Klohn Crippen Berger

Teck Highland Valley Copper Partnership

2021 Annual Facility Performance Report

Trojan Tailings Storage Facility

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March 2022

Klohn Crippen Berger

March 29, 2022

Teck Highland Valley Copper Partnership
PO Box 1500
Logan Lake, British Columbia
V0K 1W0

Mr. Bryan Bale, P.Eng.
Chief Engineer, Tailings

Dear Mr. Bale:

2021 Annual Facility Performance Report
Trojan Tailings Storage Facility

We are pleased to submit the Trojan Tailings Storage Facility Annual Facility Performance Report for the period from October 2020 through September 2021.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Rick Friedel, P.Eng.
Engineer of Record, Designated Representative
Senior Geotechnical Engineer, Principal

RF/NS:cd

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Teck Highland Valley Copper Partnership

2021 Annual Facility Performance Report

Trojan Tailings Storage Facility

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (HVC) to complete the 2021 Annual Facility Performance Report[1] (AFPR) of the Trojan Tailings Storage Facility (TSF) for the review period from October 2020 through September 2021. We have also reported on some key events that occurred during the reporting period of this document.

The Trojan TSF, located 4 km north of the operating mill, is a reclaimed, inactive facility built in 1973 and operated until 1989. The Trojan TSF is maintained by HVC and is considered to be in the Closure – Active Care Phase based on the Canadian Dam Association definition (CDA 2019).

The Trojan TSF Structures

This review covers the following structures which comprise the Trojan TSF:

- Trojan Dam – comprises a rockfill starter dam which is approximately half the height of the dam. Above the starter dam, the dam was raised in an upstream manner with cycloned sand.
- R4 Seepage Pond Dam – located downstream from Trojan Dam, this facility collects seepage from the toe of the Trojan Dam.
- Lower Trojan Dam (LTD) – this facility collects local runoff and outflows from the R3 Seepage Pond (Bethlehem No. 1 TSF) and the R4 Seepage Pond.

The facility has been inactive for more than 30 years. The surface of the dam has been reclaimed and the pond level has been lowered. No significant dam safety incidents have occurred at the facility, including while the facility was active (i.e. while tailings were being deposited). In the current configuration, the piezometric levels and gradients through the tailings and dam fill are lower than during operations, which increases the factor of safety against slope failure and internal erosion.

During the review period the following key roles, according to the definitions in the Global Industry Standard on Tailings Management (GISTM 2020), were filled as follows:

- Mr. Bryan Bale, P.Eng. (HVC Chief Engineer - Tailings) acted in the role of Responsible Tailings Facility Engineer (RTFE) / TSF Qualified Person (QP); and
- Mr. Rick Friedel, P.Eng. was the Engineer of Record (EoR), as a representative of KCB.

Activity During the Review Period

During the review period, the Trojan TSF was maintained within the design basis and conditions assumed for the approved design.

Other than routine maintenance activities, as defined in the OMS Manual (HVC 2019), such as clearing weirs of vegetation, there were no major repairs or construction activities completed during the review period.

[1] Past Annual Facility Performance Reports were referred to as Dam Safety Inspections (DSI).

November Regional Flooding

In November 2021, a combination of rainfall and early season snowmelt led to significant regional flooding and damage to public and private infrastructure, which impacted communities closest to the HVC site. The magnitude of the event was less at the HVC mine site and had no effect on the Trojan TSF. Regardless, HVC responded as they would have during any above-average flood on site, which included increased frequency of inspections, pond level monitoring, and reporting.

The Trojan TSF is designed to manage the Probable Maximum Flood (PMF) event which is significantly greater than the regional flooding that occurred in November.

August Forest Fires

The site was under a temporary evacuation order from August 12 to 17, 2021 due to forest fires in the region. Prior to the evacuation, HVC and KCB prepared a modified monitoring program that prioritized surveillance activities. The forest fires did not reach the site, and there was no impact to the Trojan TSF. While the site was under evacuation order, HVC was able to maintain a small site presence to manage essential site operations (e.g., water management).

This had no impact on the surveillance program defined in the OMS Manual (HVC 2019).

Surveillance Program

The current OMS Manual (HVC 2019) and the Emergency Preparedness and Response Plan (EPRP) (HVC 2019) are suitable for the facility. The OMS Manual was reviewed by HVC and KCB in 2021 with the updated version planned for issue in early 2022.

The Trojan TSF surveillance program is appropriate for an inactive, reclaimed tailings facility and includes:

- visual inspections;
- measured behaviour from piezometers, pond level readings, survey monuments and an inclinometer installed at the facility;
- a Trigger-Action-Response-Plan (TARP); and
- review of surveillance information by HVC during weekly dam safety meetings and annually by the EoR.

During 2021, routine surveillance activities were completed as per the OMS Manual (HVC 2019) with one exception: no readings were taken from 4 of the 12 piezometers installed in the cycloned sand beach. The 8 other piezometers installed in the beach were read during the review period. This information helps confirm piezometric levels in the beach and near the embankment are consistent with design assumptions. KCB recommend HVC prioritize inclusion of these piezometers into the ongoing OMS Manual update and routine monitoring activities to obtain full value from the existing instrumentation.

Trojan TSF Performance

The behaviour of the facility were observed to remain consistent with historical patterns; no issues of dam safety concern or unacceptable performance were identified. As the facility is inactive, changes in the conditions at the facility throughout the year, or on an annual basis, are primarily driven by variation in climate. KCB made the following key observations from the Trojan TSF performance review completed as part of the AFPR are:

- Two piezometers exceeded the threshold for the first (i.e. Notification) level of the TARP. Such exceedances identify piezometric levels that have marginally exceeded (~0.5 m) recent trends and are not related to performance or design compliance concerns. All piezometers are measuring levels below those assumed in design analyses. Based on review of the exceedances, EoR confirmed these were not signs of unacceptable performance and recommended revised threshold values to identify if another change in behaviour is measured.
- No downstream horizontal deformation trends are present based on survey monuments.
- Visual inspections by the HVC dam inspector, the EoR or others working in the area did not identify any indications of unacceptable behaviour at the dam.
- Pond levels and seasonal fluctuation were similar to historical trends. Pond level rise during freshet was typical, despite precipitation being below average, which suggests freshet was primarily driven by snowmelt.
- The pond level >6.2 m below the dam crest, which is well above the minimum required (0.2 m) under normal (i.e., non-flood) conditions. There was no discharge through the spillway as the pond level remained >1.5 m below the invert of the spillway.

Design Basis

Consequence classification is not part of HVC's tailings management governance, and they have instructed KCB not to include it when reporting on the Trojan TSF. Potential consequences from credible failure modes are managed through a rigorous risk management process. To support this approach, HVC are in the process of adopting design loading for earthquake and flood scenarios equivalent to an Extreme consequence classification (CDA 2019) for all tailings facilities. This approach has the following advantages:

- meets or exceeds Health Safety and Reclamation Code for Mines in B.C. (HSRC) (EMLCI 2021a) requirements.
- aligns with Teck's goal to eliminate any risk for loss of life.
- is consistent with the GISTM (2020), which supports evolving beyond the conventional consequence classification system.

Trojan TSF is already designed to manage the Probable Maximum Flood (PMF) with adequate freeboard and beach width. The design earthquake (1/2 between 2,475-year and the 10,000-year return period earthquakes) was selected to meet requirements of the HSRC (EMLCI 2021a). However, dam stability is not very sensitive to the magnitude of the seismic load, so the dam would still meet the criteria if the design earthquake were increased to the 10,000-year return period event.

Flood Routing

Flood routing assessments for both the Trojan TSF and R4 Seepage Pond were updated during the review period (KCB 2022), based on the most recent site hydrology (Golder 2021). The analysis confirmed the R4 Seepage Pond can route the IDF (100-year return period) required under the HSRC (EMLCI 2021a) and the Trojan TSF can route the PMF.

Based on flood routing using current site hydrology, the Lower Trojan Pond requires additional flood management upgrades to route the IDF (100-year return period) (KCB 2019). The following notes are relevant to this point:

- The facility has been able to manage flood and freshet events without a reported overtopping concern since the most recent upgrade (~32 years), including a 66 mm rainfall event during May 2011, which is equivalent in magnitude to a 100-year return period (rain only) event. In addition, the large freshet events that occurred during 2017 and 2018 were managed without engaging the spillway and maintaining more than the minimum required flood freeboard (0.5 m).
- Starting in 2017, HVC implemented additional measures to manage potential overtopping risks in the event of a large flood: a remote monitoring system is used to monitor the Lower Trojan Pond level; and alert levels are established which, if exceeded, trigger actions such as increased monitoring and deploying pumps to increase discharge capacity.
- During 2022, HVC are progressing alternatives to address the outstanding recommendation during the year.
- While the recommendation is being resolved, HVC have implemented a remote monitoring system to monitor the Lower Trojan Pond level. If alert pond levels are exceeded, the monitoring system sends out an automated notification to trigger additional actions.

Recommendations

Dam safety recommendations identified during past AFPRs, and their current status, are summarized in Table 1. During the review period, the one scheduled for completion during the review period was closed (shown in *italics*) and the last one scheduled for completion in 2022. Five of the seven outstanding recommendations from the most recent DSR (SRK 2019) were addressed during the review period with the remaining two scheduled for completion in 2022.

Two new recommendations were identified during the 2021 AFPR (Table 2). Both are related to instrumentation and have been assigned a Priority 3 meaning they are not required to address a potential dam safety concern but are necessary to implement the surveillance program as intended.

Table 1 Previous Recommendations Related to Facility Performance – Status Update

ID No.	Performance Area	Recommended Action	Priority(1)	Recommended Deadline (Status)
Trojan Dam				
TD-2018-02	*Flood Routing*	*Update flood routing assessment for Trojan TSF structures based on the most recent site wide hydrology information for consistency and to confirm compliance.*	*3*	*CLOSED*
Lower Trojan Dam				
LTD-2017-01	Inflow Design Flood	Complete appropriate upgrade works to allow LTD to safely pass IDF with adequate freeboard, including decommissioning of the spillway pipe.	2	2022

Notes:
1. Recommendation priority guidelines, specified by HVC and assigned by KCB:
   Priority 1: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
   Priority 2: If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or a repetitive deficiency that demonstrates a systematic breakdown of procedures.
   Priority 3: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
   Priority 4: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.
2. No Outstanding Recommendations for R4 Seepage Pond.

Table 2 2021 Recommendations Related to Facility Performance

ID No.	Performance Area	Recommended Action	Priority(1)	Recommended Deadline (Status)
Trojan Dam				
TD-2021-01	Instrumentation	Complete a test to confirm whether P86-3 is plugged and, if so, remove it from routine monitoring and report it as defunct.	3	Q2 2022 OPEN
TD-2021-01	Instrumentation	Prioritize inclusion of the piezometers installed in 2019 into routine monitoring activities, as per the OMS Manual, to obtain full value from the existing instrumentation.	3	Q2 2022 OPEN

Notes: Refer to Table 1 notes.

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Table of Abbreviations

AFPR	Annual Facility Performance Report
CDA	Canadian Dam Association
DSR	Dam Safety Review
EMLCI	Energy, Mines, and Low Carbon Innovation
EoR	Engineer of Record
EPRP	Emergency Preparedness and Response Plan
FOS	Factor of safety
GISTM	Global Industry Standard on Tailings Management
HVC	Teck Highland Valley Copper Partnership
IDF	Inflow Design Flood
KCB	Klohn Crippen Berger Ltd.
LLO	Low-Level Outlet
MOE	Ministry of Environment
OMS	Operation, Maintenance and Surveillance
PMF	Probable Maximum Flood
QP	TSF Qualified Person
RTFE	Responsible Tailings Facility Engineer
TARP	Trigger-Action-Response-Plan
TSF	Tailings Storage Facility

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 Highland Valley Copper Partnership (Client) for the specific application to the 2021 Dam Safety Support Project, and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
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.
3. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
4. The report is based on information provided to KCB by the Client or by other parties on behalf of the Client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
5. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (HVC) to complete the 2021 Annual Facility Performance Report[2] (AFPR) of the Trojan Tailings Storage Facility (TSF) for the review period from October 2020 through September 2021. Key events that occurred during the reporting period of this document are also noted.

The Trojan TSF, located 4 km north of the operating mill, is a reclaimed, inactive facility built in 1973 and operated until 1989. Table 1.1 summarizes the Trojan TSF structures and their function. Refer to Figure 1 and Figure 2 for the facility layout.

Table 1.1 Trojan TSF Structures

Facility	Structure	Function
Trojan TSF	Trojan Dam	Retains tailings at the southern boundary of impoundment.
	R4 Seepage Pond Dam	Retains R4 Seepage Pond, which stores seepage from the Trojan Dam.
	Lower Trojan Dam	Collects local surface runoff and flows from R4 Seepage Pond and R3 Seepage Pond.

The Trojan TSF has been reclaimed and HVC continues ongoing surveillance of the site including instrumentation monitoring, environmental sampling, visual inspections and maintenance activities. Under this level of site presence, the Trojan TSF is considered to be in the Closure – Active Care Phase based on the Canadian Dam Association definitions (CDA 2019).

The Annual Facility Performance Report scope of work consisted of:

- site visit to observe the physical conditions of the various containment facilities;
- review of surveillance data for the review period provided by HVC;
- review of climate and water balance data for the site;
- review of the Operations, Maintenance and Surveillance (OMS) Manual and EPRP to confirm its appropriateness for the existing facility; and
- review of construction activities completed at the site during the review period, if any.

The site visit of R3 Seepage Pond Dam was completed by KCB representatives Mr. Rick Friedel, P.Eng. and Mr. Delton Breckenridge, EIT on July 22, 2021. The site visit of Trojan Dam was rescheduled to September 17, 2021 due to smoky conditions which impeded visibility. The Trojan Dam site visit was completed by KCB representatives Mr. Rick Friedel, P.Eng. and Ms. Anna Geller, EIT.

[2] Past Annual Facility Performance Reports were referred to as Dam Safety Inspections (DSI).

During the review period, Mr. Bryan Bale, P.Eng. (HVC Chief Engineer – Tailings) acted in the role of Responsible Tailings Facility Engineer (RTFE) / TSF Qualified Person (QP), and Mr. Rick Friedel, P.Eng. was the Engineer of Record (EoR), as a representative of KCB. These roles are consistent with the definition in the Global Industry Standard on Tailings Management (GISTM 2020).

The Bethlehem Mine was operated under Permit M-11 issued by the Ministry of Energy, Mines and Petroleum Resources (EMPR) in January 1970. In July 1998, the mining permits for the Highmont Mine, the Lornex Mine, and the Bethlehem Mine were amalgamated under M-11 Permit (EMPR 2019). The most recent version of the permit was issued in 2021 (EMLCI 2021b).

The water discharge quantity and quality from the Trojan TSF are regulated under Permit PE 376 (09), issued by the Ministry of Environment – Waste Management Branch, dated January 1, 1971 and last amended on May 29, 2003. Other pertinent permits include water licences C114183 and C068389, issued by the Ministry of Environment – Water Rights Branch; Mines Act Permit M-11 (EMPR 2020) which includes the Trojan TSF.

2 FACILITY DESCRIPTION

The HVC Mine is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Trojan TSF is located 4 km north of the operating mill and immediately west of the Bethlehem TSF; refer to Figure 1 and Figure 2. The facility was operated from 1973 to 1989 and contains an estimated 26 Mm^3 of tailings. Under existing conditions, a pond is present on the upstream (north) side of the impoundment, separated from the dam crest by the vegetated tailings beach. Layouts of the facility and structures are shown on Figure 3 to Figure 5. Typical geometry and key dimensions of the dam are summarized in Table 2.1.

Trojan Dam

- The Trojan Dam comprises a rockfill starter dam, built in 1973, with a coarse rock shell, finer rockfill placed upstream and underdrains to direct seepage to a collection ditch along the downstream toe (refer to Figure 2.1).
- The starter dam was raised in an upstream manner with cycloned sand. A sand and gravel filter zone separates the starter dam rockfill and cycloned tailings sand (KL 1982).
- The design specified minimum beach widths to be maintained under normal and temporary flood conditions are 152 m (500 ft) and 92 m (300 ft) respectively. Under existing conditions, at normal range of pond levels, the minimum beach width is more than 200 m along the crest.
- Seepage from the underdrain system is collected in a ditch along the toe and collected by R4 Seepage Pond.
- After operations, an open channel spillway (invert of inlet El. 1435.5 m) was constructed to route flood flows around the west abutment, discharging downstream of the dam toe.

R4 Seepage Pond

- The R4 Seepage Pond is located at the toe of the Trojan Dam (Figure 4) and collects seepage from the dam toe and local surface runoff in two collection ditches along the toe.
- The dam was built in 1984 and is comprised of compacted glacial till fill, on a glacial till foundation, with a 300 mm thick layer of waste rock on the upstream slope for erosion protection (refer to Figure 2.2).
- A 300 mm diameter Low-Level Outlet (LLO), and a 100 mm diameter overflow pipe are embedded in the dam near the left abutment. Flows from both pipes report to Lower Trojan Pond.
- An open channel spillway is located near the right abutment.

Lower Trojan Dam (LTD)

- LTD is approximately 1.1 km downstream of R4 Seepage Pond (Figure 5) and collects local surface runoff and flows from R4 Seepage Pond and R3 Seepage Pond (at the toe of Bethlehem No. 1 Dam).

- The dam was constructed in 1989 but no as-built records are available. Figure 2.3 is a typical cross-section, interpreted from existing conditions.
- Outflow from the pond is through a diversion pipeline (a 460 mm diameter culvert which is buried through the dam near the left abutment) with a control valve downstream of the dam. Flow is discharged to the same channel which conveys flow from the Trojan Diversion.
- An open channel spillway is located near the right abutment as well as a decant pipe (810 mm diameter) buried through the dam at the right abutment.

Trojan Diversion

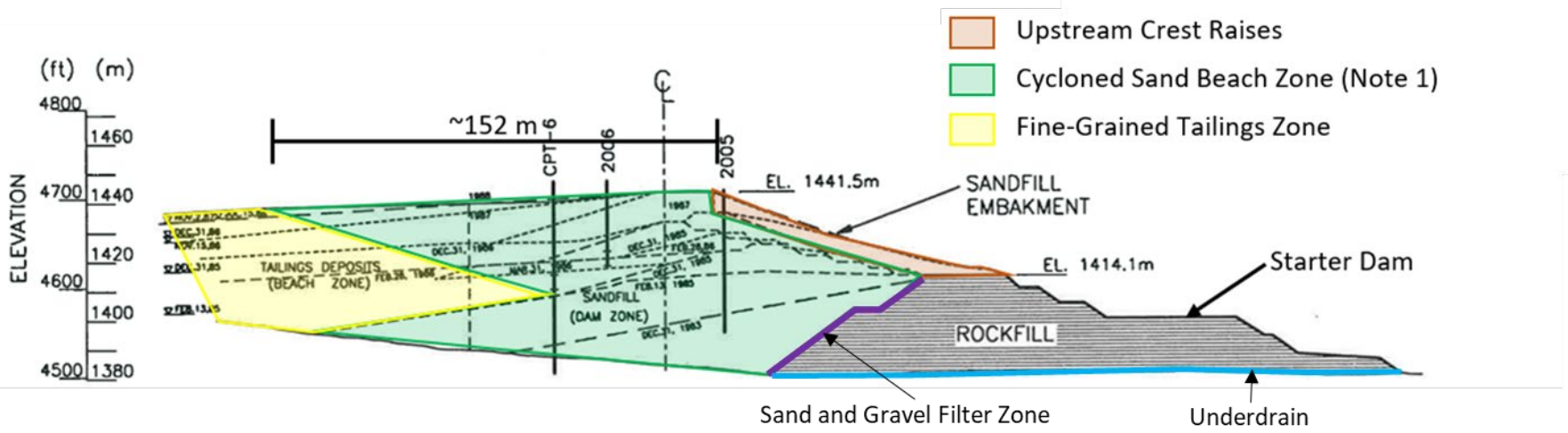
- The Trojan Diversion is constructed around the northwestern perimeter of the Trojan TSF (Figure 3), and intercepts runoff from the upslope catchment and diverts the flow away from the impoundment.
- The diversion ditch transitions to a pipeline northwest of the impoundment which ultimately discharges into Witches Brook.

Table 2.1 Summary of Approximate Dam Geometry

Dam	Trojan Dam	R4 Seepage Pond Dam	Lower Trojan Dam
Length (m)	1500	100	100
Crest Elevation (m)	Starter Rockfill Dam: 1414 Ultimate Dam: 1440	1365	1296.5 (minimum)
Minimum Crest Width (m)	39	5	5
Maximum Height[2] (m)	70	3	4
Upstream Slope	1.5H:1V (rockfill starter dam design)	2.5H:1V	1.75H:1V[3]
Downstream Slope	2.9H:1V (lower bench face) 3.5H:1V (upper bench face)[4] 3.7H:1V (overall)	2H:1V	2H:1V
Construction Method	Starter Dam with Upstream Cycloned Sand Crest Raises	Single Raise Dam with Cut-off Trench	Single Raise Dam

Notes:
1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.
3. KC (2005) indicates an upstream slope of 1.75H:1V based on a November 2004 measurement.
4. These slopes are shallower than those on design drawings (KL 1987) showing cycloned sand slopes on the upper face of the dam at 3H:1V and steeper but unspecified slopes on the rockfill toe face. However, the design drawings also show raises that were never constructed.

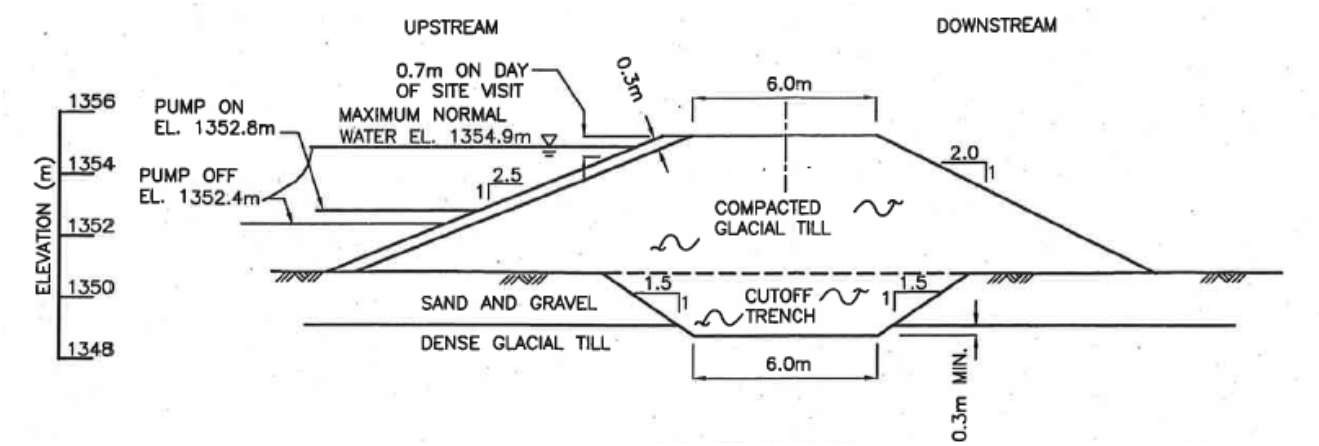
Figure 2.1 Typical Cross Section of Trojan Dam



Notes

1. Upstream extent of cycloned sand zone based on: beach placed prior to early 1985 (i.e., when tailings slimes started being discharged upstream of beach); and minimum beach width of 152 m. Pond levels from annual reports were checked to confirm pond levels were outside of assumed Cycloned Sand Beach zone.
2. Elevations in feet and meters include a change in datum which is why there is an offset elevation in feet and meters.

