Klohn Crippen Berger

Teck Highland Valley Copper Partnership

2019 Dam Safety Inspection Report

Trojan Tailings Storage Facility

FINAL

BEST MANAGED COMPANIES Platinum member

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April 2020

Klohn Crippen Berger

April 3, 2020

Teck Highland Valley Copper Partnership
PO Box 1500
Logan Lake, British Columbia
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Mr. Chris Anderson
Manager, Tailings and Water

Dear Mr. Anderson:

2019 Dam Safety Inspection Report
Trojan Tailings Storage Facility
FINAL

We are pleased to submit the 2019 Dam Safety Inspection final report for the Trojan Tailings Storage Facility. The inspection and this report were prepared to comply with Section 10.5.3 of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code) (MEM 2017), and Section 4.2 of the Code Guidance Document (MEM 2016).

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

2019 Dam Safety Inspection Report

Trojan Tailings Storage Facility

FINAL

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2019 Dam Safety Inspection (DSI) of the Trojan Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site in accordance with the requirement of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code). The DSI includes the Trojan Dam and two seepage dams (R4 Seepage Pond Dam and Lower Trojan Dam). The visual inspection was completed by the Engineer of Record (EoR), Mr. Rick Friedel, P.Eng., Mr. Pablo Urrutia, P.Eng., and Ms. Narges Solgi, EIT, as representatives of KCB on June 12, 2019. Mr. Chris Anderson, P. Eng., THVCP Tailings and Water Manager, is the TSF Qualified Person (as defined by the Code) for the Trojan TSF.

The Trojan TSF was visually in good physical condition, the observed performance during the 2019 site inspections is within expected design conditions, and 2019 surveillance data is consistent with past performance.

The Trojan TSF is located 4 km north of the operating mill. The Trojan TSF is a reclaimed, inactive facility constructed in 1973 and operated until 1989. THVCP continue 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 active care closure phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin (CDA 2014).

Trojan TSF structures are as follows:

- Trojan Dam – comprises a rockfill starter dam which is approximate half the height of the dam in the base of the natural valley. Above the starter dam, the dam was raised in an upstream manner with cyclone sand. A sand and gravel filter zone separate the starter dam rockfill and the cycloned tailings sand. A pond is continuously present in the impoundment with a minimum offset of 200 m from the dam crest.
- R4 Seepage Pond Dam – located downstream from Trojan Dam, collects seepage from the Trojan Dam toe.
- Lower Trojan Dam (LTD) – located downstream from R4 Seepage Pond, collects local runoff (which may include Trojan Diversion flows) and flows from the R3 Reclaim Pond (from Bethlehem No. 1 TSF) and from the R4 Seepage Pond.

Trojan Dam has been assigned a “Very High” consequence category as defined by CDA (2013). The downstream seepage dams have been assigned a “Low” consequence category as defined by CDA (2013). There were no significant changes to the key geotechnical or hydrotechnical hazards during 2019.

The latest dam safety review (DSR) was completed by SRK Consulting in 2018 and the report was submitted to THVCP in March 2019 (SRK 2019). The Code requires a DSR be undertaken every five years for tailings dams; therefore, the next DSR should be scheduled for 2023. SRK concluded the following (SRK 2019):

- the Trojan TSF is "reasonably safe"[1] with, in general, minor deficiencies and non-conformances, per CDA (2013) guidelines;
- the Trojan TSF is a well-managed facility with a high level of technical stewardship and appropriate operating procedures. The credible failure modes are understood and effectively controlled; and
- no changes to the consequence classification were recommended.

The DSR included 16 recommendations related to dam safety for the Trojan TSF and seepage ponds. One recommendation was given a Priority Level[2] 2 which was to revisit the assessment of static liquefaction failure modes. No issues of concern related to the existing assessment were raised but SRK recommended that in light of recent tailings dam failures in other parts of the world, it is considered appropriate to revisit this assessment for Trojan considering a wider range of sensitivity cases. A portion of the review was completed in 2019, which included a site investigation program, and will be finalized in 2020.

The other 15 recommendations were assigned a Priority Level of either 3 or 4 which represent issues that should be resolved to meet compliance requirements or best practice but alone do not represent a dam safety concern. THVCP and KCB have reviewed the DSR recommendations and a formal work plan with targeted timelines to address them should be developed by the end of April 2020.

The Lower Trojan Dam cannot safely route the Inflow Design Flood (IDF) required under the Code (i.e., 100-year flood) and upgrades to bring the facility into compliance were recommended in 2019. There have been no potential overtopping events recorded at the facility, including during above average freshet events over the past 5 years. KCB conducted studies to assess potential upgrade alternatives or possible decommissioning of the dam in 2019 with THVCP targeting construction of the preferred alternative in 2020. In the interim period, THVCP has implemented additional measures to monitor and respond to elevated pond levels in LTD, if necessary.

The emergency preparedness and response plan (EPRP) was updated in 2016. The Operation, Maintenance and Surveillance (OMS) manual was reviewed and issued in December 2018 (THVCP 2018); emergency contacts and other minor items were updated during 2019. The OMS manual and EPRP meet the intent of the Mining Association of Canada (MAC) and CDA guidelines, are current and provide adequate coverage for existing conditions.

[1] Based on APEGBC (2016) the dam is either "reasonably safe" (with or without non-conformances and / or deficiencies) or "not reasonably safe."
[2] Refer to Table 1 or summary of Priority Levels.

Routine visual inspections and instrument measurements were completed by THVCP at the OMS prescribed frequencies. There were no event-driven inspections in 2019 triggered by precipitation or earthquake events as defined in the OMS manual. 2019 instrumentation readings (e.g. piezometer, pond level, inclinometer) were consistent with recent history and do not indicate potential issues of concern.

Water quality downstream of the Trojan TSF during 2019 and compliance with requirements of Permit PE-376, and associated amendments is reported by THVCP in a separate report. KCB reviewed the 2019 data relevant to the facility which indicate water quality at all downstream sample sites were in compliance with permit limits.

Refer to Table 1 for status of outstanding recommendations from previous DSI reports. Recommendations that have been closed are shown in italics. Recommendations to address deficiencies and non-conformances identified during the 2019 DSI are summarized in Table 2.

Table 1 Previous Deficiencies and Non-Conformance Recommendations – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline (Status)
Trojan Dam					
TD-2017-02	*Flood Routing*	*Freeboard*	*Raise the road in the designated area near the left abutment to El. 1440 m, either by fill placement or grading.*	*3*	*Q4 2018 (Closed)*
TD-2018-01	*Erosion*	-	*Repair two rill erosions on the left bank of spillway channel (along riprap section), founded in tailings. Re-grade to divert water away from these areas, as feasible.*	*3*	*Q4 2019 (Closed)*
TD-2018-02	Flood Routing	10.1.8 (the Code)	Update flood routing assessment for Trojan impoundment, R4 Seepage Pond and LTD based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2 2020 (Open, LTD flood routing assessment was completed in 2019)
TD-2018-03	*Surveillance*	*Inclinometer Monitoring*	*Complete spiral correction on IB16-2 to resolve any measurement issues which may be impacting cumulative plots.*	*3*	*Q3 2019 (Closed)*
R4 Seepage Pond					
No outstanding recommendations from previous DSIs.					
Lower Trojan Dam					
LTD-2017-01	Flood Routing	Inflow Design Flood	Complete appropriate upgrade works to allow LTD to safely pass IDF with adequate freeboard, including decommissioning of the spillway pipe.	2	Q4 2020 (Open)

Notes:
1. Recommendation priority guidelines, specified by THVCP 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.

Table 2 2019 Recommendations for Deficiencies and Non-Conformances

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline (Status)
Trojan Dam					
TD-2019-01	Failure Mode Review	-	Complete and document due diligence review of upstream dam failure modes as recommended by the DSR.	2	Q3 2020
TD-2019-02	DSR Recommendation	-	KCB and THVCP to develop a work plan to address 2018 DSR recommendations.	3	April 2020
TD-2019-03	Foundation Characterization	-	Complete an assessment to characterize softer zone at the base of the tailings identified during 2019 SCPT program.	2	Q2 2020
R4 Seepage Pond					
No new recommendations in 2019.					
Lower Trojan Dam					
No new recommendations in 2019.					

Notes:
1. Recommendation priority guidelines, specified by Teck 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.

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1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2019 dam safety inspection (DSI) of the Trojan Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site. The Trojan TSF is an inactive facility constructed in 1973 and operated until 1989. The DSI includes the Trojan Dam and two downstream seepage dams (R4 Seepage Pond Dam and Lower Trojan Dam) for the review period between January 2019 to September 2019[3].

The Trojan Dam has been reclaimed and assigned a "Very High" consequence category as defined by CDA (2013). The downstream seepage dams have been assigned a "Low" consequence category as defined by CDA (2013). THVCP 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 active care closure phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin (CDA 2014).

The DSI scope of work consisted of:

- a visual inspection of the physical conditions of the various containment facilities;
- a review of updated piezometer, inclinometer and seepage monitoring data provided by THVCP;
- a review of climate and water balance data for the site;
- a review of the Operations, Maintenance & Surveillance (OMS) manual and other relevant dam safety management documents relevant to the DSI review period; and
- a review of any activities, other than routine, completed at the site during the DSI review period, where applicable.

The inspection and this report were prepared to comply with Section 10.5.3 of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code) (MEM 2017), and Section 4.2 of the Code Guidance Document (MEM 2016).

The visual inspection was completed by the Engineer of Record (EoR), Mr. Rick Friedel, P.Eng., Mr. Pablo Urrutia, P.Eng., and Ms. Narges Solgi, EIT, as representatives of KCB on June 12, 2019. During the inspection, the weather was sunny with cloudy periods and did not impact the inspection. Mr. Chris Anderson, P. Eng., THVCP Tailings and Water Manager, is the TSF Qualified Person (as defined by the Code) for the Trojan TSF.

[3] During 2019, THVCP and KCB agreed to modify the review period for the annual DSI to October through September (was previously January to December). This change was made to allow adequate time to compile all DSIs undertaken at the HVC mine site and submit them to the BC Ministry of Energy, Mines and Petroleum Resources (EMPR) prior to the March 31st deadline. The change in review period shortens the review period of the 2019 DSI to 9 months as the period from October 2018 to December 2018 was captured under the 2018 DSI (KCB 2019a).

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.

The latest dam safety review (DSR) was completed by SRK Consulting in 2018 and the report was submitted in March 2019 (SRK 2019). The Code requires a DSR be undertaken every five years for tailings dams; therefore, the next DSR should be scheduled for 2023. The findings of the 2018 DSR (SRK 2019) and related recommendations are further discussed in Section 3.3.

2 FACILITY DESCRIPTION

The HVC site 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. A pond is continuously present in the impoundment.

A layout of the main components of the facility are shown on Figure 3 to Figure 5: Trojan Dam, R4 Seepage Pond, Lower Trojan Dam (LTD); and Trojan Diversion. Typical geometry and key dimensions of the dam are summarized in Table 2.1. Refer to Appendix III for additional general information regarding the structures including history, water management, and select design drawings.

Trojan Dam

- The Trojan Dam comprises a rockfill starter dam, built in 1973, with coarse rock placed downstream of the dam axis, finer rockfill placed upstream and underdrains to direct seepage to a collection ditch along the downstream toe. The starter dam was raised in an upstream manner with cyclone sand. A 25 ft to 30 ft wide sand and gravel filter zone separates the starter dam rockfill and cycloned tailings. This zone is shown on the design drawing and stability sections in KL (1982) as well as referenced in other related reports (e.g. KC 1994, KL 1987, and GEPAC 1973).
- The design minimum beach width required to maintain, along the crest and west side of the pond, 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.

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 run-off 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.
- A 300 mm diameter Low-Level Outlet, 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 Pond Dam (LTD)

- LTD is located approximately 1.1 km downstream of R4 Seepage Pond (Figure 5) and collects local surface runoff and flows from R4 Seepage Pond and R3 Reclaim Pond (at the toe of Bethlehem No. 1 Dam).
- Dam was constructed in 1989 but no as-built records are available.

- Outflow from the pond is through a diversion pipeline (a diameter 460 mm culvert which is buried through the dam near 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 (diameter 810 mm) 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)	1414 (starter rockfill dam design) 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)	unknown	2H: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 Cutoff Trench	Single Raise Dam

1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.
3. A 2005 report indicates an upstream slope of 1.75H:1V based on a November 2004 measurement (KC 2005).
4. These slopes are shallower than those on 1987 design drawings 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.

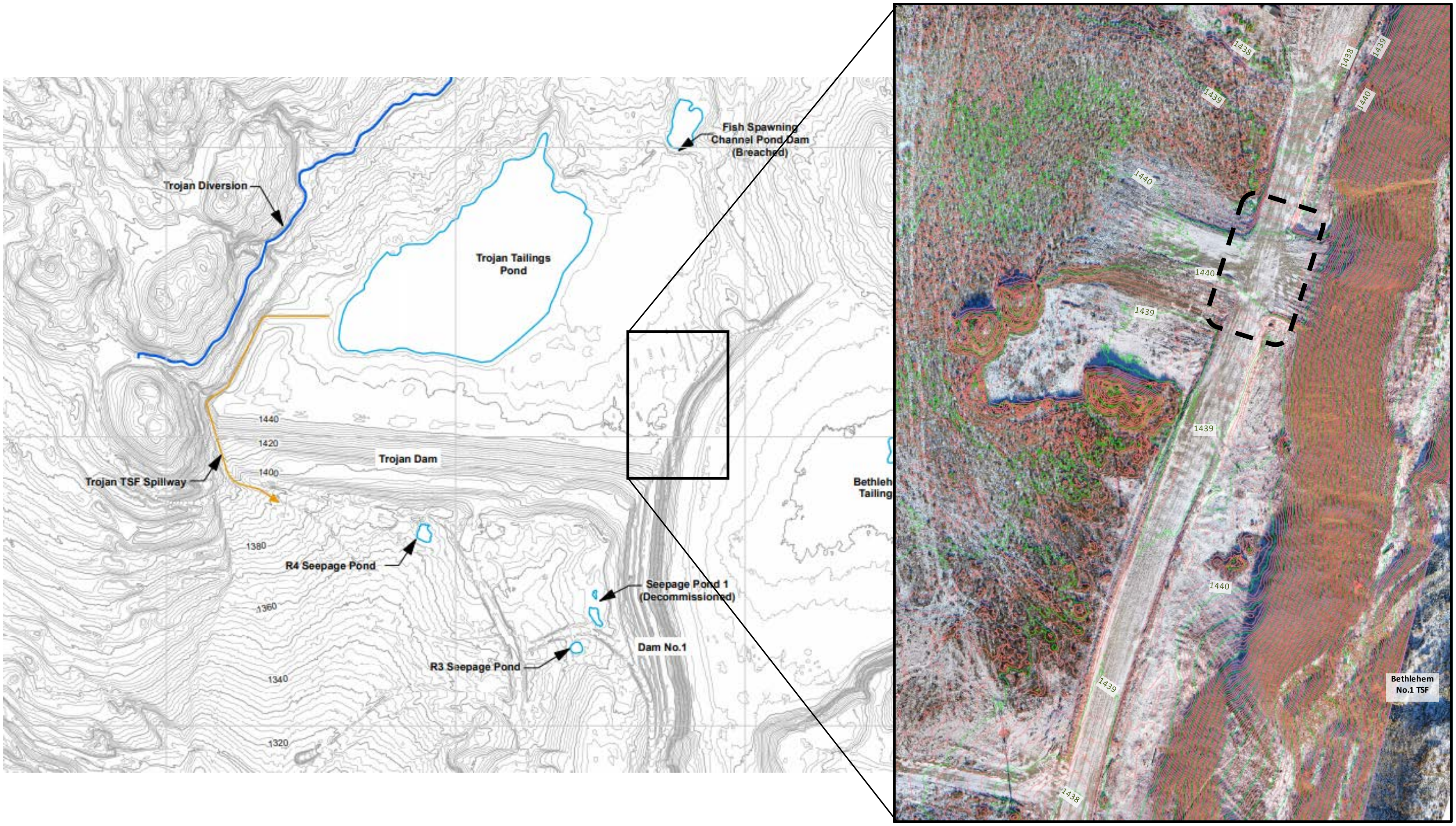
3 2019 ACTIVITIES

3.1 Operations and Maintenance

Other than routine maintenance activities, as defined in the OMS manual, (e.g., clearing weirs of vegetation), the following activities were undertaken at the Trojan TSF in 2019 to close out two recommendations from previous DSIs (refer to Table 8.1):

- THVCP raised the access road, near the left abutment of Trojan Dam, to El. 1440 m in the area shown on Figure 3.1. This increased the freeboard in this area as discussed in Section 4.5. (Recommendation DSI-2018-01, Table 8.1).
- THVCP repaired the two rill erosions on the left bank of spillway channel (along riprap section) which closes out DSI recommendation (DSI-2018-01, Table 8.1).

Figure 3.1 Area of Access Road at Left Abutment Raised in 2019 (Dashed Black Line)



3.2 2018 Dam Safety Review

A DSR 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). SRK (2019) concluded the following:

- the Trojan TSF is "reasonably safe"[4] with, in general, minor deficiencies and non-conformances, per CDA (2013) guidelines;
- the Trojan TSF is a well-managed facility with a high level of technical stewardship and appropriate operating procedures. The credible failure modes are understood and effectively controlled; and
- no changes to the consequence classification were recommended.

The DSR included 16 recommendations related to dam safety for the Trojan TSF and seepage ponds. There were no recommendations assigned a Priority Level[5] 1. Fifteen of the recommendations were assigned a Priority Level of either 3 or 4 which represent issues that should be resolved to meet compliance requirements or best practice but alone do not represent a dam safety concern. One recommendation was given a Priority Level 2 which was to revisit the assessment of static liquefaction failure modes. No issues of concern were raised related to the existing assessment but SRK recommended that in light of recent tailings dam failures in other parts of the world, it is considered appropriate to revisit this assessment for Trojan considering a wider range of sensitivity cases. THVCP and KCB agreed that this is an appropriate due diligence activity, planned for 2020.

THVCP and KCB have reviewed the DSR recommendations and a formal work plan with targeted timelines to address them will be completed by the end of April 2020. Appendix VII includes a table of all recommendations. KCB has grouped the DSR recommendations into general categories, as follows:

- (1) Review of static liquefaction failure mode and triggers;
- (5) OMS Manual updates and/or improvements;
- (2) Documentation of additional sensitivity stability analyses;
- (2) Facility maintenance; and
- (6) Updates to flood routing assessments and documenting minimum freeboard under "normal conditions" as per CDA (2013).

[4] Based on APEGBC (2016) the dam is either "reasonably safe" (with or without non-conformances and/or deficiencies) or "not reasonably safe."
[5] Refer to Table 8.1 for summary of Priority Levels.

3.3 Site Investigation

As part of an industry research program that Teck Resources is supporting, a site investigation program was completed, which comprised 10 seismic cone penetration tests (SCPT), through the Trojan Dam upstream tailings beach. As part of the program, four vibrating wire piezometers (VWP) were installed. CPT and instrument installation locations are shown on Figure 3.

The SCPT results were reviewed by KCB. These results are consistent with the assumed conditions regarding the tailings beach:

- cycloned tailings beach is “sandy” and drained to, or near to, natural ground;
- saturated fines tailings zones are present near pond (i.e. upstream of the cycloned sand zone);
- saturation level inferred from SCPT measurements are similar to current piezometer readings; and
- there is a downward vertical seepage gradient through the tailings beach into the foundation.

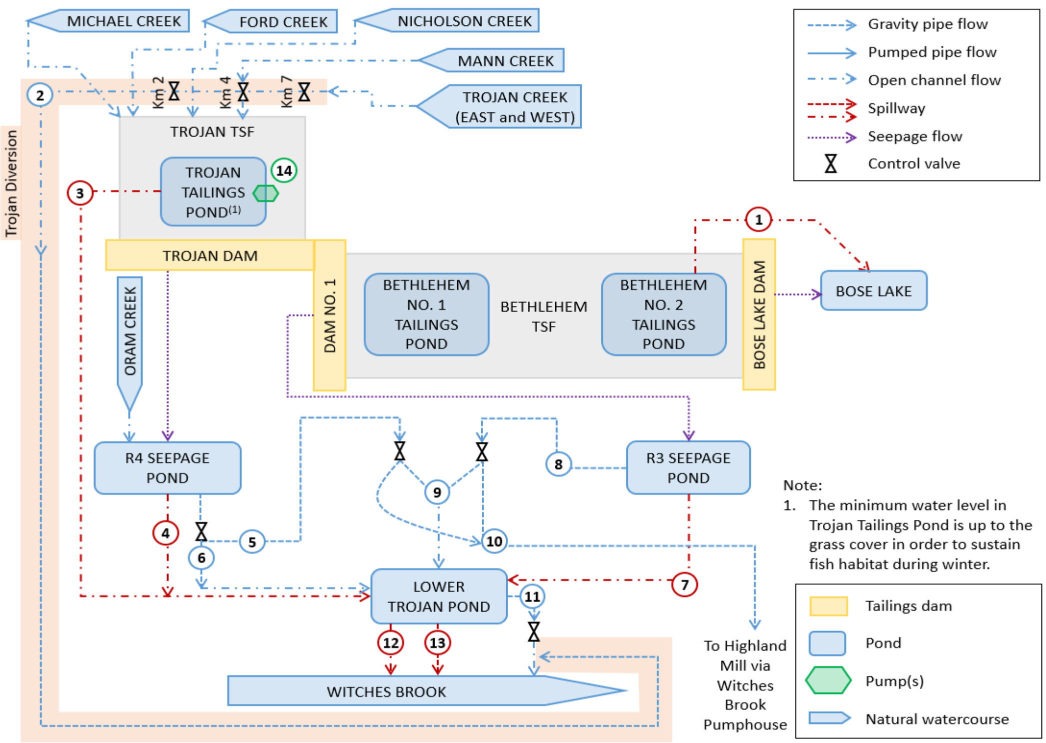
A softer layer was observed at the base of the tailings at two test locations near the right (west) abutment: SCPT19-04, and SCPT19-05. This layer was not present at any of the other test locations. There have been no observations in this area that indicate this material has caused adverse dam safety performance under existing conditions. However, this should be investigated further to confirm no impacts to dam safety under potential future conditions. Follow up activities are in progress by KCB to characterize this material and assess potential influence, if any, on dam safety. The initial activity being undertaken is a review of the available design, site characterization and construction documentation to identify this material. Based on findings, additional activities will be identified, if appropriate.

4 WATER MANAGEMENT

4.1 Overview

The flow schematic for the Trojan TSF and nearby Bethlehem TSF is shown in Figure 4.1. Refer to Appendix III-A for additional information regarding water management related to the Trojan TSF.

Figure 4.1 Flow Schematic for Bethlehem and Trojan TSFs



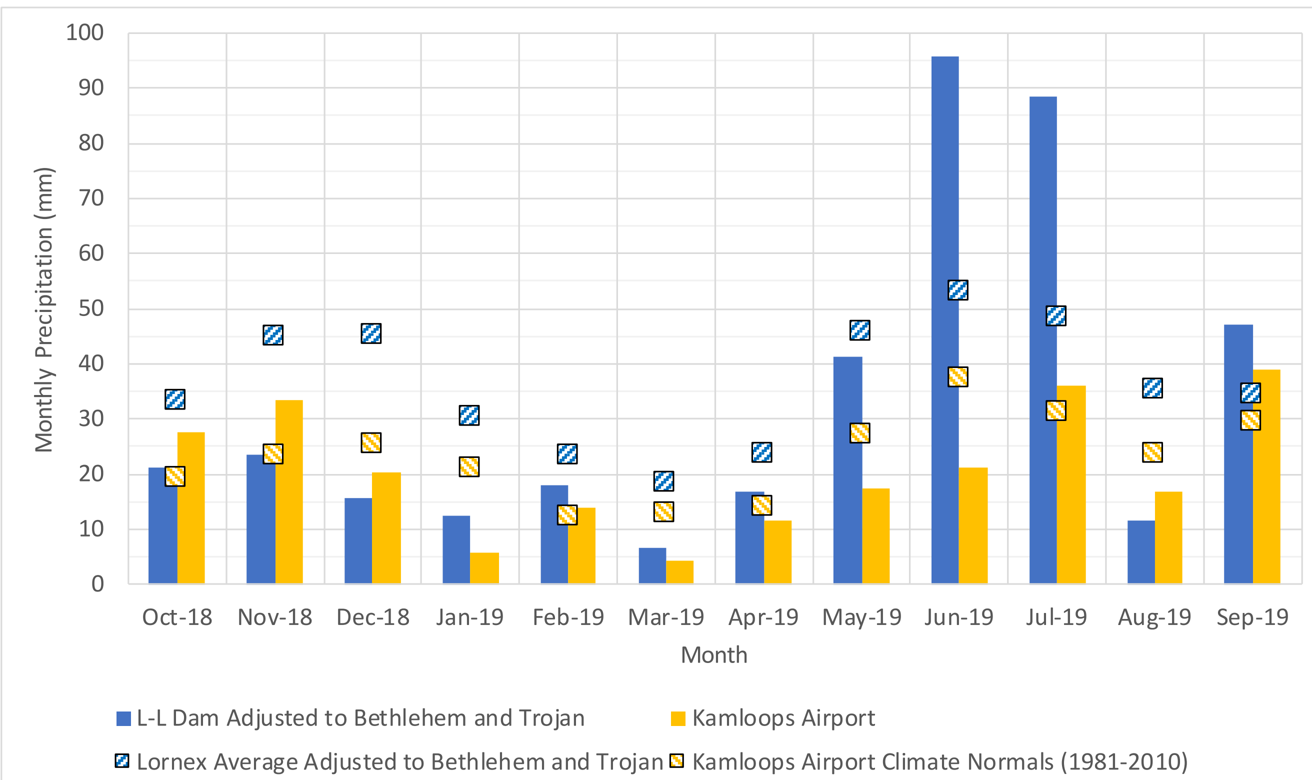
No.	Name	Description	Status
1	Bose Lake Spillway	3 m wide channel with concrete sill founded in tailings (3 m wide, vegetated) and natural ground (3 m, riprap-lined)	Operational
2	Trojan Diversion	6.5 km long series of channels, culverts, and pipelines	Operational
3	Trojan Spillway	1.3 km long open channel 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	Seepage to LTD	Buried pipeline	Operational
10	Northern Collection Line	Buried pipeline	Operational
11	LTD Low-Level Outlet	460 mm dia. HDPE pipe with control valve and intake trash rack	Operational
12	LTD Spillway	7 m wide channel	Operational
13	LTD Overflow	810 mm dia. HDPE pipe	Operational
14	Trojan Pump	Pump for Trojan Tailings Pond	Non-operational

4.2 Climate

THVCP provided climate data for the DSI reporting period to KCB for review. KCB applied the appropriate corrections, based on HVC site wide hydrology document (Golder 2016), and compared the climate data to typical values, refer to Appendix IV-A. The following observations were noted for the DSI reporting period (refer to Figure 4-2):

- January through April, precipitation measured at Trojan TSF was significantly less than historic normals (based on Highland Valley Lornex adjusted to Bethlehem and Trojan Area) which, along with reduced snowpack, contributed to a less severe freshet than recent years.
- June and July 2019 were noticeably wetter than normal.
- Snowpack depths were not measured in January and February 2019. Snowpack was significantly shallower than average in April and May 2019.

