry antecedent condition);
  - 0.430 water content at saturation point; and

[2] Based on an increase of 5% per 100 m elevation gain suggested by Quick (2005).
[3] Based on a decrease of 0.65°C per 100 m elevation gain, which is the average lapse rate defined for the International Standard Atmosphere.

  - 300 mm thick surface soil layer involved in evapotranspiration processes (i.e., 300 mm capillary rise for a silty/clay soil type).
- 10 mm of surface depression storage, assumed on a permeable surface and mild grade; and
- 5 mm of vegetation storage (before the closure cover was installed).

Using the measured data from spring freshet events to calibrate the pre-cover Goldsim model, the total moisture storage for the TSF was estimated to be 90 mm (Section 2.2), compared to the initial estimate of 80 mm. A 90 mm storage is equivalent to a curve number of 74 under the Soil Conservation Service (SCS) TR-55 hydrology model, which is reasonable for a flat and permeable area.

For the post-cover water balance, surface storage was increased to 100 mm to account for the vegetated glacial till cover. This is approximately consistent with an SCS curve number of 72.

2.1.4 Seepage Rate

Seepage is estimated as the amount of precipitation and/or snowmelt percolating into the tailings and reporting somewhere downstream of the spillway. In the 2009 water balance, a saturated hydraulic conductivity of $1x10^{-8}$ m/s, or approximately 1 mm/day, was used for the tailings. This value was not revised during pre-cover model calibration. The glacial till closure cover is assumed to have a hydraulic conductivity similar to the tailings, so no change to this value was made for the post-cover scenario.

2.2 Pre-Cover Scenario Calibration

Selection of the period for model calibration[4] was based on periods where there were concurrent data sets for pond level, discharge measurements in the TSF, and snow course measurements (at Burns Lake). This level of information was only available for the pre-cover scenario in 2007 and 2008. Results of the model calibration are presented in Figure 2.3.

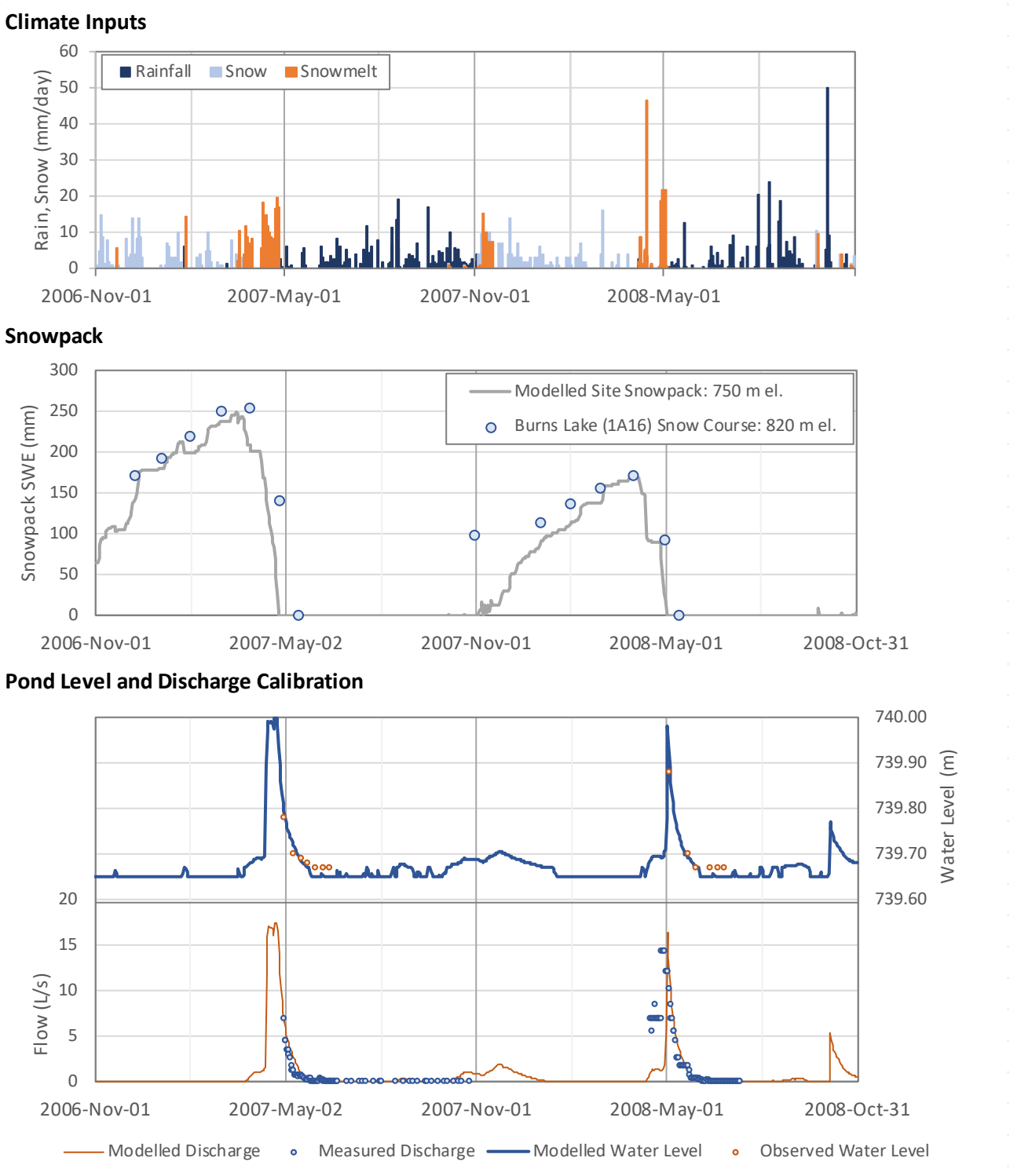
The estimated snow accumulation snow water equivalent (SWE) from the calibrated water balance model is comparable to the snow course SWE measurements at Burns Lake in 2007 and 2008. Burns Lake is at a similar elevation to the Pinchi TSF, so no elevation correction was required.