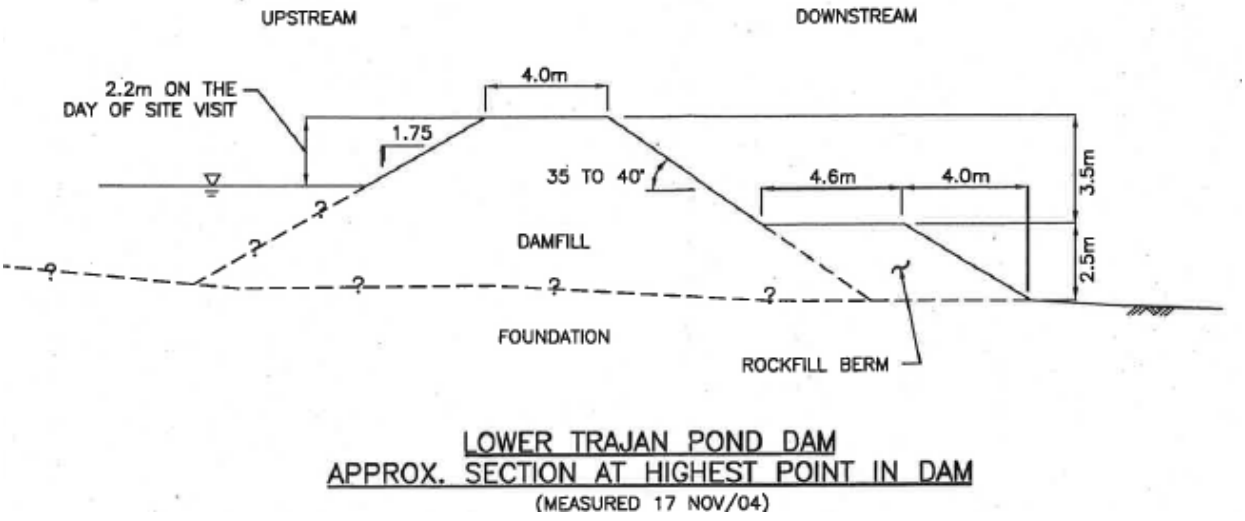
Figure 2.2 Typical Cross Section of R4 Seepage Pond Dam (KC 2005)



Note:

1. The elevations noted here are in a different datum from Table 2.1

Figure 2.3 Typical Cross Section of Lower Trojan Dam (KC 2005)



3 ACTIVITIES DURING REVIEW PERIOD

During the review period, the Trojan TSF was maintained within the design basis and specified operational conditions of the approved design.

Other than routine maintenance activities, as defined in the OMS Manual (HVC 2019), such as clearing weirs of vegetation. There were no major repairs or construction activities completed during the review period.

4 WATER MANAGEMENT

4.1 Overview

The flow schematic for the Trojan TSF and nearby Bethlehem TSF is shown in Figure 6.

4.2 Climate

HVC provided climate data from the L-L Dam Weather Station (El. 1186.0 m), for the 2021 AFPR review period, for KCB to review. KCB adjusted the L-L Dam Weather Station data and Historical Average Lornex Synthetic Record data using the Highmont, Bethlehem and Trojan Area adjustment factors provided in Golder (2021). The adjusted data over the review period was then compared to typical average values, refer to Appendix II-A. In addition, KCB downloaded the Kamloops Pratt Road station (El. 729.0 m) climate data from Environment Canada and was provided the Shula Weather Station (El. 1208 m) data by HVC, to review and compare precipitation trends against the L-L Dam Weather Station data. The Kamloops Pratt Road Weather Station was used for comparison with regional trends rather than the Kamloops Airport Station (El. 345.3 m) as the elevation at the Pratt Road Station is closer to L-L Dam Weather Station (El. 1186.0 m).

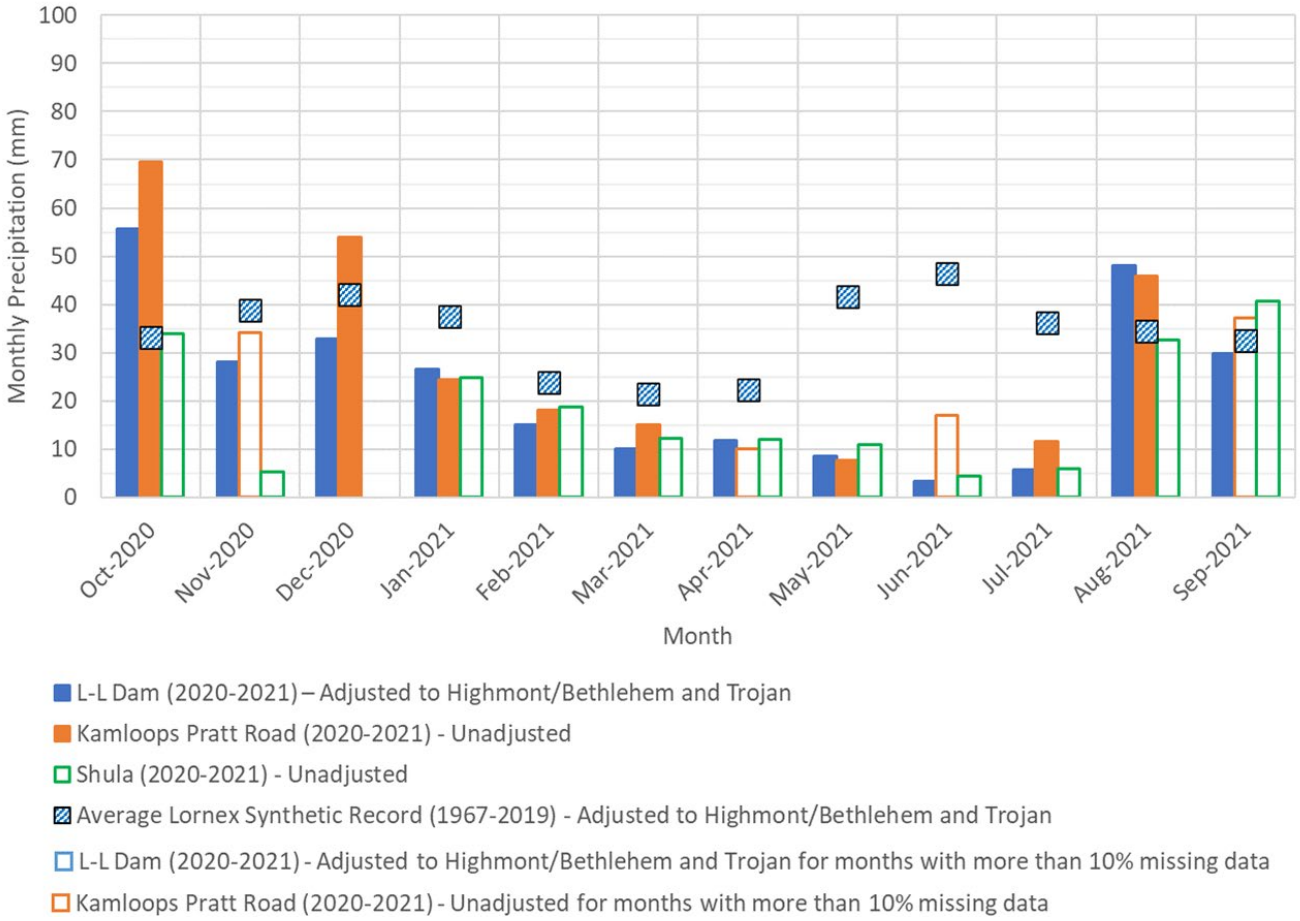
The monthly precipitation record for the reporting period is shown in Figure 4.1. The following observations are noted for the reporting period:

- All storm events during the review period were less than the 10-year return period rainfall event (40 mm in 24 hours). The largest 24-hour rainfall events measured at the L-L Dam Weather Station during the review period, were: 23.7 mm on October 23, 2020; 16.2 mm on December 21, 2020; and 18.5 mm on August 16, 2021.
- In Figure 4.1, all months, except for October 2020 and August 2021 reported 9% to 93% decreases relative to average precipitation. October 2020 precipitation increased 67% relative to the historic normals; August 2021 precipitation increased 40%.
- The L-L Dam Weather Station database included some gaps in 2020 measurements. HVC managed to improve the monitoring program and, as Figure 4.1 indicates, there were no data gaps in 2021 measurements. In addition, consistency in trends between the Kamloops Pratt Road Station, Shula Weather Station, and L-L Weather Station data for 2021 provides confidence in the L-L Weather Station data.
- Snowpack depth measurements, from the Highland Valley Station (El. 1268 m), indicate snow melted during April 2021, and was gone by May 1st. In comparison, the HVC site-wide water balance assumes 30% of snowmelt occurs in March and 70% in April (Golder 2020a).
- Figure 4.2 shows a comparison between snow water equivalent (SWE) and temperature at the HVC site from January to June 2021. The following observations are inferred from these data:
  - The daily temperature recorded between January and June 2021 is within the historical monthly average records (between 2000 and 2019).

- The snowpack was depleted over a period of three weeks (April 9 to April 29), which is a quicker rate than the forecast snowmelt pattern from the HVC site-wide water balance, which is based on Golder (2020a).
- The rise in temperature above 0°C in April coincides with the snowmelt period manually recorded at the Highland Valley station.
- Rain was not a major factor in 2021 snowmelt, as the maximum daily precipitation recorded close to the snowpack depletion period is less than 6 mm/day.

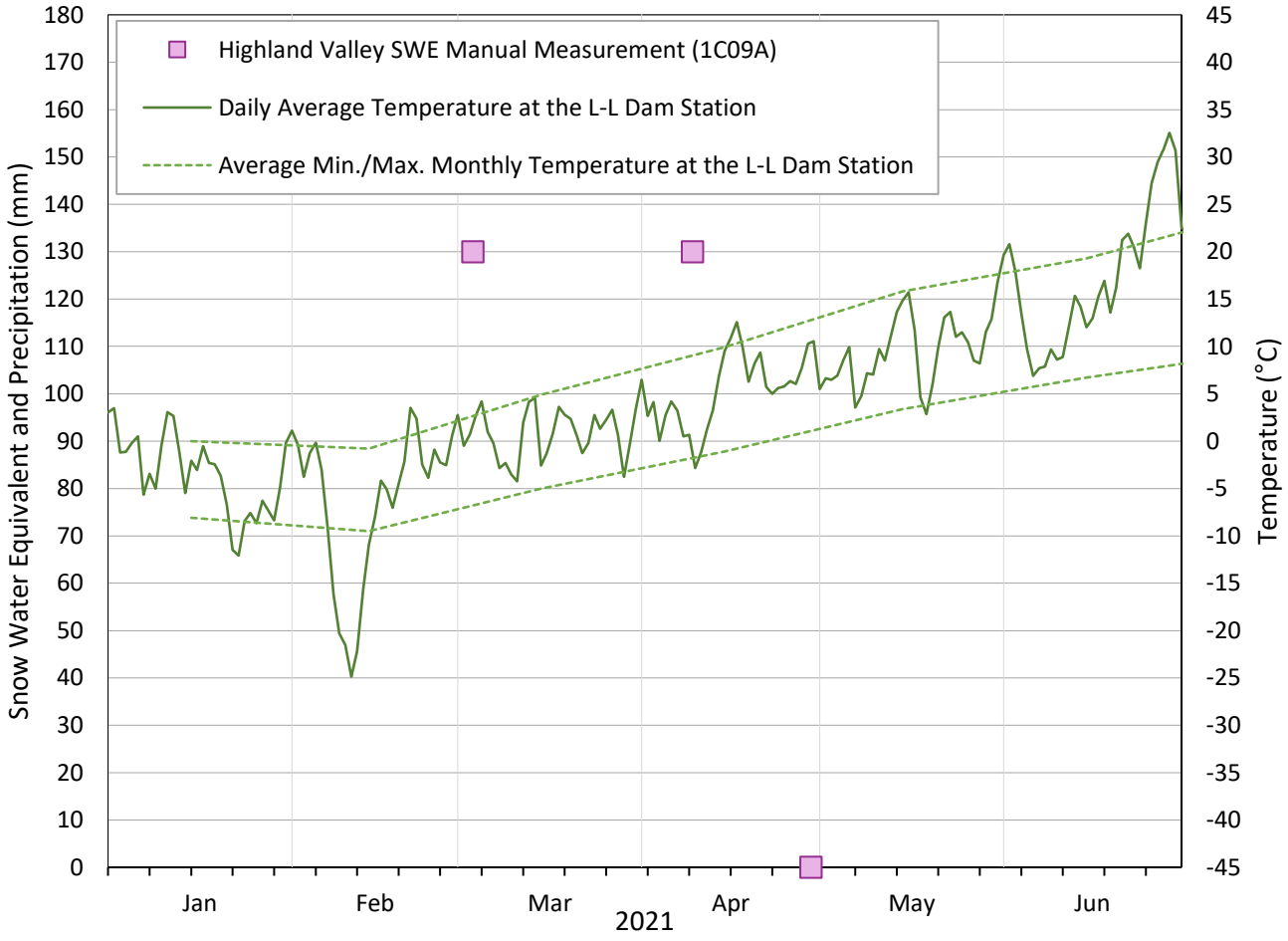
- Seasonal rise and fall of pond levels is associated with freshet. In 2021, pond levels dropped in May, coincident with completion of snowmelt, which is consistent with historic trends (Figure 5.1). Rainfall measured from March through May, when pond levels were rising, was approximately 35% of the historical average, which suggests the majority of the 2021 freshet was related to snowmelt.

Figure 4.1 Monthly Precipitation



Note:
1. The Shula weather station data used for this comparison only included monthly values (i.e., no daily data) and thus, KCB was not able to assess the completeness of the dataset.

Figure 4.2 Temperature Records and Measured Snowpack between January and June 2021



Notes:
1. SWE is manually measured at the Highland Valley snow pillow station (1C09A) typically once per month.
2. Daily average temperature data at the L-L Dam Station for 2021 was provided by HVC.
3. The average maximum and minimum monthly temperatures at the L-L Dam Station were developed by Golder (2021).

4.3 Water Balance

HVC manages and tracks the annual water balance for the Trojan TSF. Table 4.1 summarizes annual inflows and outflows, provided by HVC, and Figure 4.3 plots the Trojan Pond volume from 2015 through 2021. The water balance is based on simplified modelling results and therefore the values should be treated as indicative only.

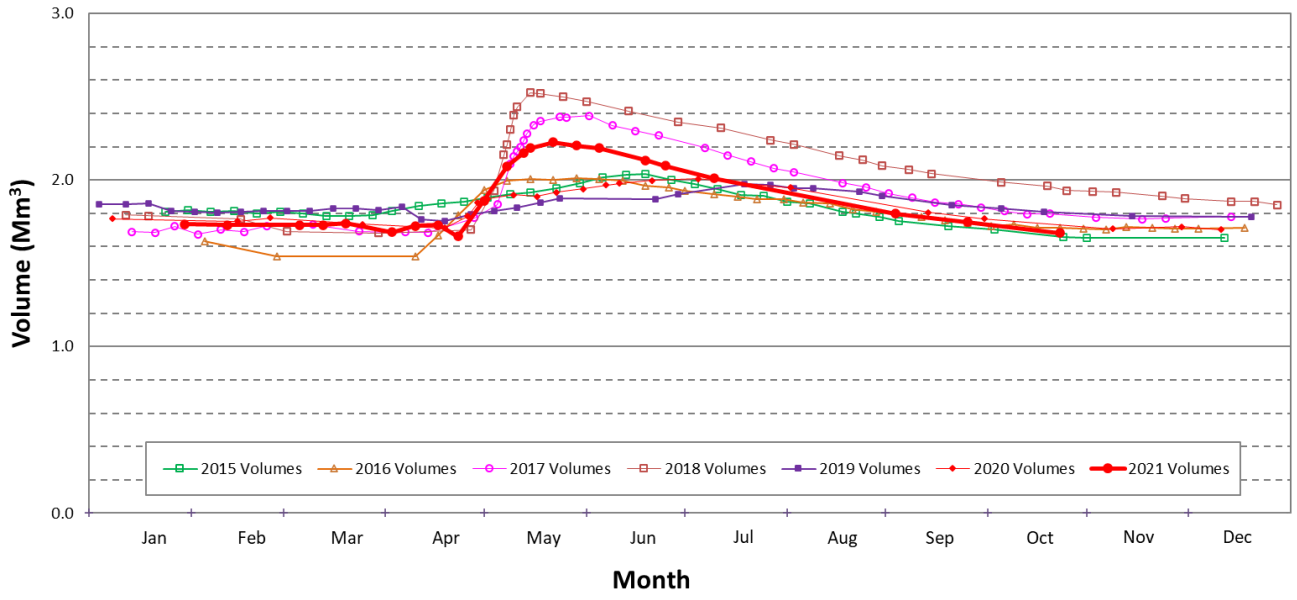
The balance indicates a small reduction in pond volume during 2021 (i.e., outflows > inflows) which is consistent with pond levels at the end of 2021 which were slightly lower but similar to levels at the end of 2020 (Section 5.2).

Table 4.1 Annual Water Balance for Trojan TSF

Item	Volume in 2021[(1)] (m^3)
Inflows	
Direct Precipitation	83,600
Runoff	902,300
Groundwater	9,500
Outflow from Fish Spawning Channel Pond	0
Total Inflow:	*995,400*
Outflows	
Seepage	853,400
Evaporation	200,600
Total Outflow:	*1,054,000*
Net Change	
Net Change (inflow minus outflow)	-58,600

Notes:
1. Values received from HVC have been rounded to the closest 100 m^3.

Figure 4.3 Trojan Pond Volumes – 2015 to 2021



4.4 Flood Management

The flood management structures at the Trojan TSF, applicable design criteria, and flood characteristics are summarized in Table 4.2 with further discussion for each structure below.

Trojan TSF and R4 Seepage Pond

Flood routing assessments for both the Trojan TSF and R4 Seepage Pond were updated (KCB 2022) based on the most recent site wide hydrology (Golder 2021). The analysis concluded the following:

- Trojan TSF can safely route, with adequate freeboard, the original spillway design event (PMF 24-hour) (KC 1994) which is greater than the IDF (Table 4.2) required under the Health, Safety and Reclamation Code for Mines in British Columbia (HSRC) (EMCLI 2021a).
- R4 Seepage Pond can safely, with adequate freeboard, the IDF (Table 4.2) required under the HSRC (EMCLI 2021a). R4 Seepage Pond can route the original design event (PMF 24-hour event) but minimum freeboard is not met.

This work addresses the related recommendations from the Dam Safety Review (DSR) (SRK 2019) and a previous AFPR, as stated in Table 8.1.

Lower Trojan Dam

Based on flood routing using current site hydrology, the LTD requires additional flood management upgrades to route the IDF (Table 4.2) (KCB 2019). The following is noted:

- The facility has been able to manage flood and freshet events without a reported overtopping concern since the most recent upgrade (~32 years), including a 66 mm rainfall event during May 2011 which is equivalent in magnitude to a 100-year return period (rain only) event. In addition, the large freshet events that occurred during 2017 and 2018 were managed without engaging the spillway and maintaining more than the minimum required flood freeboard (0.5 m).
- Starting in 2017, HVC implemented additional measures to manage potential overtopping risks in the event of a large flood: a remote monitoring system is used to monitor the Lower Trojan Pond level; and alert levels are established which, if exceeded, trigger actions such as increased monitoring and deploying pumps to increase discharge capacity.
- During 2022, HVC are progressing alternatives to address the outstanding recommendation during the year.
- While the recommendation is being resolved, HVC have implemented remote monitoring of the Lower Trojan Pond level. If alert pond levels are exceeded, the monitoring system sends out an automated notification to trigger additional actions.

Table 4.2 Inflow Design Flood Requirements for Trojan TSF

Facility	Outfall Type	Inflow Design Flood[(1)]	Spillway Design Event	Peak Design Flood Level	Peak Design Outflow
Trojan TSF	Open channel	2/3rd between 1000-year and PMF	PMF 24-hour	1438.5 m	37.5 m^3/s
R4 Seepage Pond	Open channel	100-year	100-year 24-hour[(2)]	1364.8 m	0.6 m^3/s
Lower Trojan Pond	Open channel and pipe	100-year	100-year 24-hour	Note 3	

Notes:
1. As discussed in Section 7.1, Teck have instructed KCB to no longer report on consequence classification, as defined by CDA (2019). The spillway design event for the Trojan TSF exceeds equivalent IDF required under the HSRC (EMLCI 2021a).
2. The original spillway design event for R4 Seepage Pond (AMEC 2013) was the PMF but this event can no longer be routed with adequate freeboard based on KCB (2022) so the IDF is now the stated spillway design event.
3. The LTD cannot route the IDF required under the HSRC (EMLCI 2021a) and HVC are pursuing approval to decommission the facility in 2022.

5 REVIEW OF MONITORING RECORDS AND DOCUMENTS

5.1 Monitoring Plan

The Operation, Maintenance and Surveillance (OMS) Manual (HVC 2019) was reviewed during the review period and a revised document is planned to be issued in early 2022. This was a routine update to the OMS Manual which included revisions to align with the most recent industry guidance documents (MAC 2019).

The Trojan TSF surveillance program is appropriate for an inactive, reclaimed tailings facility that includes: visual inspections; measured behaviour from piezometers, pond level readings, survey monuments and an inclinometer installed at the facility; and a Trigger-Action-Response-Plan (TARP). Information from routine surveillance activities are reviewed, once completed, by the HVC Tailings Group, including the QP, during the weekly intra-departmental meeting.

During the review period, readings at two piezometers exceeded the threshold for the first (i.e., Notification) level of the TARP. Such exceedances identify piezometric levels that have marginally exceeded (~0.5 m) recent trends and are not related to performance or design compliance concerns. These exceedances are reviewed by the EoR and are discussed in Section 5.3.

HVC compliance with the surveillance program in the OMS Manual (HVC 2019) is summarized in Table 5.1. Routine surveillance activities were completed at the specified frequency with one exception. No readings were taken from 4 of the 12 piezometers installed in the cycloned sand beach. The 8 other piezometers installed in the beach were read during the review period. This information helps confirm piezometric levels in the beach and near the embankment are consistent with design assumptions. KCB recommend HVC prioritize inclusion of these piezometers into the ongoing OMS Manual update and routine monitoring activities to obtain full value from the existing instrumentation.

Table 5.1 Monitoring Activities

TSF Monitoring	Facility	Minimum Frequency[1]	Responsibility	Documentation	2021 Frequency Compliance[1]	Notes for the Review Period
Inspections						
Routine Visual Inspection[2]	Trojan Dam	Monthly	HVC	HVC Inspection Reports	Yes	-
	LTD and R4 Seepage Pond	Quarterly	HVC	HVC Inspection Reports	Yes	-
Event-Driven Inspection	All	Event-Driven[3]	HVC	HVC Inspection Reports	N/A	No event-driven inspections were triggered during 2021.
AFPR	All	Annually	KCB	This Report	Yes	
Dam Safety Review	All	Every 5 years	HVC	Report	n/a	Next DSR is due in 2023.
Instrumentation Monitoring						
Piezometers	Trojan Dam	Quarterly	HVC	AFPR	No	The four piezometers installed in 2019 were not read.
Inclinometers	Trojan Dam	Quarterly	HVC		Yes	-
Seepage flow instruments	Trojan Dam	Quarterly	HVC	HVC Inspection Reports	Yes	-
	LTD	Quarterly	HVC		Yes	
Pond level	Trojan Dam	Quarterly	HVC		Yes	-
	LTD and R4 Seepage Pond	Quarterly	HVC		Yes	-
Surveys						
Survey monuments	Trojan Dam	Annually	HVC	AFPR	Yes	-

Notes:
1. Frequency of routine surveillance activities were modified in 2020 related to site resources restrictions required to meet COVID 19 provincial health regulations, as discussed in Section 5.1.
2. Visual inspections include pond level measurements and observations for any evidence of unusual conditions and/or dam safety concerns (e.g., settlement, sinkholes, slope sloughing, erosion, seepage, piping, etc.).
3. HVC staff are to complete an event-driven inspection in response to one of the following events:
   - Earthquake greater than magnitude 5 within 100 km of the site, or any earthquake felt at site.
   - Rainfall event greater than the 10-year, 24-hour duration storm; 39.9 mm (Golder 2020b).

5.2 Pond Levels and Freeboard

The Trojan Pond level was measured at least monthly during the review period with more frequent readings during 2021 freshet when pond levels were at the seasonal high. There was no discharge through the Trojan TSF spillway during the review period and freeboard exceeded requirements as discussed in Section 1. Pond level seasonal fluctuation during the review period was within the typical range and less than the larger freshet events from 2017 and 2018 (Figure 5.1, Table 5.2).