Figure 4.2 Monthly Precipitation



4.3 Water Balance

THVCP manages and tracks the annual water balance for the Trojan TSF. Table 4.1 is a summary of annual inflows and outflows, provided by THVCP. The water balance is based on simplified modelling results and therefore the values should be treated as indicative only.

Table 4.1 Annual Water Balance for Trojan TSF

Item	Volume in 2019[1] (m^3)
Inflows	
Direct Precipitation[2]	150,500
Runoff[3]	640,000
Groundwater	14,300
Outflow from Fish Spawning Channel Pond	0
Total Inflow:	804,800
Outflows	
Seepage	190,000
Evaporation[4]	839,500
Total Outflow:	1,029,500
Balance	
Balance (inflow minus outflow)	-224,699

Notes:
1. Values received from THVCP have been rounded to the closest 100 m^3.
2. Precipitation from the Shula Flats weather station adjusted to the Trojan area was used in the water balance.
3. Runoff to Trojan Pond was calculated based on observed increase in pond volumes over 2019. Runoff cannot be modelled due to manual operation of Trojan Diversion Valves.
4. Evaporation assumed for Trojan TSF: 540 mm/year.

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 the following discussion points noted:

- A recommendation from the 2018 DSI (KCB 2019a) and 2018 DSR (Section 3.3) was to revise flood routing for the Trojan TSF, Lower Trojan Pond and R4 Seepage Pond so all are consistent with the current site wide hydrology standard (i.e., Golder 2016). This work has been completed for Lower Trojan, as discussed further below, and is planned for the remaining structures.
- To address recommendations from previous DSIs, flood routing for the Lower Trojan Dam was updated in 2018 to assess whether the facility can safely pass the Inflow Design Flood (IDF), 100-year return period, 24-hour duration, with adequate freeboard (KCB 2019b). The assessment showed that the facility could not safely route the IDF with appropriate freeboard and upgrade works were recommended in 2018 DSI to bring the facility into compliance (KCB 2019a).

In 2019, various alternatives were assessed to bring LTD into compliance including upgrades to the existing spillway and potential to replace the dam with a diversion structure. Pending completion of design and necessary permitting, THVCP is planning to complete the upgrade works in 2020. Starting in 2017, and until the work is completed, THVCP has implemented additional measures to manage potential overtopping risks in the event of a large flood:

- Remote monitoring system is used to monitor Lower Trojan Pond level.
- If water reaches the invert of the outlet discharge pipe, THVCP would initiate increased (twice daily, minimum) monitoring for signs that flow from the pipe is causing erosion of the downstream toe of the dam. If erosion is observed, remedial actions would be taken.
- If flow through the outlet discharge pipe is not sufficient to maintain a stable pond level (i.e. pond continues to rise), THVCP would deploy a pump to the LTD to increase outflow capacity sufficiently to prevent overtopping. Pumping would keep the pond level below the overflow pipe and spillway intakes. The flow would be directed to Witches Brook via a network of ditches and pipes that are used under normal operating condition.

This procedure shall be reflected in the next revision of the OMS manual which is scheduled for completion in 2019.

Table 4.2 Inflow Design Flood for Trojan TSF and Seepage Ponds

Dam	Outfall Type	Consequence Classification	Inflow Design Flood	Spillway Design Flood (Precipitation Depth, Design Flow)		Spillway Design Reference
				Design Event	Peak Flood Level	
Trojan Dam	Open channel	Very High	2/3 between 1000-year and PMF(1)	24-hour PMP(2) (182.2 mm, 26.1 m^3/s)	1438.5 m	(AMEC 2014b)
R4 Seepage Pond Dam	Open channel	Low	100-year(3)	24-hour PMP(4) (180.7 mm, 1.57 m^3/s)	1364.6 m	(AMEC 2014c)
Lower Trojan Dam	Open channel and pipe	Low	100-year(3)	100-year 24-hour(5) (75.2 mm, 6.4 m^3/s)	1296.8 m	(KCB 2019b)

Notes:
1. Per the Code for tailings dams (MEM 2016).
2. Based on data from Atmospheric Environment Service (AES) climate stations at Kamloops Airport and Mamit Lake. A review of the spillway design was done in 2002 which concluded the 260 mm is comparable to the 230 mm estimated using the Highland Valley BCCL and Highland Valley Lornex climate stations and would accommodate a conservative snowmelt rate of 30 mm/day.
3. Per the Code for water dams (MEM 2016).
4. Based on data from the Environment Canada Highland Valley Lornex climate station (Station No. 1123469).
5. Based on data from the Environment Canada Highland Valley Lornex climate station (Station No. 1123469) and adjusted for orographic effects.

4.5 Freeboard

Minimum required freeboard[6], as per the Code, design freeboard during the IDF and minimum freeboard measured during 2019 for each dam are summarized in Table 4.3. These values were reviewed and updated in 2018 (KCB 2019b):

- Trojan Dam meets the freeboard requirement:
  - Following the raise along the access road at the left abutment (Section 3.1), the Trojan Dam meets or exceeds the minimum freeboard and beach width requirements during the design flood, which is greater than the IDF required under the Code. This additional allowance is to account for routine road maintenance activities (i.e. surface grading) which may progressively lower the road level.
- R4 Seepage Pond meets the minimum freeboard requirement.
- As discussed in Section 4.4, upgrades are recommended for the LTD to safely pass the IDF with adequate freeboard.
- For due diligence, minimum required freeboard under normal (i.e. non-flood) conditions will be calculated as part of recommended flood routing works. Normal condition freeboard is typically greater than flood freeboard but will be less than typical non-flood freeboard at each facility.

Table 4.3 Minimum Required Freeboard

Dam	Freeboard (m) – Flood Conditions			Freeboard (m) – Normal Conditions	
	Minimum Required During IDF(1)	Minimum During IDF Based on Flood Routing(1)	2019 Minimum Freeboard (freshet/flood)	Minimum Required Under Normal Conditions	2019 Freeboard (non-freshet/non-flood)
Trojan Dam	0.6 m	>0.6 m	6.8 m(2)	Note 6	6.8 m to 7.4 m(2)
R4 Seepage Pond Dam	0.5 m(3)	0.6 m	1.6 m(4)	Note 6	1.6 m(4)
Lower Trojan Dam	0.5 m(3)	Note 5	1.7 m(4)	Note 6	1.7 m(4)

Notes:
1. As per KCB (2018a).
2. Based on the 2019 recorded pond elevation through September and crest El. 1440 m
3. Minimum required freeboard to accommodate wave run-up as per CDA (2013) is 0.2 m for R4, and 0.4 m for the Lower Trojan Dam; however, minimum freeboard specified as 0.5 m to be consistent with other similar structures around the site.
4. Based on THVCP Inspection Reports
5. As discussed in Section 4.4, upgrades are recommended to safely pass the IDF with adequate freeboard.
6. For due diligence, minimum required freeboard under normal (i.e. non-flood) conditions to be calculated as part of recommended flood routing works. Normal condition freeboard is typically greater than flood freeboard but will be less than typical non-flood freeboard at each facility.

[6] The vertical distance between the pond level and the low point of the dam crest during flood or normal operation.

5 REVIEW OF MONITORING RECORDS AND DOCUMENTS

5.1 Monitoring Plan

The Operation, Maintenance and Surveillance (OMS) manual, was reviewed and issued by THVCP in December 2018 (THVCP 2018).

The activities undertaken for inspection and monitoring of the Trojan TSF are listed in Table 5.1.

Table 5.1 Monitoring Activities

TSF Monitoring	Facility	Minimum Frequency	OMS Compliance Met?	Responsibility	Documentation
Inspections					
Routine Visual Inspection[1]	Trojan Dam	Monthly	Yes	THVCP	THVCP Inspection Reports (Reviewed by KCB)
	Lower Trojan Dam And R4 Seepage Pond	Quarterly	Yes	THVCP	THVCP Inspection Reports (Reviewed by KCB)
Event-Driven Inspection	All	Event Driven[2]	none triggered in 2019	THVCP	THVCP Inspection Reports (Reviewed by KCB)
Dam Safety Inspection (DSI)	All	Annually	Yes	KCB	Inspection Report by KCB
Instrumentation Monitoring					
Piezometers	Trojan Dam	Monthly[3]	Yes	THVCP	Data reviewed by KCB as part of Annual DSI
Inclinometers	Trojan Dam	Monthly[3]	Yes	THVCP	
Seepage flow instruments	Trojan Dam	Monthly[3]	Yes	THVCP	THVCP Inspection Reports (Reviewed by KCB) Annual DSI
	Lower Trojan Dam	Monthly[3]	Yes	THVCP	
Surveys					
Dam Crest	Trojan Dam	Annually	Yes	THVCP	Data reviewed by KCB as part of Annual DSI
Survey monuments	Trojan Dam	Annually	Yes	THVCP	
Pond level	Trojan Dam	Twice per year	Yes	THVCP	

Notes:
1. Visual monitoring and inspection include pond level measurements and observations for any evidence of unusual condition and/or dam safety concerns (e.g. crest settlement, sinkholes, slope sloughing, erosion, seepage, piping, etc.)
2. THVCP 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; 41 mm (Golder 2016).
3. From March to November (when accessible).

Routine inspections, or other activities at the Trojan TSF, are summarized in THVCP's weekly dam safety report which are reviewed by the THVCP site team and provided to the KCB EoR representative for review.

The 2018 OMS manual meets the intent of the Mining Association of Canada (MAC 2011) and CDA (2014) guidelines and provides adequate coverage for existing conditions. The OMS manual is currently being revised by THVCP. Minor updates (contacts, EPRP, etc.) were completed in 2019 and a more extensive update to reflect requirements outlined in the recent updated guidance documented by MAC (2019) is planned for 2020.

5.2 Inspections

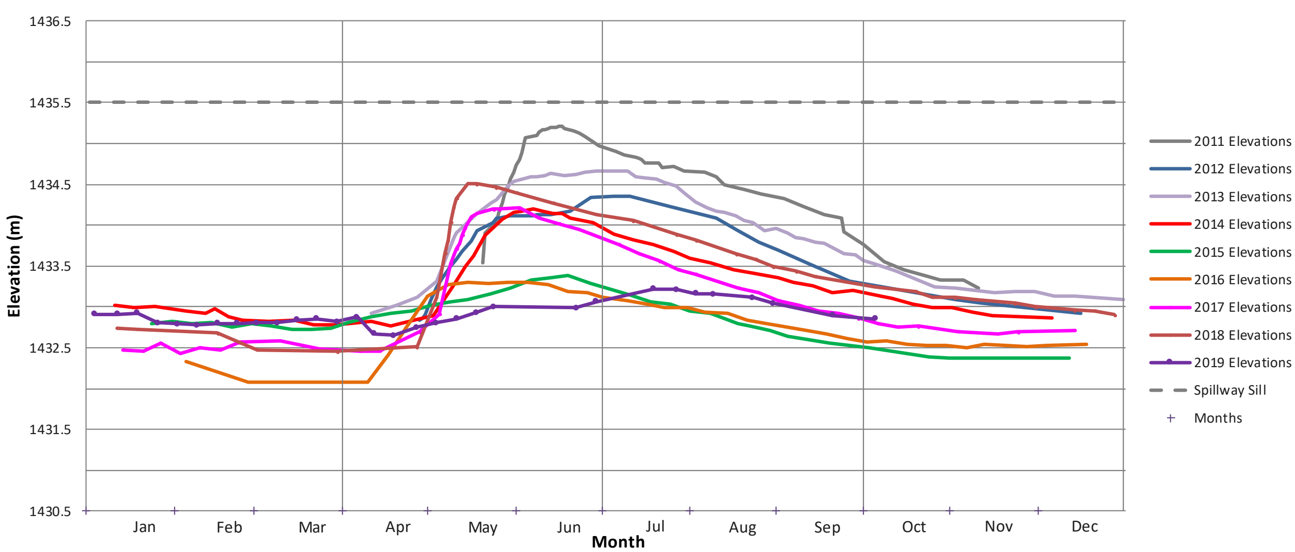
In addition to the routine and dam safety inspections referenced in Table 5.1, the Tailings Review Board toured the Highmont TSF, with KCB and THVCP, during the meeting hosted at site in August 2019. This activity is not specifically listed as a requirement of the OMS Manual but is done (typically annually) for the benefit of the Review Board members.

5.3 Pond Level

The Trojan Pond level is typically measured on a weekly basis, which is more frequent than prescribed in the 2018 OMS Manual.

From 2011 to 2016, the Trojan pond levels appeared to be trending downwards (with the exception of seasonal rise during freshet) at an overall average rate of about 0.3 m/year (refer to Figure 5.1). This trend has since reversed, and 2019 peak level happened in July due to above average precipitation in June and July. This overall change in trend is not a concern with respect to dam safety as there is significant flood storage capacity below the spillway invert that is not considered available at the onset of the IDF in the spillway design. The variation and trends in pond level will continue to be monitored and reviewed on a regular basis.

Figure 5.1 Trojan Pond Water Elevations – 2011 to 2019



5.4 Piezometers

As of end of September 2019, there are 15 active piezometers, 9 standpipes and 6 VWPs, in the Trojan TSF, as summarized in Table 5.2. Plots of piezometric readings since 2011 are shown in Figure IV-B-1 to Figure IV-B-3. Four of the VWPs were installed during the 2019 SCPT program (Section 3.3) and have been added to routine monitoring activities. However, readings from these instruments are not shown on the summary figures due to the short record period. Piezometer readings collected since 2011 from instruments which are no longer functional are also shown on the summary plots included in Appendix IV-B. Inoperative piezometers have been buried, plugged or damaged.

Table 5.2 Summary of Functional Piezometers at Trojan TSF

Installation Unit	Pre-July 2019	New Instruments	Total Instruments
Cycloned Sand	2	4	6
Sandfill	2	-	2
Foundation	6	-	6
Unknown	1		1

Functional piezometers were read monthly from April to September 2019 when safe access to the piezometer locations was available. Maximum and minimum piezometric levels, thresholds, as well piezometric trends are reported in Appendix IV-B.

A summary of key observations for readings up to end of September 2019, are as follows:

- There was one piezometric threshold exceedances in 2019 (i.e. measured reading was higher than maximum value for closure condition): May 2019 reading for TB-PS-03/P13-4 was 0.13 m above threshold. These thresholds are just intended to identify change from normal patterns and not a tailings dam safety concern.
- Tailings Beach – Cycloned Sand: Piezometers showed a continued downward trend from approximately 2014 (~0.5 m/yr to 0.75 m/yr) to 2017. However, this trend reversed over the past 2 years such that the 2019 piezometric levels are now similar to the 2014 readings. As noted in Section 5.3, the same general pattern was observed in pond level over this period which indicates that the piezometric levels in the tailings under existing conditions are primarily influenced by the pond levels.
- 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 which confirms that the sand and gravel fill of the starter dam is an effective toe drain.
- Foundation – Glacial Till: 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 measure low piezometric heads.

- Foundation – Bedrock: piezometric levels at VW16-2A has been rising since installation in 2016; refer to Figure IV-B-3. This, however, is not considered a dam safety concern as the current piezometric levels are approximately 12 m below the phreatic surface considered in the design (design assumes piezometric level at ground surface, at El. 1378 m) and is still below the elevation of other piezometers in the foundation beneath the crest.

5.5 Survey Monuments

Survey monuments at the Trojan TSF are shown on Figure 3. Active monuments were surveyed once in 2019. Refer to Figure IV-B-4 (Appendix IV-B) for a plot of monument surveys. The incremental change between November 2018 and October 2019 surveys, and the change from initial survey, are summarized in Appendix IV-B. Observations based on 2019 survey are consistent with previous trends:

- No horizontal or vertical displacement threshold exceedances were recorded.
- Similar to previous years, the surveys indicated that the downstream movements and crest settlements are negligible; refer to Appendix IV-B for more details.

5.6 Inclinometers

The single inclinometer at Trojan Dam (IB16-2), installed in 2016, was read monthly between June to October, when the instrument was accessible. There are no significant movements in the downstream direction in the readings and no discrete zones of movement has been observed to date. Cumulative displacements measured at IB16-2 are plotted on Figure IV-B-5. Refer to Appendix IV-B for more details.

5.7 Seepage

Seepage flow measured/estimated at weirs downstream of the Trojan TSF are plotted and reported in Appendix IV-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 Lower Trojan Dam, respectively. TB-LT-FS-01 measures the outflow from LTD as well as flow from the Trojan diversion pipe.

Readings were taken monthly. 2019 flows were consistent with previous trends with no observations of turbid flow or other unsatisfactory condition.

5.8 Water Quality

As required by permit (PE-376), water quality downstream of the Trojan TSF is monitored by THVCP. A summary of data to be included in the 2019 Annual Water Quality Monitoring Report was provided to KCB by THVCP for review as part of the DSI. Select observations and findings from the monitoring data are summarized as follows:

- There are thirteen permitted surface water quality monitoring sites in the Trojan/Bethlehem area, as shown on the site monitoring plan in Appendix V.
- All sampling sites were in compliance with the permit levels, required sampling frequencies and parameters except for:
  - Sample Site #304 (End of Trojan Diversion) exceeded the permit limit for copper concentration in April, May, and July. This sample site is upstream of the Trojan TSF and therefore the exceedance is not related to facility performance.
  - Sample Site #220 (Bethlehem Reclaim Pond 3) missing measurements of organic carbon (TOC) and dissolved organic carbon (DOC) in March and April.

The 2019 monitoring results were screened against applicable BC Water Quality Guidelines (WQG). Further discussion on specific WQG exceedances and water quality trends observed during 2019 are separately reported in the 2019 Annual Water Quality Monitoring Report which is submitted by THVCP to Ministry of Environment and EMPR.

6 VISUAL OBSERVATIONS AND PHOTOGRAPHS

The visual observations made during the DSI site visit and the selected photographs of each site are included in Appendix II. Copies of the completed field inspection forms are included in Appendix I.

No issues in terms of dam safety were observed. A summary of general observations and comments during 2019 DSI site visit is as follows:

- Trojan Dam spillway channel – heavily vegetated and should be cleared as part of routine maintenance, prior to 2020 freshet.
- Trojan Dam spillway, the riprap section –the surface erosion scour features at a point along the spillway and point along the crest that were previously observed during 2018 DSI site visit was present during the 2019 site visit but was later repaired by THVCP and photographs of the repair work were provided to KCB for review.
- R4 Seepage Dam – vegetation build up near inlet should be cleared as part of routine maintenance prior to 2020 freshet.
- R4 Seepage Dam upstream slope – heavily vegetated and should be cleared/removed as part of routine maintenance.
- Lower Trojan Dam – downstream outflow pipe does not have a defined channel or means of toe erosion protection. A mitigation measure would be advanced during the LTD flood routing upgrade.
- Lower Trojan Dam – current configuration of the Lower Trojan pond comprises two basins, referred to as the upper and lower basins. The upper basin of the pond can overflow to the lower basin in the event of flooding. KCB noted that the upper basin in the ongoing flood management review.
- Lower Trojan Dam – heavy vegetation is present in front of the pond overflow pipe, which should be removed as part of routine maintenance prior to 2020 freshet.
- Lower Trojan Dam Low-Level Outlet – build up of leaves on intake cage should be removed as part of routine maintenance.

7 ASSESSMENT OF DAM SAFETY

7.1 Dam Classification Review

Based on the 2013 DSR (AMEC 2014a) a "Very High" consequence classification, as defined by CDA (2013), was recommended for the Trojan Dam. The R4 Seepage Pond and Lower Trojan Dam were both assigned a "Low" consequence classification as defined by CDA (2013).

Based on the most recent dam consequence review hosted by THVCP on January 23, 2019, and the review in 2018 DSR, no change in consequence classification was recommended for either of the three dam sites.

7.2 Failure Mode Review

KCB reviewed the potential failure modes identified in the CDA (2014) for Trojan TSF and the results are summarized in Appendix VI. An overview of key failure modes for each structure are summarized below.

7.2.1 Trojan Dam

- Overtopping: the open channel spillway is designed (AMEC 2014a) to safely pass a flood (PMF, 24-hour duration) greater than the minimum IDF recommended under the Code. In addition to the spillway, the pond would be kept well away from the dam crest (minimum 90 m) by the tailings beach. Both are effective controls to manage overtopping risks.
- Slope Stability: the structural integrity of the dam is based on a competent Glacial Till foundation with a rockfill starter dam and upstream unsaturated cycloned sand beach. Each of these units have relatively high shear strength and not subject to significant strength loss during earthquake loading. SCPTs and piezometers installed in the cycloned sand beach are relied upon to monitor the phreatic surface within the tailings upstream of the dam to demonstrate it remains below design assumptions. As discussed in Section 3.3, a due diligence review of the softer layer at the base of the tailings, upstream of the crest, at the right abutment encountered during the 2019 SCPT program will be completed in 2020.

7.2.2 R4 Seepage Pond

- Overtopping: the open channel spillway is designed to safely pass a flood (PMF, 24-hour duration) significantly greater than the minimum IDF recommended under the Code (100-year flood) and provides an effective control to manage overtopping risks.

7.2.3 Lower Trojan Pond

- Overtopping:
  - Flood routing conducted for the Lower Trojan Dam in 2017 indicates that upgrades are required so the facility can safely pass the IDF event, as per the Code. The recommended upgrades are discussed in Section 4.4 and included in the recommendation summary

(Table 8.2). The consequence of such overtopping during the IDF is limited to release of contact water to the environment with no safety concern to a permanent downstream population.

- The facility records do not indicate the facility has approached an overtopping condition under typical seasonal conditions, including larger freshet events over the past 4 years. A larger flood event is necessary to develop a risk of overtopping. To mitigate overtopping risks for the interim period when the facility is out of compliance with the IDF, THVCP have implemented threshold values to increase monitoring periods during period of high flow and initiate pumping as discussed in Section 4.4.

7.3 Emergency Preparedness and Response

The emergency preparedness and response plan (EPRP) for the Trojan TSF forms a part of the 2018 OMS manual.

Training of THVCP staff and contractors who work near the dams is provided by a PowerPoint slides presentation which outlines dam safety warning signs that all staff must be aware of and report if any of these signs are observed during their work.

In the case of an emergency, an incident command center would be established on site to coordinate with regional emergency response organizations and local authorities. The roles and responsibilities of key team members are well defined, along with reporting structures and who is responsible for declaring an emergency and starting the incident response. The EPRP also outlines strategies that could be implemented in the event of several types of dam emergencies. Additional systems are also being considered to further enhance the overall system.

Training and testing of the EPRP currently is done using desktop scenarios. Along with testing of the system, offsite emergency response resources are contacted regularly to ensure that contact information is still up to date. The emergency reporting contact list is also reviewed and updated as required. A tabletop exercise to review and update the EPRP for the HVC site was hosted by THVCP and attended by representatives of Communities of Interest (COIs), the KCB on site, and the EoR on the phone on November 26, 2019.

8 SUMMARY

The Trojan TSF appears to be in good physical condition and the observed performance during the 2019 site inspections is consistent with the expected design conditions and past performance. The status of recommendations to address deficiencies and non-conformances identified during past DSIs are summarized in Table 8.1. Closed recommendations actions are shown in *italics*. Recommendations to address deficiencies and non-conformances identified during the 2019 DSI are summarized in Table 8.2.

Table 8.1 Previous Deficiencies and Non-Conformances – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority(1)	Recommended Deadline (Status)
Trojan Dam					
TD-2017-02	*Flood Routing*	*Freeboard*	*Raise the road in the designated area near the left abutment to El. 1440 m, either by fill placement or grading.*	*3*	*Q4 2018 (Closed)*
TD-2018-01	*Erosion*	-	*Repair two rill erosions on the left bank of spillway channel (along riprap section), founded in tailings. Re-grade to divert water away from these areas, as feasible.*	*3*	*Q4 2019 (Closed)*
TD-2018-02	Flood Routing	10.1.8 (the Code)	Update flood routing assessment for Trojan impoundment, R4 Seepage Pond and LTD based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2 2020 (Open, LTD flood routing assessment was completed in 2019)
TD-2018-03	*Surveillance*	*Inclinometer Monitoring*	*Complete spiral correction on IB16-2 to resolve any measurement issues which may be impacting cumulative plots.*	*3*	*Q3 2019 (Closed)*
R4 Seepage Pond					
No outstanding recommendations from previous DSIs.					
Lower Trojan Dam					
LTD-2017-01	Flood Routing	Inflow Design Flood	Complete appropriate upgrade works to allow LTD to safely pass IDF with adequate freeboard, including decommissioning of the spillway pipe.	2	Q4 2020 (Open)

Notes:
1. Recommendation priority guidelines, specified by THVCP 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.