The estimated water level and TSF discharges from the calibrated water balance model closely correlate to the measured data in 2007 and 2008. The model predicted some discharge in late fall in both years when measurements were not taken; however, these volumes were small compared to the freshet discharge volumes.

The results described above and shown in Figure 2.3 indicate that the calibrated water balance model provides a reasonable representation of the hydrologic performance of the Pinchi TSF.

[4] Calibration included adjusting watershed storage, seepage and evaporation input parameters to fit measured pond level and flow data. Modelled snow accumulation was compared to measured values at Burns Lake, but no snowmelt parameters were adjusted.

Figure 2.3 Pre-Cover Model Calibration using 2007 and 2008 Data



2.3 Post-Cover Scenario Validation

The post-cover scenario was validated[5] using flow rates measured[6] approximately 450 m downstream of the TSF spillway. In 2011 and 2012, flows were measured five and four times, respectively; however, in 2013 to 2019, flows were measured either once or twice a year. Due to the higher number of measurements in 2011 and 2012, this period was selected for validation of the post-cover scenario model. Flow measurements and the associated runoff volume estimated for April-May in 2011 and 2012 are compared with modelled April-May runoff volumes in Table 2.3.

Table 2.3 Post-Cover Model Validation using 2011 and 2012 Data

Parameter	2011	2012
Flow Measurement 1	3.2 L/s on April 19	11.8 L/s on April 23
Flow Measurement 2	9.4 L/s on April 26	9.2 L/s on April 30
Flow Measurement 3	7.3 L/s on May 3	3.6 L/s on May 7
Flow Measurement 4	3.2 L/s on May 10	0.9 L/s on May 14
Flow Measurement 5	0 L/s on May 17	n/a
Measured April-May Runoff Total[1]	10,500 m^3	11,000 m^3
Modelled April-May Runoff Total	8,300 m^3	9,400 m^3

Note:
1. Total April-May runoff volumes were estimated based on the measured flow rates and estimated flow durations.

The estimated measured runoff volume is between 15% and 25% higher than the modelled April-May runoff volumes in 2011 and 2012. This difference is likely due to the increase in catchment area between the TSF outlet and the location of the measurements. This comparison indicates that the post-closure scenario model is a reasonable representation of the conditions and that no further calibration of the model is needed.

3 RESULTS

The estimated average monthly TSF water balance[7] results reflecting the current (2018) post-cover closure conditions, with no free water pond and a vegetated glacial till cover, are summarized in Table 3.1. The table also includes annual totals for 2017[(8)] for comparison purposes.

An estimated 10% of direct precipitation on the TSF is lost to seepage, while 80% is lost to AET on an average annual basis. Average spillway discharge is the remaining 10% of direct precipitation on the TSF plus runoff from the upstream catchment.

[5] Validation included to comparing modelled April and May runoff volumes for the post-cover scenario to measured data in 2011 and 2012, without the adjustment of any input parameters.
[6] Collected by Ecofor in April and May between 2011 and 2019.
[7] The post-closure water balance used climate data from 1998 to 2017.
[8] 2017 totals reflect the period January 1, 2017 to December 31, 2017. This is different from the 2017 water year, which runs from October 1, 2016 to September 30, 2017.

Table 3.1 Average and 2017 TSF Water Balance Results

Period	TSF Inflows		TSF Outflows and Storage			
	Upstream Catchment Runoff (m^3)	Rainfall and Snowmelt (m^3)	AET (m^3)	Seepage (m^3)	Spillway Discharge (m^3)	Change in Storage[1] (m^3)
January	100	3,600	700	1,400	400	1,200
February	200	1,800	1,500	1,200	600	-1,300
March	1,000	13,900	6,000	1,900	3,000	4,000
April	3,300	19,800	12,600	3,100	9,800	-2,400
May	200	9,200	16,500	1,200	700	-9,000
June	0	10,400	11,900	0	0	-1,500
July	0	10,700	9,800	100	0	800
August	0	9,500	9,500	0	0	0
September	0	8,800	8,700	0	0	100
October	100	10,400	4,700	300	200	5,300
November	100	6,100	1,500	1,200	300	3,200
December	100	1,700	400	1,300	300	-200
Average Annual Totals	**5,100 (0.2 L/s)**	**105,900 (3.4 L/s)**	**83,800 (2.7 L/s)**	**11,700 (0.4 L/s)**	**15,300 (0.5 L/s)**	**200 (0.0 L/s)**
2017 Totals	**1,900 (0.1 L/s)**	**82,200 (2.6 L/s)**	**61,000 (1.9 L/s)**	**17,600 (0.6 L/s)**	**5,300 (0.2 L/s)**	**200 (0.0 L/s)**

Note:

1. Reflects water stored as pore water in the closure cover over the tailings or in depressions on the surface.

4 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 Tailings Storage Facility. The letter'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.

Yours truly,

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APPENDIX VI

Quantifiable Performance Objectives

Appendix VI
Quantifiable Performance Objectives

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

VI-1 PIEZOMETERS

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

Table VI 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

VI-2 SURVEY MONUMENTS

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

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