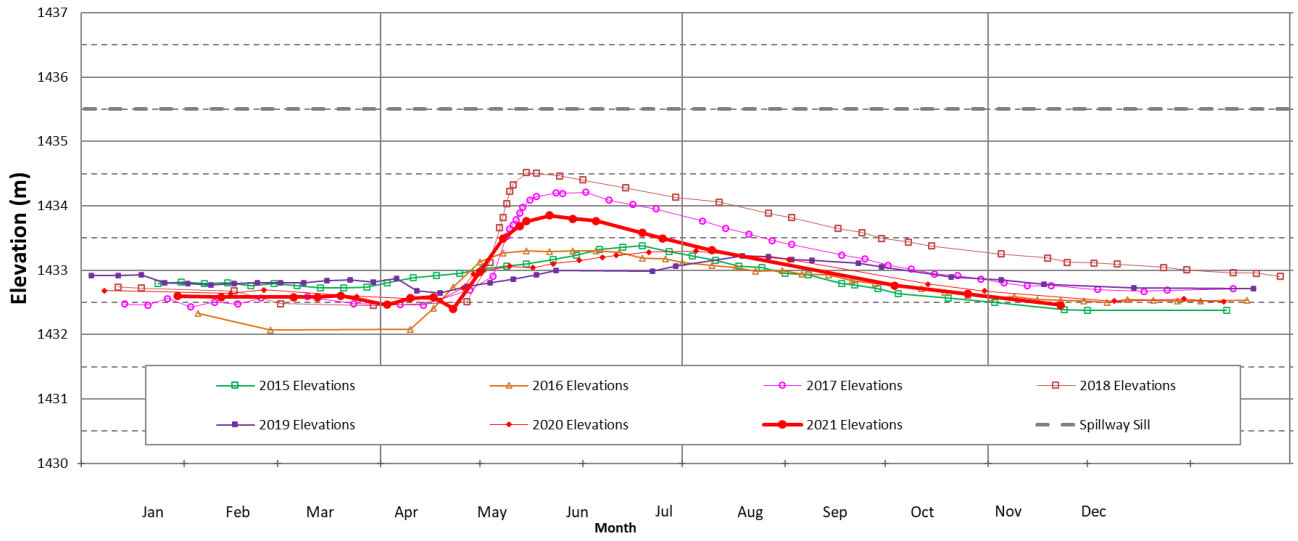
Of note, precipitation during the review period was significantly below average overall, including during April and May 2021 (Figure 4.1) when the pond level rose and peaked. This implies that the rise and fall was driven by snowmelt and not precipitation. Snowmelt being the dominant contributor would also be consistent when comparing to pond levels during 2020, which was a wetter year[3] but the peak pond level was ~0.6 m below the peak during this review period.

Table 5.2 Trojan TSF Change in Pond Elevation

Annual Change	Change in Pond Level 2020 to 2021	Range of Annual Pond Level Change 2015 to 2020
Peak Pond	0.6 m	-0.7 m to 0.6 m (avg. 0.2 m)
Pond at End of Review Period (1)	-0.2 m	-0.5 m to 0.1 m (avg. -0.2 m)

Notes:
1. End of review periods, between 2015 and 2020 is in December.

Figure 5.1 Trojan Pond Water Elevations – 2015 to 2021



The minimum freeboard measured during the review period at Trojan Pond and the downstream seepage ponds are summarized in Table 5.3. Target flood freeboards were met at all facilities during the review period.

[3] ~30% more precipitation was measured at the Kamloops Pratt Road climate station during the 2020 AFPR reporting period in comparison to this reporting period.

Freeboard requirements and predictions during the IDF/spillway design event for R4 Seepage Pond and Trojan TSF (Table 5.3) were updated during the flood routing work discussed in Section 4.4 (KCB 2022). This closed outstanding recommendations from the DSR (SRK 2019).

Table 5.3 Freeboard at Trojan TSF, R4 Seepage Pond and Lower Trojan Pond

Facility	Minimum Freeboard (m) [1]			
	Required During IDF	Predicted During IDF	Required During Non-Flood Conditions	Observed During the Review Period[2]
Trojan TSF	0.2	1.5 [3]	0.2	6.2
R4 Seepage Pond	0.5 [4]	0.5	0.25	1.4
Lower Trojan Pond	0.5 [4]	Note 5	-	1.6

Notes:
1. Refers to minimum vertical distance between dam crest and pond level based on KCB (2022).
2. Based on maximum recorded pond elevation during the review period.
3. As per KCB (2022), Trojan TSF values are based on the spillway design flood event which is greater than the IDF, refer to Section 4.4.
4. Freeboard target of 0.5 m has been adopted by HVC which is greater than the minimum required freeboard to accommodate wave run-up (0.43 m for R4 Seepage Pond, and 0.4 m for the Lower Trojan Dam).
5. As discussed in Section 4.4, upgrades are required to the existing structure to safely pass the IDF with adequate freeboard.

5.3 Piezometers

As of end of September 2021, there are 18 piezometers in the Trojan TSF: 12 standpipes; and six vibrating wire piezometers (VWPs). This includes the four VWPs installed in 2019 but were not read, as discussed in Section 5.1. The current suite of instruments is considered sufficient to monitor key performance indicators, assuming the 2019 VWPs are read. Some of the instruments are reported as defunct or dry. As part of the OMS Manual update, HVC and KCB are reviewing these to confirm whether they are providing representative or useful information or if they should be removed from the surveillance program.

Maximum and minimum piezometric levels since 2009, instrument thresholds, as well as piezometric levels during the review period are reported in Appendix II-B. September 2021 piezometric levels during the review period are shown on typical design sections, along with the surface assumed in stability analyses (Figure II-B-8).

A summary of key observations for readings during the review period, are as follows:

- Two threshold exceedances were measured, during the review period:
  - P86-1 (tip El. 1407.65 m, tailings beach upstream of dam crest) exceeded the previous peak reading (over the past 12 years) by ~0.5 m during the review period. The piezometric level at this location has been rising, at modest rate, since the start of 2017 (~1 m over that period). The piezometric rise during the review period coincides with pond rise and similar rises measured at other instruments in the cycloned sand beach, as shown on Figure II-B-8:

- The piezometric reading projects just above natural ground which confirms the beach is well drained in that area and is >10 m below the peak reading present during operations or assumed in design.

- VWP16-2A (tip El. 1321.85 m, Glacial Till foundation) has measured rising levels since installation with a relatively consistent rate since mid 2018. The current level is 7 m below existing ground which is the assumed piezometric level in design. The pattern suggests this instrument is still equilibrating after installation. The duration of the equilibration period can be extended if the instrument tip was not full saturated at installation and is not in a high flow unit.
- KCB revised the threshold value for both instruments based on the new peak reading to notify if this trend continues.

- Tailings Beach (Cycloned Sand) (Figure II-B-1): piezometric readings and trends during 2021 were typical based on readings over the past 12 years. Piezometers near the crest are measuring piezometric levels 30 m or more below tailings surface, in all cases well below the piezometric levels present during operations and assumed in design analysis. As reported in KCB (2021a), at the highest point of the dam, piezometric levels would have to rise ~50 m to lower the slope stability factor of safety to design criteria and no mechanism capable of such a rise has been identified for the existing condition:
  - P86-3 has been reported as plugged but HVC continue to collect readings which are not representative of the actual piezometric conditions in that area based on all other instruments in the cycloned sand beach. KCB recommends HVC complete a test to confirm whether the instrument is plugged and, if so, remove it from routine monitoring and report it as defunct.
- Starter Dam Fill: Piezometers installed in sand and gravel fill zones of the starter dam (TB-PS-04/P13-3 and TB-PS-03/P13-4) measure low piezometric heads (Figure II-B-2). This indicates the sand and gravel fill of the starter dam is an effective toe drain.
- Foundation: Piezometers installed in the glacial till foundation at the starter dam upstream toe, near the low point of the valley, and beneath the downstream slope, measured low piezometric heads with little variance throughout the year (Figure II-B-2, Figure II-B-3, and Figure II-B-8).

5.4 Survey Monuments

Survey of the monuments at the Trojan TSF (Figure 3), since November 2019, are plotted on Figure II-B-4. In November 2019, HVC started to use GPS Real Time Kinematic (RTK) to survey the monuments which is an improvement over the previous method as readings are showing less variance with respect to Northing / Easting. The baseline location for each monument using the RTK method is offset from the previous method and for that reason surveys prior to November 2019 are not shown on the Northing / Easting plots. However, a continuous record of settlement has been maintained based on incremental change between RTK surveys.

During 2021, there were no threshold value exceedances and the annual survey during the review period was within the cluster of previous readings and showing no prevalent deformation trend. Incremental vertical displacements are positive (i.e., uplift) which could be due to the vertical accuracy of RTK method. Overall magnitude of settlement to date is not impacting freeboard (Section 5.2) or other aspect of performance.

5.5 Inclinometers

The single inclinometer at Trojan Dam (IB16-2), installed in 2016, was read monthly during the review period, when the instrument was accessible. There are no significant deformations in the downstream direction in the readings and no discrete zones of deformation have been observed to date. Cumulative displacements measured at IB16-2 are plotted on Figure II-B-5.

Since the inclinometer was installed in 2017, the data indicates no deformation trends or observations of concern. Based on this, KCB recommended to HVC that the reading frequency of the inclinometer could be reduced to twice per year (min. 5 months apart) which they have adopted and will be included in the next OMS Manual update.

5.6 Seepage

Seepage flow measured at weirs downstream of the Trojan TSF are plotted and reported in Appendix II-B. The number and relative locations of the active weirs are listed below:

- two weirs (TB-R4-FS-01 and TB-R4-FS-02) located immediately upstream of R4 Seepage Pond, which measure flow from the collection ditch along the Trojan Dam toe; and
- two weirs located upstream (TB-LT-FS-02) and downstream (TB-LT-FS-01) of Lower Trojan Pond, which measure flow to and from LTD, respectively. TB-LT-FS-01 measures a combination of outflow from LTD and the Trojan diversion pipe.

Flows were recorded by a data logger at each weir and were consistent with previous trends. Visual inspections did not observe turbid flow or other unsatisfactory condition. The highest seepage flow at Lower Trojan weir (TB-LT-FS-01) is within the typical range for freshet.

5.7 Water Quality

Permit PE-376 specifies minimum water quality sampling requirements at HVC, including downstream of the Trojan TSF (refer to Appendix III). Water sampling activities and results are reported in the following report, which were provided to KCB for review:

- 2021 Annual Water Quality Monitoring Report (ERM 2022)

The report was signed by a qualified professional in the related field and should be referred to for monitoring data and discussion of results. The EoR (Mr. Friedel, P.Eng.) reviewed the documents (ERM 2022) for discussion related to items of compliance with sampling requirements and key observations, which are summarized as follows:

- There are fifteen permitted and one voluntary surface water quality monitoring sites in the Trojan-Bethlehem area, seven of which are upstream or downstream of the Trojan TSF, as shown on the site monitoring plan in Appendix III.
- HVC met the required sampling frequency and parameters tested with exceptions at two sites where not all parameters were tested, as noted in the report (ERM 2022).
- Permit PE-376 establishes maximum permitted limits for specified parameters of interest at the point of discharge to the receiving environment. Seepage water coming from the Trojan TSF is a component of this discharge. Compliance is measured downstream of the facility in Witches Brook (Site 304, Appendix III). The permitted limit for total copper concentration was exceeded at Site 304 in five samples collected during freshet (April and May 2021). The exceedances were reported to the British Columbia Ministry of Environment and Climate Change Strategy (ENV). HVC completed confirmatory sampling at an increased frequency, following the initial non-compliance, until total copper concentrations decreased below the permitted limit.
  - Site 304 is downstream of several mine areas, including the Trojan TSF, but also contains a non-mine influenced component, sourced upstream of the Trojan TSF and other HVC disturbances. The source of the exceedance has not been identified and may not be related to the Trojan TSF. HVC are planning to modify sampling during freshet in an attempt to identify the source of the exceedance.

6 VISUAL OBSERVATIONS AND PHOTOGRAPHS

Copies of the site visit forms, photographs and summary observations made during the AFPR site visit are included in Appendix I. No issues in terms of dam safety were observed. A summary of key observations and comments during 2021 AFPR site visit is as follows:

- Vegetation clearing (routine maintenance) is required at the spillway inlets and some other areas of each facility as noted in Appendix I. In December 2020, HVC received permit approvals to complete the necessary clearing as part of routine maintenance. The LTD Spillway was cleared during the review period.
- LTD – the facility comprises two basins, referred to as the upper and lower basins. The upper basin comprises several smaller connected areas where water ponds. There was active flow from the upper basin to the lower basin at the time of the site visit. During the site visit, HVC confirmed the upper basin is included in routine visual inspections and is included in the scope for the planned decommissioning (Section 4.4).
- LTD LLO – build up of debris on the trash rack and change to the debris boom was noted during the AFPR site visit. After the inspection, both of these were resolved by HVC as part of routine maintenance.
- R4 Seepage Pond – Good physical condition. LLO valve cannot be hand turned. The need to close the valve is not a critical control for the structure but HVC may want to fix the valve for routine operations.

7 ASSESSMENT OF DAM SAFETY

7.1 Review of Potential Downstream Consequences

Consequence classification is not part of HVC's tailings management governance, and they have instructed KCB not to include it when reporting on the Trojan TSF or supplementary structures. Potential consequences from credible failure modes are managed through a rigorous risk management process. HVC provided the following regarding the change:

> *Consequence Classification has traditionally been used to select appropriate design criteria for tailings facilities. The use of Consequence Classification comes from the Water Dams industry and have components that do not align with Mining's safety culture – a culture that Teck fully embraces. Traditional and existing Consequence Classification schemes have a typical five level of hypothetical consequence that includes the potential for human fatality right down to the second lowest level. For Teck, any fatality would be of extreme consequence. Further, per the GISTM, designing for closure and the perpetual timeframe for the tailings facilities means adopting extreme loads (e.g., GISTM recommends both 1:10,000 earthquake and precipitation events) which render any other classification unnecessary. Finally, the use of hypothetical failures that are not based on credible modes, or lack thereof, for a given facility creates a false narrative that hampers effective and transparent community discussions and confusing discussions with regulators and investors.*

To support this approach, HVC are in the process of adopting design loading for earthquake and flood scenarios equivalent to an Extreme consequence classification (CDA 2019) for tailings facilities. This approach:

- meets or exceeds the HSRC (EMLCI 2021a) requirements;
- aligns with Teck's goal to eliminate any risk for loss of life; and
- is consistent with the GISTM (2020), which supports evolving beyond the conventional consequence classification system.

Trojan TSF is already designed to the extreme flood (i.e., PMF) condition and the design earthquake (1/2 between 2,475-year and the 10,000-year return period earthquakes) was selected to meet requirements of the HSRC (EMLCI 2021a). However, dam stability is not very sensitive to the magnitude of the seismic load so the dam would still meet criteria if the design earthquake were increased to the 10,000-year return period event.

HVC utilize a similar approach to manage potential credible failure modes for management of the water retaining structures that supplement operation of the Trojan TSF (e.g., LTD and R4 Seepage Pond).

The conditions and land use downstream of the Trojan TSF were reviewed by HVC and KCB on April 15, 2021 and no significant changes were identified.

7.2 Status of 2018 Dam Safety Review Recommendations

A DSR site visit of the Trojan TSF and seepage collection ponds was completed by SRK Consulting (SRK) in 2018 with the final report issued in March 2019 (SRK 2019). The report concluded the facility is well-managed with a high level of technical stewardship and appropriate operating procedures. The credible failure modes are understood and effectively controlled.

The DSR included 16 recommendations related to dam safety for the Trojan TSF and seepage ponds. At the start of the current AFPR review period seven recommendation were outstanding, and five have been addressed as reported in Appendix IV. The remaining two recommendations are scheduled to be addressed in 2022. Recommendations that were documented as addressed in a previous AFPR reports are not included in Appendix IV.

7.3 Failure Mode Review

HVC's long-term goal for all tailings storage facilities is to reach landform status, so that the structures can be declassified as a "dam." KCB fully supports HVC towards achieving this long-term goal and their adoption of the GISTM (2020) for tailings management.

Design and operational controls in place to manage potential failure modes, and their status at the end of the review period, are summarized below. All potential failure modes are reviewed and characterized in the facility risk assessment (AMEC 2019), which was reviewed and updated by HVC and KCB during the review period.

7.3.1 Trojan Dam

Overtopping:

The spillway design flood (PMF) greater than the minimum IDF (Table 4.2) recommended under the HSRC (EMLCI 2021a) and is an effective control to manage overtopping risks. In addition, under existing conditions, the following additional controls and factors significantly reduce the potential for overtopping:

- Beach width: even during a peak PMF flood level, the tailings beach between the pond and dam crest would be 90 m or more.
- Freeboard: the Trojan TSF has maintained a freeboard greater than 5.5 m (since 2016) under normal and freshet conditions. Even under peak PMF flood level, the minimum freeboard between the pond and low point of the perimeter crest would be 1.5 m. This exceeds the minimum freeboard required to accommodate wave run-up and wind (~0.6 m).

Slope Stability:

The existing condition of the dam meets design factor of safety criteria for global slip surfaces which would result in an uncontrolled release of tailings under static ($\geq$ 1.5) and post-earthquake ($\geq$ 1.2) loading (KCB 2020). The tailings are retained by a drained sandy tailings beach and embankment, which is supported by a compacted rockfill Starter Dam with underdrains and is founded on a competent Glacial Till.

There were multiple layers of control included in design and operation of the Trojan TSF to prevent structural failure of the dam. These included measures to reduce the likelihood of saturated, fine-grained tailings from being deposited within a certain distance from the embankment and having a pervious Starter Dam to provide underdrainage for the cycloned sand beach. Cone penetration tests through the beach area demonstrate these were successful and the as-built condition of the facility is consistent with design assumptions.

Internal Erosion:

The primary controls to manage internal erosion risks through the dam are:

- Wide tailings beach which reduces the piezometric levels and seepage gradients near the dam, and the filter zones on the upstream slope of the Starter Dam.
- Filter zones on the upstream slope of the Starter Dam.

There is a culvert buried below the Starter Dam which was used to divert creek flows during Starter Dam construction (Figure 2). The upstream 15 m of the culvert were plugged with concrete prior to tailings deposition in the impoundment. No turbid seepage or other indicators of material being washed through the culvert have been observed under existing conditions and during operations, when seepage gradients and piezometric levels were higher than existing.

7.3.2 R4 Seepage Pond

Overtopping:

To manage overtopping risks, the design flood for the emergency spillway (100-year) meets the requirements under the HSRC (EMLCI 2021a). The spillway is capable of routing much larger events, including the PMF, 24-hour duration, albeit with less than minimum flood freeboard.

Slope Stability:

The existing condition of the dam meets the design factor of safety criteria for global slip surfaces which would result in an uncontrolled release of water under static ($\geq$ 1.5) and post-earthquake ($\geq$ 1.2) loading (KCB 2021b).

7.3.3 Lower Trojan Pond

Overtopping:

An outlet pipe and spillway are in place to manage overtopping risks. As noted in Section 4.4, additional flood management upgrades are required to route the IDF (100-year return period) (KCB 2019). HVC are pursuing approval to decommission the facility in 2022. If this is not successful, the flood routing capacity will be upgraded to route the IDF. Refer to Section 4.4 for further discussion on the ongoing upgrade works, interim mitigations and previous flood performance.

7.4 Emergency Preparedness and Response Plan

The EPRP for the Trojan TSF forms a part of the OMS Manual (HVC 2019) and is being reviewed as part of the ongoing OMS Manual updates to ensure it remains consistent with changes made to the OMS Manual and site emergency response procedures.

As part of the update, HVC contacted off-site emergency response resources to ensure that all contact information was current. The EPRP includes a list of preventative measures to take in response to potential unusual or emergency conditions. The EPRP is appropriate for the existing structure and is linked to the site-wide emergency response plan.

On January 18, 2022, participants from HVC's operation team (including site management), the HVC QP, and the EoR tested the EPRP using a hypothetical scenario at tailings facility on-site.

8 SUMMARY

Based on the review of measured performance and observations summarized herein, KCB conclude the Trojan TSF performed as expected, and within design requirements during the review period from October 2020 through September 2021.

Dam safety recommendations identified during past AFPRs, and their current status, are summarized in Table 8.1. During the review period, the recommendation scheduled for completion during the review period was closed (shown in *italics*), and the other is scheduled for completion in 2022. Five of the seven outstanding recommendations from the most recent DSR (SRK 2019) were addressed during the review period with the remaining two scheduled for completion in 2022.

Two new recommendations were identified during the 2021 AFPR (Table 8.2). Both are related to instrumentation and have been assigned a Priority 3, meaning they are not required to address a potential dam safety concern but are necessary to implement the surveillance programs as intended.

Table 8.1 Previous Recommendations Related to Facility Performance – Status Update

ID No.	Performance Area	Recommended Action	Priority(1)	Recommended Deadline (Status)
Trojan Dam				
TD-2018-02	*Flood Routing*	*Update flood routing assessment for Trojan TSF structures based on the most recent site wide hydrology information for consistency and to confirm compliance.*	*3*	*CLOSED*
Lower Trojan Dam				
LTD-2017-01	Inflow Design Flood	Complete appropriate upgrade works to allow LTD to safely pass IDF with adequate freeboard, including decommissioning of the spillway pipe.	2	2022

Notes:
1. Recommendation priority guidelines, specified by HVC and assigned by KCB:
   Priority 1: A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
   Priority 2: If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or a repetitive deficiency that demonstrates a systematic breakdown of procedures.
   Priority 3: Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
   Priority 4: Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.
2. No Outstanding Recommendations for R4 Seepage Pond.

Table 8.2 2021 Recommendations Related to Facility Performance

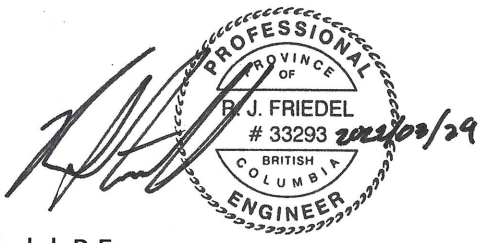
ID No.	Performance Area	Recommended Action	Priority(1)	Recommended Deadline (Status)
Trojan Dam				
TD-2021-01	Instrumentation	Complete a test to confirm whether P86-3 is plugged and, if so, remove it from routine monitoring and report it as defunct.	3	Q2 2022 OPEN
TD-2021-01	Instrumentation	Prioritize inclusion of the piezometers installed in 2019 into routine monitoring activities, as per the OMS Manual, to obtain full value from the existing instrumentation.	3	Q2 2022 OPEN

Notes: Refer to Table 8.1 notes.

9 CLOSING

We thank you for the opportunity to work on this project. Should you have any questions, please contact the undersigned.

KLOHN CRIPPEN BERGER LTD.
B.C Permit to Practice No. 1000171



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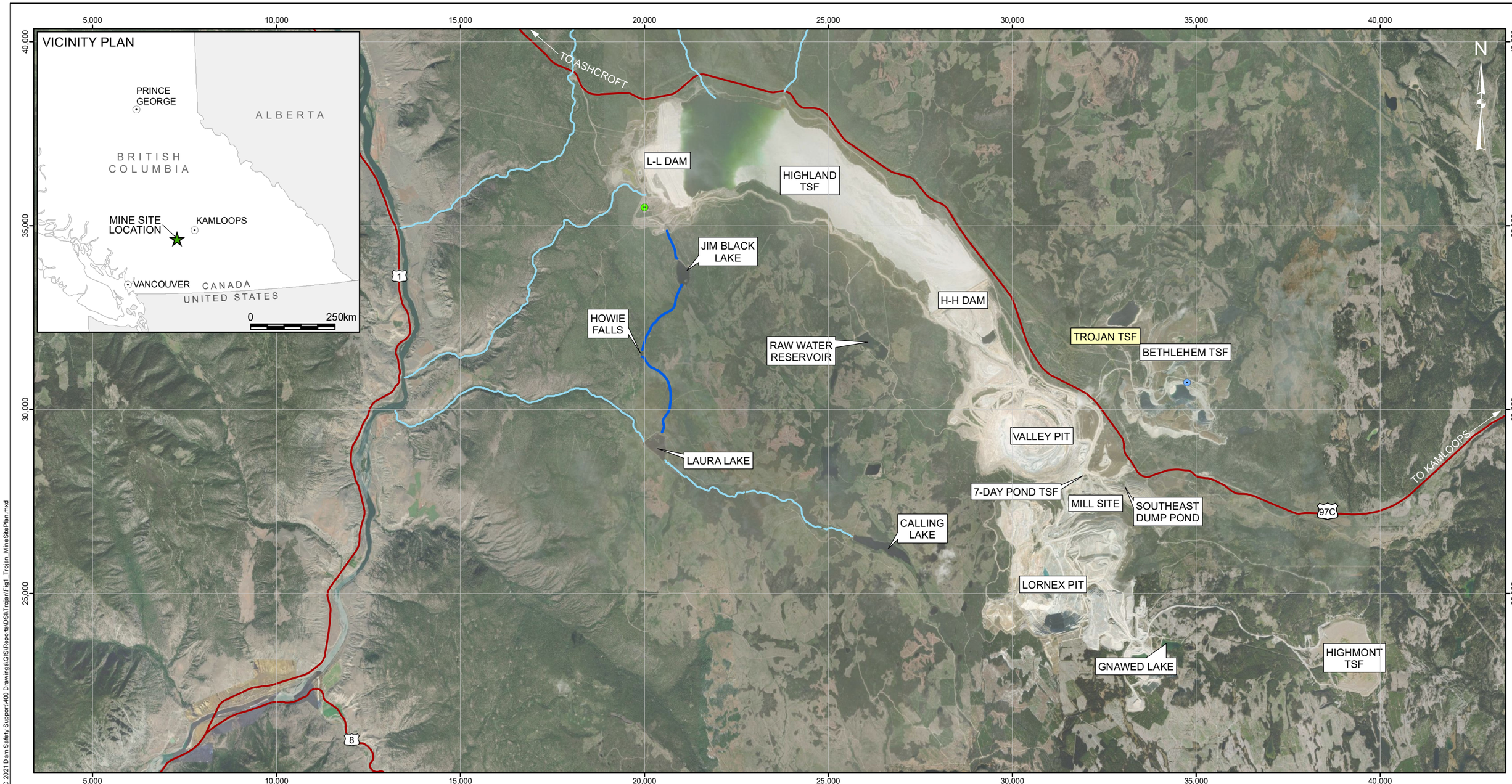
FIGURES



LEGEND

- L-L DAM CLIMATE STATION
- HIGHLAND VALLEY SNOW SURVEY STATION (NO. 1C09A)
- CREEK/RIVER
- HIGHWAY
- DITCH

0 5km

NOTES:
1. PROJECTION: HVC MINE GRID.
2. TSF = TAILINGS STORAGE FACILITY.
3. BASE DATA PROVIDED BY THE GOVERNMENT.
4. IMAGERY PROVIDED BY ESRI.
5. SNOW SURVEY LOCATION FROM GOVERNMENT OF BRITISH COLUMBIA SNOW STATIONS INTERACTIVE MAP, ACCESSED NOVEMBER 2021.