Table 8.2 2019 Recommendations for Deficiencies and Non-Conformances

ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority(1)	Recommended Deadline (Status)
Trojan Dam					
TD-2019-01	Failure Mode Review	-	Complete and document due diligence review of upstream dam failure modes as recommended by the DSR.	2	Q3 2020
TD-2019-02	DSR Recommendation	-	KCB and THVCP to develop a work plan to address 2018 DSR recommendations.	3	April 2020
TD-2019-03	Foundation Characterization	-	Complete an assessment to characterize softer zone at the base of the tailings identified during 2019 SCPT program.	2	Q2 2020
R4 Seepage Pond					
No new recommendations in 2019.					
Lower Trojan Dam					
No new recommendations in 2019.					

Notes:

1. Recommendation priority guidelines, specified by Teck 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.

9 CLOSING

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 2019 Dam Safety Inspection 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.

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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.
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5. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

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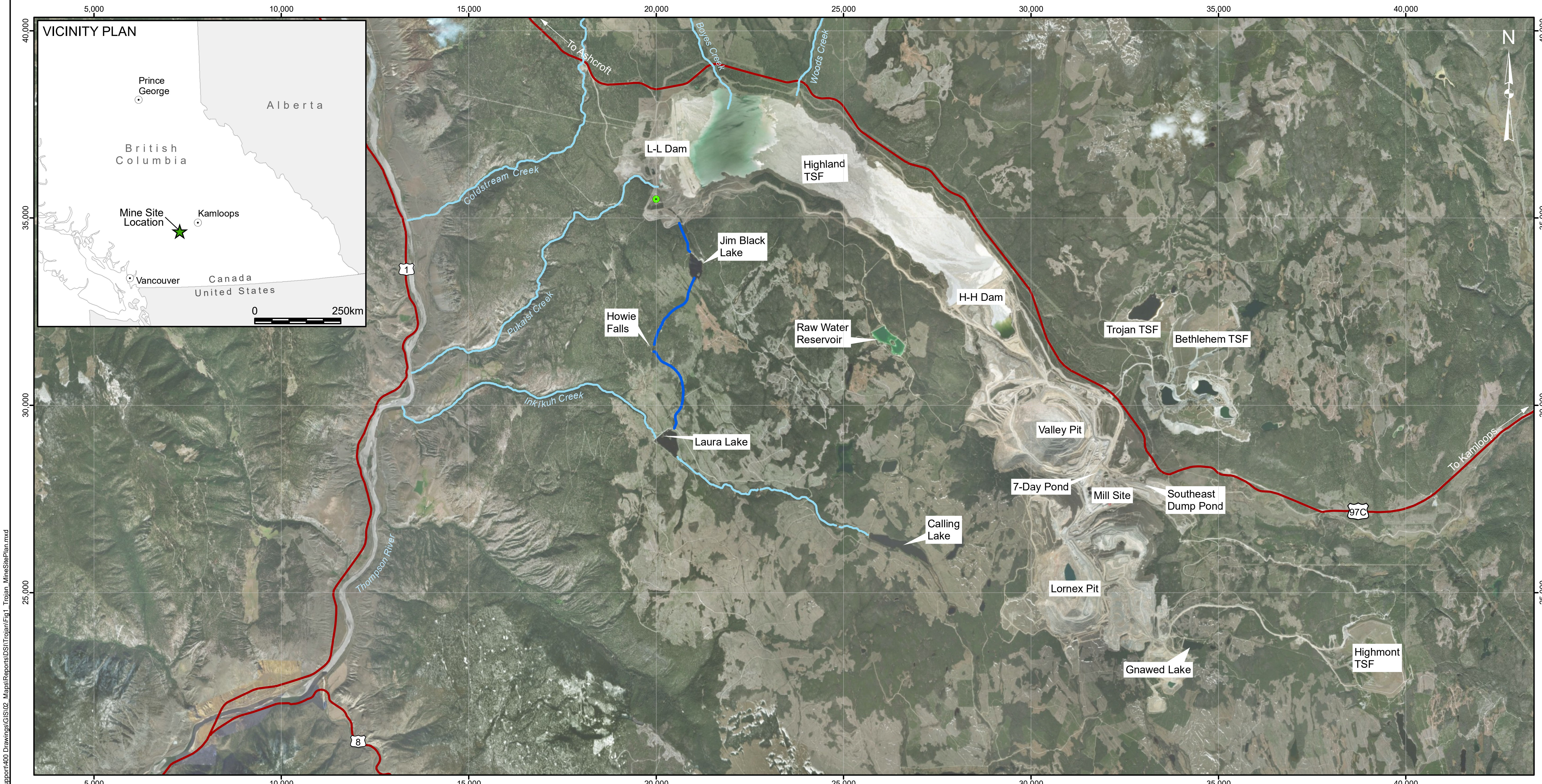
FIGURES

Figure 1	Mine Site Plan
Figure 2	Trojan Tailings Storage Facility Overview
Figure 3	Trojan Dam Plan
Figure 4	R4 Seepage Pond Dam Plan
Figure 5	Lower Trojan Dam Plan



Legend

- L-L Dam Climate Station
- Creek / River
- Highway
- Ditch

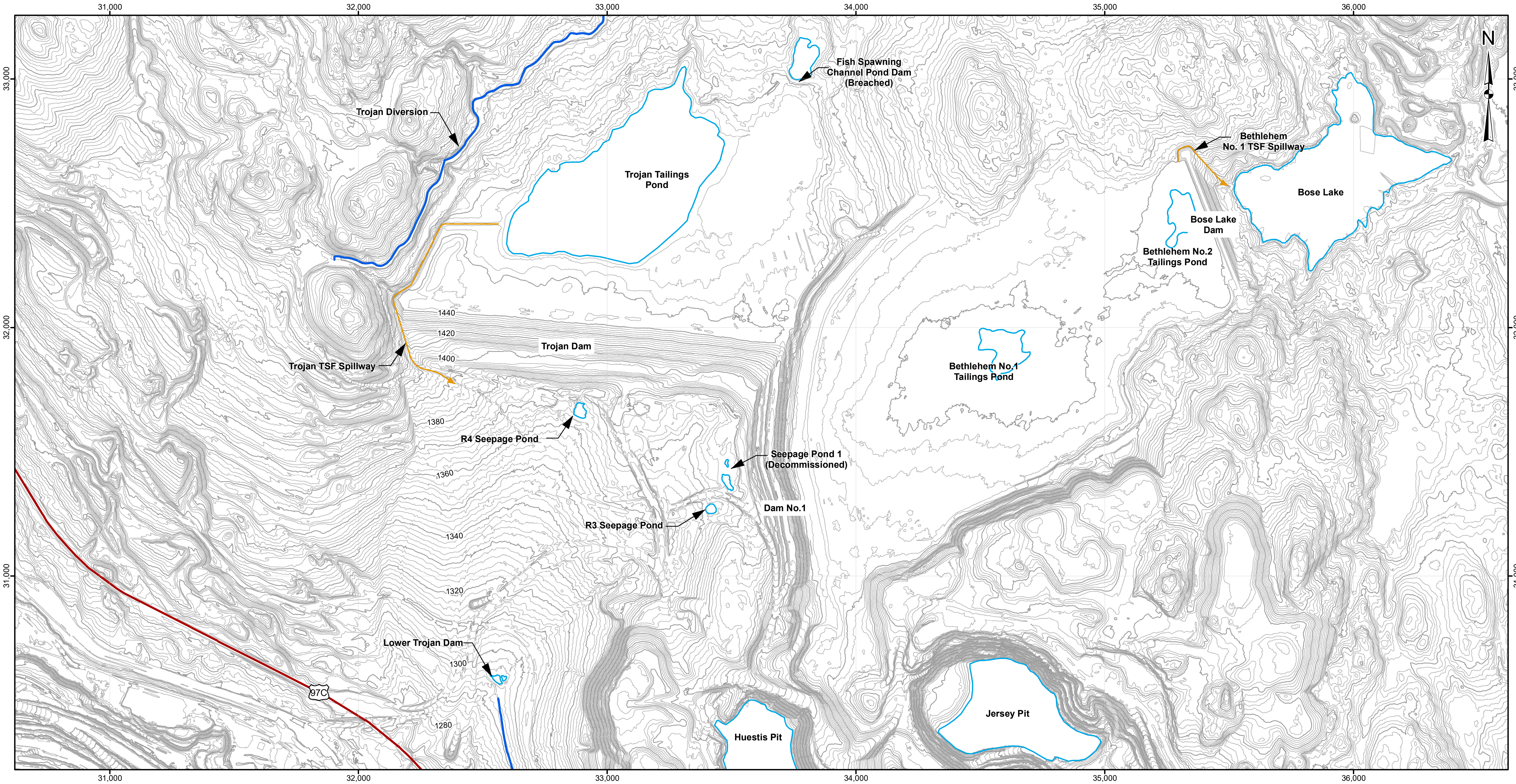
0 5km

CLIENT	PROJECT
Highland Valley Copper / Teck	TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION
Klohn Crippen Berger	TITLE: MINE SITE PLAN

SCALE	PROJECT No.	FIG No.
1:100,000	M02341B53	1

Notes:
1. Projection: HVC Mine Grid.
2. TSF = Tailings Storage Facility.
3. Base data provided by the Government.
4. Imagery provided by ESRI.

Date: 2020-01-13
Document Path: Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Trojan\Fig1_Trojan_MineSitePlan.mxd



Legend

- Ditch
- Spillway
- Highway
- Index Contour (10 m)
- Intermediate Contour (2 m)
- Waterbody

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.

Date: 2020-01-13
Document Path: Z:\MIVCR\M02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Trojan\Fig2_Trojan_Overview.mxd

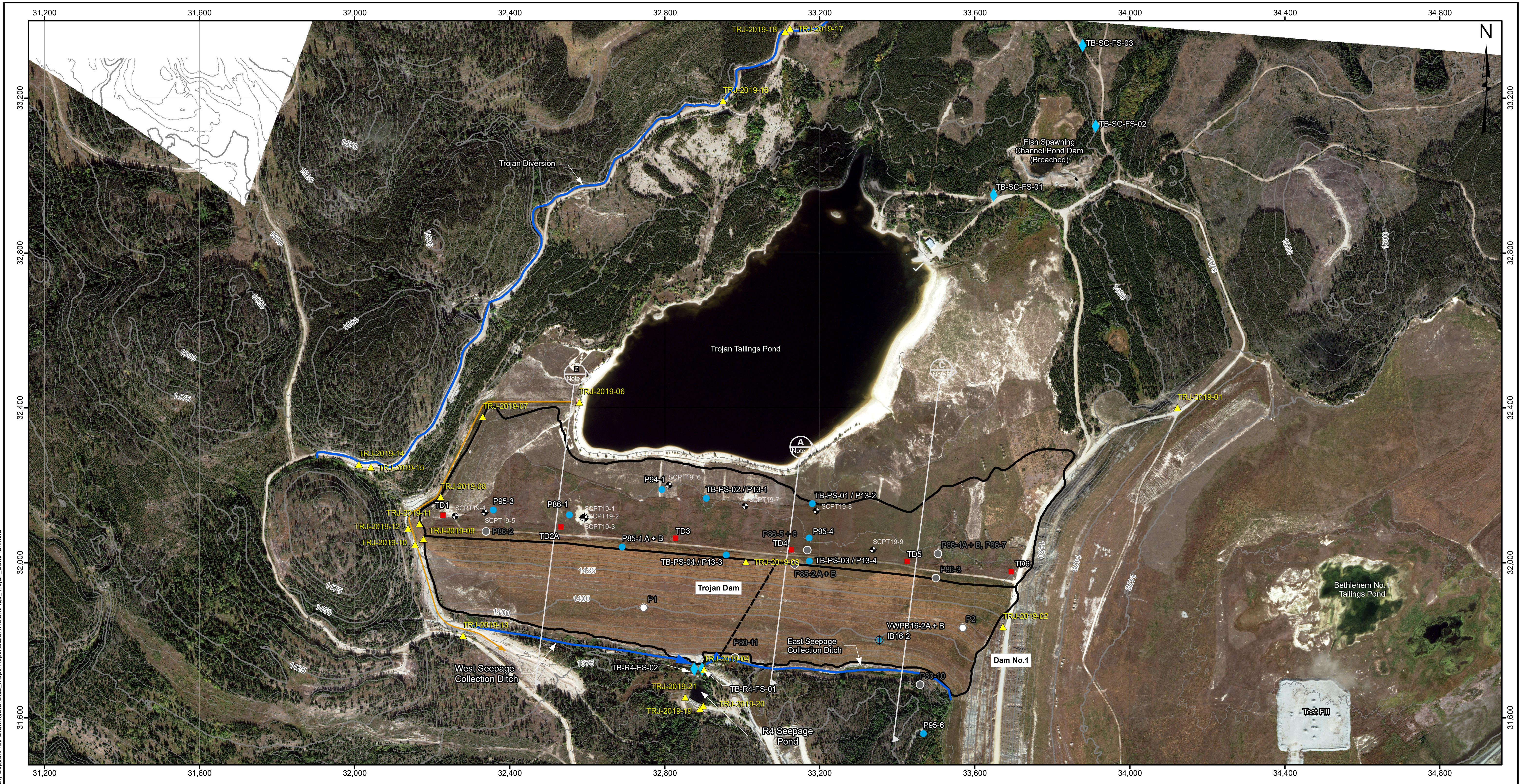
CLIENT
Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT
TROJAN TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE
TROJAN TAILINGS STORAGE FACILITY
OVERVIEW

SCALE	PROJECT No.	FIG No.
1:15,000	M02341B53	2



Legend

Instrument Type (Active)
- Standpipe Piezometer
- Vibrating Wire Piezometer
- Inclinometer

Instrument Type (Defunct)
- Standpipe Piezometer
- Pneumatic Piezometer

- Waypoint (TRJ-2019-xx)
- Cone Penetration Test
- Weir
- Survey Monument
- Plugged Diversion Culvert

- Spillway
- Ditch
- Index Contour (25 m)
- Intermediate Contour (5 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2019.
3. Topography from HVC, LiDAR flown on August 23rd, 2014.
4. Refer to Figure IV-8 in Appendix IV for section details.
5. TRJ-2019-05 is 1170 m south of TRJ-2019-02 and is not shown here.

Date: 2020-01-30
Document Path: Z:\MV\CRM02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Trojan\Fig3_Trojan_DamPlan.mxd

CLIENT: Highland Valley Copper / Teck	PROJECT: TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION
Klohn Crippen Berger	TITLE: TROJAN DAM PLAN
	SCALE 1:9,500 · PROJECT No. M02341B53 · FIG No. 3

Legend

Instrument Type (Active)	Instrument Type (Defunct)		
Weir	Standpipe Piezometer	Waypoint (TRJ-2019-xx)	Index Contour (5 m)
		Culvert	Intermediate Contour (1 m)
		Spillway	
		Buried Pipeline	

0 50m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2019
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.

Date: 2020-01-13
Document Path: Z:\MIVCR\M02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Trojan\Fig4_Trojan_R4SeepagePond.mxd

CLIENT	PROJECT
Highland Valley Copper / Teck	TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION
Klohn Crippen Berger	TITLE R4 SEEPAGE POND DAM PLAN

SCALE	PROJECT No.	FIG No.
1:1,000	M02341B53	4

Legend

Instrument Type (Active)
- Weir
- Waypoint (TRJ-2019-xx)
- Spillway
- Buried Pipeline
- Ditch
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 50m

CLIENT Highland Valley Copper / Teck	PROJECT TROJAN TAILNGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION
Klohn Crippen Berger	TITLE LOWER TROJAN DAM PLAN
	SCALE 1:1,000 / PROJECT No. M02341B53 / FIG No. 5

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2019
3. Topography from HVC, LiDAR flown on August 23rd, 2014.
4. Locations of buried pipes are approximate.

Date: 2020-01-13
Document Path: Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Trojan\Fig5_Trojan_LowerTrojanDam.mxd

APPENDIX I

Dam Safety Inspection Checklist

APPENDIX I-A

Dam Safety Inspection Checklist – Trojan Dam

2019 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Trojan Dam	**Inspection Date:**	June 12th, 2019
Consequence Classification:	Very High		
Weather:	Mostly Sunny	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	8 m based on the May 23rd 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

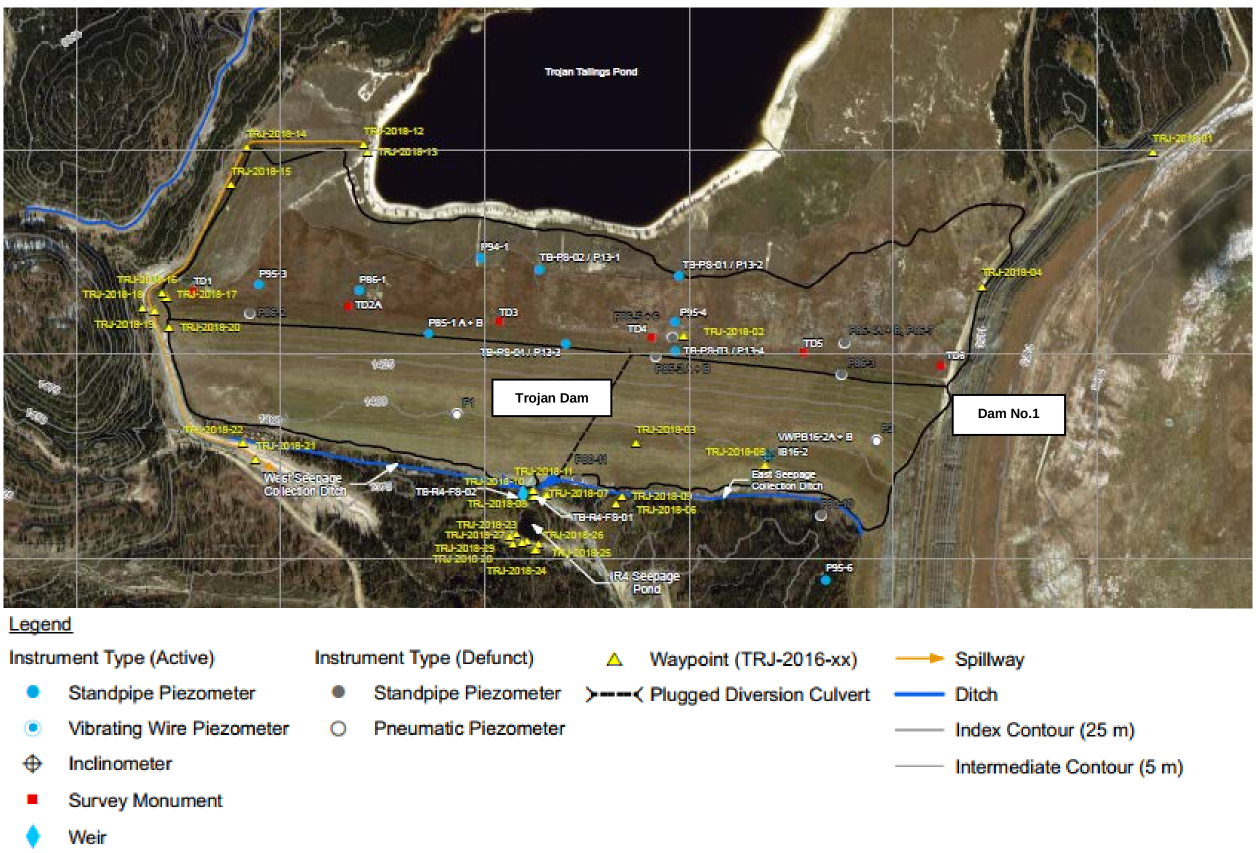
List and describe any deficiencies (all deficiencies require assessment and/or repair):

- No dam safety deficiencies observed

Comments / Notes:

- Trojan Diversion Pipe is disconnected. THVCP is aware and repairs are planned. Flow is diverted away from the area.
- Minor erosion and gaps on closure cover present near spillway on right abutment (identified in 2018).
- Left abutment requires re-grading for freeboard beach width (work is planned for later in 2019).
- Some vegetation built up upstream of spillway bedrock chute which should be cleared as part of the routine maintenance.

SITE PLAN



APPENDIX I-B

Dam Safety Inspection Checklist – R4 Seepage Pond Dam

2019 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Trojan R4 Seepage Pond Dam	**Inspection Date:**	June 12th, 2019
Weather:	Sunny	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	1.6 m on April 12, 2019 (as per THVCP Weekly Inspection Report of Week 15, ending April 16, 2019)		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate	Visual Review?	Testing / Detailed Inspection?
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 (all deficiencies require assessment and/or repair):

- No dam safety deficiencies observed

Comments / Notes:

- Vegetation and small trees present on upstream and downstream slopes of the dam near spillway invert. Excess vegetation near spillway inlet should be removed as part of routine maintenance. Remaining of vegetation clearing is at THVCP discretion.

SITE PLAN

APPENDIX I-C

Dam Safety Inspection Checklist – Lower Trojan

2019 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Lower Trojan Dm	**Inspection Date:**	June 12th, 2019
Weather:	Mostly Sunny	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	1.7 m on April 12, 2019 (as per THVCP Weekly Inspection Report of Week 15, ending April 15, 2019)		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate	Visual Review?	Testing / Detailed Inspection?
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 (all deficiencies require assessment and/or repair):

- No dam safety deficiencies observed

Comments / Notes:

- Upper basin should be included in flood routing upgrade/decommissioning plan.

SITE PLAN


Spillway Channel
Lower Trojan Dam
TRJ-2018-32
Lower Trojan
Pond
TRJ-2018-31
810 mm Dia.
Spillway Pipe
200 mm Dia.
Low-Level
Outlet Pipe
(Decommissioned)
TRJ-2018-33
TRJ-2018-30
TB-LT-FS-01
Control Valve
460 mm Dia.
Diversion Pipeline
TRJ-2018-34
Diversion Ditch
Legend
Instrument Type (Active)
Weir
Waypoint (TRJ-2016-xx)
Spillway
Buried Pipeline
Ditch
Index Contour (5 m)
Intermediate Contour (1 m)

APPENDIX II

Visual Observations and Inspection Photographs

APPENDIX II-A

Visual Observations and Inspection Photographs – Trojan Dam

Appendix II-A
Visual Observations and Inspection Photographs
Trojan Dam

VISUAL OBSERVATIONS

Crest

No indication of erosion or deterioration, crest was observed to be in good physical condition. Local low points (<1 m) and "hummocky" surface observed and believed to be from differential settlement or formed for land reclamation. Freeboard is uncompromised by these features.

Left Abutment

Good physical condition, no excessive scour damage. Access road near the left abutment requires to be raised to El. 1440 m, per 2017 DSI recommendation (KCB 2018).

Right Abutment

Good physical condition. Spillway channel is excavated through bedrock and Glacial Till material, parallel to the dam abutment. No sign of abutment deterioration or erosion at the abutment; however, some erosion was observed along the spillway channel (additional details noted in spillway channel observations).

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 II-A-2 through Photo II-A-6).

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 ditch (Photo II-A-7).

Seepage

No seepage observed, except for seepage flow within the toe collection ditches (Photo II-A-7).

Tailings Beach

Good physical condition. No issues of concerns observed during inspection. Elevation of the vegetated portion of the beach is approximately 2 m above the reservoir level (Photo II-A-9).

Pond

No indication of recent high-water event that encroached above typical levels, at the time of inspection (Photo II-A-9).

Spillway Inlet

Log booms secured in place, with no obstructions present besides minor vegetation. Spillway inlet in good condition with no signs of deterioration (Photo II-A-10).

Spillway Channel

- **General:**
  - Good physical condition. Initial section of channel is heavily vegetated with grass and slopes at minimal grade towards the first curve of the dam spillway. Following the first curve the vegetated Glacial Till channel transitions to a bedrock excavated channel at the right abutment of the dam. Spillway channel riprap increases in size as the channel grade steepens towards the outfall. No major obstructions or deterioration was observed along the channel (Photo II-A-11 to Photo II-A-15). The vegetation should be cleared as part of THVCP routine monitoring and maintenance, prior to freshet.
- **Erosion features:**
  - No change to surface erosion scour at the riprap section of Trojan Dam spillway observed during 2018 DSI. No active seepage faces, or erosion were observed which indicates this is a dam safety concern. KCB recommends that this area be re-established (Photo II-A-16).
    - THVCP provided photographs showing that this work was completed after the DSI site visit.
  - No change to the erosion feature observed near the crest during 2018 DSI. KCB recommends that this area be re-established and graded so that surface water drains away from the slope. The sand in the channel does not require clearing, would be washed away (Photo II-A-18).
    - THVCP provided photographs showing that this work was completed after the DSI site visit.
- **Spillway extension section:**
  - Riprap appears to be in good condition; however, it does not appear to be uniform (Photo II-A-17 and Photo II-A-18); refer to discussion in Appendix III-A.

INSPECTION PHOTOGRAPHS

LEGEND:

- TRJ = Trojan Tailings Facility
- TRJ-2019-## refers to 2019 DSI waypoint shown on Figure 3
- All photographs taken during inspection on June 12, 2019.