CLIENT: Highland Valley Copper / Teck

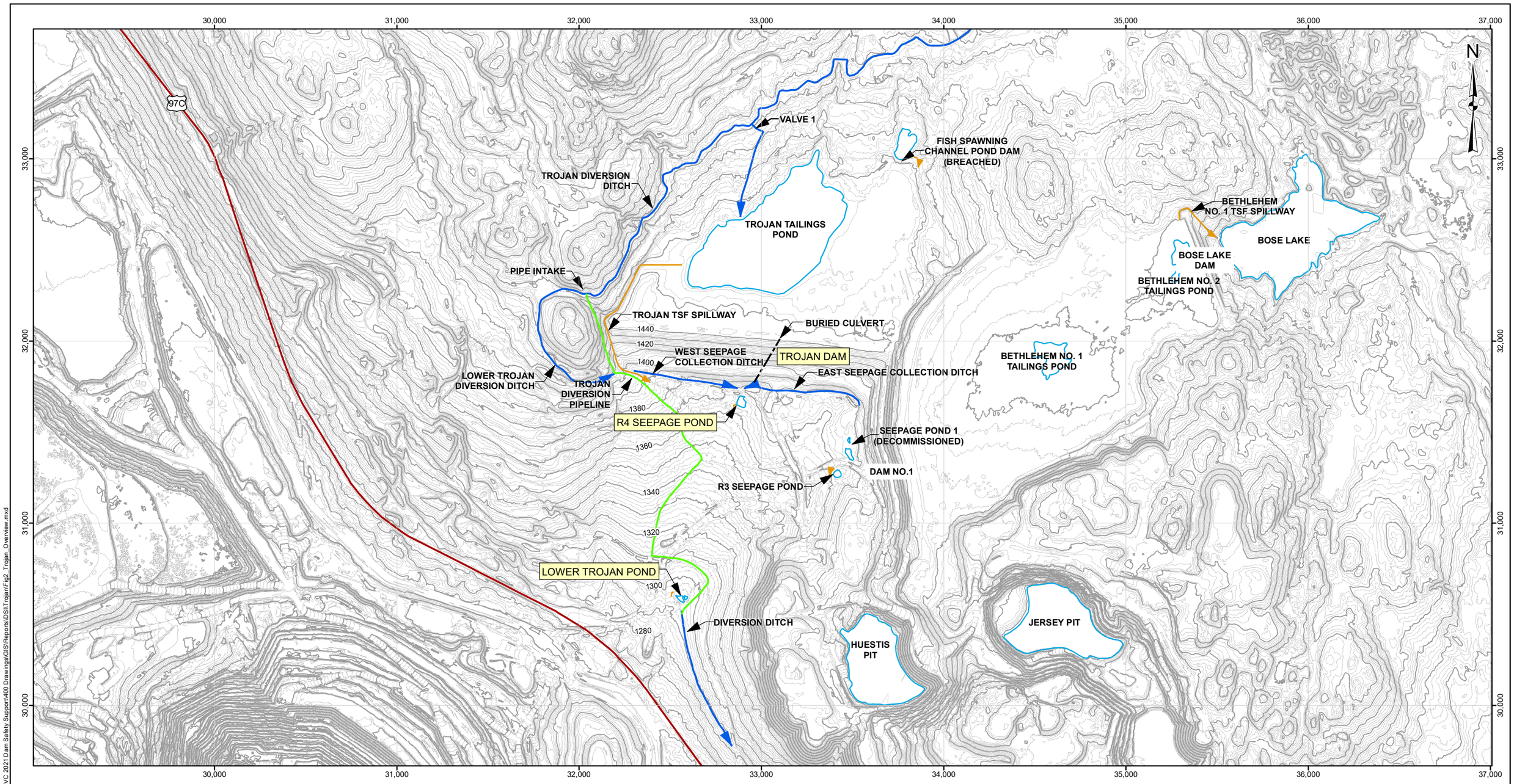
Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: MINE SITE PLAN

SCALE	PROJECT No.	FIG No.
AS SHOWN	M02341C12	1

Date: 2021-12-24
Document Path: \\vt.klohn.com\Proj\Data\M\VCR\M02341C12-HVC 2021 Dam Safety Support\400 Drawings\GIS\Reports\DSI\TrojanFig1_Trojan_MineSitePlan.mxd



LEGEND

- SPILLWAY
- DITCH
- ABOVE GROUND PIPELINE
- BURIED CULVERT
- HIGHWAY (97C)
- WATERBODY

0 1,000 m

NOTES:
1. PROJECTION: HVC MINE GRID.
2. TSF = TAILINGS STORAGE FACILITY.
3. TOPOGRAPHY FROM HVC, LIDAR FLOWN ON AUGUST 23RD, 2014.
4. TAILINGS AND SEEPAGE POND EXTENTS BASED ON IMAGERY FROM SEPTEMBER, 2016.

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: TROJAN TAILINGS STORAGE FACILITY OVERVIEW

SCALE	PROJECT No.	FIG No.
AS SHOWN	M02341C12	2

Date: 2021-12-24
Document Path: \\int.klohn.com\Proj\Data\MVCR\M02341C12-HVC 2021 Dam Safety Support\400 Drawings\GIS\Reports\DS\TrojanIFig2_Trojan_Overview.mxd

0 500m

LEGEND

INSTRUMENT TYPE (ACTIVE)	INSTRUMENT TYPE (DEFUNCT)		
STANDPIPE PIEZOMETER	STANDPIPE PIEZOMETER	WAYPOINT (TRJ-2021-XX)	SPILLWAY
VIBRATING WIRE PIEZOMETER	PNEUMATIC PIEZOMETER	CONE PENETRATION TEST	DITCH
INCLINOMETER		WEIR	ABOVE GROUND PIPELINE
		SURVEY MONUMENT	

NOTES:
1. PROJECTION: HVC MINE GRID.
2. IMAGERY OBTAINED SEPTEMBER, 2020, SUPPLEMENTED WITH IMAGERY FROM ESRI.
3. TOPOGRAPHY FROM HVC, LIDAR FLOWN ON AUGUST 23RD, 2014.
4. REFER TO FIGURE II-B-8 IN APPENDIX II-B FOR SECTION DETAILS.

CLIENT
Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT
TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE
TROJAN DAM
PLAN

SCALE	PROJECT No.	FIG No.
AS SHOWN	M02341C12	3

Date: 2022-03-01
Document Path: \\int.klohn.com\ProjData\MIVCR\M02341C12-HVC 2021 Dam Safety Support\400 Drawings\GIS\Reports\DSI\Trojan\Fig3_Trojan_DamPlan.mxd

LEGEND

INSTRUMENT TYPE (ACTIVE)
- WEIR

INSTRUMENT TYPE (DEFUNCT)
- STANDPIPE PIEZOMETER

- WAYPOINT (TRJ-2021-XX)
- SPILLWAY
- DITCH
- BURIED PIPELINE

0 50m

NOTES:
1. PROJECTION: HVC MINE GRID.
2. IMAGERY OBTAINED SEPTEMBER, 2020.
3. TOPOGRAPHY FROM HVC, LIDAR FLOWN ON AUGUST 23RD, 2014.
4. THE STATUS OF THE ORIGINAL OUTLET PIPE IS UNKNOWN.
5. LOCATIONS OF BURIED PIPES ARE APPROXIMATE.

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: R4 SEEPAGE POND DAM
PLAN

SCALE	PROJECT No.	FIG No.
AS SHOWN	M02341C12	4

Date: 2022-01-05
Document Path: Z:\MVCR\M02341C12-HVC 2021 Dam Safety Support\400 Drawings\GIS\Reports\DS\\TrojanFig4_Trojan_R4SeepagePond.mxd

LEGEND

- △ WAYPOINT (TRJ-2021-XX)
- ♦ WEIR
- SPILLWAY
- BURIED PIPELINE
- DITCH
- ABOVE GROUND PIPELINE

0 50m

NOTES:
1. PROJECTION: HVC MINE GRID.
2. IMAGERY OBTAINED SEPTEMBER, 2020.
3. TOPOGRAPHY FROM HVC, LIDAR FLOWN ON AUGUST 23RD, 2014.
4. LOCATIONS OF BURIED PIPES ARE APPROXIMATE.

CLIENT: Highland Valley Copper / Teck

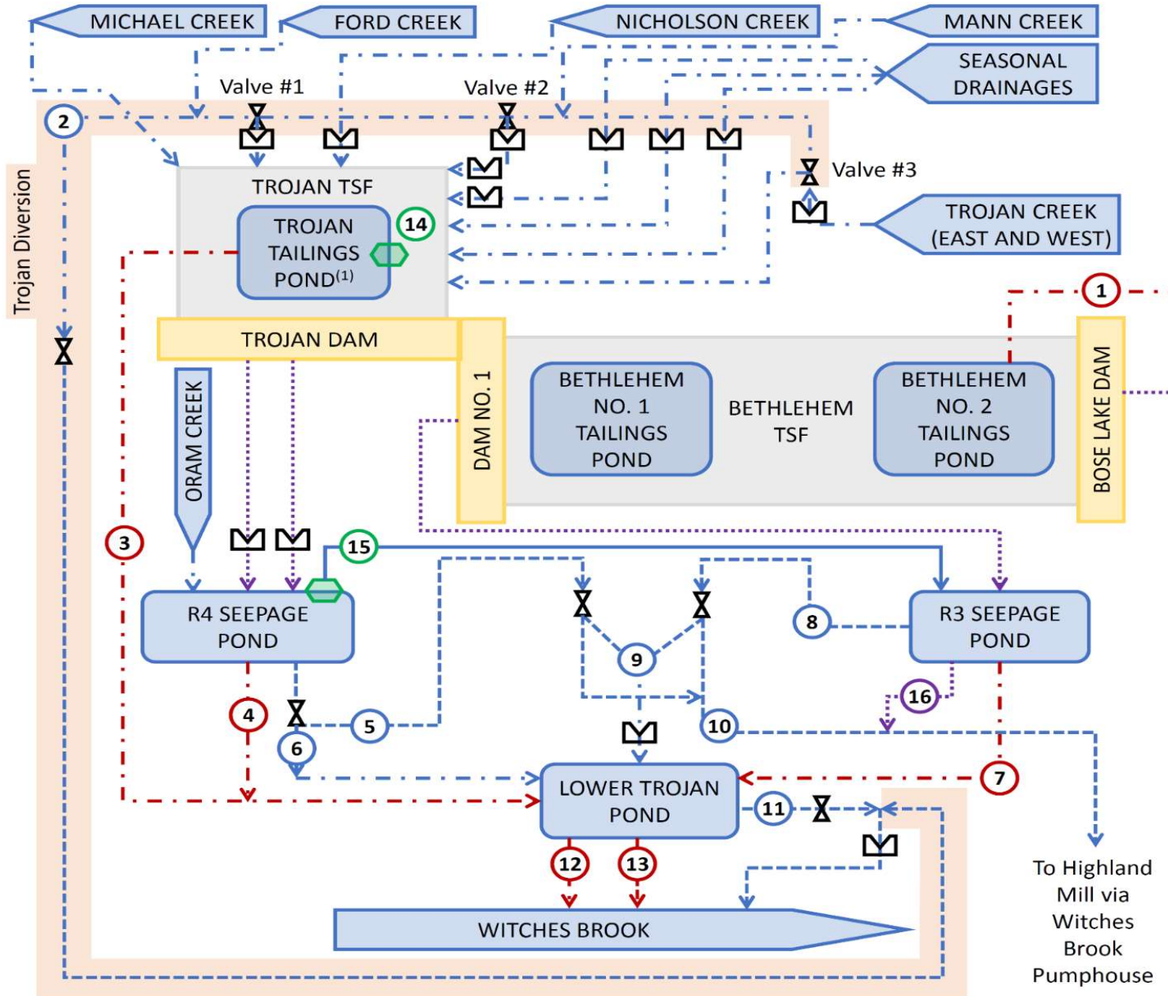
Klohn Crippen Berger

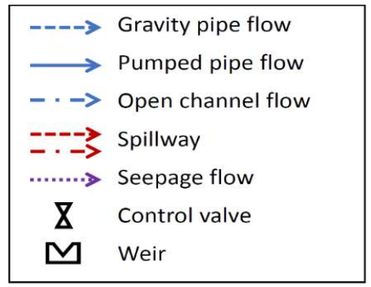
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

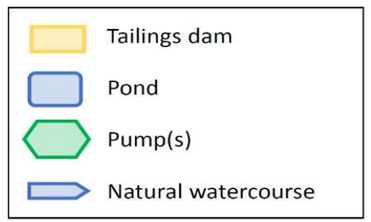
TITLE: LOWER TROJAN DAM
PLAN

SCALE	PROJECT No.	FIG No.
AS SHOWN	M02341C12	5

Date: 2022-01-05
Document Path: Z:\MV\CRM\02341C12-HVC 2021 Dam Safety Support\400 Drawings\GIS\Reports\DS\TrojanFig5_Trojan_LowerTrojanDam.mxd







Note:

1: The minimum water level in Trojan Tailings Pond is 1432.1m to maintain fish habitat.

No.	Name	Description	Status
1	Bose Lake Spillway	3 m wide channel with concrete sill founded in tailings (3 m wide, vegetated) and natural ground (3 m, riprap-lined)	Operational
2	Trojan Diversion	6.5 km long series of channels, culverts, and pipelines	Operational
3	Trojan Spillway	957 m open channel founded in tailings (5 m wide, vegetated), natural ground (3 m, riprap-lined) and bedrock (3 m)	Operational
4	R4 Spillway	2 m wide riprap-lined channel	Operational
5	R4 Low-Level Outlet	300 mm dia. HDPE pipe with U/S and D/S control valves and intake trash rack	Operational
6	R4 Overflow	100 mm dia. HDPE pipe with U/S control valve	Operational
7	R3 Spillway	2 m wide riprap-lined channel	Operational
8	R3 Low-Level Outlet	460 mm dia. HDPE pipeline with D/S control valve	Operational
9	R3/R4 Seepage to Lower Trojan Pond	Open channel from Valve Box to Lower Trojan Pond	Operational
10	R3/R4 Seepage to Northern Collection Line	10" dia. buried steel pipeline	Operational
11	LTP Low-Level Outlet	460 mm dia. HDPE pipe with valve and intake trash rack	Operational
12	LTP Spillway	7 m wide channel	Operational
13	LTP Overflow	810 mm dia. HDPE pipe	Operational
14	Trojan Pump	Pump for Trojan Tailings Pond	Non-operational
15	R4 Pump to R3 Pond	Steel pipe from R4 Pumphouse discharge to R3 Pond	Non-operational
16	R3 Overland Collector	8"-12" HDPE pipe collecting surface water	Operational

CLIENT
Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT
TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE
FLOW SCHEMATIC FOR BETHLEHEM NO. 1 AND TROJAN TAILINGS STORAGE FACILITIES

SCALE	PROJECT No.	FIG. No.
NTS	M02341C12	6

FILE PATH: Z:\MV\CR\M02341C12-HVC 2021 DAM SAFETY SUPPORT\700 DELIVERABLES\720 WORKING\2021 AFPR\TROJAN\FIGURES\DO NOT ISSUE - FOR PFD (FIG6)\211129 - FIG 6-PFD.XLSX - 2021-11-29 12:55

APPENDIX I

Annual Facility Performance Report
Site Visit Checklists, Observations and Photographs

APPENDIX I-A

Trojan Dam

Site Visit Checklist, Observations and Photographs

Appendix I-A
Annual Facility Performance Report Site Visit Checklist, Observations and Photographs – Trojan Dam

SITE VISIT CHECKLIST

Facility:	Trojan Dam	**Site Visit Date:**	September 17, 2021
Weather:	Sunny	**Inspector(s):**	Rick Friedel, P.Eng. Anna Geller, EIT
Freeboard (pond level to dam crest):	7.4 m based on the September 24, 2021 pond survey.		

Outlet Condition Survey

Description	Outlet Controls?	Was it Flowing?	Flow rate
Spillway Channel	N/A	☐ Yes ☒ No	N/A

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

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Beach	☒ Yes ☐ No	Debris Boom	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Channel	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No
Drains	☒ Yes ☐ No		

Were any of the following ***POTENTIAL PROBLEM INDICATORS*** found?

INDICATOR	EMBANKMENT	SPILLWAY
Piping	☐ Yes ☒ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☒ No
External Erosion	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No

List and describe any deficiencies (all deficiencies require assessment and/or repair):
- No dam safety deficiencies observed.

Comments / Notes:
- Refer to Site Visit Observations section.

SITE VISIT OBSERVATIONS

Crest

Crest was observed to be in good physical condition with no indication of erosion or deterioration. Local low points (<1 m) and "hummocky" surface observed and believed to be primarily related to grading for land reclamation. Freeboard is uncompromised by these features.

Left Abutment

Good physical condition with no excessive scour damage or visual evidence that road has been cut down, impacting freeboard and minimum beach width under peak flood.

Right Abutment

The right abutment is in good physical condition with no sign of deterioration or erosion. Spillway channel is excavated through bedrock and Glacial Till material, parallel to the dam abutment.

No change to surface erosion area near crest, at most western portion of the crest, initially referenced during 2018 Annual Facility Performance Review (Photo I-A-9).

Downstream Slope

Good physical condition. Downstream slope is well vegetated with grass and has no observed locations of concern or signs of adverse displacement (Photo I-A-1).

Toe Collection Ditches

Good physical condition. Extensive vegetation observed, which provides a measure of erosion protection. Seepage flow (clear, no turbidity observed) observed through ditches and weirs. Weirs in good condition, and no sign of obstructions in either toe collection ditches.

Seepage

No seepage observed from face but seepage does report to toe ditch, consistent with historical performance and design.

Tailings Beach

Good physical condition. No issues of concern observed during the site visit. Elevation of the vegetated portion of the beach is approximately 2 m above the reservoir level (Photo I-A-2 to Photo I-A-4).

Pond

There was no indication of recent high-water above typical levels, at the time of the site visit (Photo I-A-3).

Spillway Inlet and Approach Channel

Boom secured in place, with no obstructions present besides minor vegetation. Spillway inlet in good condition with no signs of deterioration (Photo I-A-4 and Photo I-A-5).

Spillway Channel

- **General:**
  - Following the first bend in the channel, the vegetated Glacial Till channel transitions to a bedrock excavated channel at the right abutment of the dam (Photo I-A-6).
  - Spillway channel riprap increases in size as the channel grade steepens towards the outfall. No major obstructions or deterioration were observed along the channel (Photo I-A-5 to Photo I-A-7). In December 2020, HVC received permit approvals to complete clearing of vegetation as part of routine maintenance.
- **Erosion features:**
  - No change to surface erosion scour at the riprap section of Trojan Dam spillway observed during 2018 Annual Facility Performance Review. No active seepage faces, or erosion were observed.
- **Spillway extension section:**
  - Riprap appears to be in good condition and has not received flow since construction in 2018 (Photo I-A-10).

SITE VISIT PHOTOGRAPHS

LEGEND:

- TRJ = Trojan Tailings Facility
- TRJ-2021-## refers to 2021 AFPR waypoint shown on Figure 3
- All photographs taken during the site visit on September 17, 2021.

Photo I-A-1 Overview of Trojan Tailings Pond and Trojan Dam downstream slopes from the Bethlehem Dam crest. No visible erosion or scour (TRJ-2021-01)

Photo I-A-2 Overview of Trojan Tailings Pond and tailings beach from Trojan Diversion Channel (TRJ-2021-02)

Photo I-A-3 Overview of Trojan Tailings Pond. Sand beach is exposed. Spillway inlet is visible. Debris boom is secured (TRJ-2021-03)

Photo I-A-4 Trojan spillway inlet. Approach channel is clear and debris boom is secured. (TRJ-2021-03)

Photo I-A-5 Trojan spillway approach channel looking downstream (TRJ-2021-03)

Photo I-A-6 **Overview of upper segment of spillway, downstream of approach channel, looking toward southwest (top photo) and looking toward northeast (bottom photo). No sign of weathering/disruption of riprap was observed. No evidence of sloughing of cut slopes was observed. Channel is heavily vegetated with shrubs and bushes. In December 2020, THVCP received permit approvals to clear vegetation so the work can be included in routine maintenance.**

Photo I-A-7 **Spillway channel, downstream of rock chute, near transition to riprap segment, looking toward south (top) and looking north (bottom). Minor vegetation and sediment accumulation but would not significantly impact flood capacity as it would be washed away by spillway flows prior to peak discharge. (TRJ-2021-05)**

Photo I-A-8 **Sand on the base of the spillway, not visual change from previous site visit. Sand appears to have been placed/deposited on top of riprap, suggesting this is not related to piping/seepage. No active seepage faces. This is not a dam safety concern. (TRJ-2021-05)**

Photo I-A-9 **Surface erosion / scour feature near western edge of crest. No visual indication of scour developing further since HVC regraded area (in 2019) to divert water away from this point. No additional follow up required. (TRJ-2021-05)**

Photo I-A-10 Overview of extension to Trojan Dam spillway channel, built in 2018, at the toe of the right abutment. Channel in foreground is surface channel that drains into, but is not part of, the spillway channel (TRJ-2021-06)

Photo I-A-11 Example of liner damage observed along Trojan Diversion ditch. Not a dam safety issue but should be repaired as part of general maintenance activities. (TRJ-2021-07)

Photo I-A-12 Trojan Diversion Ditch (TRJ-2021-07)

Photo I-A-13 Water flowing at the pipe intake southwest of Trojan TSF. Outlet valve here is open. Gate has minor debris accumulation. No flow bypassing diversion (i.e. flowing further downstream of channel). (TRJ-2021-08)

Photo I-A-14 Upstream potion of Trojan Diversion Pipeline, near discharge from Trojan Diversion, well supported with no leaks observed. Water discharging / valve open. (TRJ-2021-08)

Photo I-A-15 Trojan Diversion Valve 1 was closed (no flow into impoundment) and locked. Valve is located at the transition of unlined channel to lined channel. (TRJ-2021-09)

Photo I-A-16 Open channel downstream of Trojan Diversion Valve 1. Valve 1 was closed during the site visit and there was no discharge from Trojan Diversion Valve 1 Pipe into the impoundment. No sign of excessive scour or erosion damage. (TRJ-2021-09)

APPENDIX I-B

R4 Seepage Pond Dam

Site Visit Checklist, Observations and Photographs

Appendix I-B
Annual Facility Performance Report Site Visit Checklist, Observations and Photographs – R4 Seepage Pond Dam

SITE VISIT CHECKLIST

Facility:	R4 Seepage Pond Dam	**Site Visit Date:**	July 22, 2021
Weather:	Mostly cloudy / smoky	**Inspector(s):**	Rick Friedel, P.Eng. Delton Breckenridge, EIT
Freeboard (pond level to dam crest):	1.0 m based on maximum water elevations on July 22nd from remote pond level monitoring system		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate	Visual Review?	Testing / Detailed Site Visit?
Low Level Outlet	☒ Yes ☐ No	☒ Yes ☐ No	Not estimated	☒ Yes ☐ No	☐ Yes ☒ No
Spillway Channel	N/A	☐ Yes ☒ No	N/A	☒ Yes ☐ No	N/A
Original Outlet Pipe	N/A	☐ Yes ☒ No	None	☐ Yes ☒ No	☐ Yes ☒ No

Are the following components in ***SATISFACTORY CONDITION***?

(check one if applicable)

EMBANKMENT	Yes/No	LOW LEVEL OUTLET	Yes/No	SPILLWAY CHANNEL	Yes/No
U/S Slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Outlet Channel	☒ Yes ☐ No	Channel	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No				

ORIGINAL OUTLET PIPE	Yes/No
Entrance	☒ Yes ☐ No
Pipe	☒ Yes ☐ No

Were any of the following ***POTENTIAL PROBLEM INDICATORS*** found?

INDICATOR	EMBANKMENT	LOW LEVEL OUTLET	SPILLWAY CHANNEL
Piping	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Erosion	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No

List and describe any deficiencies:

- No dam safety deficiencies observed.

Comments / Notes:

- Refer to Site Visit Observations section.

SITE VISIT OBSERVATIONS

Crest

Good physical condition. No observed signs of deterioration, lateral movement, or cracking (Photo I-B-1).

Left and Right Abutments

Good physical condition. Little vegetation at abutments. No signs of deterioration observed.

Downstream Slope

Good physical condition. Tall grass and vegetation observed. No signs of deterioration or erosion (Photo I-B-2).

Pond

During the site visit, the pond water level was observed to be approximately >0.5 m below the spillway invert which is typical for this time of the year (Photo I-B-3 and Photo I-B-5).

Spillway

Good physical condition. No observed signs of recent flow, channel erosion, or deterioration. Minor vegetation present in the spillway inlet which is not a concern at this time (Photo I-B-5).

Low-level Outlet

Good physical condition. Any obstructions or excess vegetation growth are monitored and cleared as part of HVC ongoing monitoring and routine maintenance plan (Photo I-B-3). The valve cannot be hand turned. The need to close the valve is not a critical control for the structure but HVC may want to fix the valve for routine operations. (Photo I-B-4).

Seepage

No observed signs of seepage during the site visit.

SITE VISIT PHOTOGRAPHS

LEGEND:

- TRJ = Trojan Tailings Facility
- TRJ-2021-## refers to 2021 Annual Facility Performance Report (AFPR) waypoint shown on Figure 4.
- All photographs taken during the site visit on July 22, 2021.

Photo I-B-1 Overview of R4 Seepage Pond Dam crest and downstream slope looking towards left abutment (TRJ-2021-10)

Photo I-B-2 Overview of downstream slope looking towards left abutment (TRJ-2021-10)

Photo I-B-3 Overview of the pond and low-level outlet (LLO) to Witches Brook via Lower Trojan Dam (TRJ-2021-11)

Photo I-B-4 **Low Level Outlet valve in shed downstream of toe. The valve cannot be hand turned. The need to close the valve is not a critical control for the structure but HVC may want to fix the valve for routine operations (TRJ-2021-12)**

Photo I-B-5 Overview of pond and spillway inlet – Spillway inlet is clear of debris (TRJ-2021-13)

Photo I-B-6 Spillway Channel (TRJ-2021-13)

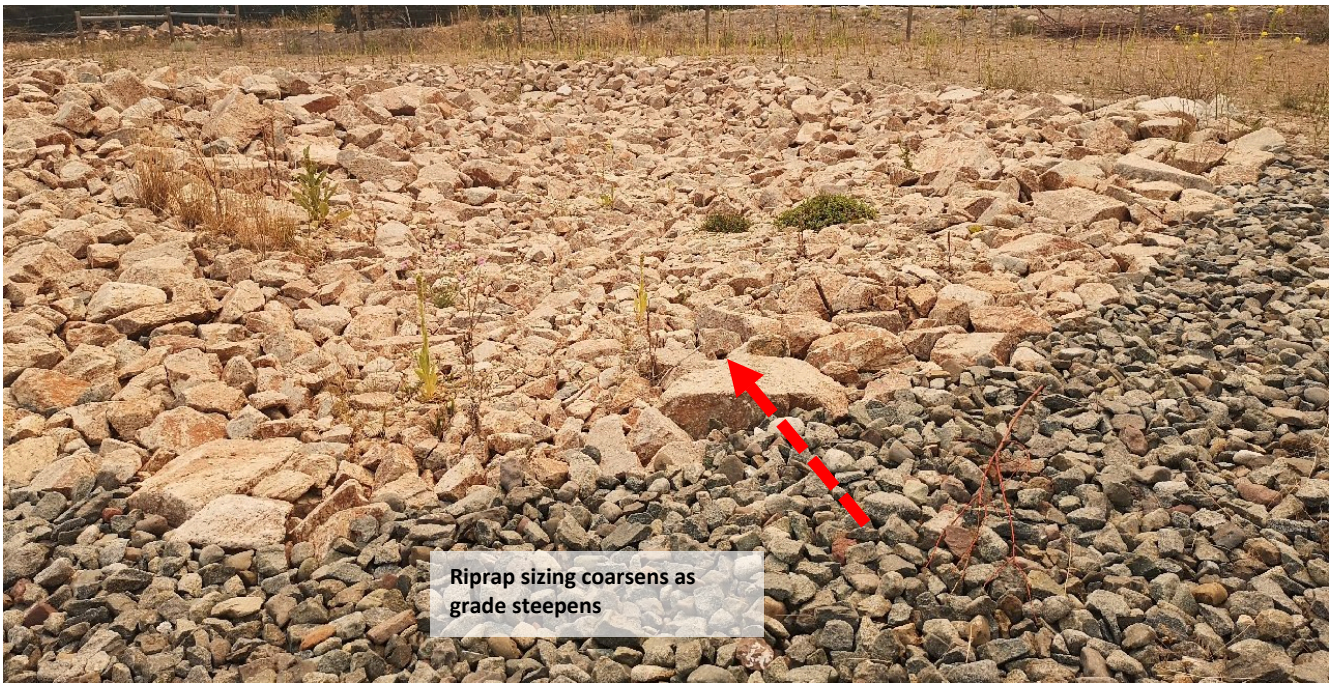


Photo I-B-7 Spillway Channel (TRJ-2021-13)

APPENDIX I-C

Lower Trojan Dam
Site Visit Checklist, Observations and Photographs

Appendix I-C
Annual Facility Performance Report Site Visit Checklist, Observations and Photographs – Lower Trojan Dam

SITE VISIT CHECKLIST

Facility:	Lower Trojan Dm	**Site Visit Date:**	July 22, 2021
Weather:	Mostly cloudy / smoky	**Inspector(s):**	Rick Friedel, P.Eng. Delton Breckenridge, EIT
Freeboard (pond level to dam crest):	1.3 m based on maximum water elevations on July 22nd from remote pond level monitoring system		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate	Visual Review?	Testing / Detailed Site Visit?
460 mm HDPE Outlet to Weir	☒ Yes ☐ No	☒ Yes ☐ No	Not Estimated	☒ Yes ☐ No	☐ Yes ☒ No
200 mm HDPE Low Level Outlet	N/A	N/A	Decommissioned	N/A	N/A
810 mm HDPE Spillway Pipe	☐ Yes ☒ No	☐ Yes ☒ No	N/A	☒ Yes ☐ No	N/A
Spillway Channel	N/A	☐ Yes ☒ No	N/A	☒ Yes ☐ No	N/A

Are the following components in ***SATISFACTORY CONDITION***?
(check one if applicable)

EMBANKMENT	Yes/No	OUTLET TO WEIR	Yes/No	LOW LEVEL OUTLET	Yes/No
U/S Slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Outlet Channel	☒ Yes ☐ No	Outlet Channel	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No				

SPILLWAY PIPE	Yes/No	SPILLWAY CHANNEL	Yes/No
Entrance	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
Pipe	☒ Yes ☐ No	Channel	☒ Yes ☐ No
		Channel Slopes	☒ Yes ☐ No

Were any of the following ***POTENTIAL PROBLEM INDICATORS*** found?

INDICATOR	EMBANKMENT	LOW LEVEL OUTLET (Decommissioned)	OUTLET TO WEIR
Piping	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Erosion	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No	☒ Yes ☐ No

INDICATOR	SPILLWAY PIPE	SPILLWAY CHANNEL
Piping	☐ Yes ☒ No	☐ Yes ☒ No
Sinkholes	☐ Yes ☒ No	☐ Yes ☒ No
Seepage	☐ Yes ☒ No	☐ Yes ☒ No
Erosion	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No

List and describe any deficiencies:

- No dam safety deficiencies observed.

Comments / Notes:

- Refer to Site Visit Observations Section.

SITE VISIT OBSERVATIONS

Crest

Good physical condition. Minor vegetation. No signs of erosion, deterioration, or cracking observed. Crest is uneven and appears to be sloped (rises from left abutment to right abutment) (Photo I-C-1).

Left and Right Abutment

Good physical condition.

Downstream Slope

Good physical condition. Minor vegetation observed, no signs of erosion or deterioration. Downstream outflow pipe shown on Photo I-C-3 does not have a defined channel or means of toe erosion protection.

Pond

Level at time of the site visit was comparable to the level during the 2020 site visit. Pond level >0.5 m below the invert of spillway pipe which is typical for this time of the year. Basin is heavily vegetated (Photo I-C-3 and Photo I-C-4).

Current configuration of the Lower Trojan Pond comprises two basins, referred to as the upper basin and the lower basin. There was active flow from the upper basin to the lower basin at the time of the site visit (Photo I-C-4).

Spillway

Heavy vegetation was observed in front of the pond overflow pipe. HVC report this was cleared as part of routine maintenance after the AFPR site visit.

Low-level Outlet

build up of debris on the trash rack and change to the debris boom was noted during the 2020 AFPR site visit (Photo I-C-5). After the inspection both of these were resolved by HVC as part of routine maintenance. Low-level outlet valve can be hand turned (Photo I-C-6).

Seepage

None observed.

SITE VISIT PHOTOGRAPHS

LEGEND:

- TRJ = Trojan Tailings Facility.
- TRJ-2021-## refers to 2021 Annual Facility Performance Report (AFPR) waypoint shown on Figure 5.
- All photographs taken during the site visit on July 22, 2021.

Photo I-C-1 Overview of Lower Trojan Dam crest from right abutment. Crest is uneven and appears to be sloped (rises from left abutment to right abutment) (TRJ-2021-14)

Photo I-C-2 Upstream slope near right abutment with overflow pipe through the dam. Heavy vegetation present in front of the pipe inlet which should be cleared (TRJ-2021-15)

Photo I-C-3 Lower Trojan Dam Pond upper basin (TRJ-2021-16)

Photo I-C-4 **Outlet which appeared to connect the upper basin to the lower basin at Lower Trojan Pond. There were no sounds or visual observations of flow from the outlet. During the site visit, flow from upper basin was reporting to lower basin via overland flow. (TRJ-2021-17)**

Photo I-C-5 **Low-Level Outlet (LLO) inlet. Accumulated debris on trash rack was cleared and the debris boom put back in place by HVC as part of routine maintenance following the 2020 AFPR. (TRJ-2021-18)**

Photo I-C-6 Low-Level Outlet (LLO) valve can be hand operated (TRJ-2021-19)

APPENDIX II

Climate and Instrumentation

APPENDIX II-A

Climate Data

Appendix II-A
Climate Data

HVC provided weather data from the L-L Dam Weather Station (El. 1186.0 m), for the 2021 AFPR review period, for KCB to review. KCB adjusted the L-L Dam Weather Station data and Historical Average Lornex Synthetic Record data using the Highmont/Bethlehem and Trojan Area adjustment factors provided in Golder (2021). KCB selected these adjustment factors as their elevation is consistent with the Trojan TSF catchment (crest ~El. 1440 m). To support key precipitation trends and impacts on observed dam performance, KCB downloaded data from the Kamloops Pratt Road Weather Station (Environment Canada Station No. 116C8P0, El. 729.0 m, 73 km away), and was provided data from the Shula Weather Station (El. 1208 m, station located on HVC property) by HVC, to review and compare precipitation trends against the L-L Dam Weather Station data. The Kamloops Pratt Road Weather Station (El. 729.0 m) was used for comparison rather than the Kamloops Airport Station (El. 345.3 m), as the elevation at the Pratt Road Station is closer to L-L Dam Weather Station (El. 1186.0 m).

The precipitation normals (adjusted Highland Valley Lornex Synthetic Record) and precipitation records between October 2020 and September 2021 (adjusted L-L Dam, unadjusted Kamloops Pratt Road and unadjusted Shula Flats data), are tabulated and plotted in Table II-A-1 and Figure II-A-1, respectively. The following observations are noted for the L-L Dam adjusted precipitation in the reporting period:

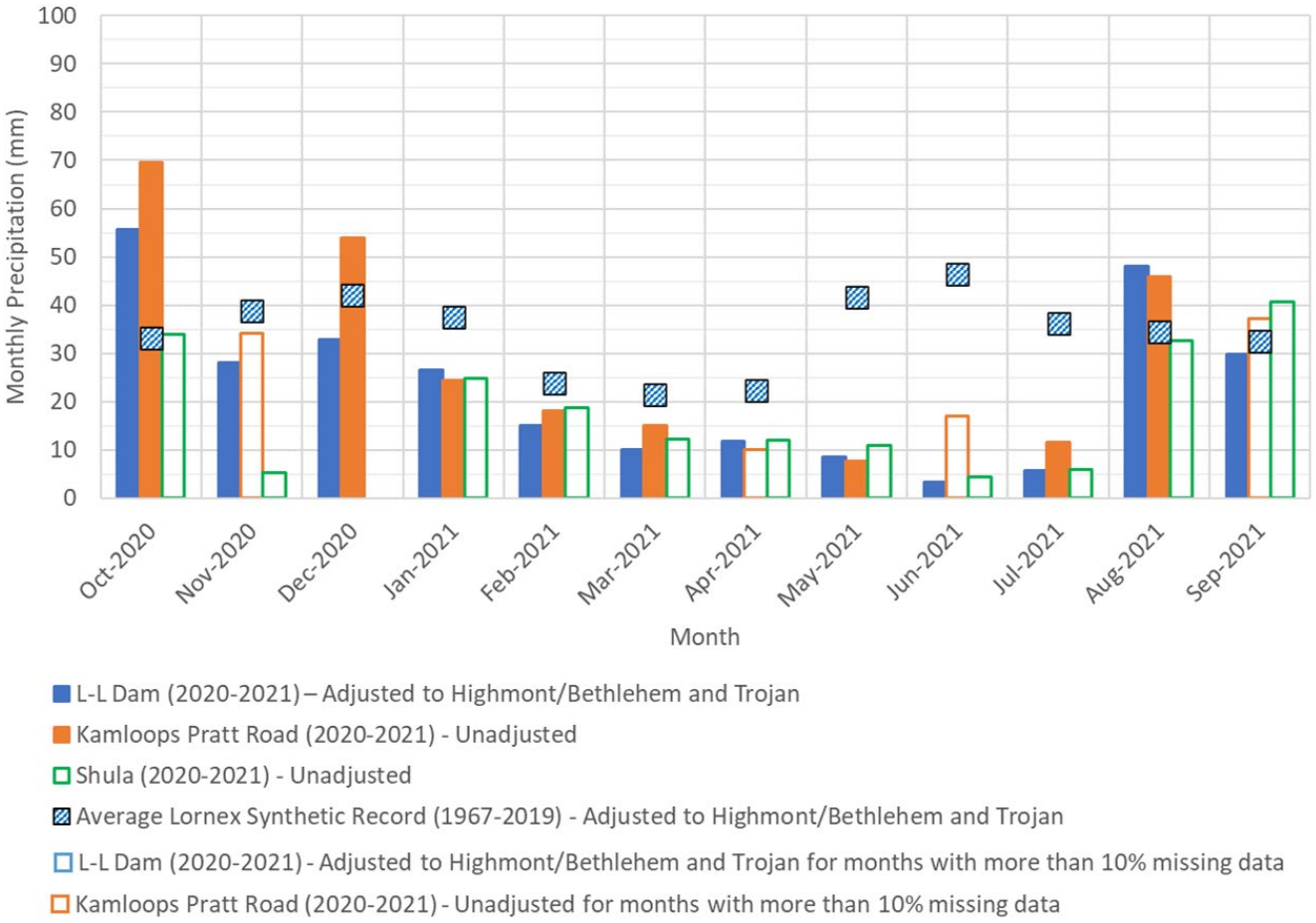
- All storm events during the review period were less than the 10-year return period rainfall event (40 mm in 24 hours). The largest 24-hour rainfall events measured at the L-L Dam Weather Station during the review period were: 23.7 mm on October 23, 2020; 16.2 mm on December 21, 2020; and 18.5 mm on August 16, 2021.
- In Figure II-A-1, all months, except for October 2020 and August 2021 reported 9% to 93% decreases relative to average precipitation. October 2020 precipitation increased 67% relative to the historic normals; August 2021 precipitation increased 40%.
- The L-L Dam Weather Station database included some gaps in 2020 measurements. HVC managed to improve the monitoring program and, as Figure II-A-1 indicates, there were no data gaps in the 2021 measurements. In addition, consistency in trends between the Kamloops Pratt Road Station, the Shula Weather Station data for 2021, and the L-L Weather Station provides confidence in the L-L Weather Station data.
- In Table II-A-2, snowpack depth measurements from the Highland Valley Station (El. 1268 m) indicate the snow had melted during April 2021, and was gone by May 1st. In comparison, the water balance assumes 30% of snowmelt occurs in March and 70% in April (Golder 2020a).
- Seasonal rise and fall of pond levels is associated with freshet. In 2021, pond levels dropped in May, coincident with completion of snowmelt, which is consistent with historic trends. Rainfall measured from March through May, when reservoir level was rising, was approximately 35% of the historical average during that same period, which suggests the majority of the 2021 freshet was related to snowmelt.

Table II-A-1 Monthly Precipitation

Month	Availability of Data (%)	Precipitation (mm)			
	L-L Dam Weather Station	L-L Dam Weather Station Data Adjusted to Highmont/Bethlehem and Trojan Area [1] (2020 to 2021)	Average Lornex Synthetic Record Adjusted to Highmont/Bethlehem and Trojan Area [2] (1967 to 2019)	Unadjusted Kamloops Pratt Road Weather Station (2020 to 2021)	Unadjusted Shula Weather Station [5] (2020-2021)
Oct 2020	99	55.6	33.3	69.6	33.9
Nov 2020	100	28.1	38.9	34.2 [4]	5.2 [4]
Dec 2020	100	32.9	42.1	54.0	N/A [6]
Jan 2021	100	26.5	37.5	24.4	24.9
Feb 2021	100	15.0	23.7	18.0	18.7
Mar 2021	100	10.1	21.5	15.0	12.3
Apr 2021	100	11.7	22.4	10.0 [4]	11.9
May 2021	100	8.4	41.7	7.6	10.9
Jun 2021	100	3.4	46.5	17.0 [4]	4.4
Jul 2021	100	5.8	36.3	11.6	5.9
Aug 2021	100	48.1	34.4	45.8	32.6
Sep 2021	100	29.7	32.6	37.2 [4]	40.7
Annual Total	-	275.4	410.8	344.4	201.4

Notes:
1. Available data from L-L Dam climate station was adjusted by a L-L Dam-to-Highmont/Bethlehem and Trojan Area adjustment factor of 1.02 (Golder 2021).
2. Estimated by Golder (2021) using appropriate adjustment factors and average precipitation measured at Highland Valley Lornex climate station (Environment Canada ID No. 1123469 at El. 1268 m from 1967 to 2011). Golder (2021) infilled the data gaps prior to November 2011 and created a long-term synthetic precipitation record to the end of 2019. Monthly average of the synthetic record adjusted to Highmont/Bethlehem and Trojan Area by a Lornex-to-Highmont/Bethlehem and Trojan Area adjustment factor of 1.12 are shown herein, refer to Golder (2021) for detailed information.
3. Review period for the Trojan TSF Annual Facility Performance Reports is from October 2020 through September 2021.
4. Monthly precipitation with more than 10% missing data.
5. 2021 monthly precipitation data provided to KCB as summarized data for the given month; therefore, the completeness of the data was not independently verified.
6. HVC noted that the data set was not complete enough to report, and as a result it was not counted.

Figure II-A-1 Monthly Precipitation



Note:
1. The Shula weather station data used for this comparison only included monthly values (i.e., no daily data) and thus, KCB was not able to assess the completeness of the dataset.

Seasonal snowpack depth is not measured at the L-L Dam weather station. Instead, HVC to monitors snowpack with monthly measurements at the Highland Valley snow survey station (Station No. 1C09A) near the Trojan TSF. The measurements are sorted by survey period (the first of January through May) to compare snowpack depths, in snow-water equivalent (SWE), for the same period each year. Historical average and 2021 snowpack depths, based on available records, are summarized in Table II-A-2.

Figure II-A-2 compares SWE data and temperature data from January to June 2021. The following observations are inferred from these data:

- The daily temperature recorded between January and June 2021 is within the historical monthly average records (between 2000 and 2019).

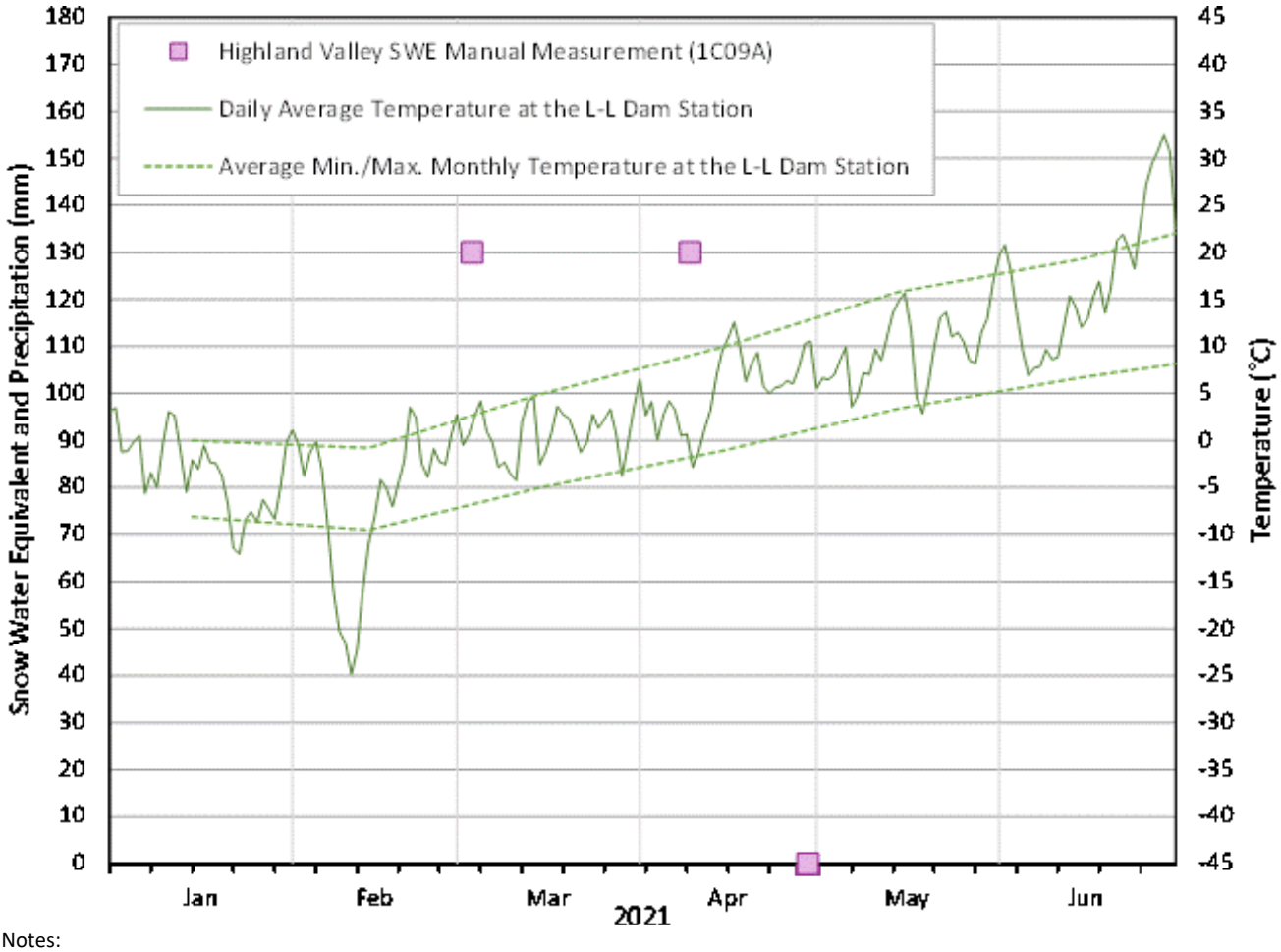
- The snowpack was depleted over a period of three weeks (between April 9 to 29), which is a quicker rate than the forecast snowmelt pattern from the HVC site wide water balance based on Golder (2020a).
- The rise in temperature above 0°C in April coincides with the snowmelt period manually recorded at the Highland Valley station.
- Rain was not a major factor in 2021 snowmelt, as the maximum daily precipitation recorded close to the snowpack depletion period is less than 6 mm/day.