Photo II-A-1 Overview of Trojan Tailings Storage Facility (TSF) from access road between Trojan TSF and Bethlehem TSF (TRJ-2019-01)

Photo II-A-2 Panoramic overview of Trojan Dam downstream slopes from left abutment. No visible erosion or scour. (TRJ-2019-02)

Photo II-A-3 Overview of Trojan Dam downstream slopes from mid-crest looking towards east. Bethlehem Dam No.1 downstream slope is visible. (TRJ-2019-03)

Photo II-A-4 Overview of Trojan Dam downstream slopes from mid-crest looking towards west (TRJ-2019-03)

Photo II-A-5 Overview of Trojan Dam downstream slopes from mid-crest looking towards south (TRJ-2019-03)

Photo II-A-6 Overview of Trojan Dam downstream toe from seepage collection ditch (TRJ-2019-04)

Photo II-A-7 Overview of weir TD-R4-SF01 and weir TD-R4-SF02 downstream of East and West Seepage Collection Ditches (TRJ-2019-04)

Photo II-A-8 Overview of Trojan Dam downstream slope from left abutment toe (TRJ-2019-05)

Photo II-A-9 Overview of Trojan Tailings Pond. Pond level appears similar to previous years. Sand beach is exposed. (TRJ-2019-06)

Photo II-A-10 Trojan spillway inlet. Approach channel is clear and debris boom is secured. (TRJ-2019-06)

Photo II-A-11 Overview of first length of spillway channel, looking toward southwest (top photo) and looking toward northeast (bottom photo). No sign of recent flow or weathering / disruption of riprap was observed. No evidence of sloughing of cut slopes was observed. Channel is heavily vegetated and should be cleared as part of routine maintenance (TRJ-2019-07)

Photo II-A-12 Overview of spillway channel, downstream of chute. Slopes are in good condition. (TRJ-2019-08)

Photo II-A-13 Overview of spillway channel, looking toward north. (TRJ-2019-09)

Photo II-A-14 Overview of spillway channel, looking toward south. No sign of recent flow or weathering / disruption of riprap was observed. Exposed sand in slope (as per 2018 DSI) was not covered. Not a dam safety concern as there is no active seepage faces or erosion were observed. (TRJ-2019-09)

Note: THVCP provided photographs showing that this work was completed after the DSI site visit.

Photo II-A-15 Overview of spillway channel, looking toward west. Some eroded sand from area has accumulated in channel. Not a concern as it would be washed away by flow. (TRJ-2019-09)

Photo II-A-16 Sand on the base and on right bank of spillway. Sand appears to have been placed/deposited on top of riprap, suggesting this is not related to piping/seepage. No active seepage faces or erosion were observed which indicates these are a dam safety concern. (TRJ-2019-10)

Note: THVCP provided photographs showing that this work was completed after the DSI site visit.

Photo II-A-17 Spillway channel downstream of the sand area observed in Photo II-A-16. No sand was observed downstream (TRJ-2019-10)

Photo II-A-18 Fan shape sand area observed in spillway channel. Surface erosion / scour evidence was observed upslope on dam slope. Visually looks more fluvially deposited and is not seepage-related. KCB recommends THVCP repair the scour and re-establish the cover. (TRJ-2019-11 and TRJ-2019-12)

Note: THVCP provided photographs showing that this work was completed after the DSI site visit.

Photo II-A-19 Downstream of fan shape sand area observed in Photo II-A-18 (TRJ-2019-11)

Note: THVCP provided photographs showing that this work was completed after the DSI site visit.

Photo II-A-20 Surface erosion scour upslope of the u/s sand observed in spillway channel (refer to Photo II-A-14). Not seepage flow related. KCB recommends repairing the area. (TRJ-2019-11)

Note: THVCP provided photographs showing that this work was completed after the DSI site visit.

Photo II-A-21 Overview of 2018 Extension Trojan Dam spillway and the toe of right abutment (TRJ-2019-13)

Photo II-A-22 Overview of Trojan Diversion Ditch. New outlet southwest of Trojan TSF. (TRJ-2019-14)

Photo II-A-23 Water standing at the pipe intake. No outflow was observed, outlet valve is closed. Diversion channel flow being discharges from outlet further upstream at Photo II-A-26. (TRJ-2019-14)

Photo II-A-24 Diversion pipe disconnected. There is some evidence of previous flow from the disconnected pipe. THVCP was aware and attempted unsuccessful repairs prior to the site visit. THVCP informed KCB that the permanent repair was completed after the site visit. (TRJ-2019-15)

Photo II-A-25 Valve 1 is open and no flowing water bypassing this point was observed. Valve is located at the transition of unlined to lined channel. (TRJ-2019-16)

Photo II-A-26 Water flowing in the unlined section of channel upstream of Valve 1 (TRJ-2019-16)

Photo II-A-27 No scour was observed at Valve 1 pipe discharge point. (TRJ-2019-16)

Photo II-A-28 Overview of Trojan Diversion Ditch road culvert (TRJ-2019-17)

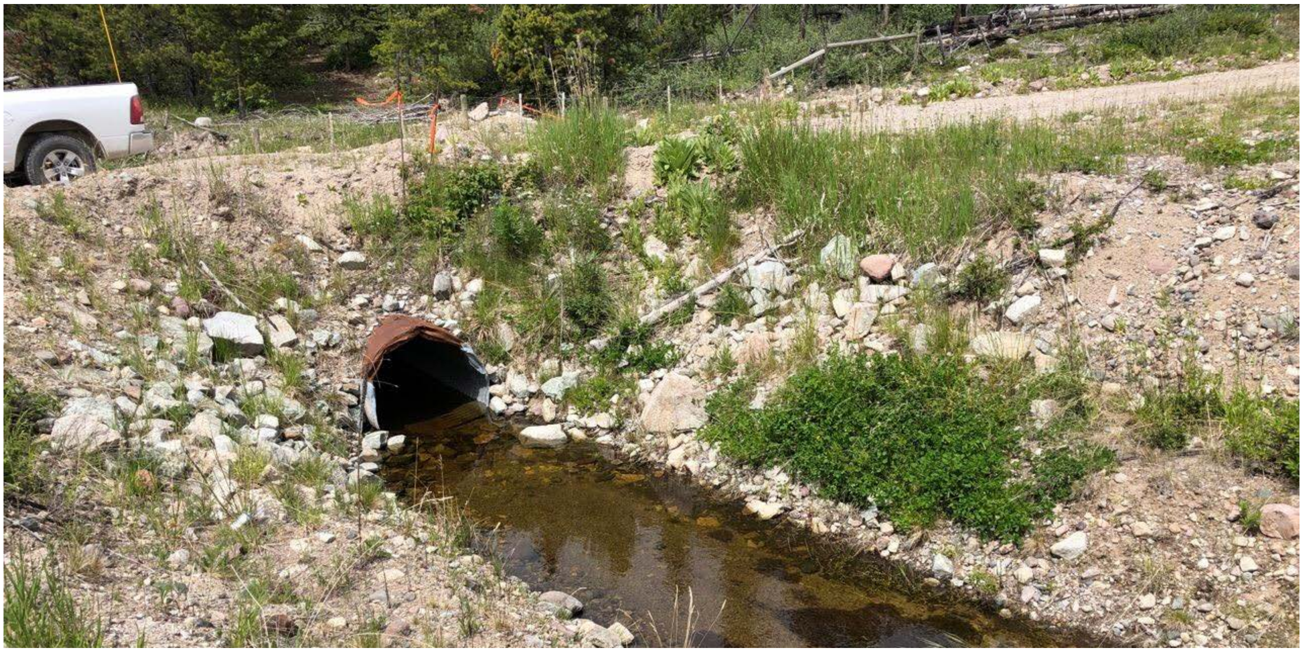


Photo II-A-29 Overview of Trojan Diversion Ditch upstream of road culvert (TRJ-2019-17)

Photo II-A- 30 Downstream of Trojan Diversion Ditch road culvert (TRJ-2019-18)

APPENDIX II-B

Visual Observations and Inspection Photographs – R4 Seepage Pond Dam

Appendix II-B
Visual Observations and Inspection Photographs
R4 Seepage Pond Dam

VISUAL OBSERVATIONS

Crest

Good physical condition. No observed signs of deterioration, lateral movement, or cracking (Photo II-B-1 and Photo II-B-2). The upstream slope is heavily vegetated, and KCB recommends that this vegetation be removed (Photo II-B-1).

Left and Right Abutments

Good physical condition. Little vegetation at abutments, and no signs of deterioration observed.

Downstream Slope

Good physical condition. Tall grass and vegetation present, no signs of deterioration or erosion (Photo II-B-2 to Photo II-B-3).

Pond

During inspection, the pond water level was observed to be approximately 1 m below the spillway invert (Photo II-B-4 and Photo II-B-5).

Spillway

Good physical condition. No observed signs of recent flow, channel erosion, or deterioration. No obstructions present in spillway (Photo II-B-6 and Photo II-B-7).

Low-level Outlet

Good physical condition. Any obstructions or excess vegetation growth are monitored and cleared as part of THVCP ongoing monitoring and routine maintenance plan (Photo II-B-4).

Seepage

No observed signs of seepage during inspection.

INSPECTION PHOTOGRAPHS

LEGEND:

- TRJ = Trojan Tailings Facility
- TRJ-2019-## refers to 2019 DSI waypoint shown on Figure 4.
- All photographs taken during inspection on June 12, 2019.

Photo II-B-1 Overview of crest looking towards right abutment (TRJ-2019-19)

Photo II-B-2 Overview of crest looking towards left abutment with partial view of catwalk to low level outlet intake (lifebuoy in place) (TRJ-2019-19)

Photo II-B-3 Overview of downstream slope looking towards left abutment (TRJ-2019-19)

Photo II-B-4 Overview of the pond and low-level outlet to Witches Brook via Lower Trojan Dam with view of Trojan Dam downstream slope (TRJ-2019-20)

Photo II-B-5 Overview of pond and spillway inlet – Spillway inlet is clear of debris. Vegetation build up near inlet to be cleared as part of routine maintenance prior to 2020 freshet. (TRJ-2019-21)

Photo II-B-6 Overview of crest and downstream slope looking towards spillway channel (TRJ-2019-19)

Photo II-B-7 Spillway channel (TRJ-2019-21)

Photo II-B-8 Overview of weir TD-R4-SF01 and weir TD-R4-SF02, downstream of East and west Seepage Collection Ditches (TRJ-2019-04)

APPENDIX II-C

Visual Observations and Inspection Photographs – Lower Trojan Dam

Appendix II-C
Visual Observations and Inspection Photographs
Lower Trojan Dam

VISUAL OBSERVATIONS

Crest

Good physical condition. Minor vegetation with no signs of erosion, deterioration, or cracking observed (Photo II-C-1).

Left and Right Abutment

Good physical condition. Tree debris observed during 2018 DSI was cleared from the spillway channel at right abutment (Photo II-C-7).

Downstream Slope

Good physical condition. Minor vegetation present, no signs of erosion or deterioration (Photo II-C-2). Downstream outflow pipe shown on Photos II-C-6 does not have a defined channel or means of toe erosion protection. KCB recommends that a mitigation be advanced.

Pond

Level at time of inspection consistent with level at 2018 inspection. Invert of spillway pipe and pond approximately 0.5 m apart (Photo II-C-4 and Photo II-C-5).

Current configuration of the Lower Trojan pond comprises two basins. The upper basin of the pond can overflow to the lower basin in the event of flooding. KCB recommends that the upper basin be considered in ongoing flood management review.

Spillway

Heavy vegetation present in front of pond overflow pipe should be removed as part of routine maintenance prior to 2020 freshet (Photo II-C-7 to Photo II-C-9).

Low-level Outlet

Debris boom in good condition. Build up of leaves present on intake cage will be removed as part of routine maintenance (Photo II-C-10).

Seepage

None observed.

INSPECTION PHOTOGRAPHS

LEGEND:

- TRJ = Trojan Tailings Facility.
- TRJ-2019-## refers to 2019 DSI waypoint shown on Figure 5.
- All photographs taken during inspection on June 12, 2019.

Photo II-C-1 Overview of crest with partial view of catwalk to Low Level Outlet intake (lifebuoy in place) (TRJ-2019-22)

Photo II-C-2 Overview of downstream slope (TRJ-2019-22)

Photo II-C-3 Overview of upstream slope (TRJ-2019-23)

Photo II-C-4 Upstream slope near right abutment with overflow pipe through dam. No erosion at outlet (TRJ-2019-23 and TRJ-2019-25)

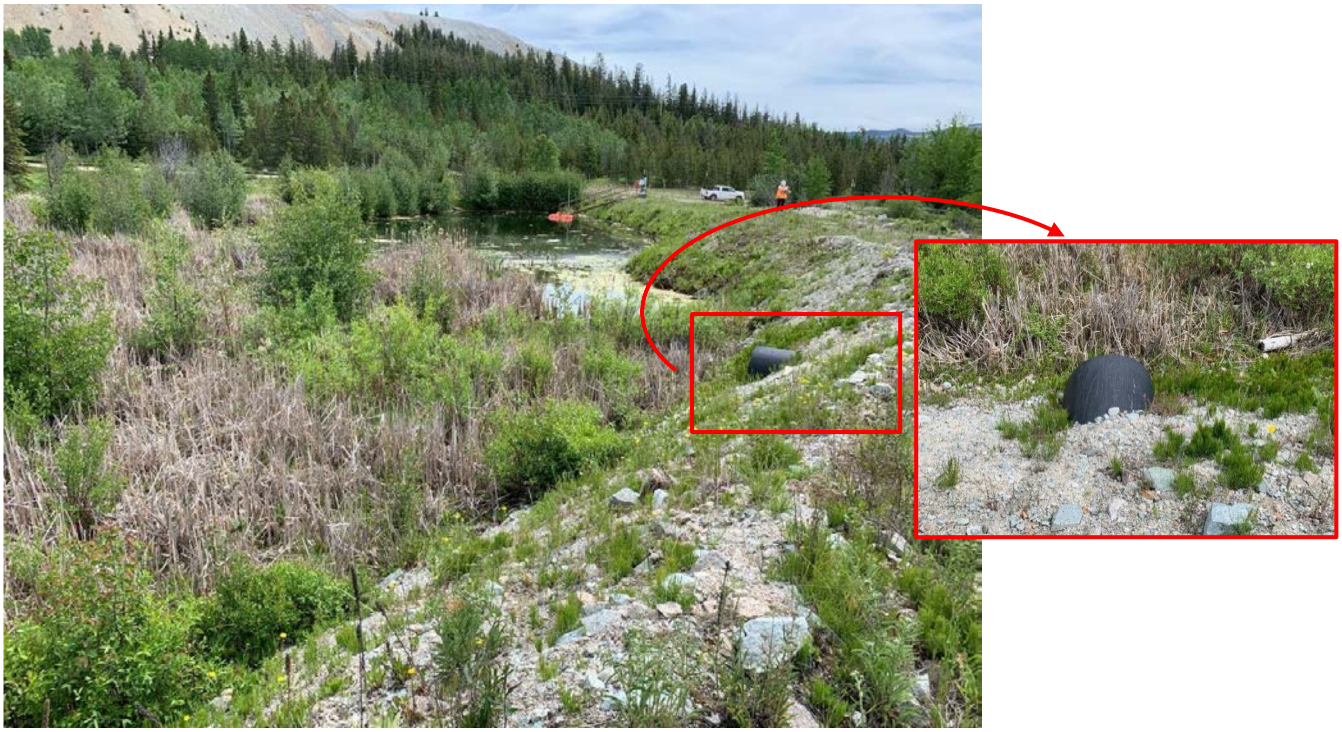


Photo II-C-5 Lower Trojan Dam Pond (TRJ-2019-24)

Photo II-C-6 Downstream slope near right abutment with overflow pipe through dam (TRJ-2019-23)

Photo II-C-7 Spillway channel looking toward southwest. Channel is cleared from trees or major debris (TRJ-2019-25)

Photo II-C-8 Spillway channel looking toward west (TRJ-2019-25)

Photo II-C-9 Spillway approach channel (TRJ-2019-25)

Photo II-C-10 Overview of the pond, catwalk and Low-Level Outlet (LLO) inlet (TRJ-2019-20 and TRJ-2019-26)

APPENDIX III

APPENDIX III-A

Overview, History, and Water Management

Appendix III-A
Overview, History, and Water Management

OVERVIEW

Trojan Dam

A layout of the Trojan Dam and associated structures is shown in Figure 3 and the typical geometry and dimensions of the dam are summarized in Table III-A-1. Refer to Appendix III-B for relevant design drawings. The Trojan Dam left abutment[1] is in contact with Bethlehem Dam No. 1. Natural high ground forms the right abutment. A spillway near the right abutment was constructed following end of tailings discharge.

General information regarding the dam is as follows:

- Dam was constructed in 1973. Construction record reports are not available but are referenced and form the basis of section drawings in two design reports (KL 1982 and KL 1987) and in a stability assessment (KC 1996). A letter detailing the as-built condition of the spillway was available (KC 2002).
- The foundation is generally noted as dense glacial deposits over bedrock. The depth to bedrock increases from about 3 m at the right abutment to about 61 m in the mid-valley. A sandy silt layer with some clay is noted at 30 m to 36 m depth in the 1973 design report of the starter dam (Gepac 1973). A drill hole was completed in 2016 (KCB 2016b) which intercepted silt and clay layers, up to 150 mm thick, that were stratified within the glacial till. No distinctive laminated glaciolacustrine clay or silt was intersected by the drill hole.
- A shallow layer of forest mat and overburden was stripped from the starter dam foundation. Muskeg deposits were removed in the area of two creeks in the foundation footprint.
- The dam comprises a rockfill starter dam with coarse rock placed downstream of the dam axis and finer rockfill placed upstream. The starter dam was raised in an upstream manner with cyclone sand. A 25 ft to 30 ft wide sand and gravel filter zone separates the starter dam rockfill and cycloned tailings.
- Foundation drains direct seepage to the R4 Seepage Pond via two ditches that run along the toe of the dam, namely the West Seepage Collection Ditch and East Seepage Collection Ditch. Flow in both of these ditches are monitored using weirs (TB-R4-FS-01 and TB-R4-FS-02).
- During operations, tailings were discharged from the dam crest to form a beach between the pond and crest. The design minimum beach length was 152 m (500 ft) under normal conditions, and 92 m (300 ft) under temporary design flood conditions. The beach was also required to extend north a minimum distance of 500 m (1,640 ft) upstream of the crest along the west side of the pond. The existing minimum beach width under normal conditions is

[1] Left and right convention assumes point of view is in the downstream direction.

greater than 200 m. During the IDF peak pond elevation (1438.5 m) the beach width remains greater than 100 m except for a 50 m wide area where the beach is approximately 90 m.

- The riprap lined spillway channel was originally constructed (approx. in 1996) from the right abutment to just past the toe of the Trojan Dam from which an excavated channel (without riprap erosion protection) conveyed flow through a wooded area and eventually to Witches Brook. To mitigate the risk of spillway flow from overtopping the channel and potentially eroding the toe of Trojan Dam, as noted in the 2013 DSR (AMEC 2014a), the lower portion of the spillway channel was upgraded in 2018. Works included raising an 80 m section of the left bank to design height and constructing a 300 m extension; refer to Section 3.2 for further discussion. The Trojan TSF spillway is designed for storm events with return periods greater than those required by the Code.

R4 Seepage Pond Dam

The R4 Seepage Pond is located in the mid-valley section at the old Trojan Creek bed with the right abutment in contact with a waste dump from the Trojan Dam construction. No details are available regarding the left abutment. A layout of the R4 Seepage Pond is shown in Figure 4 and the typical geometry and dimensions of the dam are summarized in Table III-A-1. Refer to Appendix III-B for relevant design drawings.

General information regarding the dam is as follows:

- Dam was constructed in 1984. Construction record reports are not available. 1984 design drawings showing the dam section were appended in the *Trojan Creek Ponds – Long Term Options* design report (KC 2005).
- The foundation was prepared with a 6 m wide cutoff trench with 1.5H:1V side slopes, excavated through the upper sand and gravel foundation layer and 0.3 m to 0.6 m into the underlying dense glacial till. The trench extends to the dam crest level at both abutments and extends north into the waste dump tying into the till foundation soil.
- The dam is comprised of compacted glacial till fill borrowed from the Lake Zone open pit excavation, now part of the Valley Pit located approximately 4 km southwest of Trojan Dam. A 300 mm thick layer of waste rock riprap is present on the upstream slope.
- A 300 mm diameter Low Level Outlet, and a 100 mm diameter overflow pipe are embedded in the dam near the left abutment.
- An open channel spillway designed by AMEC is located near the right abutment. Record drawings of the spillway, which was constructed subsequent to the completion of dam construction, are available in Appendix III-B (AMEC 2014d). R4 spillway is designed for storm events with return periods greater than those required by the Code.
- Water from R4 Seepage Pond is released through a 300 mm dia. low-level outlet pipe to an open channel that leads to Lower Trojan Pond and ultimately discharges into Witches Brook. A secondary outlet (intake west of the low-level outlet) diverts water to the Highland Mill when required.

Lower Trojan Dam

A layout of the Lower Trojan Pond is shown in Figure 5 and the typical geometry and dimensions of the dam are summarized in Table III-A-1. Refer to Appendix III-B for relevant design drawings.

General information regarding the dam is as follows:

- Dam was constructed in 1989. Construction record reports are not available.
- A 2005 design drawing shows the existing pond and dam in plan and section (KC 2005). The section provided appears to be based on measurements taken in November 2004.
- Inflows, made up of discharge from R3 and R4 Seepage Ponds and surface runoff, are measured by THVCP upstream of the Lower Trojan Dam on the west side of the access road.
- Outflow from the pond is through a 460 mm dia. diversion pipeline with a control valve downstream of the dam. Flows join the Trojan Diversion downstream of the dam and are discharged to Witches Brook.
- A low-level outlet that discharged to Witches Brook via a 200 mm pipe with a control valve downstream of the dam has been decommissioned (the method and date of decommissioning are unknown). The outlet exited approximately 8 m downstream of the dam toe.
- A spillway near the right abutment comprises an 810 mm pipe through the dam. Spillway flows discharge to Witches Brook. An open channel spillway is also located near the right abutment.

Table III-A-1 Summary of Approximate Dam Geometry

Dam	Trojan Dam	R4 Seepage Pond Dam	Lower Trojan Dam
Length (m)	1500	100	100
Crest Elevation (m)	1414 (starter rockfill dam design) 1440	1365	1297.5 to 1296
Minimum Crest Width (m)	39	5	5
Maximum Height(2) (m)	70	3	4
Upstream Slope	1.5H:1V (rockfill starter dam design)	unknown	2H: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 Cutoff Trench	Single Raise Dam

1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.
3. A 2005 report indicates an upstream slope of 1.75H:1V based on a November 2004 measurement (KC 2005).
4. These slopes are shallower than those on 1987 design drawings 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.

HISTORY

A brief history of the construction and operations of the Trojan TSF is summarized as follows:

- From 1973 to 1980, the Trojan rockfill starter dam, designed by Gepac Consultants Ltd. (Gepac), was constructed to El. 1414 m (KL 1987).
- In 1981/1982, Klohn Leonoff Ltd. reviewed the dam design and proposed an upstream raise using cycloned sand. The already placed rockfill would serve as a downstream buttress and toe drain (KL 1982).
- Between 1982 and 1984, (different reports provide different dates), the dam was raised upstream using cycloned sand. Initially cyclone overflow was pumped into Bethlehem No. 1 TSF. The dam was regularly raised until 1987 to a final El. of 1441.5 m (AMEC 2014a; KL 1987).
- In 1983, a 24-inch diameter corrugated steel culvert which provided drainage of Trojan Creek flows through the original rockfill dam in the natural channel was backfilled with concrete (AMEC 2014a).
- In 1984, the R4 Seepage Pond was constructed (KC 1996).
- During 1989 the Lower Trojan Pond was constructed and tailings deposition in the Trojan TSF was stopped (KC 1996).
- In 1995, the Fish Spawning Channel Pond Dam was constructed (KC 2005).
- In 1996, a permanent spillway was constructed at the right abutment of Trojan Dam (KC 2002).
- In 2004, a spillway was constructed at the right abutment of R4 Seepage Pond Dam (AMEC 2014d).
- In 2016, the Fish Spawning Channel Pond Dam was decommissioned as discussed.
- In 2016, two vibrating wire piezometers and an inclinometer were installed in one drill hole on the downstream face of Trojan Dam.
- In 2018, the Trojan spillway was upgraded (Refer to Trojan TSF 2018 DSI for more information).

WATER MANAGEMENT

Water management at each structure in upstream to downstream order and how they interact with each other is summarized below. The flow schematic for the nearby Bethlehem TSF and Trojan TSF is shown in Figure III-A-1. Figure references for key operating water management structures are summarized in Table III-A-2.

Trojan TSF

- The Trojan Diversion is a series of ditches, culverts and pipelines located upslope of the Trojan TSF. The direction of flow is east to west with the open channel terminating west of Trojan Dam's right abutment and spillway. The flow is then diverted into a pipeline which discharges downstream of Lower Trojan Pond into an open channel. This open channel, considered to be part of Trojan Diversion, transitions back into a pipeline approximately 1 km downstream of the Lower Trojan Dam, and ultimately discharges into Witches Brook.
- Inflows include precipitation on the impoundment, surface runoff from upstream catchments, and flow from the breached Fish Spawning Channel Pond.
- The tailings free water pond is located at the center of the impoundment as shown on Figure 3. The water level varies seasonally up to 2.0 m based on historic records, typically with a peak in June and low in the winter months; refer to Figure IV-1.
- Outflows include seepage and when necessary, would discharge through the spillway (no discharge through spillway to date). Seepage reports to R4 Seepage Pond via the East and West Seepage Collection Ditches. The spillway, an open channel founded partially in tailings (upstream) and partially in natural ground (downstream) and lined with vegetation and riprap where needed, discharges into an existing tributary which drains into Witches Brook. As noted in previous section, the lower spillway channel upgrade construction works were completed in March 2018.