Table II-A-2 Historical Average and 2021 Snowpack Depths

Survey Period	Years of Record[1]	Historic Average Snowpack Depth[2] (mm SWE[3])	2021 Snowpack Depth (mm SWE[3])	Percent Change Relative to Historic Average
January 1st	11	50.2	Not surveyed	N/A
February 1st	25	83.5	Not surveyed	N/A
March 1st	55	91.9	130	42%
April 1st	53	101.3	130	28%
May 1st	54	27.6	0	-100%
May 15th	25	2.4	Not surveyed	N/A
June 1st	8	0	Not surveyed	N/A

Notes:
1. At the Highland Valley snow survey station (Station No. 1C09A) near the Bethlehem TSF. Data prior to 1966 were not included as the station was moved to its current location in 1965.
2. Calculated based on available period on record.
3. SWE = snow water equivalent.

Figure II-A-2 Temperature Records and Measured Snowpack between January and June 2021



Notes:
1. SWE is manually measured at the Highland Valley snow pillow station (1C09A), typically once per month.
2. Daily average temperature data at the L-L Dam Station for 2021 was provided by HVC.
3. The average maximum and minimum monthly temperatures at the L-L Dam Station were developed by Golder (2021).

APPENDIX II-B

Instrumentation Summary and Plots

Appendix II-B
Instrumentation Summary and Plots

II-B-1 PIEZOMETERS

Historic piezometric readings are shown in Figure II-B-1 to Figure II-B-3.

Recent threshold values for piezometers are intended to identify changes from established behaviour as a trigger to review the data and are not linked to dam performance criteria. Therefore, thresholds have been set at 0.5 m above the maximum historic water levels. Questionable readings (e.g., where there was a spike that has not been repeated) were not used when defining thresholds.

Maximum and minimum water levels during this review period and instrument thresholds were reviewed as part of the 2021 Annual Facility Performance Report (Refer to Table II-B-1). Threshold exceedances from the year are discussed in the main text.

The piezometric level at VW16-02A, at VW16-02B and P86-1 exceeded the previous threshold during 2021 (refer to main text for discussion) and a revised threshold is proposed to flag deviations from recent behaviour. Thresholds have not yet been set for the piezometers installed in 2019 due to the limited data set.

Table II-B-1 Piezometric Levels during the review period and 2022 thresholds

Instrument ID	Installation Unit	Piezometric Levels during the review period (1) (m)		Proposed 2022 Threshold Value (m)(2)
		Minimum	Maximum	
P95-4	Sandfill	n/a	n/a	Note 3
P85-1A	Foundation	1396.3	1396.8	1399.2
TB-PS-02/P13-1	Cycloned Sand	1419.8	1421.9	1423.4
TB-PS-01/P13-2	Cycloned Sand	1416.4	1417.2	1418.6
TB-PS-04/P13-3	Sand and Gravel	1383.1	1383.8	1385.4
TB-PS-03/P13-4	Glacial Till	1387.4	1389.4	1390.5
P86-1	Sandfill	1407.5	1409.1	***1409.6***
VW16-2A	Glacial Sediments / Debris	1367.3	1367.6	***1368.1***
VW16-2B	Glacial Till	1379.3	1379.6	***1380.1***
P94-1	Sandfill	1420.3	1421.1	1423.6

Notes:
1. October 2020 through September 2021.
2. ***Bold Italics*** indicate revised threshold for 2022.
3. Piezometric level continues trending downward since 2015 falling head test; no threshold set until water level stabilizes.

II-B-2 SURVEY MONUMENTS

Survey monuments at the Trojan Dam are shown on Figure 3. Starting in November 2019, HVC changed the method used to survey the displacement monuments. Previously, monuments were surveyed using a ground based total station with digital level. This has changed to a GPS Real Time Kinematic (RTK) survey. Based on the survey data collected to date, the RTK method is suitable to monitor displacement. In comparison to the total station method, the RTK surveys show less variance (i.e., error) in the horizontal plane but increased variance in elevation.

Survey results using the RTK method are shown on Figure II-B-4. Horizontal surveys using the previous method are not shown as they reference a different basepoint.

Table II-B-2 summarizes incremental and cumulative displacement from October 2020 to September 2021. Incremental displacements are relative to the September 2020 survey. Change from initial survey for horizontal displacement is reported relative to the November 2019 RTK baseline.

KCB estimated change from initial survey for vertical displacement by adding the incremental vertical displacement over the reporting period to the cumulative vertical displacement from the last total station survey. This assumes no vertical displacement occurred between the last total station survey (October 2019) and the date of the first GPS RTK survey (November 2019).

Table II-B-2 2021 Survey Monument Incremental Displacement Summary

Monument	Incremental[1]		Cumulative	
	Vector Horizontal Displacement (mm)	Vertical Displacement (mm)	Vector Horizontal Displacement[2] (mm)	Vertical Displacement[3] (mm)
TD-1	5, downstream (toward south)	+19	4, upstream (toward northeast)	+13
TD-2A	0	+3	7, parallel to dam crest (toward east)	-4
TD-3	9, downstream (toward south)	+15	4, downstream (toward southeast)	-72
TD-4	5, downstream (toward south)	+12	4, downstream (toward southeast)	-81
TD-5	7, downstream (toward south)	+15	10, downstream (toward south)	-48
TD-6	10, downstream (toward southeast)	+12	12, downstream (toward southeast)	-33

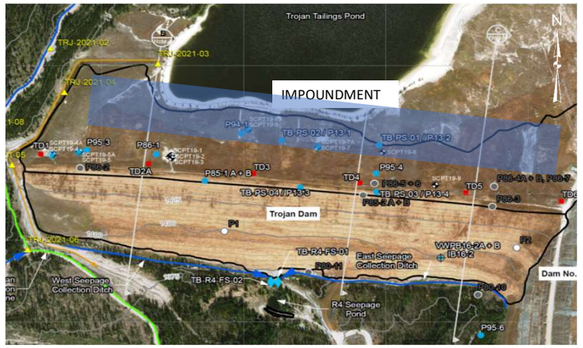
Notes:
1. Incremental horizontal displacements are calculated between the September 2020 and September 2021 surveys.
2. Cumulative horizontal displacements calculated relative to the RTK November 2019 baseline.
3. Cumulative vertical displacements calculated relative to the full survey record, regardless of survey method: TD-2A since 2014; and all other monuments since 1998.

The current survey movement thresholds were set during the 2016 Annual Facility Performance Report based on typical variance and error using the total station method (refer to Table II-B-3). Threshold values for 2022 are to be reviewed by KCB and HVC during preparation of the next OMS Manual update.

Table II-B-3 Total Station Survey Monument Displacement Thresholds

Instrument ID	Horizontal Vector Displacement from Original Position Threshold (mm)	Incremental Vertical Displacement Between Readings Threshold (mm)	Total Vertical Displacement Threshold (mm)
TD1	80	20	50
TD2A			50
TD3			100
TD4			100
TD5			75
TD6			75

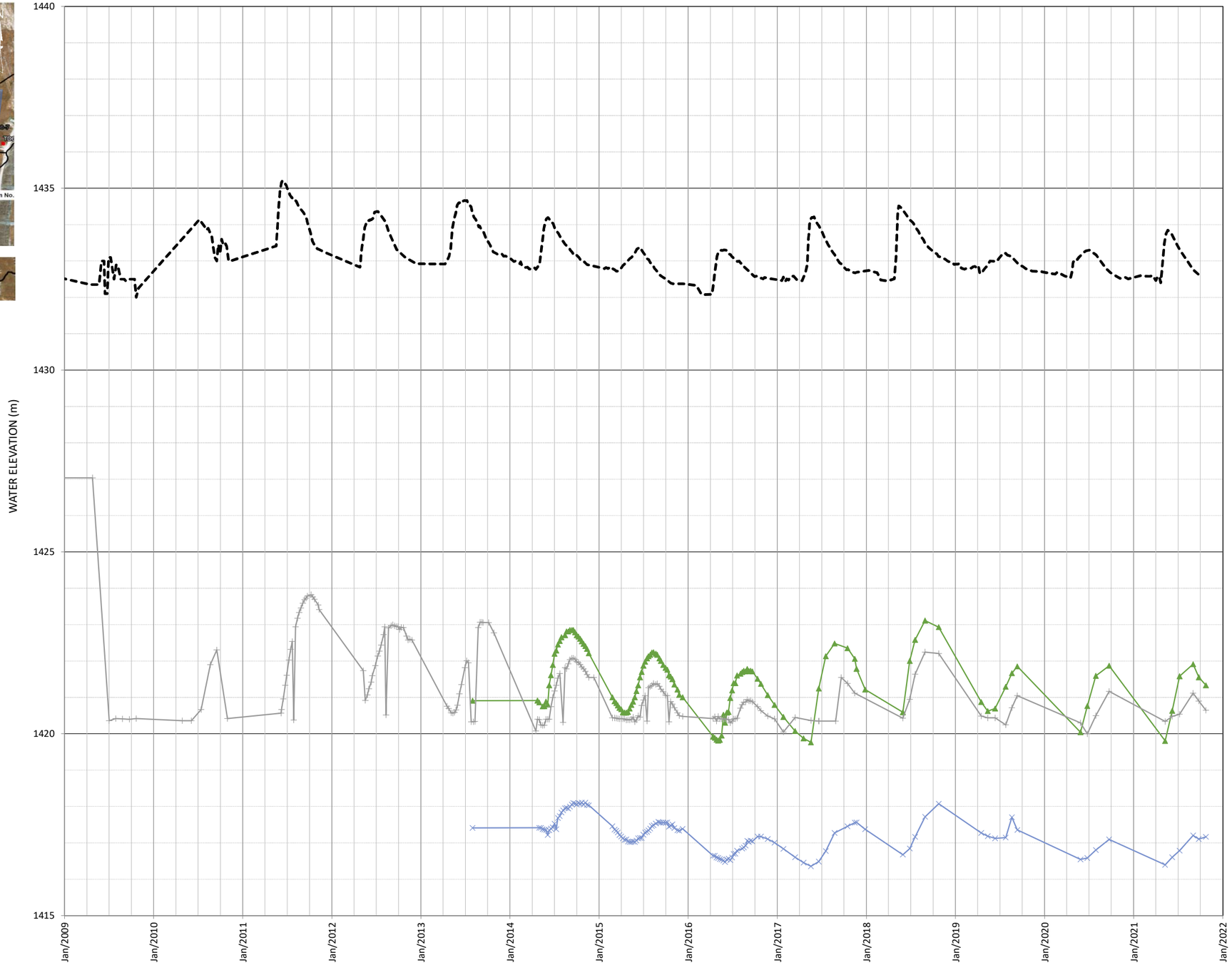
INSTRUMENTATION PLOTS



LEGEND:

- TB-PS-02/P13-1 (TIP EL. 1409.5 m, CYCLONED SAND)
- TB-PS-01/P13-2 (TIP EL. 1413 m, CYCLONED SAND)
- P94-1 (TIP EL. UNKNOWN m, SANDFILL)
- TROJAN POND LEVEL

PIEZOMETER ID	2021 THRESHOLD EL. (m)
TB-PS-02/P13-1	1423.4
TB-PS-01/P13-2	1418.6
P94-1	1423.6

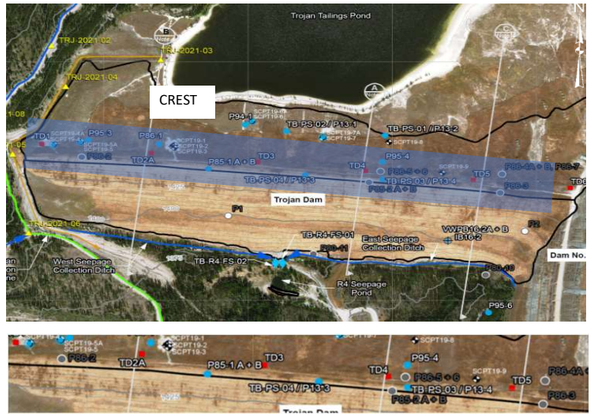


NOTES:

1. P94-1 AND P86-1 HAVE HISTORICALLY BEEN REPORTED PLUGGED/DRY.

December 22, 2021
Z:\MV\CRM\02341C12-HVC 2021 Dam Safety Support\300 Design\320 Piezometer Data\Trojan\[211129 Trojan Piezo.xlsx]Piezo Data Entry

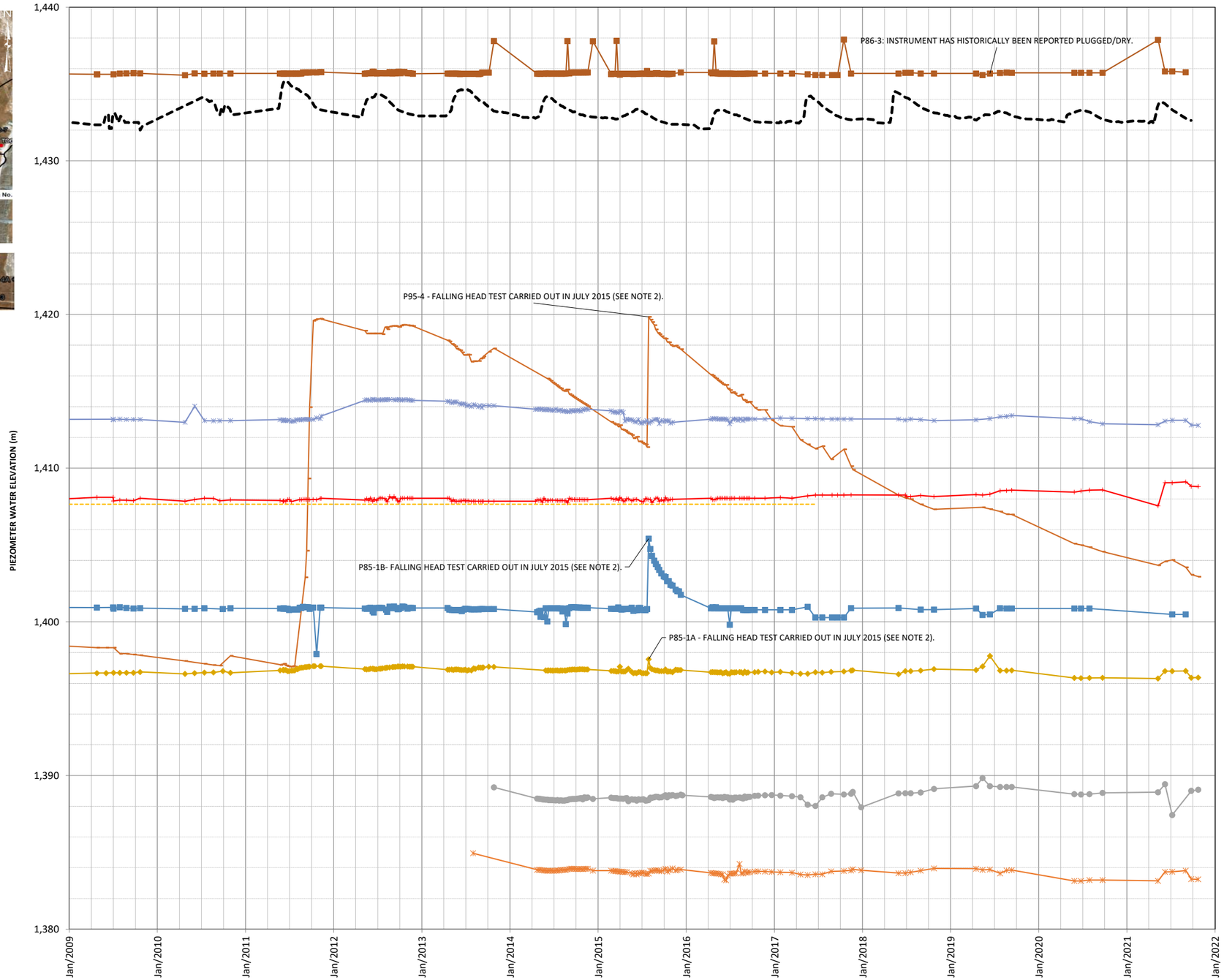
CLIENT: Highland Valley Copper / Teck
Klohn Crippen Berger
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT
TITLE: TROJAN DAM PIEZOMETRIC DATA
2009-2021
IMPOUNDMENT
PROJECT No. M02341C12
FIG No. II-B-1



LEGEND:

- P86-3 (TIP EL. 1395.83 m, SANDFILL)
- P95-4 (TIP EL. 1389.09 m, SANDFILL)
- P85-1A (TIP EL. 1388.12 m, FOUNDATION)
- P85-1B (TIP EL. 1398.78 m, SANDFILL)
- TB-PS-04/P13-3 (TIP EL. 1376.2 m, SAND AND GRAVEL)
- TB-PS-03/P13-4 (TIP EL. 1376.6 m, GLACIAL TILL)
- P86-1 (TIP EL. 1407.65 m, SANDFILL)
- P95-3 (TIP EL. 1412.7 m, FOUNDATION)
- P86-1 (TIP EL. 1407.65 m, SANDFILL)
- TROJAN POND LEVEL

PIEZOMETER ID	2021 THRESHOLD EL. (m)
P85-1A	1399.2
P86-1	1409.2
P86-7	n/a
P95-3	n/a
TB-PS-04/P13-3	1385.4
TB-PS-03/P13-4	1390.5



NOTES:

1. POND ELEVATIONS AND P86-3 WATER ELEVATIONS PLOTTED ON SECONDARY (RIGHT) AXIS. OTHER PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS.
2. FALLING HEAD TESTS WERE CONDUCTED IN P85-1A (JULY 23, 2015), P95-4 (JULY 24, 2015) AND P85-1B (JULY 23, 2015). THE ELEVATED READINGS FOR P85-1A DURING THIS TIME WERE NOT USED TO DETERMINE THE REVISED PIEZOMETRIC LEVEL THRESHOLD.
3. THE FOLLOWING PIEZOMETERS HAVE BEEN REPORTED PLUGGED/DRY: P86-1, P86-7, P95-3, P86-4A, P86-4B, and P85-2A.

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

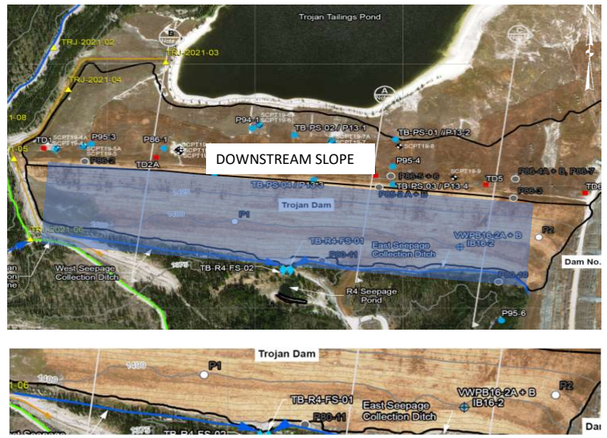
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

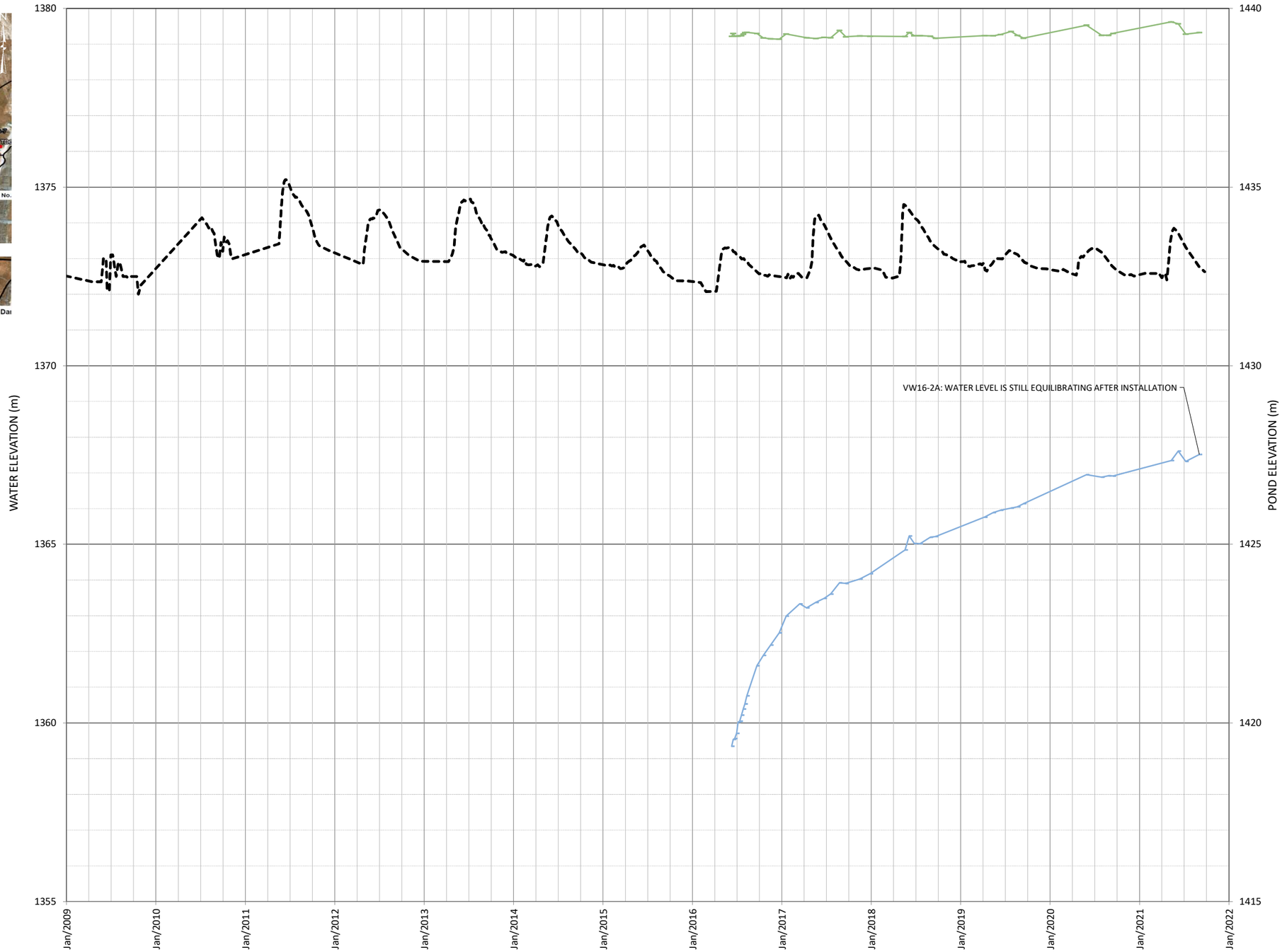
TITLE: TROJAN DAM PIEZOMETRIC DATA
2009-2021

CREST

PROJECT No. M02341C12 | FIG No. II-B-2

December 22, 2021
Z:\MVCR\M02341C12-HVC 2021 Dam Safety Support\300 Design\320 Piezometer Data\Trojan\[211129 Trojan Piezo.xlsx]Piezo Data Entry





LEGEND:

- VW16-2A (TIP EL. 1321.85 m, GLACIAL SEDIMENTS / DEBRIS)
- VW16-2B (TIP EL. 1373.35 m, GLACIAL TILL)
- TROJAN POND LEVEL

PIEZOMETER ID	2021 THRESHOLD EL. (m)
VW16-2A	1367.7
VW16-2B	1379.9

NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. BAROMETRIC PRESSURE READING FROM SEPTEMBER 15, 2019 USED FOR DATA FROM 2021 AFPR REPORTING PERIOD.