R4 Seepage Pond Dam

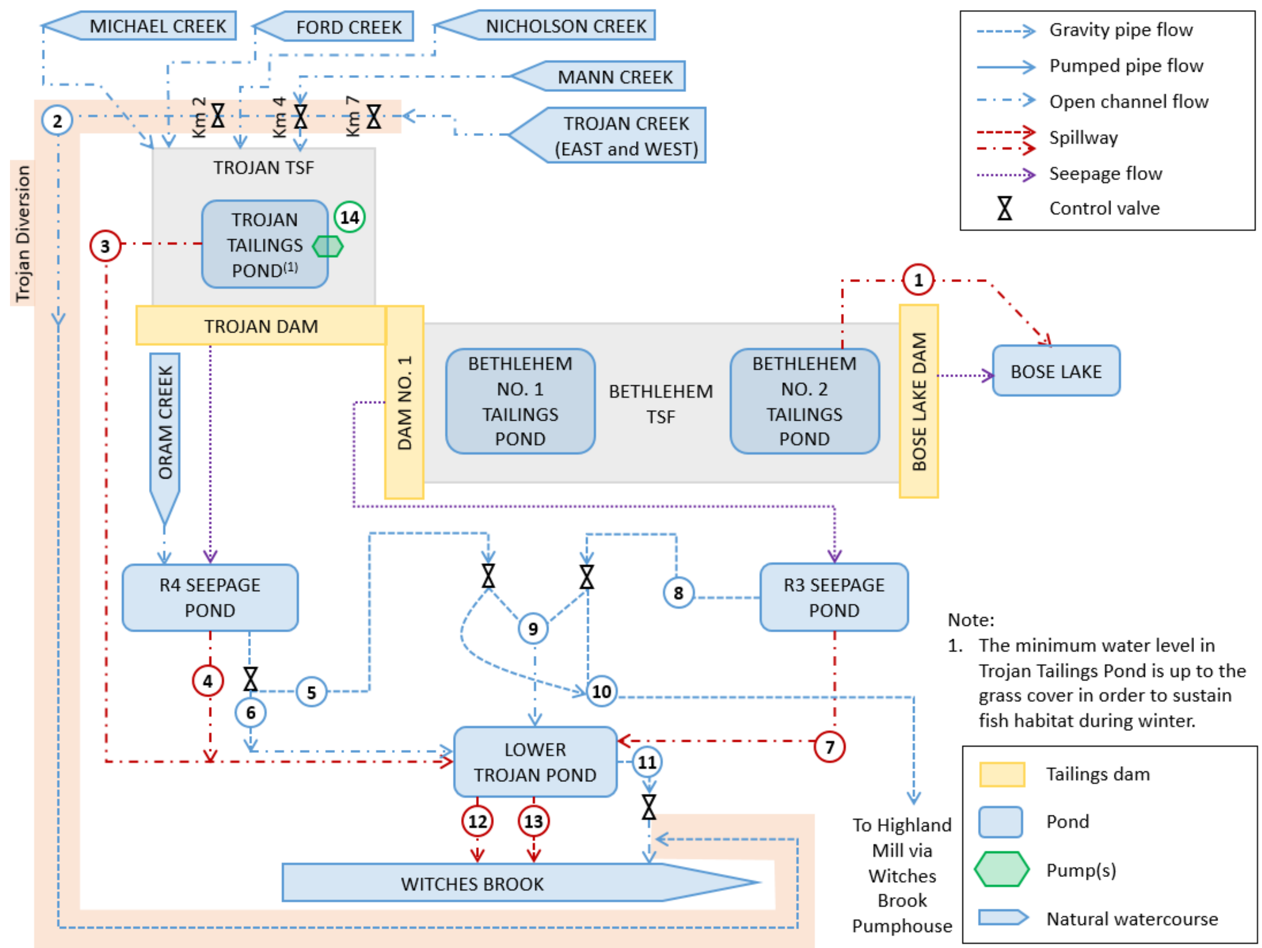
- Inflows include precipitation on the pond, surface runoff from upstream catchments, seepage from the Trojan Dam toe, and pumped flows from R3 Seepage Pond at the toe of Bethlehem Dam No. 1 (not part of regular operations). Inflows are measured monthly.
- The water level in the pond is not regularly surveyed by THVCP; however, visual estimates of available freeboard are included in the quarterly inspections by THVCP. These visual estimates of available freeboard ranged from 1.3 m to 1.7 m in 2018. The vertical distance between the pond and dam crest was approximately 1.5 m based on a visual estimate during the 2018 DSI site visit.
- Outflows include flow through a 300 mm dia. pipeline which leads to the Lower Trojan Dam, seepage and when necessary, diversion via another pipeline to the Highland Mill or discharge through the spillway. The pipeline flow to Lower Trojan Dam is controlled by a valve at the downstream toe of the dam. The spillway, a riprap-lined open channel with an energy dissipater, discharges into an existing tributary which drains into Witches Brook.

Lower Trojan Dam

- Inflows include precipitation on the pond, surface runoff from upstream catchments, outflow from R3 Seepage Pond at the toe of Dam No. 1, and outflow from R4 Seepage Pond. Flows from the Trojan Diversion bypass the Lower Trojan Dam. Inflows are measured weekly during freshet, and monthly for the remainder of the year.

- The water level in the pond is not regularly surveyed by THVCP; however, visual estimates of available freeboard are included in the quarterly inspections by THVCP. The visual estimate of available freeboard was 1.7 m in 2018. The vertical distance between the pond and dam crest was approximately 1.5 m based on a visual estimate during the 2018 DSI site visit. This is consistent with visual estimates during DSI site visits between 2014 and 2017 which observed the water level between 1.2 m and 2 m.
- Outflows include flow through the 460 mm dia. diversion pipeline, which is the normal operating outlet. This outflow joins the Trojan Diversion and reports to Witches Brook. If necessary, water discharges through the 810 mm dia. spillway pipe and a 7 m wide channel spillway on the right abutment. Both outflows also report to Witches Brook, but no recent flow has been noted.

Figure III-A-1 Flow Schematic for Bethlehem and Trojan TSFs



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	1.3 km long 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	Seepage to LTD	Buried pipeline	Operational
10	Northern Collection Line	Buried pipeline	Operational
11	LTD Low-Level Outlet	460 mm dia. HDPE pipe with control valve and intake trash rack	Operational
12	LTD Spillway	7 m wide channel	Operational
13	LTD Overflow	810 mm dia. HDPE pipe	Operational
14	Trojan Pump	Pump for Trojan Tailings Pond	Non-operational

Table III-A-2 References for Operational Water Management Structures for Trojan Facility

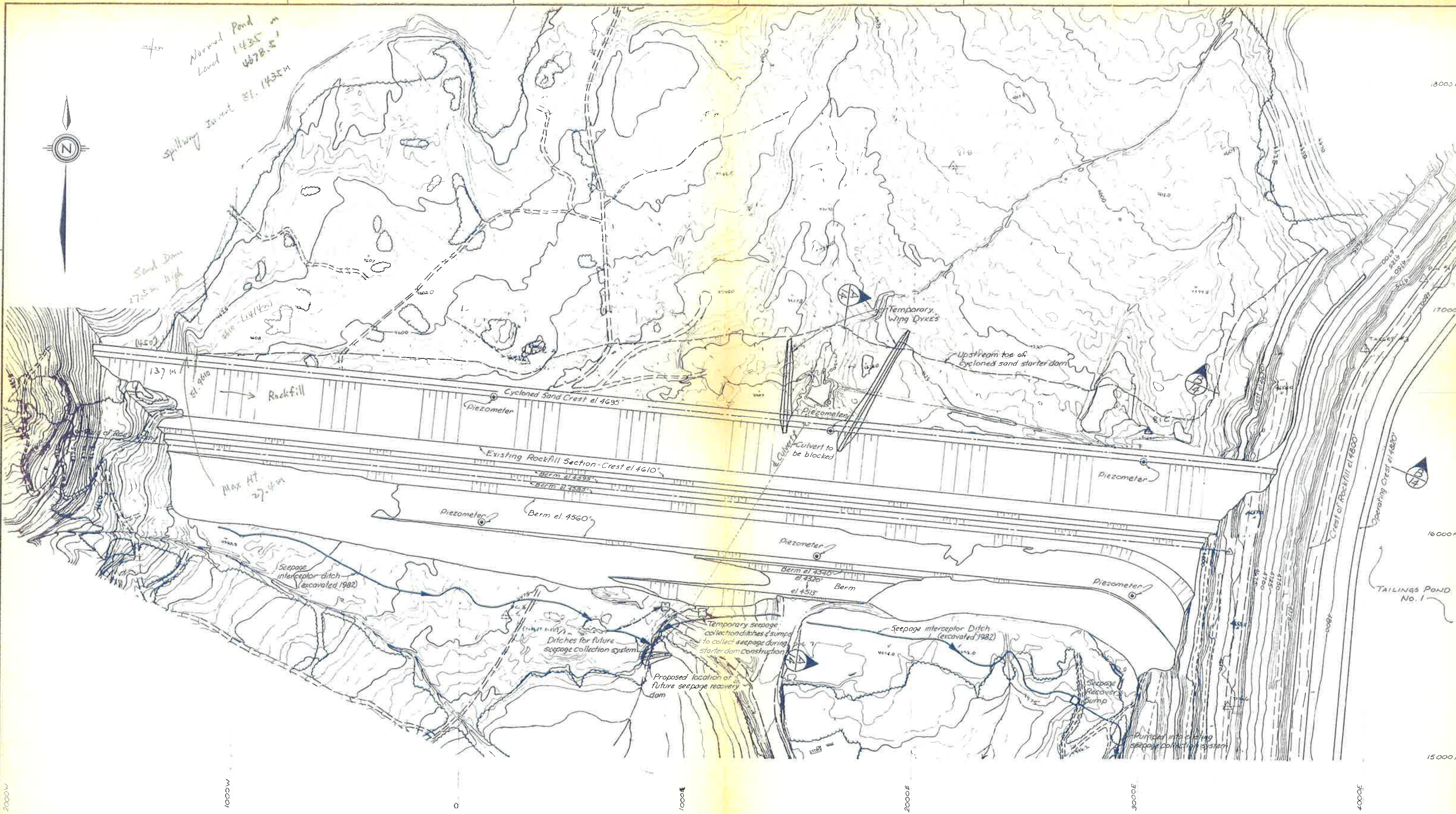
<table>
<tr><th>Dam</th><th>Structure Name</th><th>Drawing or Figure Reference (Appendix III)</th></tr>
<tr><td rowspan="3">Trojan TSF</td><td>Trojan Diversion</td><td>None available, see Figure 2</td></tr>
<tr><td>Trojan Spillway</td><td>114-808-202, C-001 to C-003, Figure 1</td></tr>
<tr><td>East and West Seepage Collection Ditches</td><td>D-2916-13
The East Seepage Collection Ditch has since been regraded to flow west into R4 Seepage Pond.</td></tr>
<tr><td rowspan="2">R4 Seepage Pond</td><td>Outlet Pipeline</td><td>B-007</td></tr>
<tr><td>Spillway</td><td>AB-2 to AB-6</td></tr>
<tr><td rowspan="2">Lower Trojan Dam</td><td>Diversion Pipeline</td><td>B-004</td></tr>
<tr><td>Spillway Pipe</td><td>B-004</td></tr>
</table>

APPENDIX III-B

Reference Dam Design Drawings

APPENDIX III-B-1

Reference Dam Design Drawings – Trojan Dam



REFERENCE

Base plan taken from Pencil manuscript supplied by Bethlehem Copper Corporation dwg 81-184, dated July 17, 1981

AS A MUTUAL PROTECTION TO OUR CLIENT THE PUBLIC AND OURSELVES ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL

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

SCALE: 200 0 400FT

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

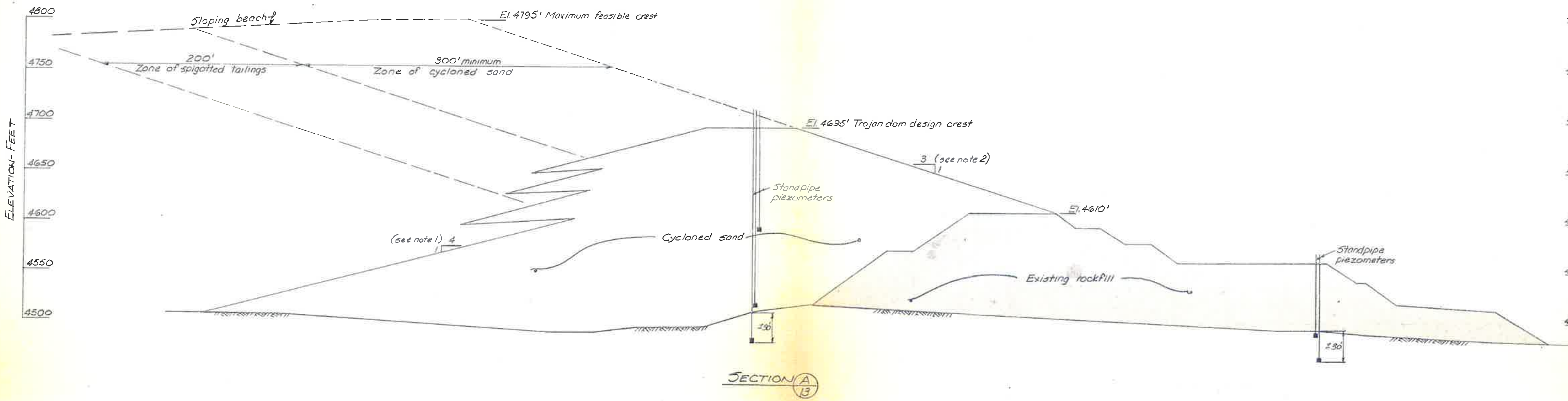
CLIENT: BETHLEHEM COPPER CORPORATION

REV.	DATE	REVISION DETAILS		
DESIGN S.R	DRAWN EDP	DATE NOV. 1982	SCALES AS SHOWN	

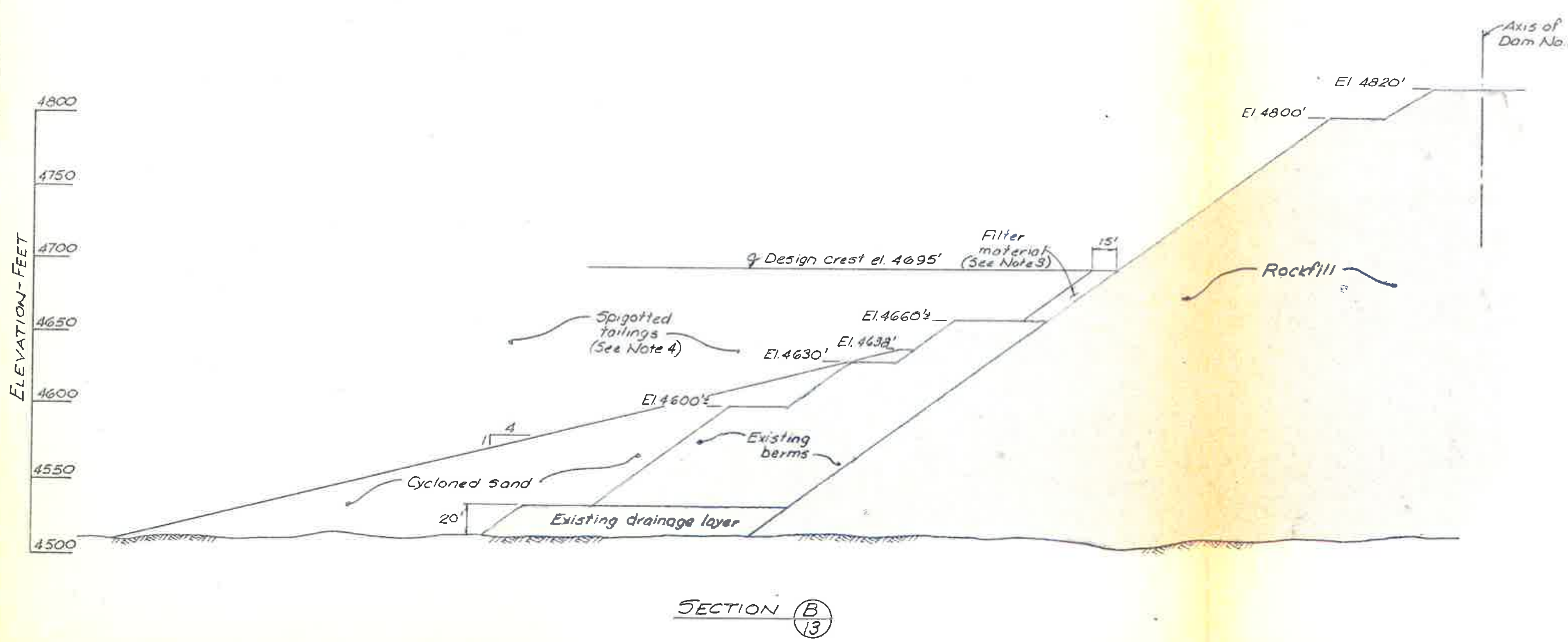
PROJECT: TROJAN TAILINGS DAM

TITLE: PLAN OF TROJAN DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
APPROVED Steve Rice	VA2916	D-2916-13	



SECTION A/13



SECTION B/13

NOTES:

1. Upstream slopes of the cycloned sand dam should be no flatter than 4 horizontal to 1 vertical and can be steepened if placement procedures allow.

2. An average downstream slope of 3 horizontal to 1 vertical should be achieved by constructing a series of toe berms on the downstream edge of the dam to retain the cycloned sand.

3. Filter material to conform to the design gradation shown on figure 2, appendix 1. Material should be placed in maximum 18 inch lifts, heavily watered and compacted.

4. Tailings will be hydraulically placed from spigot points along the dam crest to develop uniform beaches.

5. For construction schedule and sequencing see drawing D-2916-16

6. For location of standpipe piezometers see drawing D-2916-13.

7. The design presented in this report is for the dam constructed to elev. 4695 ft. The section above 4695 ft is presented to illustrate the feasibility of future dam raising.

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

SCALE: 50 0 50 100 FT.

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

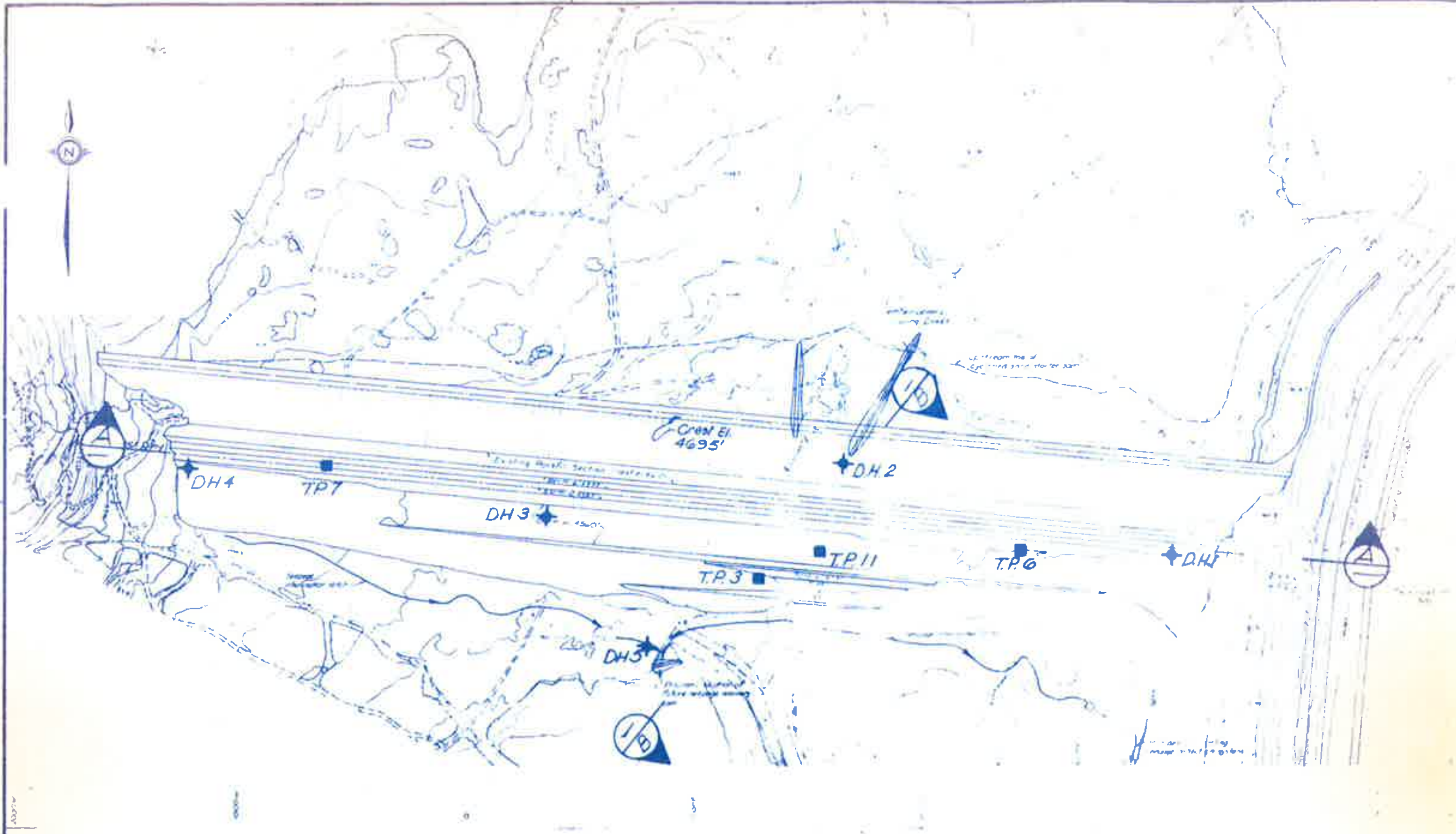
CLIENT: BETHLEHEM COPPER CORPORATION

REV.	DATE	REVISION DETAILS	
DESIGN S R	DRAWN E D P	DATE NOV., 1982	SCALES AS SHOWN

PROJECT: TROJAN TAILINGS DAM

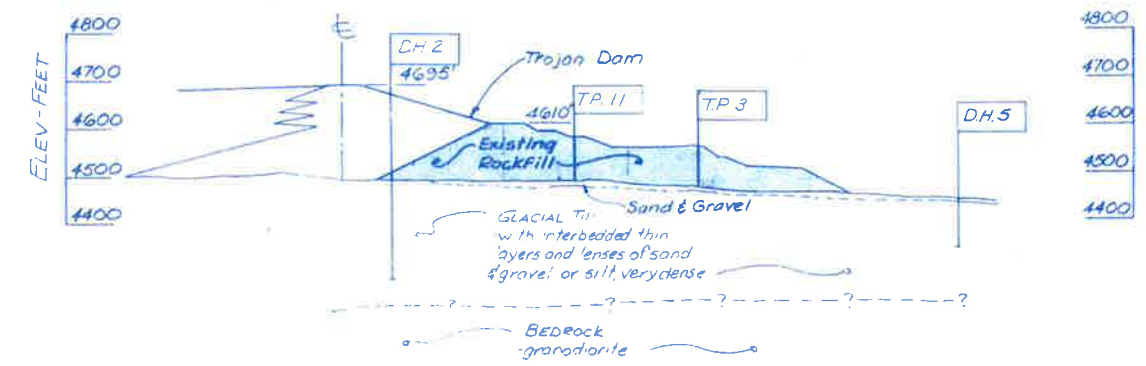
TITLE: TYPICAL DESIGN SECTIONS

DATE OF ISSUE	PROJECT No	DWG. No	REV.
APPROVED Steve Rice	VA2916	D-2916-14	

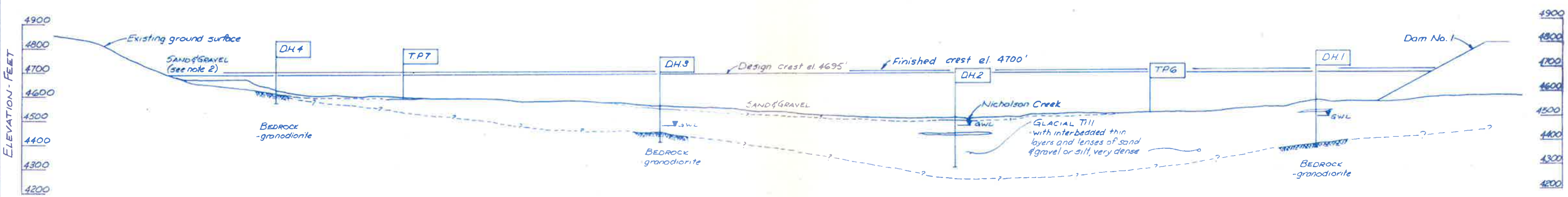


LOCATION PLAN

400' 0 800'



SECTION (B)



SECTION (A)

NOTES

1. Subsoil information based on site investigation carried out by Geopac Consultants Ltd in April & May, 1972.

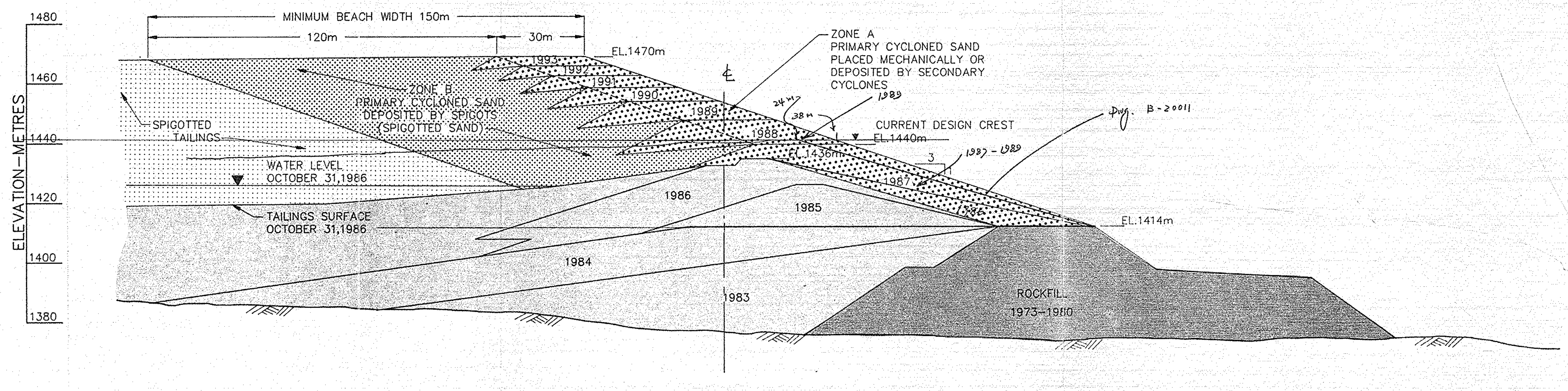
2. Sand & gravel at west end of Trojan Dam used for Filter on Trojan Dam.