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: TROJAN DAM PIEZOMETRIC DATA
2009-2021

DOWNSTREAM SLOPE

PROJECT No. M02341C12

FIG No. II-B-3

December 22, 2021
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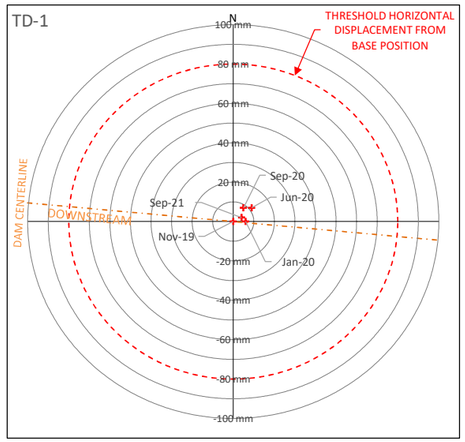
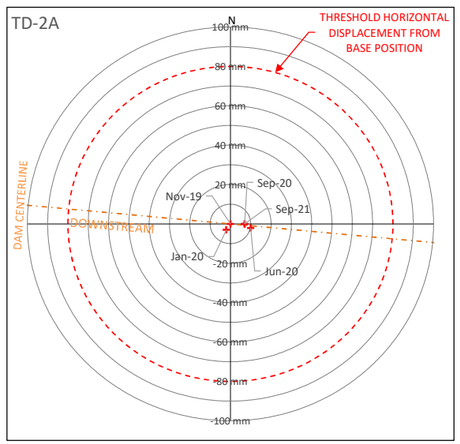
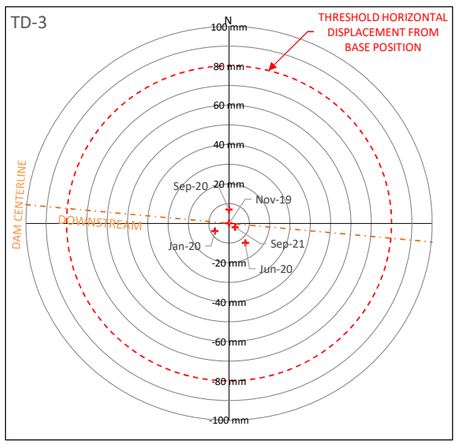
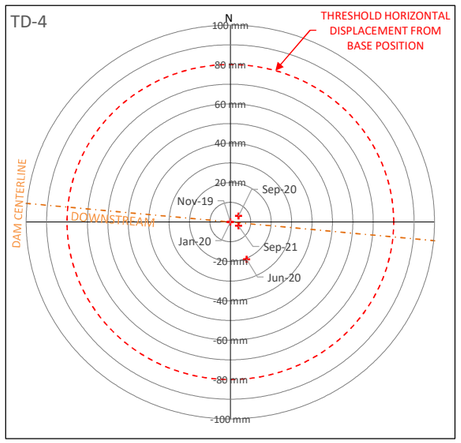
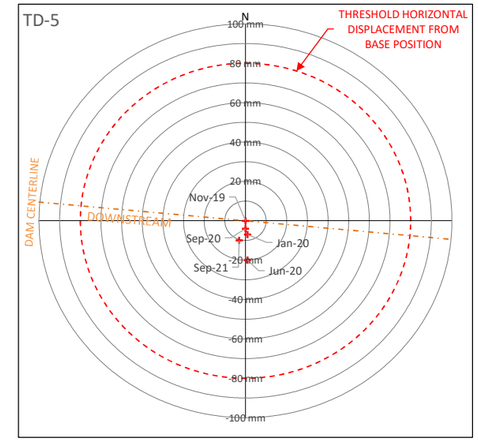


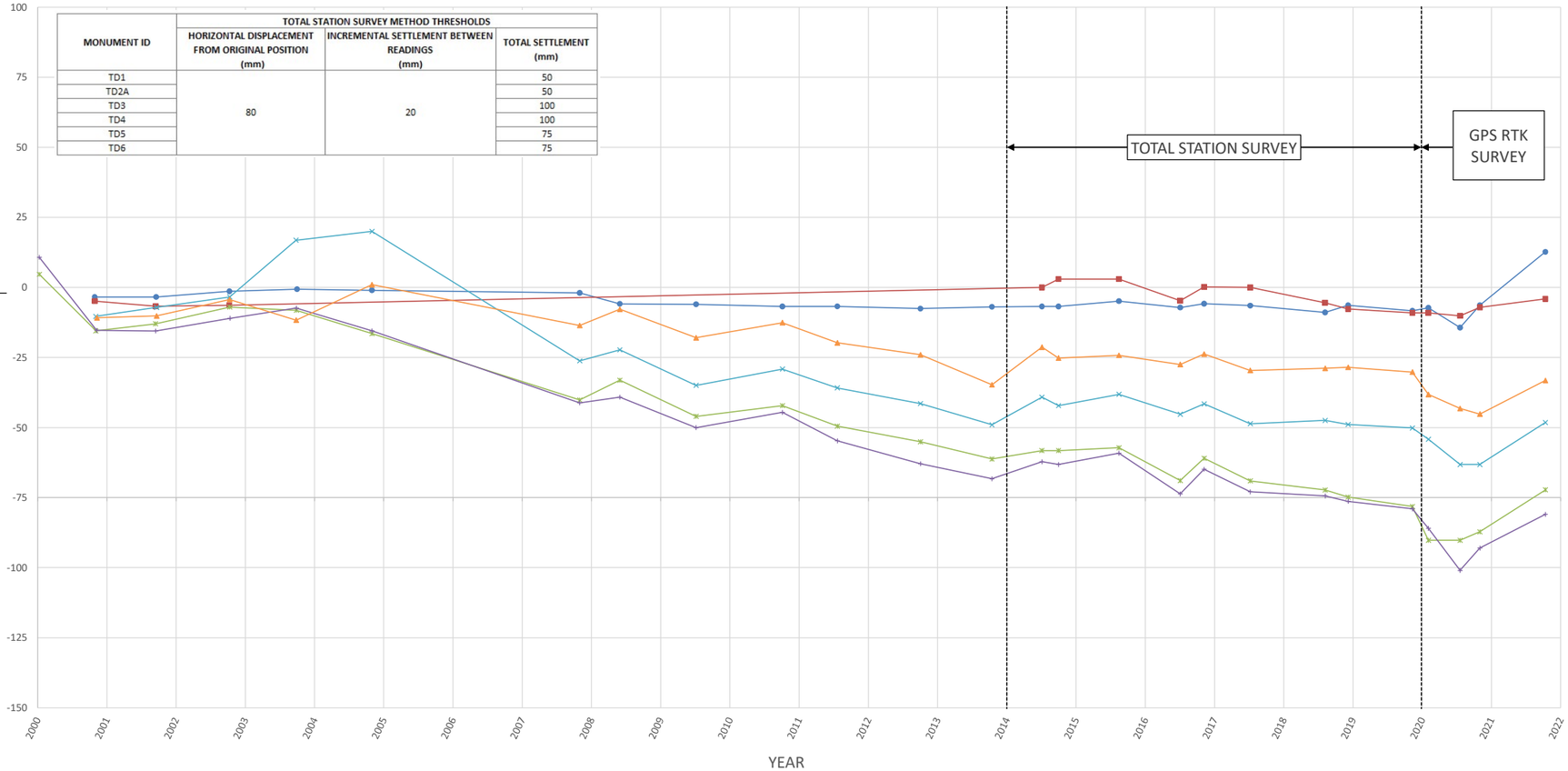






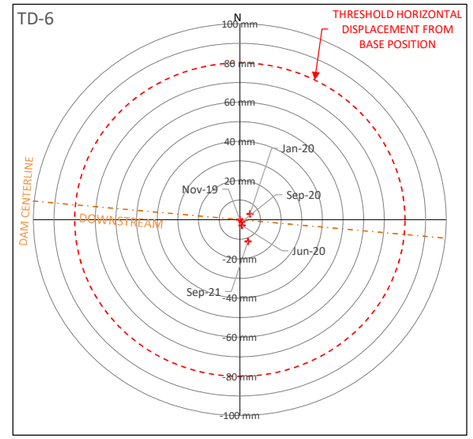


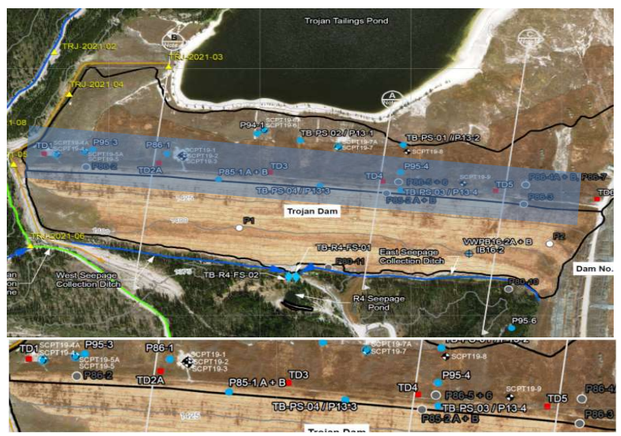
MONUMENT ID	TOTAL STATION SURVEY METHOD THRESHOLDS		
	HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION (mm)	INCREMENTAL SETTLEMENT BETWEEN READINGS (mm)	TOTAL SETTLEMENT (mm)
TD1	80	20	50
TD2A			50
TD3			100
TD4			100
TD5			75
TD6			75



LEGEND:

- TD-1
- TD-2/2A
- TD-3
- TD-4
- TD-5
- TD-6





NOTES:

1. SURVEY METHOD SWITCHED FROM TOTAL STATION TO GPS RTK ON NOVEMBER 26, 2019.
2. HORIZONTAL DISPLACEMENT PRIOR TO NOVEMBER 2019 NOT SHOWN. HORIZONTAL DISPLACEMENT BASELINES SET TO NOVEMBER 26, 2019 GPS RTK SURVEY READINGS.
3. TROJAN DAM MOVEMENT MONITORING DATA PRIOR TO 2000 NOT SHOWN.
4. REFER TO FIGURE 3 FOR MONUMENT LOCATIONS IN PLAN VIEW.
5. TD-1 RELOCATED AFTER OCT 2001.
6. TD-1 2009 READING (NOT SHOWN IN PLAN PLOT) LOCATED 297 mm FROM INITIAL 1998 READING . READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT.
7. 2021 SETTLEMENT PLOTTED BY ADDING INCREMENTAL DISPLACEMENT BETWEEN GPS RTK SURVEY READINGS TO CUMULATIVE TOTAL DISPLACEMNENT ON OCT. 9, 2019. THIS ASSUMES NO SETTLEMENT OCCURED BETWEEN OCT. 9 AND NOVEMBER 12, 2019.

CLIENT: Highland Valley Copper / Teck
Klohn Crippen Berger

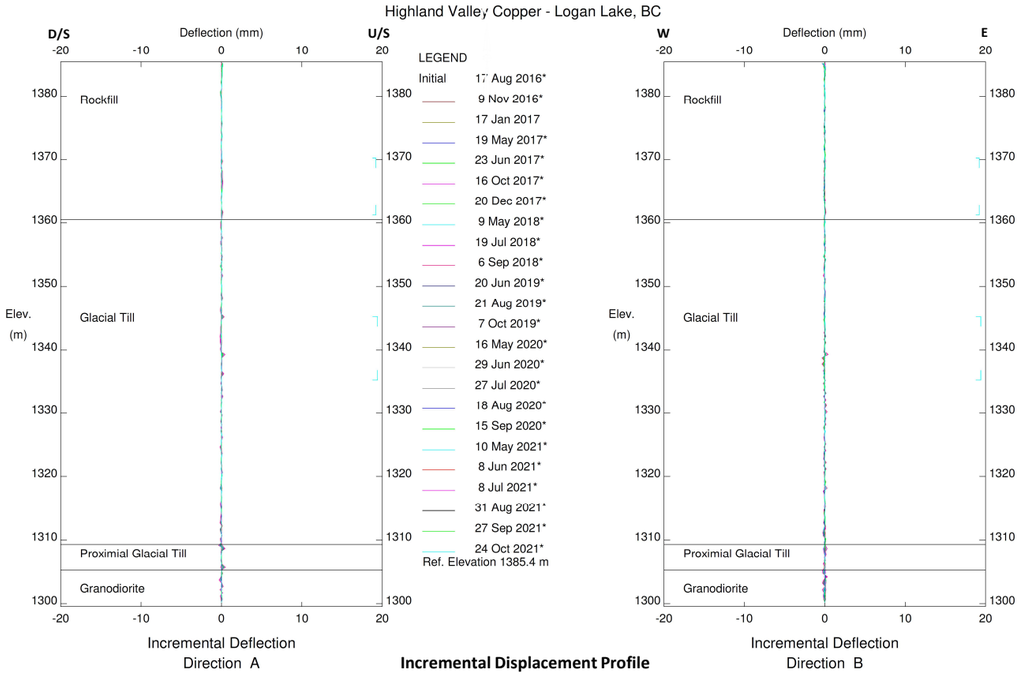
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: TROJAN DAM
SURVEY MONUMENT READINGS

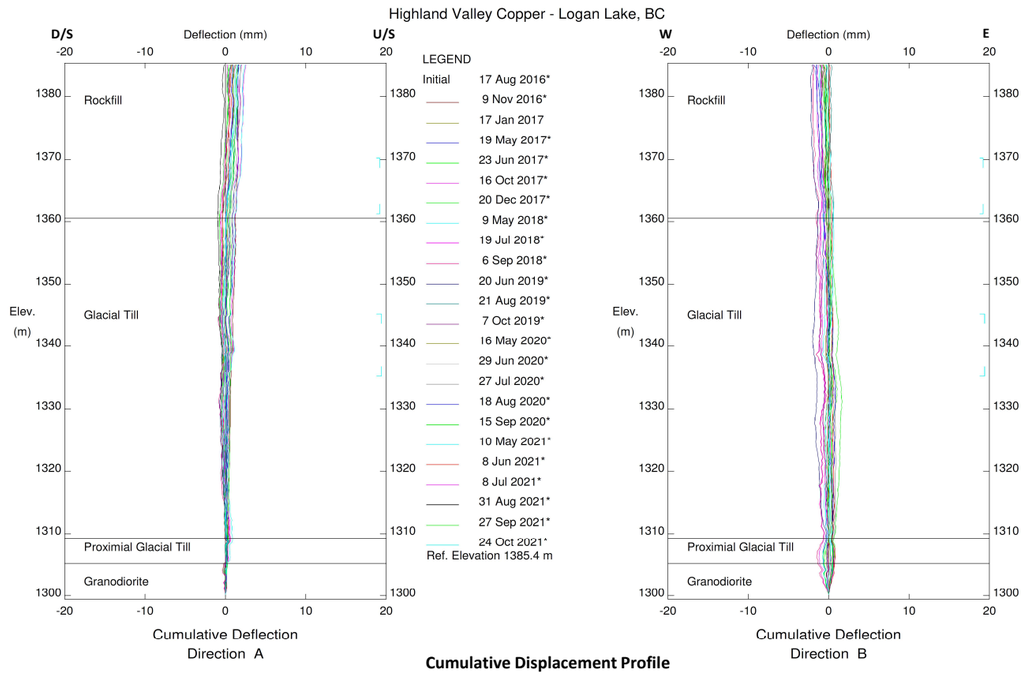
M02341C12

FIG No. II-B-4

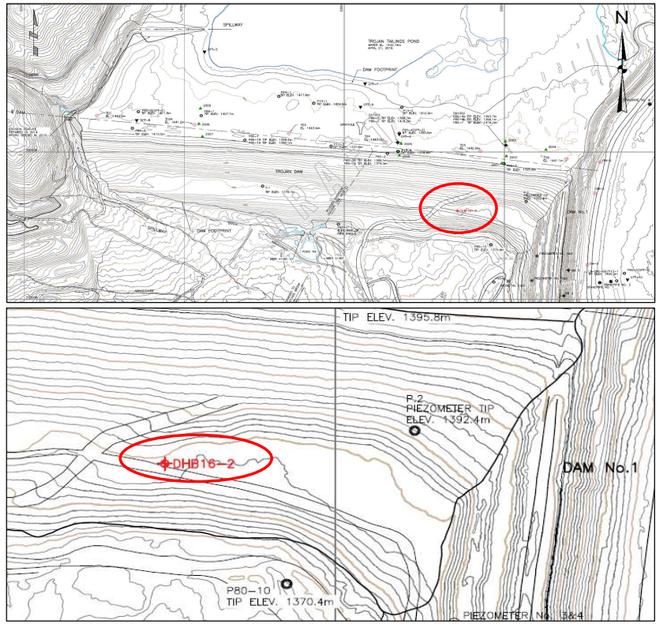
December 22, 2021
Z:\MV\CRM\02341C12-HVC 2021 Dam Safety Support\300 Design\340 Dam Movement Monitoring\347 Survey Monuments\Trojan\[211216 TrojanDamMonitoring.xlsm]Fig V-B-4

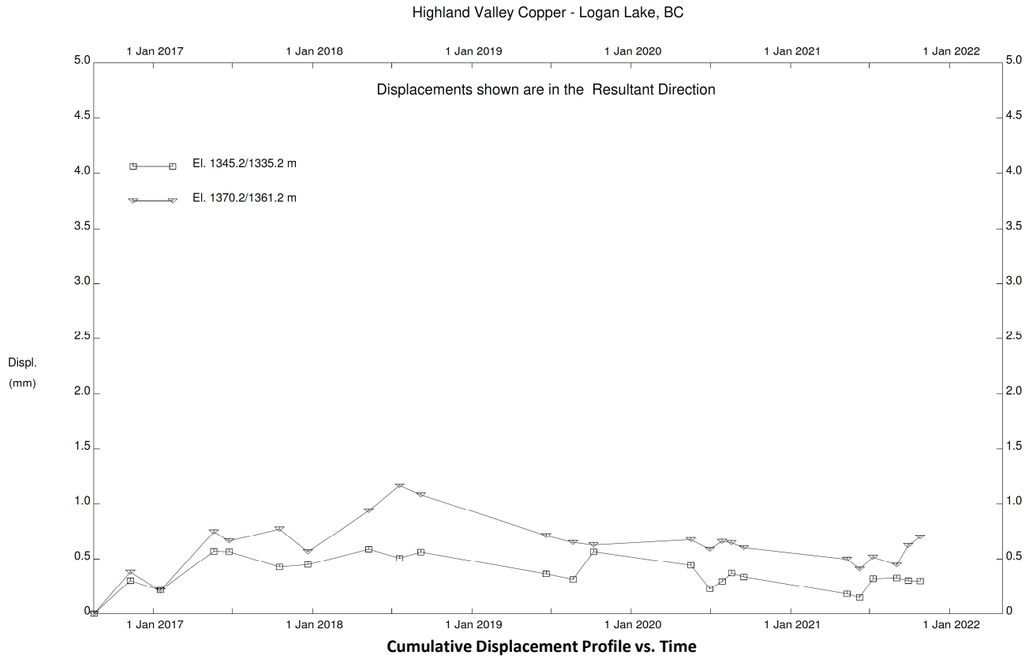


Incremental Displacement Profile



Cumulative Displacement Profile





Cumulative Displacement Profile vs. Time

NOTES:

1) IB16-2 was installed on April 29, 2016.
2) IB16-2 was initialized on June 10, 2016.
3) Reel/Probe Serial Number for the initial reading: DR15020000/DP06580000.

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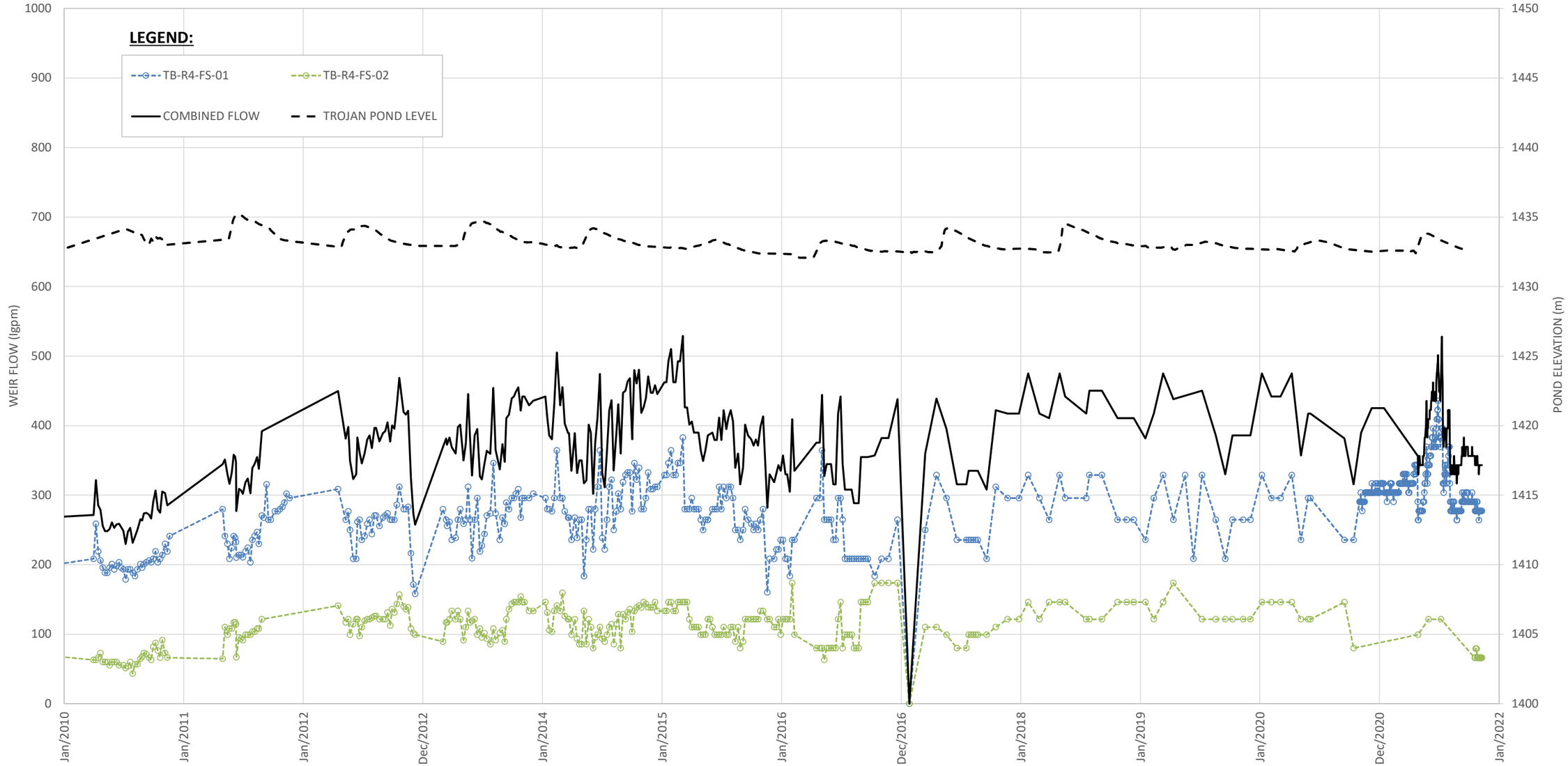
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: INCLINOMETER DISPLACEMENT PROFILE
IB16-2

PROJECT No. M02341C12

FIG No. II-B-5

November 29, 2021
Z:\MVCR\M02341C12-HVC 2021 Dam Safety Support\300 Design\340 Dam Movement Monitoring\340 StBeth & Trojan\[211129 Inclinometer plots (Beth and Troj) xlsx]II-B-5 IB-1 Beth



NOTES:
1. WEIR FLOW PLOTTED ON PRIMARY (LEFT) AXIS, TROJAN POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.