3. Foundation conditions have been simplified and inferred between test holes.

SOURCE : KLOHN LEONOFF PROJECT VA 2916
DWG. No. D-2916-18, DATED NOV. 22, 1982.

TO BE READ WITH
KLOHN - CRIPPEN REPORT DATED DEC. 9, 1996

SCALE: 200' 0 400'	REV. DATE	REVISION DETAILS	
	DESIGN S.R.	DRAWN E.D.P.	DATE NOV. 1982 / SCALES AS SHOWN
KLOHN-CRIPPEN	PROJECT: LONG-TERM STABILITY ASSESSMENT		
	TITLE: SUBSOIL DATA - TROJAN DAM		
CLIENT: HIGHLAND VALLEY COPPER	DATE OF ISSUE DEC 9, 1996 / APPROVED	PROJECT No. FM2916 23	DWG. No. B-23018

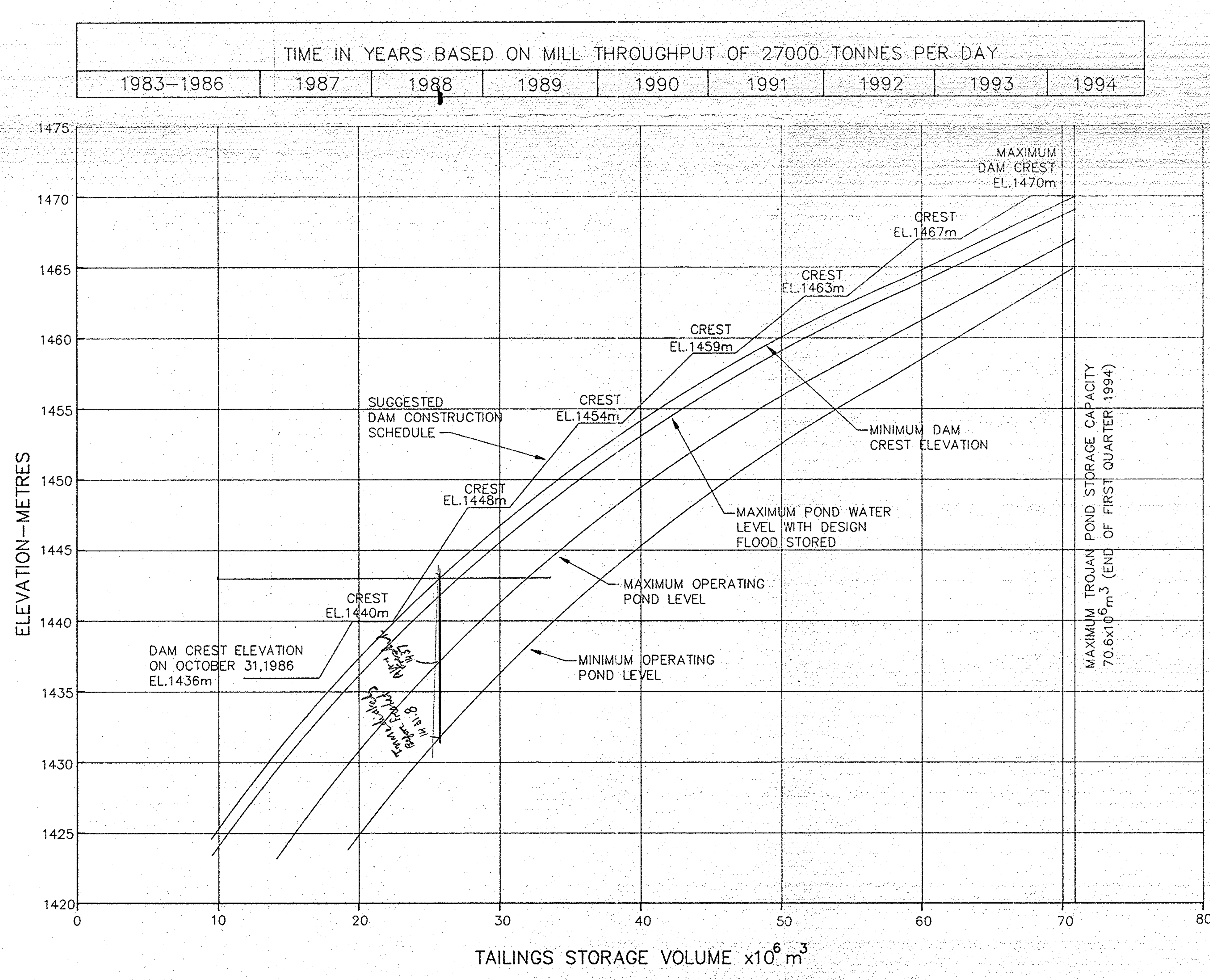


SECTION (A / 10008)

TYPICAL DESIGN SECTION AND CONSTRUCTION SCHEDULE

LEGEND

- ZONE A–PRIMARY CYCLONED SAND PLACED MECHANICALLY OR DEPOSITED BY SECONDARY CYCLONES
- ZONE B–PRIMARY CYCLONED SAND DEPOSITED BY SPIGOT
- SPIGOTTED TAILINGS
- EXISTING TAILINGS SAND EMBANKMENT
- ROCKFILL



TAILINGS POND STORAGE CURVES

YEAR	DESIGN CREST ELEVATION (m)	APPROXIMATE SAND VOLUME ZONE A (m^3)
1987	1440	0.98×10^6
1988	1448	0.78×10^6
1989	1454	0.54×10^6
1990	1459	0.39×10^6
1991	1463	0.31×10^6
1992	1467	0.27×10^6
1993	1470	0.22×10^6

APPROXIMATE ZONE A CONSTRUCTION SCHEDULE AND CYCLONED SAND VOLUMES

min – 4668
max – 4685 — Nov. 2, 1987 4613

NOTES:

1. THE PRIMARY CYCLONED SAND DEPOSITED IN ZONES A AND B SHALL CONTAIN LESS THAN 10 PERCENT BY WEIGHT PASSING THE No. 200 SIEVE AND SHALL BE DEPOSITED WITH THE FOLLOWING MINIMUM AVERAGE IN-SITU DRY DENSITY:

ZONE	DRY DENSITY (kN/m^3)
A	14.4
B	14.9

2. THE MINIMUM DAM CREST ELEVATION REQUIRED AT ANY TIME DURING THE OPERATION OF TROJAN POND WILL PROVIDE THE FOLLOWING DESIGN STORAGE REQUIREMENTS, PLUS 1m OF FREEBOARD:
   a) THE TAILINGS PRODUCED BY THE MILL;
   b) A MINIMUM OPERATING POND CONTAINING $1.2 \times 10^6 m^3$ OF WATER;
   c) A MAXIMUM OPERATING POND CONTAINING $2.2 \times 10^6 m^3$ OF WATER FOLLOWING THE SPRING FRESHET; AND
   d) FLOOD STORAGE OF $3.4 \times 10^6 m^3$, ABOVE THE MAXIMUM OPERATING POND LEVEL, TO STORE THE PROBABLE MAXIMUM FLOOD.
3. THE SUGGESTED DAM CONSTRUCTION SCHEDULE IS BASED ON AN AVERAGE MILL THROUGHPUT RATE OF 27000 TONNES PER DAY(tpd) AND IS PRESENTED AS A GUIDE. THE ACTUAL DAM CONSTRUCTION SCHEDULE SHALL BE REVIEWED ANNUALLY AND ADJUSTED IN ACCORDANCE WITH OPERATING CONDITIONS.
4. TAILINGS STORAGE VOLUMES ARE BASED ON THE FOLLOWING ASSUMED IN-SITU DRY DENSITIES:

SLIMES	=	$9.4kN/m^3$ ($0.96t/m^3$)
SPIGOTTED TAILINGS	=	$13.0kN/m^3$ ($1.33t/m^3$)
ZONE A SAND	=	$14.4kN/m^3$ ($1.47t/m^3$)
ZONE B SAND	=	$14.9kN/m^3$ ($1.52t/m^3$)

DRAFT

TO BE READ WITH KLOHN LEONOFF REPORT DATED

SCALE: 20m 0 50m

KLOHN LEONOFF LTD. CONSULTING ENGINEERS

CLIENT: HIGHLAND VALLEY COPPER

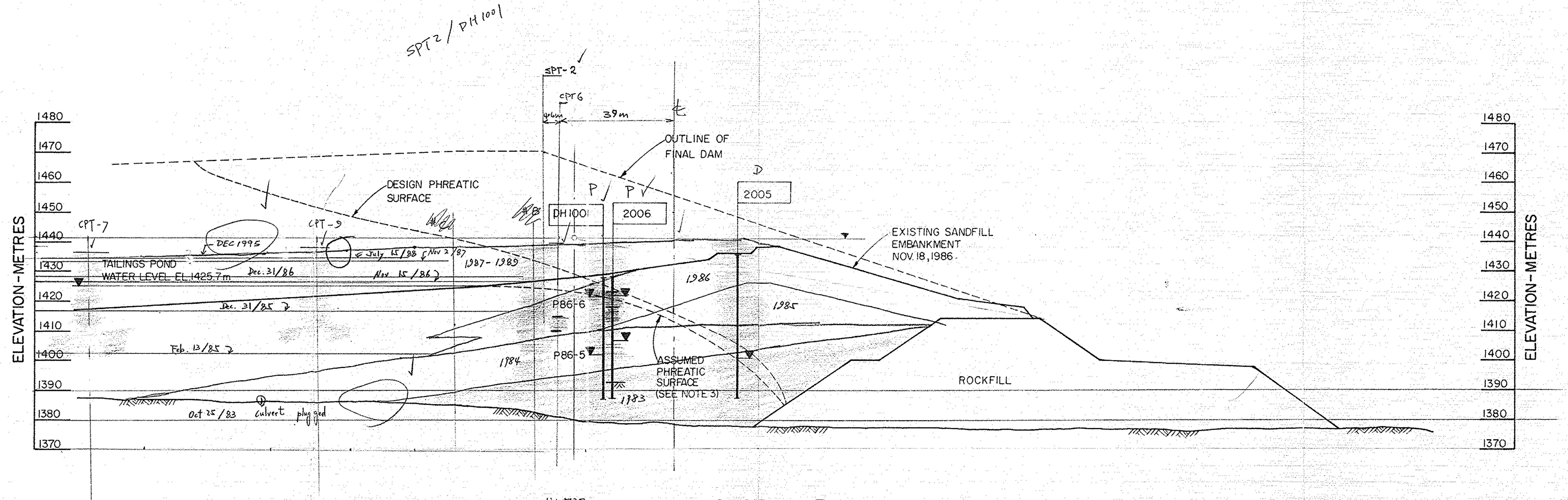
REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R.	E.D.P.	MAY,1987	AS SHOWN

PROJECT: TROJAN TAILINGS DAM

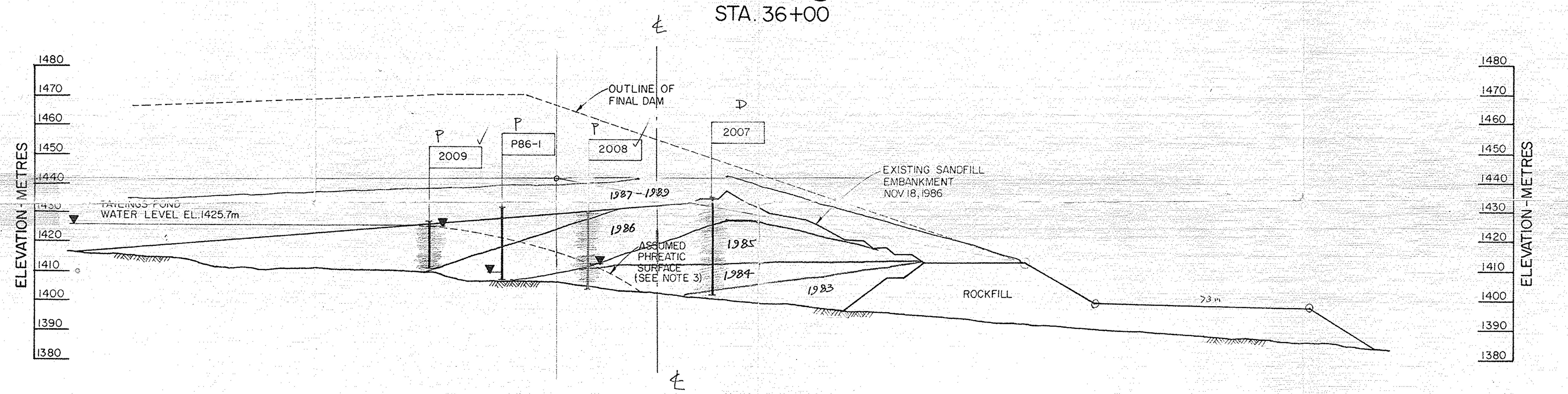
TITLE: TROJAN DAM DESIGN SECTION, CONSTRUCTION SCHEDULE AND POND STORAGE CURVES

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
APPROVED	PB291610	D-10009	



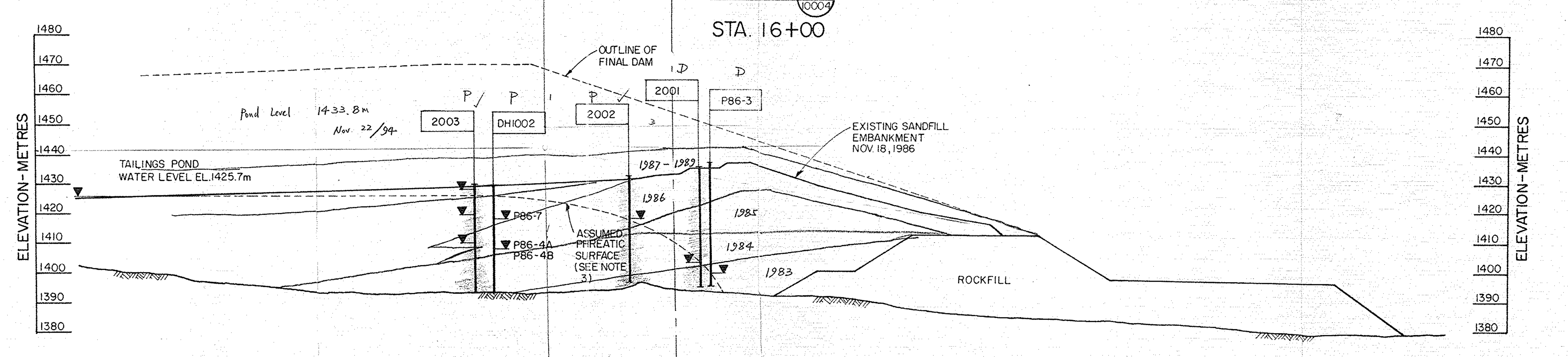
SECTION A (10004)

STA. 36+00



SECTION B (10004)

STA. 16+00



SECTION C (10004)

STA. 47+00

LEGEND

2003	CONE PENETRATION TEST
DH1001	SAMPLED DRILLHOLE
P86-1	STANDPIPE PIEZOMETER
▼	MEASURED WATER LEVEL OR WATER LEVEL INTERPRETED FROM CONE LOG
▼P86-6	MEASURED WATER LEVEL IN STANDPIPE PIEZOMETER INSTALLED IN, OR ADJACENT TO, SAMPLED DRILLHOLE

NOTES

1. FOR TEST HOLE LOCATIONS SEE DRAWING D-10004.
2. WATER LEVELS IN THE CONE PENETRATION TEST HOLES WERE INTERPRETED FROM THE CONE LOGS (SEE APPENDIX II). WATER LEVELS IN STANDPIPE PIEZOMETERS WERE MEASURED APPROX. ONE MONTH AFTER THE FIELD INVESTIGATION.
3. THE ASSUMED PHREATIC SURFACE PLOTTED ON THE SECTIONS CORRESPONDS TO THE HIGHEST MEASURED WATER LEVEL.
4. SECTIONS BASED ON AS-BUILT SECTIONS PROVIDED BY HIGHLAND VALLEY COPPER.

1 : 100

DRAFT

TO BE READ WITH KLOHN LEONOFF REPORT DATED ____

SCALE: 20m 0 50m

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

CLIENT: HIGHLAND VALLEY COPPER

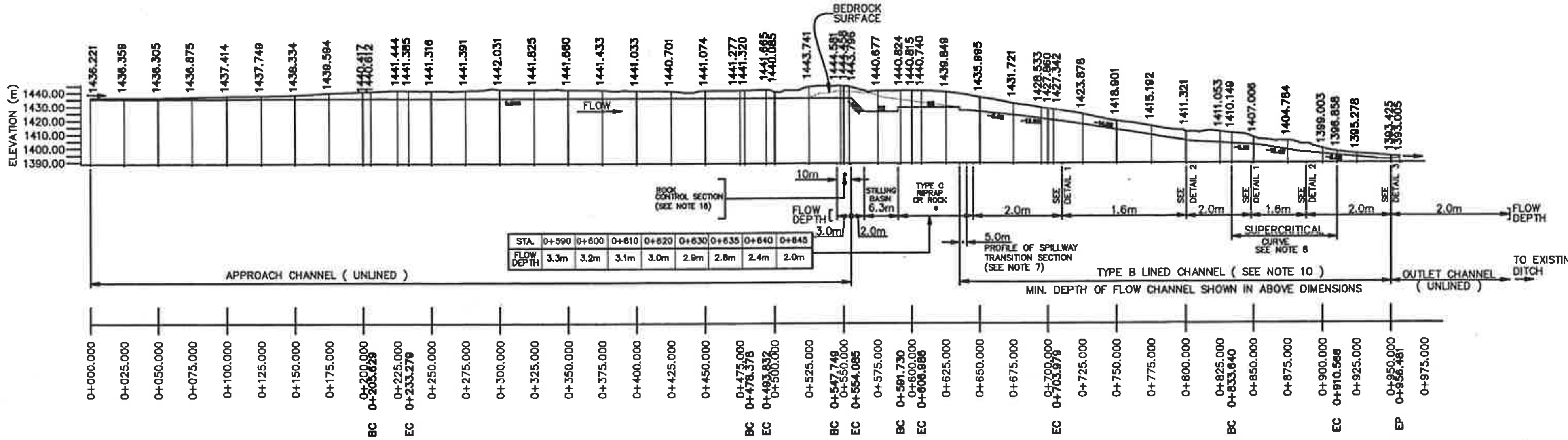
REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R	E.D.P	AUG., 1987	AS SHOWN

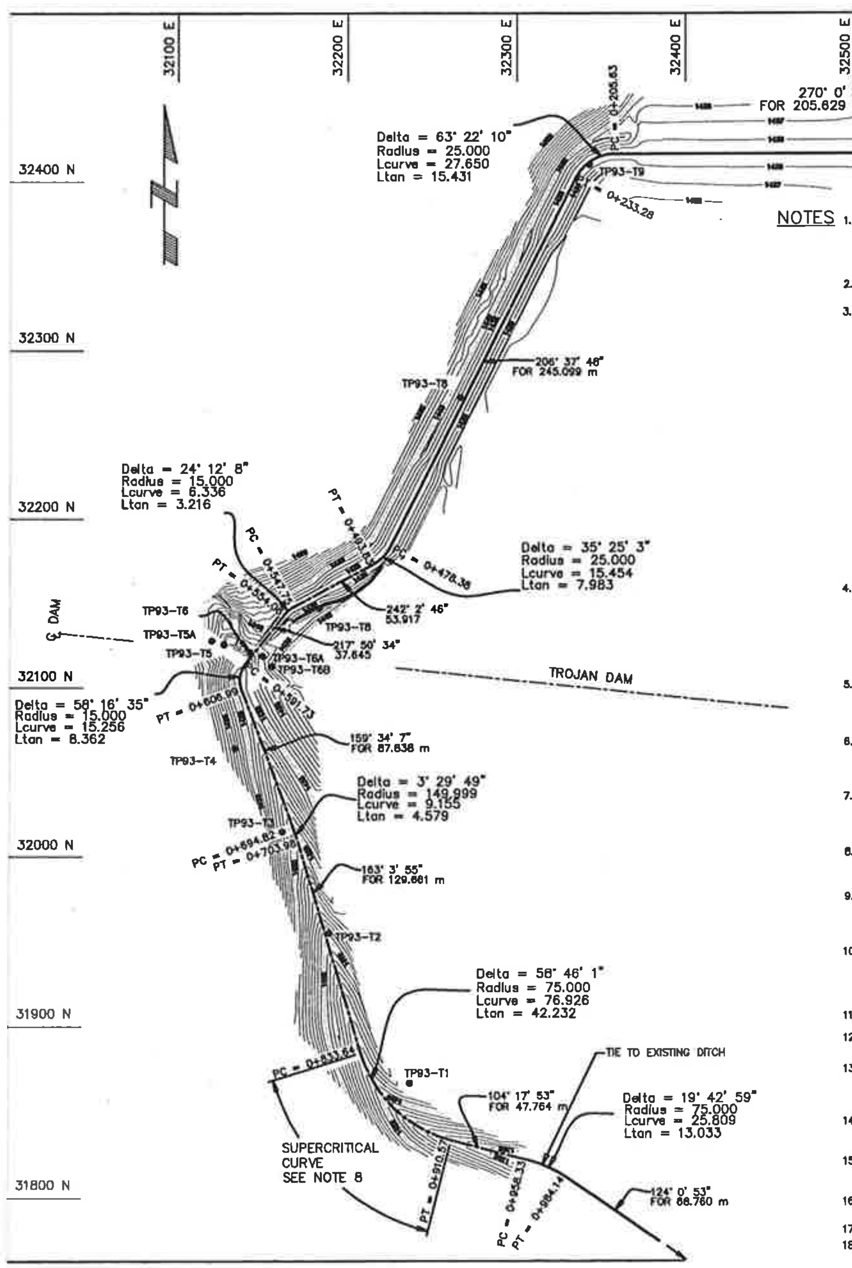
PROJECT: TROJAN TAILINGS DAM

TITLE: SECTIONS

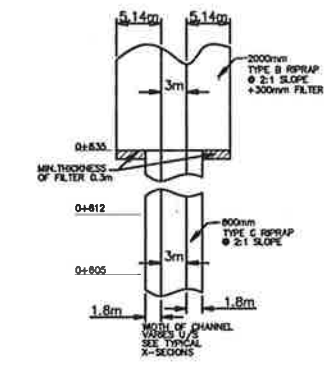
DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
APPROVED	PB2916-10	D-10005	



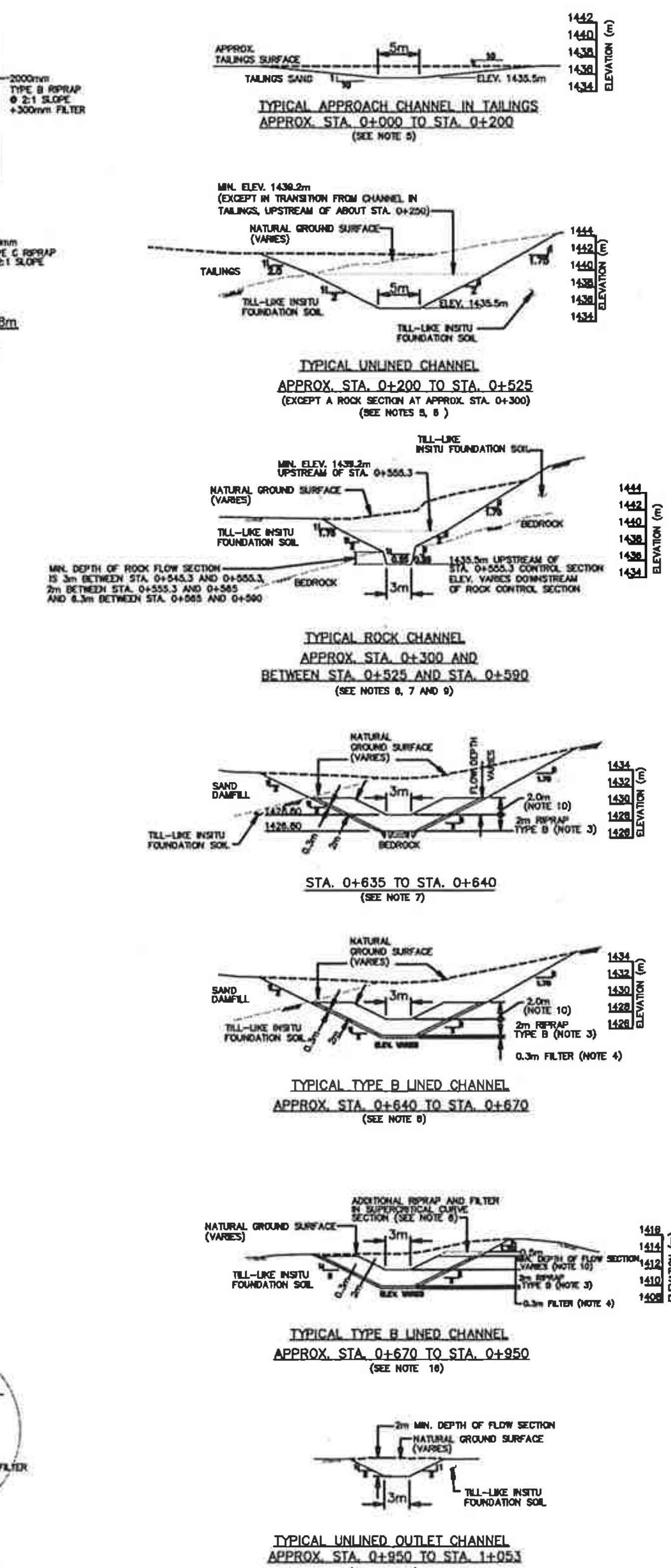
PROFILE ALONG SPILLWAY CHANNEL
(SEE NOTE 14)