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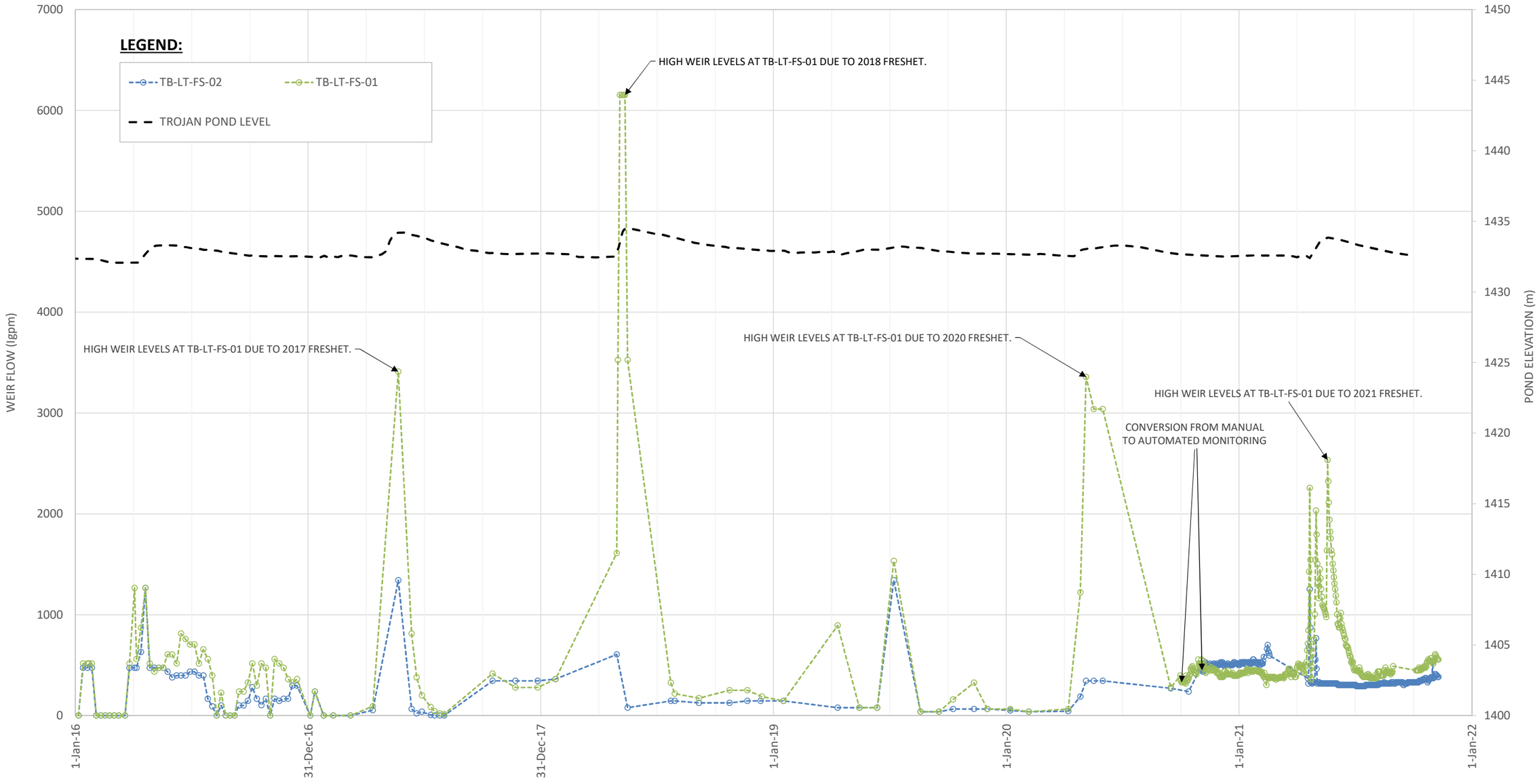
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE: TROJAN DAM
WEIR FLOWS

PROJECT No. M02341C12

FIG No. II-B-6

January 3, 2022
Z:\MVCR\M02341C12-HVC 2021 Dam Safety Support\300 Design\350 Seepage Data\Trojan\[220103 Trojan Weir.xlsx]Fig. V-B-7 Lower Trojan Weir



CLIENT
Highland Valley Copper / Teck
Klohn Crippen Berger

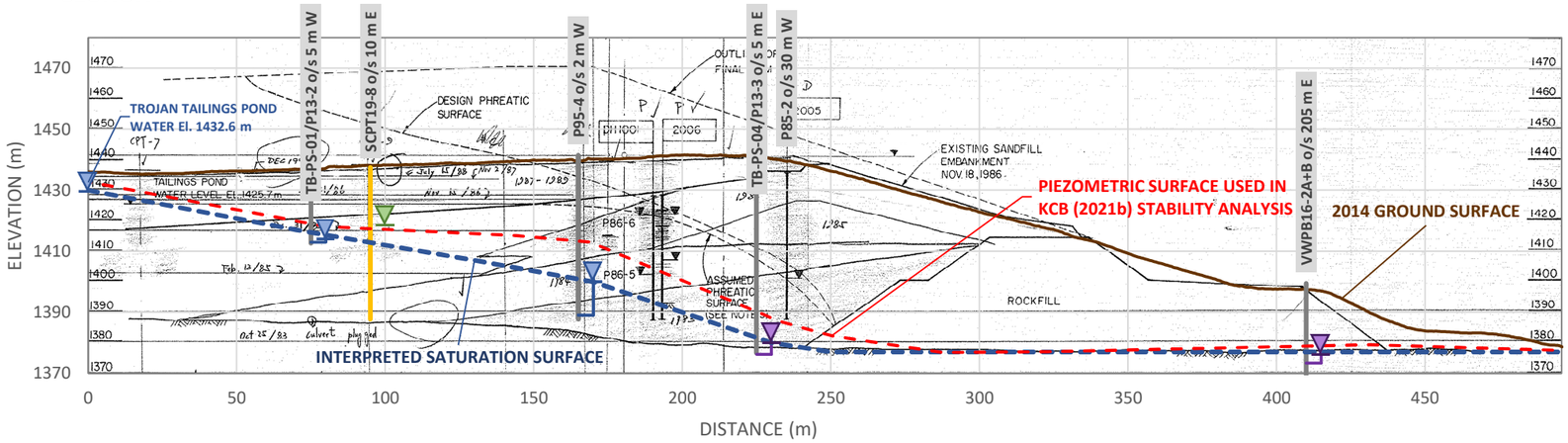
PROJECT
TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

TITLE
LOWER TROJAN POND
WEIR FLOWS

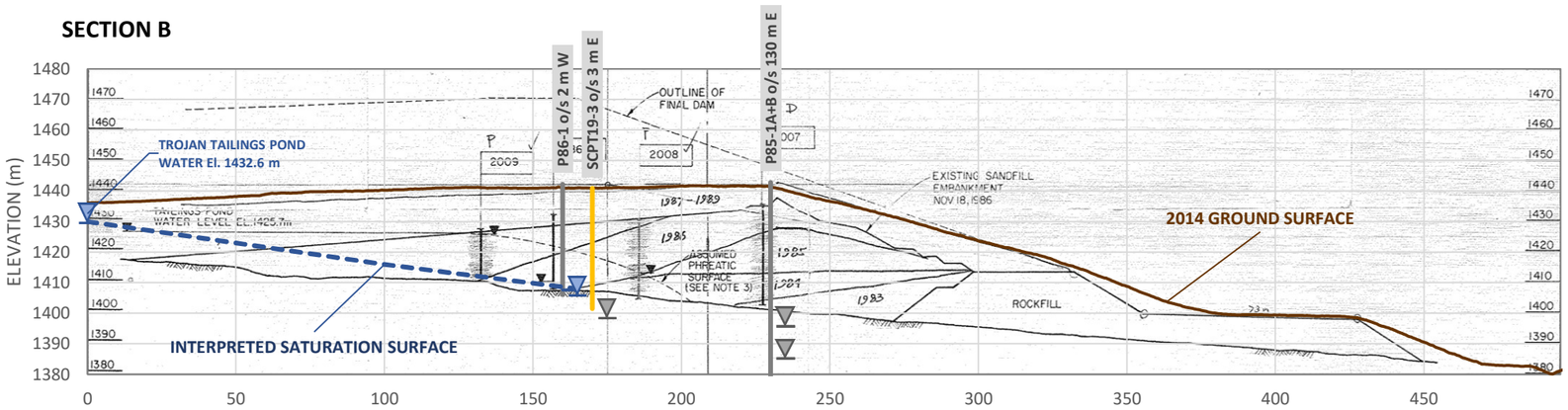
PROJECT No. M02341C12
FIG No. II-B-7

January 3, 2022
Z:\MVCR\M02341C12-HVC 2021 Dam Safety Support\300 Design\350 Seepage Data\Trojan\[220103 Trojan Weir.xlsx]Fig. V-B-7 Lower Trojan Weir

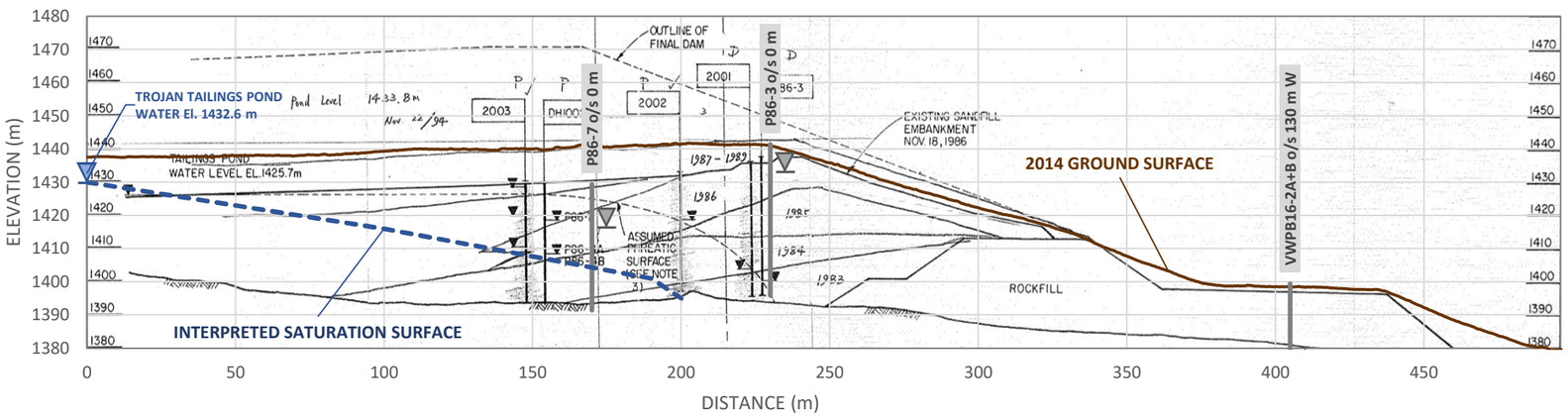
SECTION A



SECTION B



SECTION C



- DRILLHOLE
- CPT
- WATER ELEVATION AT FILL PIEZOMETER (SEPTEMBER 2021)
- WATER ELEVATION AT FOUNDATION PIEZOMETER (SEPTEMBER 2021)
- WATER ELEVATION AT CPT PIEZOMETER (SEPTEMBER 2021)
- WATER ELEVATION AT DRY PIEZOMETER (SEPTEMBER 2021)
- PIEZOMETRIC LEVEL DURING OPERATIONS

NOTES:

1. REFER TO FIGURE 3 FOR THE LOCATION OF SECTIONS.
2. 2014 GROUND SURFACE IS AT THE APPROXIMATE LOCATION FROM THE SECTIONS.
3. PIEZOMETER AND CPT LOCATIONS ARE APPROXIMATE.
4. PIEZOMETRIC ELEVATIONS ARE BASED ON SEPTEMBER 2021 READINGS.

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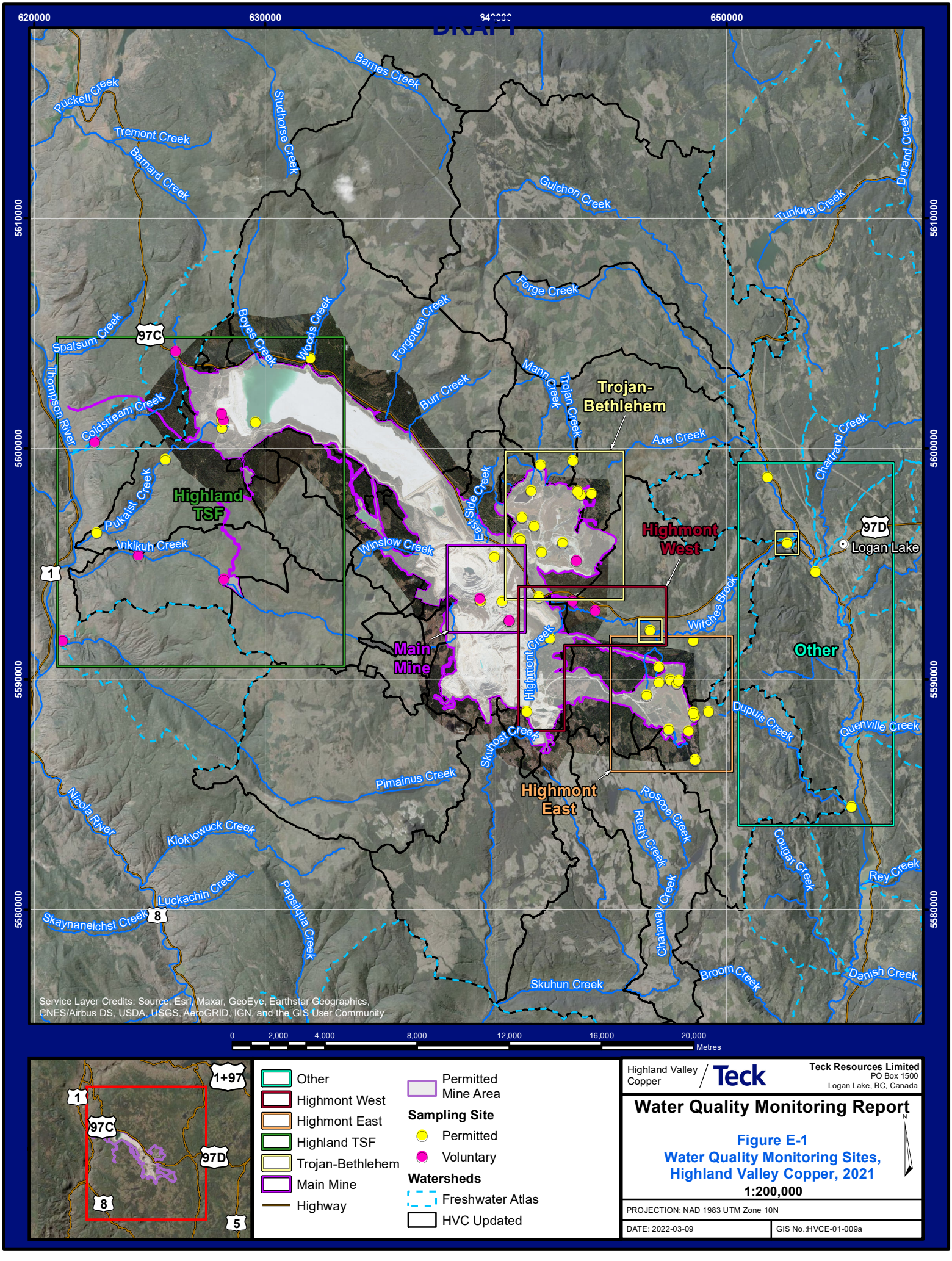
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2021 ANNUAL FACILITY PERFORMANCE REPORT

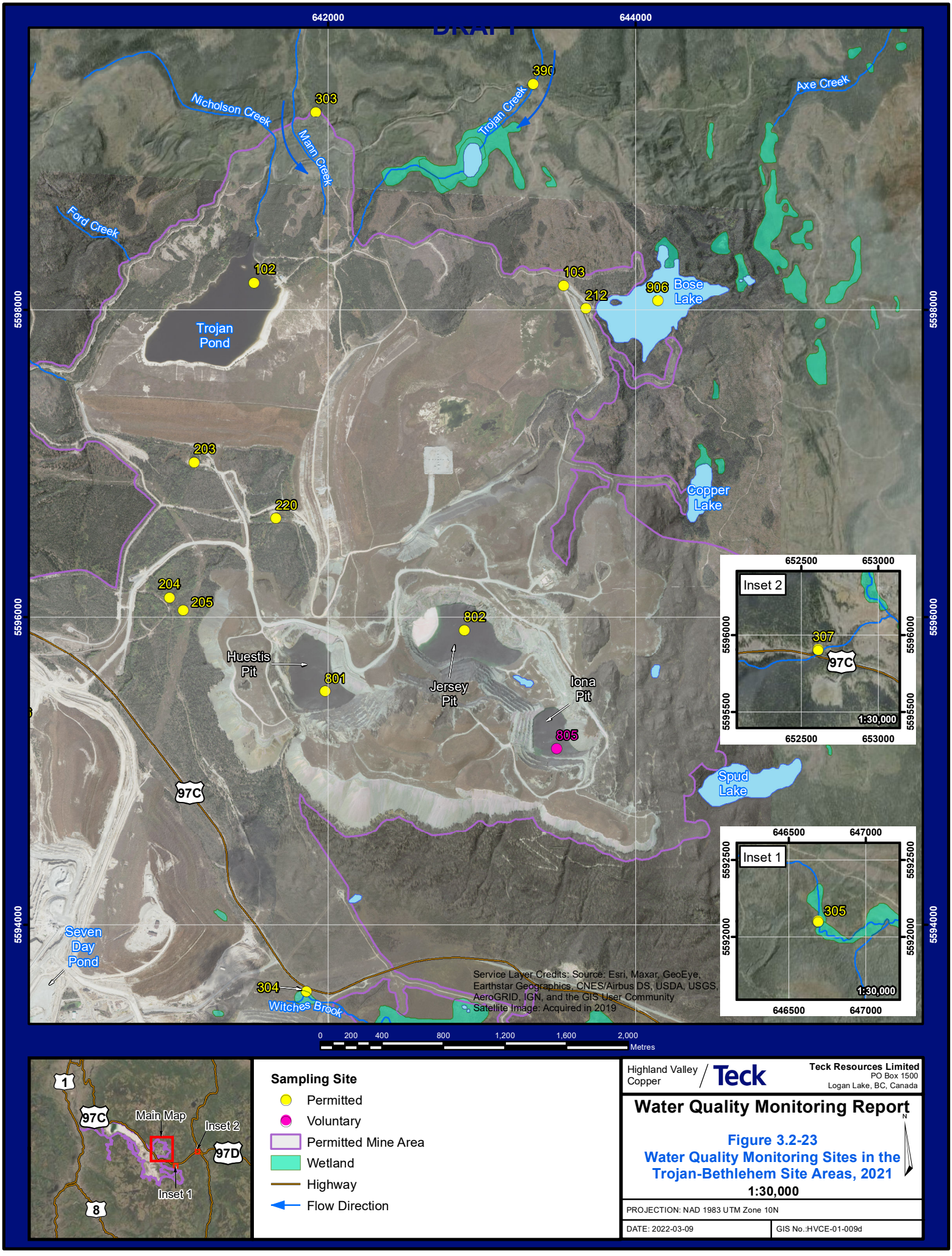
TITLE: TROJAN DAM INSTRUMENTATION SECTIONS
DOWNSTREAM SLOPE

SCALE	PROJECT No.	FIG. No.
NTS	M02341C12	II-B-8

APPENDIX III

Map of Water Quality Monitoring Points


DRAFT
620000
630000
640000
650000
5610000
5600000
5590000
5580000
Puckett Creek
Tremont Creek
Barnard Creek
Barnes Creek
Studhorse Creek
Guichon Creek
Tunkwa Creek
Durand Creek
Forge Creek
Spatsum Creek
97C
Boyes Creek
Woods Creek
Forgotten Creek
Thompson River
Coldstream Creek
Burr Creek
Mann Creek
Trojan Creek
Trojan-Bethlehem
Axe Creek
Chartrand Creek
Pukaist Creek
Highland TSF
East Side Creek
Highmont West
97D
Logan Lake
Inkikuh Creek
1
Winslow Creek
Witches Brook
Main Mine
Highmont Creek
Other
Dupuis Creek
Quenville Creek
Skuhost Creek
Pimainus Creek
Highmont East
Roscoe Creek
Rusty Creek
Nicola River
Klokiowuck Creek
Cougar Creek
Rey Creek
Luckachin Creek
Papsilqua Creek
Skaynaneichst Creek
8
Chatawai Creek
Broom Creek
Danish Creek
Skuhun Creek
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0
2,000
4,000
8,000
12,000
16,000
20,000
Metres
1+97
1
97C
97D
8
5
Other
Highmont West
Highmont East
Highland TSF
Trojan-Bethlehem
Main Mine
Highway
Permitted Mine Area
Sampling Site
Permitted
Voluntary
Watersheds
Freshwater Atlas
HVC Updated
Highland Valley Copper
Teck
Teck Resources Limited
PO Box 1500
Logan Lake, BC, Canada
Water Quality Monitoring Report
N
Figure E-1
Water Quality Monitoring Sites, Highland Valley Copper, 2021
1:200,000
PROJECTION: NAD 1983 UTM Zone 10N
DATE: 2022-03-09
GIS No.:HVCE-01-009a


DRAFT
642000
644000
5598000
5596000
5594000
Nicholson Creek
Mann Creek
Trojan Creek
Axe Creek
Ford Creek
303
390
102
103
212
906
Bose Lake
Trojan Pond
203
220
Copper Lake
204
205
802
Huestis Pit
801
Jersey Pit
Iona Pit
805
97C
Spud Lake
Seven Day Pond
304
Witches Brook
Inset 2
652500
653000
5596000
5595500
307
97C
1:30,000
Inset 1
646500
647000
5592500
5592000
305
1:30,000
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Satellite Image: Acquired in 2019
0 200 400 800 1,200 1,600 2,000
Metres
1
97C
Main Map
Inset 2
97D
Inset 1
8
Sampling Site
Permitted
Voluntary
Permitted Mine Area
Wetland
Highland Valley Copper
Teck
Teck Resources Limited
PO Box 1500
Logan Lake, BC, Canada
Water Quality Monitoring Report
N
Figure 3.2-23
Water Quality Monitoring Sites in the Trojan-Bethlehem Site Areas, 2021
1:30,000
PROJECTION: NAD 1983 UTM Zone 10N
DATE: 2022-03-09
GIS No.:HVCE-01-009d

APPENDIX IV

DSR Recommendations – HVC Work Plan

Appendix IV
DSR Recommendations – HVC Workplan

Table IV-1 Trojan TSF: 2018 SRK DSR Recommendations for Deficiencies and Non-Conformances

ID No.	Recommended Action	DSR Assigned Priority[1]	Status (Scheduled completion)	Workplan To Complete
SRK19-GEN-001	HVC relies on KCB for retaining many documents related to the TSF in contravention with the document control section of the OMS manual. Store all required documents in HVC's SharePoint site. Ideally, a list of all available documents is appended or referenced in the OMS manual.	4	OPEN (2021 – Revised 2022)	HVC is planning for KCB to prepare a consolidated summary of key reference documents which will be included in a future OMS Manual update and used to identify which reports to store on SharePoint. This activity was deferred to 2022.
SRK19-TD-03	*HVC have installed public safety signs as recommended by AMEC in the previous DSR (AMEC 2014a). However, these signs do not identify hazards specifically. Include identification and description of hazards in the public safety signs near the Trojan fish pond.*	*4*	*ADDRESSED*	*The AMEC DSR is specific to public safety signs bystanders for hazards near dams, specifically the site gates near Bose Lake Dam and Trojan Pond. HVC reviewed the BC Dam Safety Regulations. HVC concluded that public signage is not warranted as the risk of failure does not fall into the "unacceptable" category.*
SRK19-TD-05	*The flood routing analysis for the Trojan TSF should be updated. The PMF IDF is greater than the Code requirement but was not determined in accordance with CDA (2013) requirements (i.e. spring PMF vs summer/autumn PMF).*	*3*	*ADDRESSED*	*Completed with summary of findings and report reference in main text.*
SRK19-TD-06	*Required and available normal freeboards have not been reported. Evaluate and report required and available normal freeboards.*	*3*	*ADDRESSED*	*Completed with summary of findings and report reference in main text.*
SRK19-R4-01	*The required normal freeboard as per CDA (2013) guidelines has not been evaluated. Evaluate required and available normal freeboards.*	*3*	*ADDRESSED*	*Completed with summary of findings and report reference in main text.*
SRK19-LTD-01	Risk of overtopping. The minimum freeboard requirement set by HVC (0.5 m) is not met during the IDF. As recommended in the 2017 DSI (LTD-2017-01), the spillway should be upgraded to be compliant with CDA (2013).	3	OPEN (2022)	Planned for Completion in 2022, by implementing the preferred approach to decommission the dam structure and replace intake, which will provide the same routing capability but retain no reservoir.
SRK19-LTD-03	*The required normal freeboard as per CDA (2013) guidelines was not evaluated. Evaluate required and available normal freeboards.*	*3*	*ADDRESSED*	*Completed with summary of findings and report reference in main text.*

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