GENERAL ARANGEMENT – PLAN



PLAN @ 0+635



TYPICAL APPROACH CHANNEL IN TAILINGS
APPROX. STA. 0+000 TO STA. 0+200
(SEE NOTE 5)

TYPICAL UNLINED CHANNEL
APPROX. STA. 0+200 TO STA. 0+525
(EXCEPT A ROCK SECTION AT APPROX. STA. 0+300)
(SEE NOTES 5, 6)

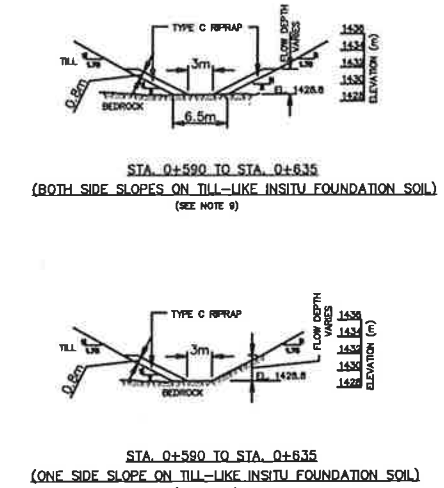
TYPICAL ROCK CHANNEL
APPROX. STA. 0+300 AND
BETWEEN STA. 0+525 AND STA. 0+590
(SEE NOTES 6, 7 AND 9)

STA. 0+635 TO STA. 0+640
(SEE NOTE 7)

TYPICAL TYPE B LINED CHANNEL
APPROX. STA. 0+640 TO STA. 0+670
(SEE NOTE 6)

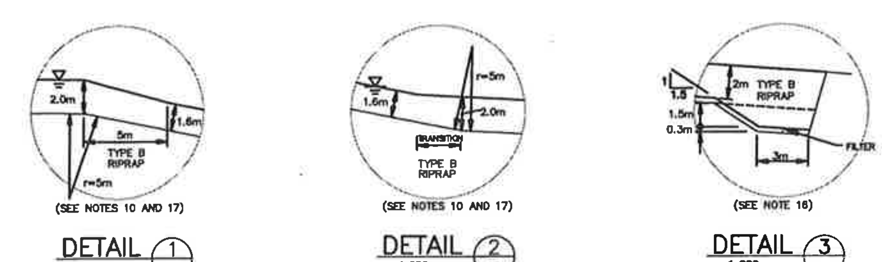
TYPICAL TYPE B LINED CHANNEL
APPROX. STA. 0+670 TO STA. 0+950
(SEE NOTE 10)

TYPICAL UNLINED OUTLET CHANNEL
APPROX. STA. 0+950 TO STA. 1+053
(SEE NOTE 15)



STA. 0+590 TO STA. 0+635
(BOTH SIDE SLOPES ON TILL–LIKE INSITU FOUNDATION SOIL)
(SEE NOTE 9)

STA. 0+590 TO STA. 0+635
(ONE SIDE SLOPE ON TILL–LIKE INSITU FOUNDATION SOIL)
(SEE NOTE 9)



(SEE NOTES 10 AND 17) DETAIL 1 1:200

(SEE NOTES 10 AND 17) DETAIL 2 1:200

(SEE NOTE 16) DETAIL 3 1:200

NOTES

1. BASE TOPOGRAPHY AND AS-BUILT SURVEY WERE SUPPLIED BY HIGHLAND VALLEY COPPER. THE TOPOGRAPHIC MAP AND 1993 TEST PITTING DATA FORMED THE BASIS OF THE ORIGINAL SPILLWAY DESIGN. DESIGN MODIFICATIONS AND CONSTRUCTION ADJUSTMENTS ARE BASED ON ADDITIONAL TEST PITTING DATA OBTAINED IN 1995 AND THE ACTUAL GROUND CONDITIONS ENCOUNTERED.
2. APPROACH CHANNEL HORIZONTAL AT ELEV. 1435.5m FROM START OF TAILINGS CHANNEL AT STA. 0+000 TO STA. 0+555.3 IN ROCK CHANNEL.
3. TYPE B LINED CHANNEL RIPRAP TO CONSIST OF A 2000mm THICK LAYER OF HARD DURABLE ROCK WITH UNIT WEIGHT NOT LESS THAN 2400 kg/m^3. NO DIMENSION OF AN INDIVIDUAL ROCK SHOULD BE LESS THAN 1/3 OF LARGEST DIMENSION. NO ROCK SHALL HAVE OBVIOUS FRACTURE PLANES OR FISSURES. THE RIPRAP SHOULD BE WELL GRADED AND CONFORM TO THE FOLLOWING:

% LESS THAN BY WEIGHT	WEIGHT (kg)	DIA. (mm)
100	1500 TO 3000	1050 TO 1340
50	750 TO 1270	840 TO 1000
15	190 TO 630	530 TO 800
5	160	500

TYPE C RIPRAP TO CONSIST OF A 800mm THICK LAYER OF HARD DURABLE ROCK WITH UNIT WEIGHT NOT LESS THAN 2400 kg/m . NO DIMENSION OF AN INDIVIDUAL ROCK SHOULD BE LESS THAN 1/3 OF LARGEST DIMENSION. NO ROCK SHALL HAVE OBVIOUS FRACTURE PLANES OR FISSURES. THE RIPRAP SHOULD BE WELL GRADED AND CONFORM TO THE FOLLOWING:

% LESS THAN BY WEIGHT	WEIGHT (kg)	DIA. (mm)
100	70 TO 140	350 TO 450
50	35 TO 60	300 TO 360
15	10 TO 30	190 TO 290
5	9	180

4. FILTER MATERIAL FOR TYPE B RIPRAP ON TILL–LIKE FOUNDATION SOIL SHOULD BE WELL GRADED AND CONFORM TO THE FOLLOWING:
   MAXIMUM PARTICAL SIZE = 400mm
   D_{85}= 150mm TO 300mm
   D_{50}= 40mm TO 100mm
   D_{15}= 10mm TO 30mm
5. WHERE EXCAVATION WAS IN TAILINGS BELOW HIGH FLOW LEVEL, SIDE SLOPES WERE 10H:1V. SIDE SLOPES ABOVE HIGH FLOW LEVEL WERE NO STEEPER THAN 2.5H:1V. BETWEEN APPROX. STA. 0+200 AND 0+525, THE UPPER PORTION OF THE FLOW SECTION MAY BE IN TILL–COVERED TAILINGS–SAND SLOPE LOCALLY.
6. WHERE EXCAVATION WAS THROUGH TILL–LIKE FOUNDATION SOIL BELOW HIGH FLOW LEVEL, SIDE SLOPES WERE NO STEEPER THAN 2H:1V. SIDE SLOPES ABOVE HIGH FLOW LEVEL WERE NO STEEPER THAN 1.75H:1V IN TILL–LIKE FOUNDATION SOIL AND NO STEEPER THAN 2H:1V IN SAND DAMFILL.
7. WHERE EXCAVATION WAS THROUGH BEDROCK, SIDE SLOPES WERE NO STEEPER THAN 0.25H:1V. DOWNSTREAM OF STA. 0+635, TYPE B RIPRAP AND FILTER ZONE WERE IMPLEMENTED IN A TRANSITION SECTION FOR A LENGTH OF AT LEAST 5m AT HORIZONTAL GRADE.
8. TYPE B RIPRAP AND FILTER ZONES AT OUTER CHANNEL SLOPE BETWEEN STA. 0+834 AND STA. 0+911 WERE 0.5m ABOVE THE HIGH FLOW LEVEL TO ACCOUNT FOR FLOW SUPERELEVATION.
9. THE CHANNEL ALIGNMENT AND DESIGN WERE MODIFIED AFTER OVERLYING SAND DAMFILL WAS REMOVED. A STILLING BASIN WAS IMPLEMENTED BETWEEN STA. 0+585 AND 0+590, AND LIGHTER TYPE C RIPRAP WITH NO FILTER WAS PLACED BETWEEN STA. 0+590 AND 0+635.
10. TYPE B LINED CHANNEL SECTION WAS IN TILL–LIKE FOUNDATION SOIL FOR THE FULL DEPTH OF THE RIPRAP LINED SECTION. MINIMUM DEPTH OF FLOW SECTION ABOVE INVERT VARIES WITH CHANNEL SLOPE AS SHOWN ON SPILLWAY CHANNEL PROFILE. TRANSITION DETAIL BETWEEN FLOW DEPTHS IS SHOWN IN DETAIL 1 AND 2.
11. ALL DIMENSIONS, AND ELEVATIONS IN METRES.
12. RIPRAP AND FILTER MATERIALS WERE PLACED IN A MANNER TO PREVENT SEGREGATION OF THE PLACED MATERIALS.
13. MODIFICATIONS TO THE SPILLWAY AND CONSTRUCTION MATERIALS FOR RIPRAP AND FILTERS REQUIRED FOR LINING THE SPILLWAY CHANNEL WERE CHECKED BY FIELD ENGINEER AND DESIGNERS FOR COMPLIANCE WITH THE DESIGN INTENT.
14. CHANNEL PROFILE SHOWS EXCAVATION ELEVATION ALONG CENTRELINE. FINISHED ELEVATION WILL DEPEND ON LINING AND FILTER THICKNESS, IF ANY.
15. EXISTING DIVERSION DITCH WAS ENLARGED WITHIN THE SEGMENT OF OUTLET CHANNEL. BEYOND STA. 1+053, SMOOTH TRANSITION TO EXISTING DITCH WAS MADE.
16. DETAIL 3 SHOWS END SECTION OF TYPE B RIPRAP AND FILTER AT STA. 0+950.
17. CHANNEL SLOPE TRANSITIONS HAD A VERTICAL RADIUS OF 5m.
18. IN ROCK CONTROL SECTION, APPROX. 0+545.3 TO 0+555.3, ENTIRE FLOW SECTION WAS IN COMPETENT BEDROCK.
19. UNLINED OUTLET CHANNEL MAY REQUIRE RIPRAP PROTECTION IF EXCESSIVE EROSION DEVELOPS IN THE FUTURE.

TO BE READ WITH KLOHN CRIPPEN REPORT DATED JANUARY 18, 2002

NO.	DATE	ISSUE / REVISION	DRAWN	APPROVED
	JANUARY 18, 2002	ISSUED WITH REPORT	CYW	

KLOHN CRIPPEN
PROJECT No. PM 2916 29 DWG. No. D-29002

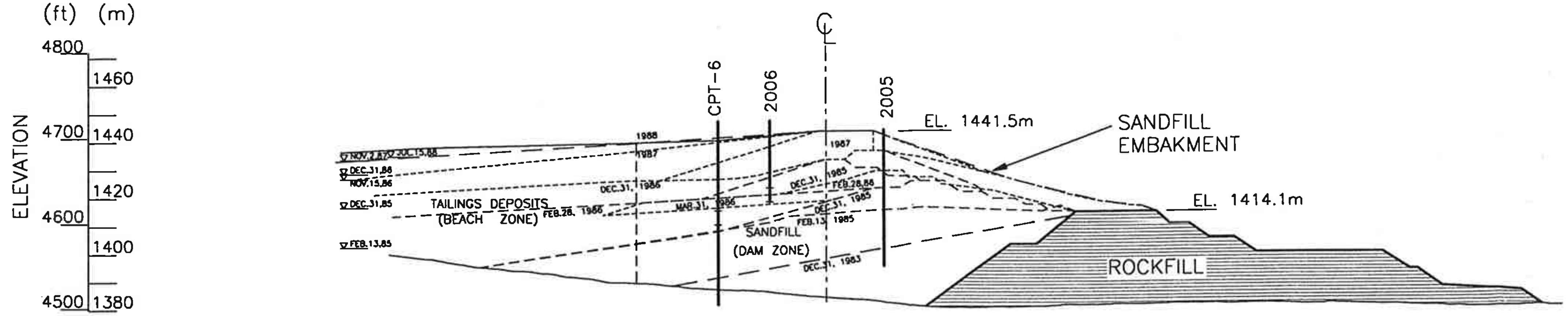
CAD File: 114-808-202-1

No.	Revision	Date	By	Ch'd	App'd	No.	Reference Drawings
1	ADDED KLOHN-CRIPPEN DESIGN SECTIONS & NOTES		R.B.				

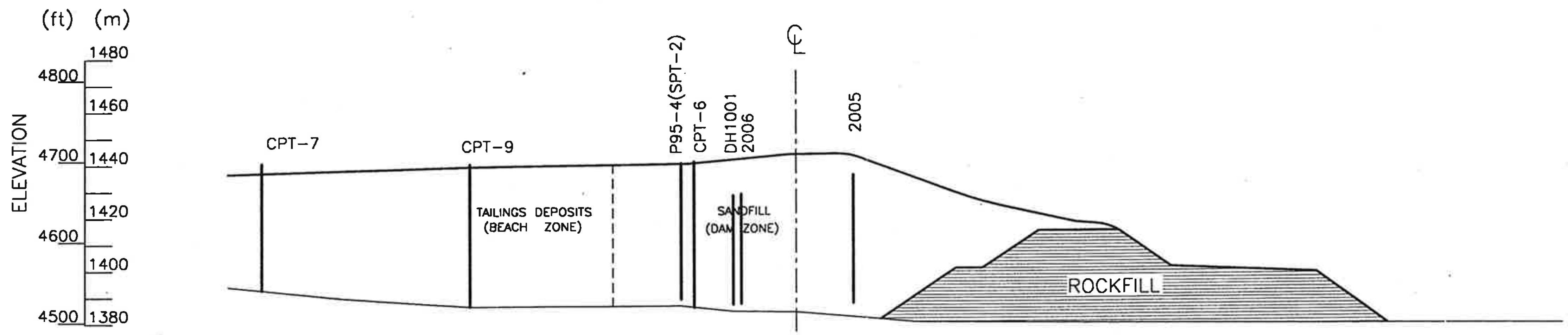
Highland Valley Copper

AS-BUILT TROJAN DAM SPILLWAY
PLAN, PROFILE & SECTIONS

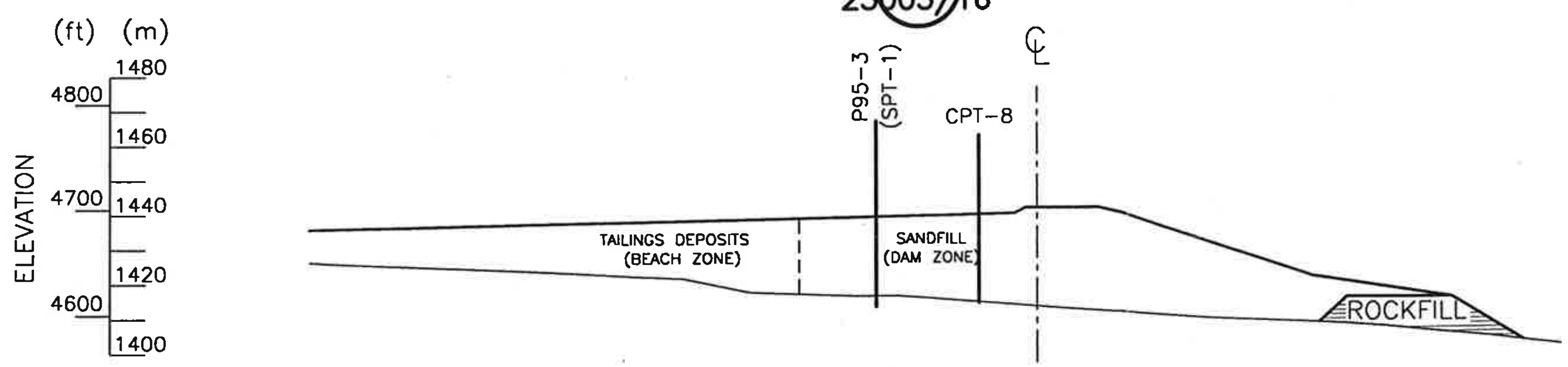
DRAWN H.P. CHECKED
DATE 99 03 08 SCALE 1:2000
DWG No. 114-808-202 REV. 1



TYPICAL CONSTRUCTION SEQUENCE



SECTION A 23005/16 VALLEY SECTION



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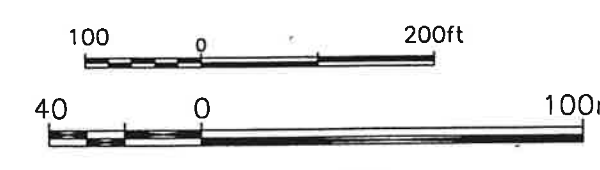


TO BE READ WITH KLOHN-CRIPPEN REPORT DATED DEC. 9, 1996

KLOHN-CRIPPEN		DATE
DESIGNED		
DRAWN		
CHECKED		
RECOMMENDED		
APPROVED	RJF	DEC 96

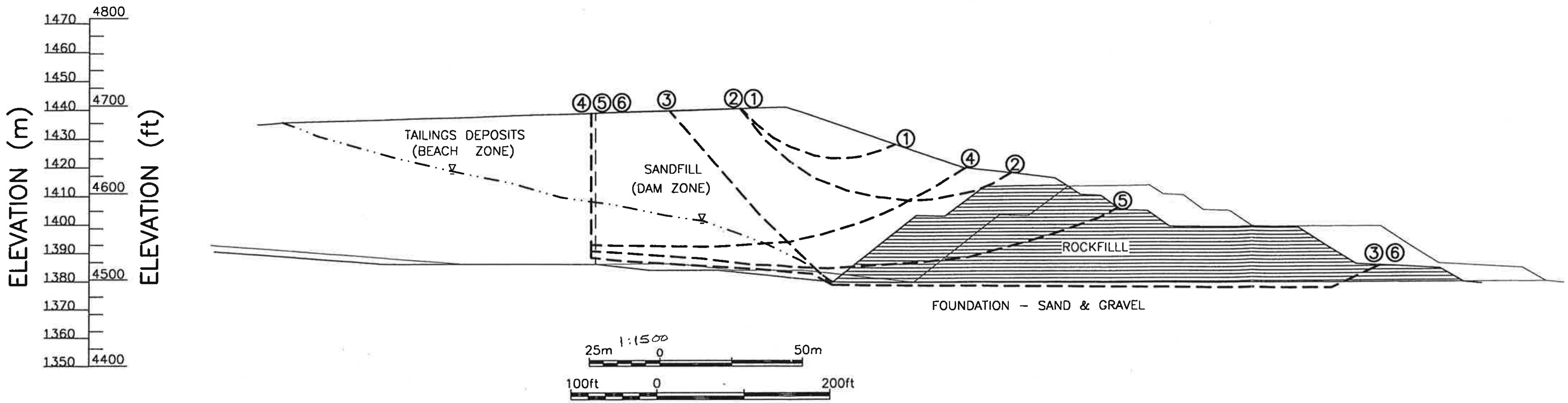
KLOHN-CRIPPEN

CLIENT: HIGHLAND VALLEY COPPER

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: TYPICAL SECTIONS TROJAN DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23017	



STATIC AND PSEUDO-STATIC STABILITY ANALYSES
SUMMARY OF SAFETY FACTOR AND YIELD ACCELERATION

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)		YIELD ACCELERATION (g)
	STATIC	PSEUDO-STATIC (a=0.1g)	
①	3.22	2.24	0.45
②	2.85	2.05	0.42

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE-W COMPUTER PROGRAM.

MATERIAL PROPERTIES

TYPE OF MATERIAL	UNIT WEIGHT		EFFECTIVE SHEAR STRENGTH(1) FRICTION ANGLE ø' (degree)
	γ_{moist} (kN/m³)	γ_{sat} (kN/m³)	
SANDFILL (DAM ZONE)	18	–	35
TAILINGS DEPOSITS (BEACH ZONE)	–	19	25
ROCKFILL	18.9	–	37
SAND AND GRAVEL (FOUNDATION)	–	22.8	35

(1) EFFECTIVE SHEAR STRENGTH – COHESION C' = 0 kN/m²

POST-EARTHQUAKE STABILITY ANALYSIS
SUMMARY OF SAFETY FACTOR

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)
①	1.26
②	1.21
③	2.72
④	2.72
⑤	1.68
⑥	2.86

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE-W COMPUTER PROGRAM.

LEGEND

④- - - -④ FAILURE SURFACE No.4

–··▽··– PIEZOMETRIC SURFACE

NOTES

1. ELEVATION IN METRES REFERS TO HIGHLAND VALLEY COPPER DATUM.
2. ELEVATION IN FEET REFERS TO BETHLEHEM COPPER DATUM.

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED DEC. 9, 1996

KLOHN-CRIPPEN		DATE
DESIGNED	PH	JUNE 96
DRAWN	CYW	
CHECKED		
RECOMMENDED		
APPROVED	[signature]	DEC.96

KLOHN-CRIPPEN

CLIENT: HIGHLAND VALLEY COPPER

SCALE

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: STABILITY ANALYSES
TROJAN DAM SECTION A-A
– VALLEY SECTION

DATE OF ISSUE: DEC. 9, 1996

PROJECT No.: PM2916 23

DWG. No.: B-23020

REV

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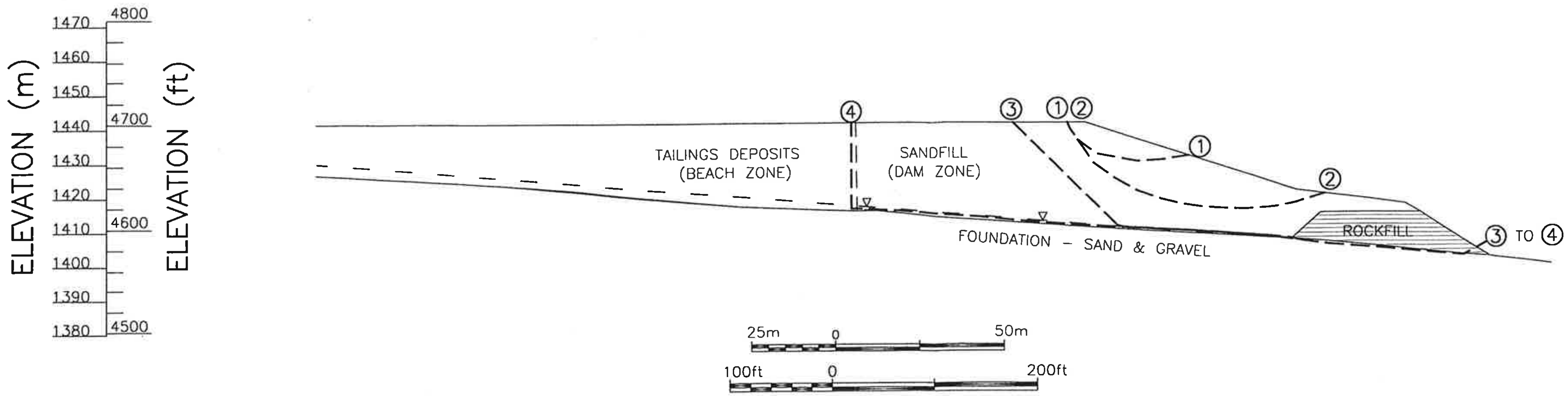

STATIC AND PSEUDO-STATIC STABILITY ANALYSES
SUMMARY OF SAFETY FACTOR AND YIELD ACCELERATION

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)		YIELD ACCELERATION (g)
	STATIC	PSEUDO-STATIC (a=0.1g)	
①	2.72	1.97	0.42
③	3.05	2.02	0.43

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE-W COMPUTER PROGRAM.

MATERIAL PROPERTIES

TYPE OF MATERIAL	UNIT WEIGHT		EFFECTIVE SHEAR STRENGTH(1) FRICTION ANGLE ø' (degree)
	γ_{moist} (kN/m³)	γ_{sat} (kN/m³)	
SANDFILL (DAM ZONE)	18	–	35
TAILINGS DEPOSITS (BEACH ZONE)	–	19	25
TAILINGS DEPOSITS (POND ZONE)	–	19	25
ROCKFILL	18.9	–	37
SAND AND GRAVEL (FOUNDATION)	–	22.8	35

(1) EFFECTIVE SHEAR STRENGTH – COHESION C' = 0 kN/m^2

POST-EARTHQUAKE STABILITY ANALYSIS SUMMARY OF SAFETY FACTOR

FAILURE SURFACE NUMBER	FACTOR OF SAFETY (1)
①	1.17
②	1.18
③	1.75
④	2.52

(1) FACTOR OF SAFETY OBTAINED FROM SIMPLIFIED JANBU METHOD OF SLICES WITH NO CORRECTION FOR SIDE FORCES BETWEEN SLICES, USING SLOPE-W COMPUTER PROGRAM.

LEGEND

④– – – –④ FAILURE SURFACE No.4

– ∇ – PIEZOMETRIC SURFACE

NOTES

1. ELEVATION IN METRES REFERS TO HIGHLAND VALLEY COPPER DATUM.
2. ELEVATION IN FEET REFERS TO BETHLEHEM COPPER DATUM.

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED DEC. 9, 1996

KLOHN-CRIPPEN		DATE
DESIGNED	PH	JUNE 96
DRAWN	CYW	
CHECKED		
RECOMMENDED		
APPROVED	RFO	DEC.96

KLOHN-CRIPPEN

CLIENT: HIGHLAND VALLEY COPPER

PROJECT: LONG-TERM STABILITY ASSESSMENT

SCALE

TITLE: STABILITY ANALYSES
TROJAN DAM SECTION B-B
– WEST ABUTMENT SECTION

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23021	

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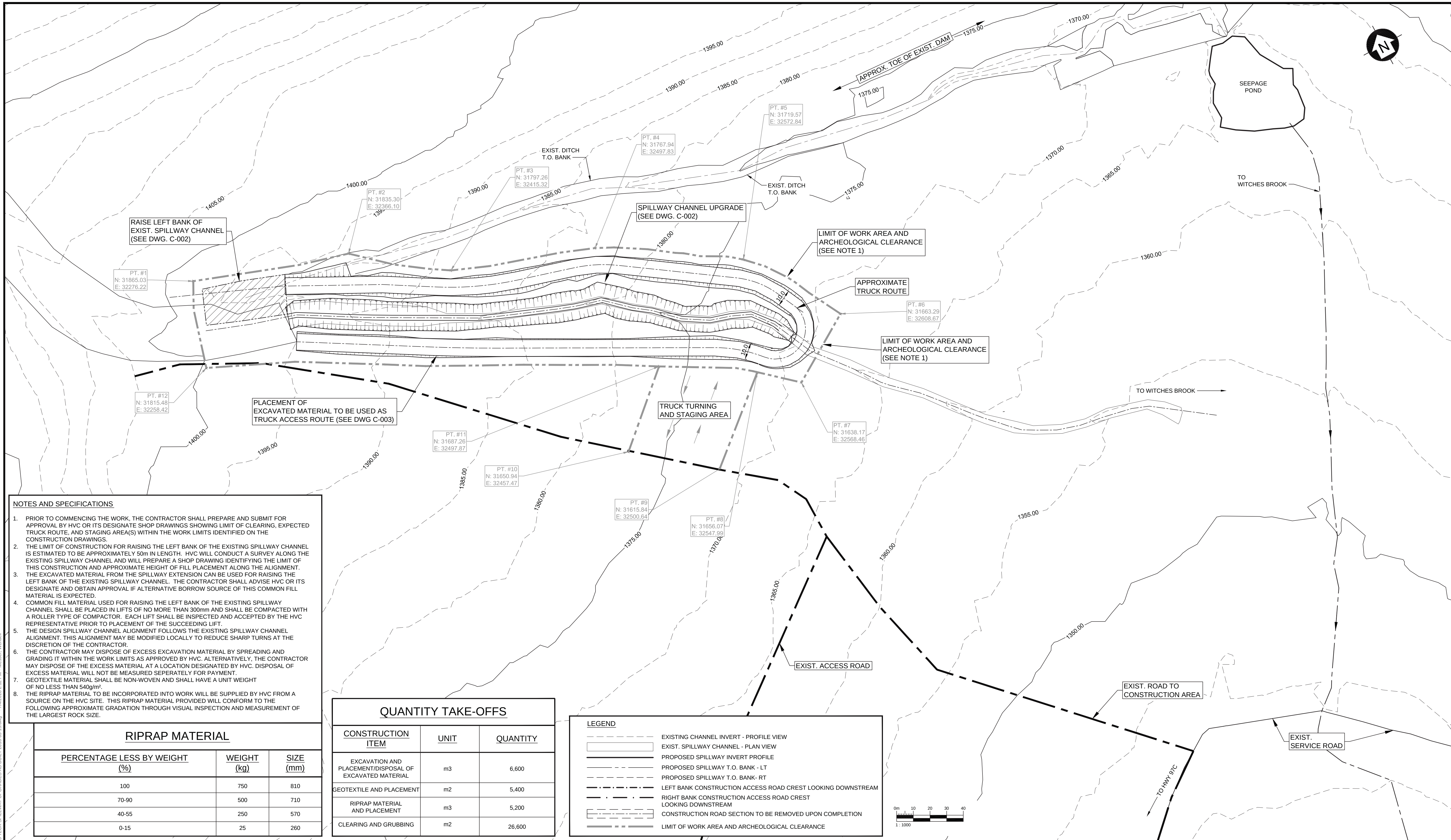


NOTES AND SPECIFICATIONS

1. PRIOR TO COMMENCING THE WORK, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL BY HVC OR ITS DESIGNATE SHOP DRAWINGS SHOWING LIMIT OF CLEARING, EXPECTED TRUCK ROUTE, AND STAGING AREA(S) WITHIN THE WORK LIMITS IDENTIFIED ON THE CONSTRUCTION DRAWINGS.
2. THE LIMIT OF CONSTRUCTION FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL IS ESTIMATED TO BE APPROXIMATELY 50m IN LENGTH. HVC WILL CONDUCT A SURVEY ALONG THE EXISTING SPILLWAY CHANNEL AND WILL PREPARE A SHOP DRAWING IDENTIFYING THE LIMIT OF THIS CONSTRUCTION AND APPROXIMATE HEIGHT OF FILL PLACEMENT ALONG THE ALIGNMENT.
3. THE EXCAVATED MATERIAL FROM THE SPILLWAY EXTENSION CAN BE USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL. THE CONTRACTOR SHALL ADVISE HVC OR ITS DESIGNATE AND OBTAIN APPROVAL IF ALTERNATIVE BORROW SOURCE OF THIS COMMON FILL MATERIAL IS EXPECTED.
4. COMMON FILL MATERIAL USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL SHALL BE PLACED IN LIFTS OF NO MORE THAN 300mm AND SHALL BE COMPACTED WITH A ROLLER TYPE OF COMPACTOR. EACH LIFT SHALL BE INSPECTED AND ACCEPTED BY THE HVC REPRESENTATIVE PRIOR TO PLACEMENT OF THE SUCCEEDING LIFT.
5. THE DESIGN SPILLWAY CHANNEL ALIGNMENT FOLLOWS THE EXISTING SPILLWAY CHANNEL ALIGNMENT. THIS ALIGNMENT MAY BE MODIFIED LOCALLY TO REDUCE SHARP TURNS AT THE DISCRETION OF THE CONTRACTOR.
6. THE CONTRACTOR MAY DISPOSE OF EXCESS EXCAVATION MATERIAL BY SPREADING AND GRADING IT WITHIN THE WORK LIMITS AS APPROVED BY HVC. ALTERNATIVELY, THE CONTRACTOR MAY DISPOSE OF THE EXCESS MATERIAL AT A LOCATION DESIGNATED BY HVC. DISPOSAL OF EXCESS MATERIAL WILL NOT BE MEASURED SEPERATELY FOR PAYMENT.
7. GEOTEXTILE MATERIAL SHALL BE NON-WOVEN AND SHALL HAVE A UNIT WEIGHT OF NO LESS THAN $540 g/m^2$.
8. THE RIPRAP MATERIAL TO BE INCORPORATED INTO WORK WILL BE SUPPLIED BY HVC FROM A SOURCE ON THE HVC SITE. THIS RIPRAP MATERIAL PROVIDED WILL CONFORM TO THE FOLLOWING APPROXIMATE GRADATION THROUGH VISUAL INSPECTION AND MEASUREMENT OF THE LARGEST ROCK SIZE.

RIPRAP MATERIAL

PERCENTAGE LESS BY WEIGHT (%)	WEIGHT (kg)	SIZE (mm)
100	750	810
70-90	500	710
40-55	250	570
0-15	25	260

QUANTITY TAKE-OFFS

CONSTRUCTION ITEM	UNIT	QUANTITY
EXCAVATION AND PLACEMENT/DISPOSAL OF EXCAVATED MATERIAL	m3	6,600
GEOTEXTILE AND PLACEMENT	m2	5,400
RIPRAP MATERIAL AND PLACEMENT	m3	5,200
CLEARING AND GRUBBING	m2	26,600

LEGEND

- EXISTING CHANNEL INVERT - PROFILE VIEW
- EXIST. SPILLWAY CHANNEL - PLAN VIEW
- PROPOSED SPILLWAY INVERT PROFILE
- PROPOSED SPILLWAY T.O. BANK - LT
- PROPOSED SPILLWAY T.O. BANK- RT
- LEFT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- RIGHT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- CONSTRUCTION ROAD SECTION TO BE REMOVED UPON COMPLETION
- LIMIT OF WORK AREA AND ARCHEOLOGICAL CLEARANCE

NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE NOTED.

RECORD DRAWING

NO.	DESCRIPTION

REFERENCE DRAWINGS

NO.	DATE	DESCRIPTION
5		
4		
3		
2		
0	2018 07/04	ISSUE FOR RECORD DRAWING

REVISIONS

STAMP:

CLIENT: Highland Valley Copper Teck

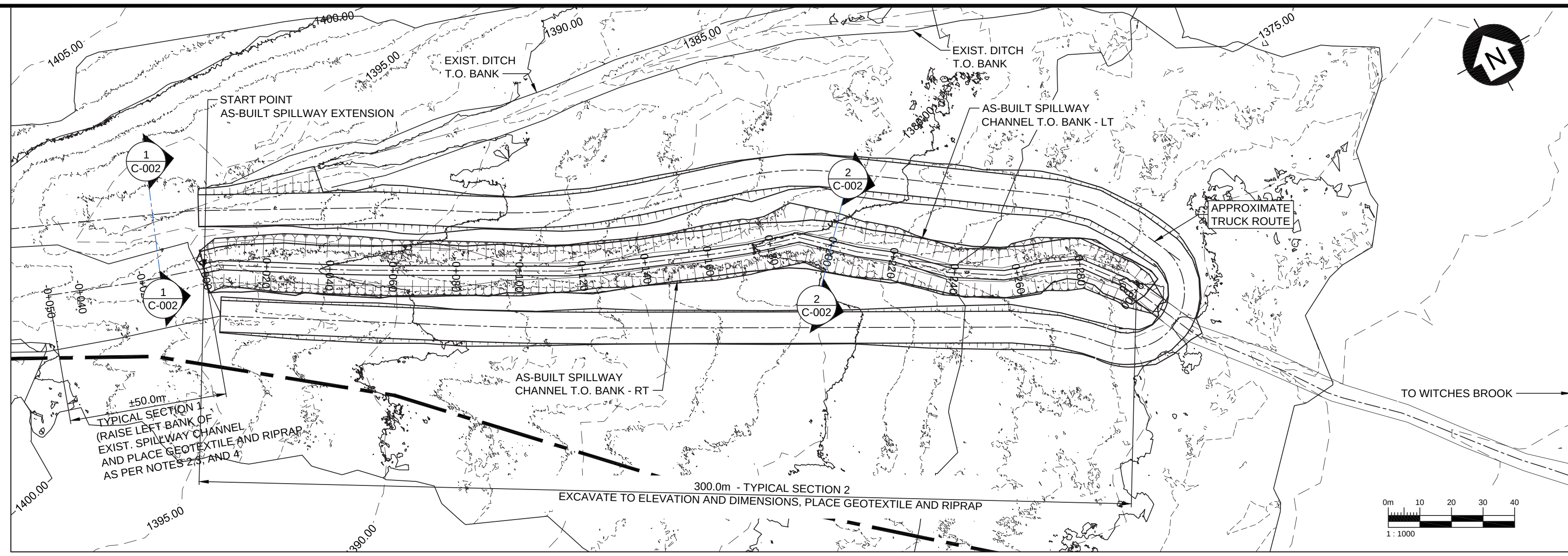
amec foster wheeler

DRAWN BY: WM
DESIGNED BY: HX
CHECKED BY :
SCALE : 1:1000
DATE : 2017-04-07

PROJECT: TROJAN SPILLWAY EXTENSION

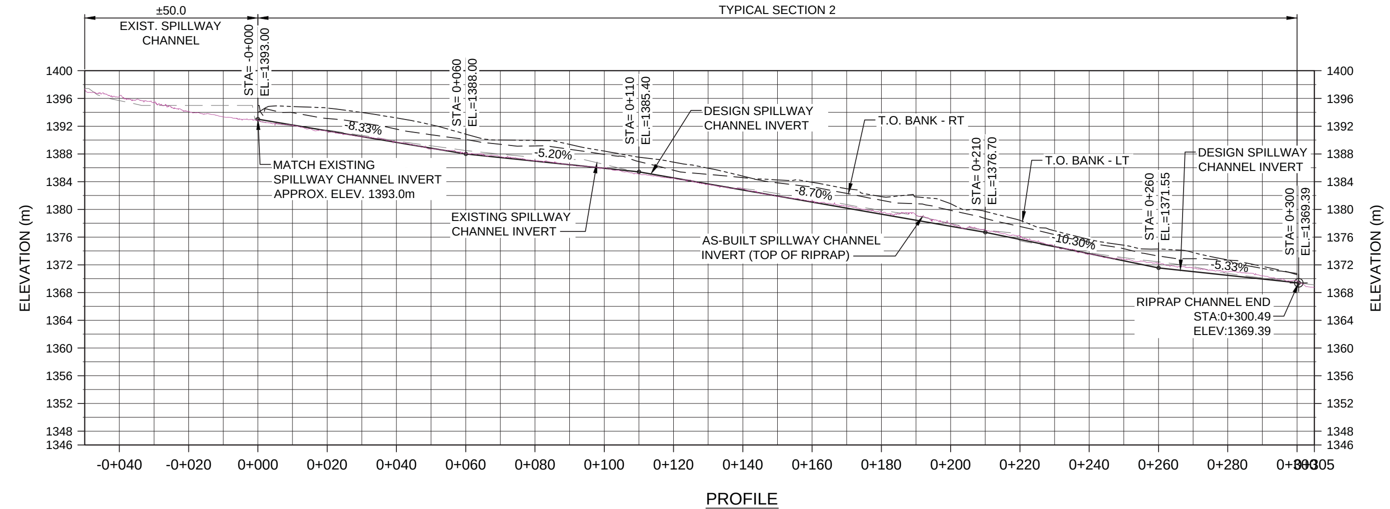
TITLE: RECORD DRAWING TROJAN DAM SPILLWAY SITE LOCATION, AND WORK LIMITS

DATUM : MINE GRID
PROJECTION :
PROJECT NO. : TE154025
REV. : 0
DRAWING NO. : C-001



PLAN

1:1000



PROFILE

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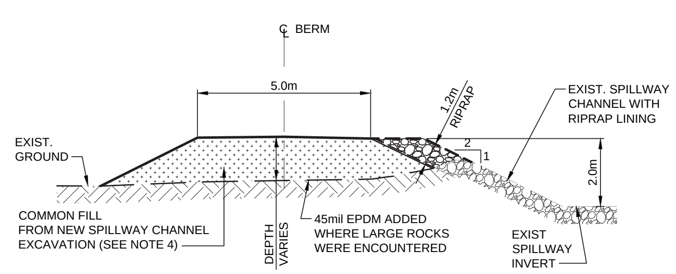
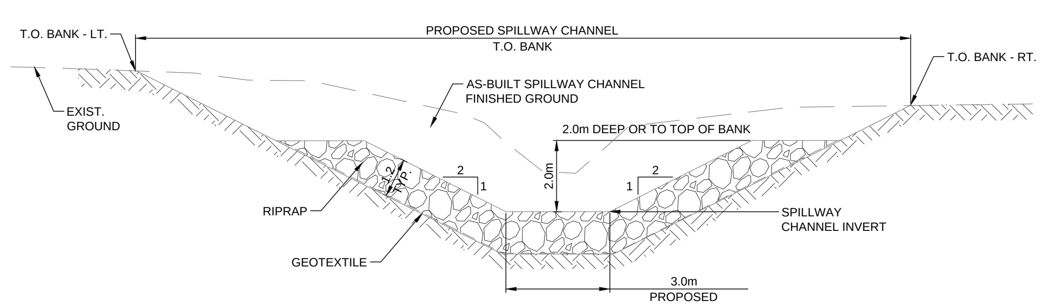


1 C-002 TYPICAL SECTION 1 - RAISE LEFT BANK OF EXISTING SPILLWAY CHANNEL (SEE NOTES 2, 3 AND 4)

SCALE: 1:100



2 C002 TYPICAL SECTION 2 - SPILLWAY CHANNEL WITH RIPRAP

SCALE: 1:100

LEGEND

- EXISTING CHANNEL INVERT - PROFILE VIEW
- EXIST. SPILLWAY CHANNEL - PLAN VIEW
- PROPOSED SPILLWAY INVERT PROFILE
- PROPOSED SPILLWAY T.O. BANK - LT
- PROPOSED SPILLWAY T.O. BANK- RT
- LEFT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- RIGHT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
- CONSTRUCTION ROAD SECTION TO BE REMOVED UPON COMPLETION
- LIMIT OF WORK AREA AND ARCHEOLOGICAL CLEARANCE

NOTES AND SPECIFICATIONS

1. PRIOR TO COMMENCING THE WORK, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL BY HVC OR ITS DESIGNATE SHOP DRAWINGS SHOWING LIMIT OF CLEARING, EXPECTED TRUCK ROUTE, AND STAGING AREA(S) WITHIN THE WORK LIMITS IDENTIFIED ON THE CONSTRUCTION DRAWINGS.
2. THE LIMIT OF CONSTRUCTION FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL IS ESTIMATED TO BE APPROXIMATELY 50m IN LENGTH. HVC WILL CONDUCT A SURVEY ALONG THE EXISTING SPILLWAY CHANNEL AND WILL PREPARE A SHOP DRAWING IDENTIFYING THE LIMIT OF THIS CONSTRUCTION AND APPROXIMATE HEIGHT OF FILL PLACEMENT ALONG THE ALIGNMENT.
3. THE EXCAVATED MATERIAL FROM THE SPILLWAY EXTENSION CAN BE USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL. THE CONTRACTOR SHALL ADVISE HVC OR ITS DESIGNATE AND OBTAIN APPROVAL IF ALTERNATIVE BORROW SOURCE OF THIS COMMON FILL MATERIAL IS EXPECTED.
4. COMMON FILL MATERIAL USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL SHALL BE PLACED IN LIFTS OF NO MORE THAN 300mm AND SHALL BE COMPACTED WITH A ROLLER TYPE OF COMPACTOR. EACH LIFT SHALL BE INSPECTED AND ACCEPTED BY THE HVC REPRESENTATIVE PRIOR TO PLACEMENT OF THE SUCCEEDING LIFT.
5. THE DESIGN SPILLWAY CHANNEL ALIGNMENT FOLLOWS THE EXISTING SPILLWAY CHANNEL ALIGNMENT. THIS ALIGNMENT MAY BE MODIFIED LOCALLY TO REDUCE SHARP TURNS AT THE DISCRETION OF THE CONTRACTOR.
6. THE CONTRACTOR MAY DISPOSE OF EXCESS EXCAVATION MATERIAL BY SPREADING AND GRADING IT WITHIN THE WORK LIMITS AS APPROVED BY HVC. ALTERNATIVELY, THE CONTRACTOR MAY DISPOSE OF THE EXCESS MATERIAL AT A LOCATION DESIGNATED BY HVC. DISPOSAL OF EXCESS MATERIAL WILL NOT BE MEASURED SEPERATELY FOR PAYMENT.
7. GEOTEXTILE MATERIAL SHALL BE NON-WOVEN AND SHALL HAVE A UNIT WEIGHT OF NO LESS THAN 540g/m².
8. THE RIPRAP MATERIAL TO BE INCORPORATED INTO WORK WILL BE SUPPLIED BY HVC FROM A SOURCE ON THE HVC SITE. THIS RIPRAP MATERIAL PROVIDED WILL CONFORM TO THE FOLLOWING APPROXIMATE GRADATION THROUGH VISUAL INSPECTION AND MEASUREMENT OF THE LARGEST ROCK SIZE.

RIPRAP MATERIAL

PERCENTAGE LESS BY WEIGHT (%)	WEIGHT (kg)	SIZE (mm)
100	750	810
70-90	500	710
40-55	250	570
0-15	25	260

NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE NOTED.

RECORD DRAWING

NO.	DESCRIPTION	NO.	DATE	DESCRIPTION
		5		
		4		
		3		
		2		
		0	2018 07/17	ISSUE FOR RECORD DRAWING
REFERENCE DRAWINGS		REVISIONS		

STAMP:

CLIENT: Highland Valley Copper Teck

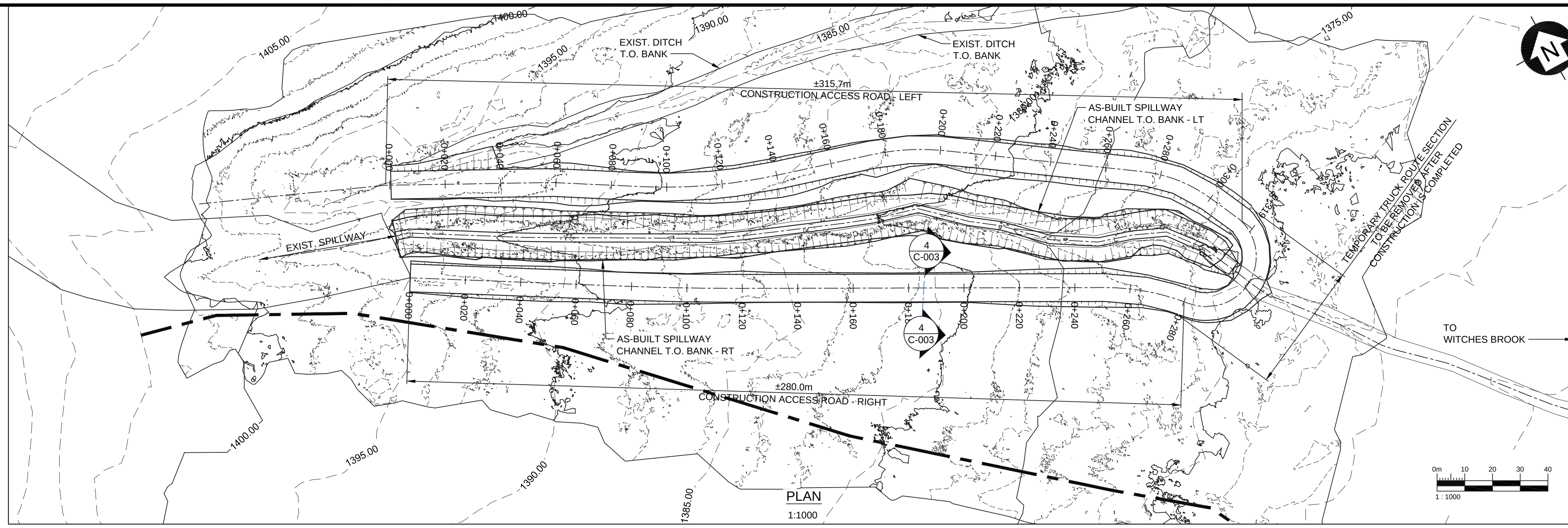
amec foster wheeler

DRAWN BY: DM/WM
DESIGNED BY: HX
CHECKED BY:
SCALE: AS SHOWN
DATE: 2016-11-24

PROJECT: TROJAN SPILLWAY EXTENSION

TITLE: RECORD DRAWING SPILLWAY CHANNEL PLAN - PROFILE AND SECTIONS

DATUM: MINE GRID
PROJECTION:
PROJECT NO.: TE154025
REV.: 0
DRAWING NO.: C-002



PLAN
1:1000

LEGEND

— — — —	EXISTING CHANNEL INVERT - PROFILE VIEW
▭	EXIST. SPILLWAY CHANNEL - PLAN VIEW
———	PROPOSED SPILLWAY INVERT PROFILE
— - —	PROPOSED SPILLWAY T.O. BANK - LT
— — —	PROPOSED SPILLWAY T.O. BANK- RT
— · — · —	LEFT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
— · —	RIGHT BANK CONSTRUCTION ACCESS ROAD CREST LOOKING DOWNSTREAM
▭ (dashed)	CONSTRUCTION ROAD SECTION TO BE REMOVED UPON COMPLETION
— · —	LIMIT OF WORK AREA AND ARCHEOLOGICAL CLEARANCE

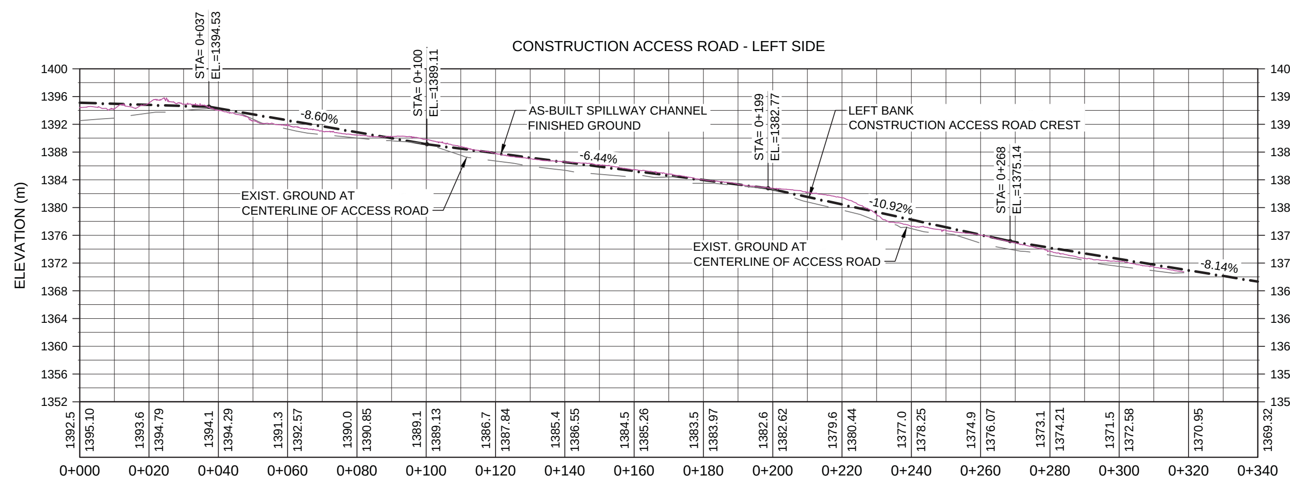
NOTES AND SPECIFICATIONS

1. PRIOR TO COMMENCING THE WORK, THE CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL BY HVC OR ITS DESIGNATE SHOP DRAWINGS SHOWING LIMIT OF CLEARING, EXPECTED TRUCK ROUTE, AND STAGING AREA(S) WITHIN THE WORK LIMITS IDENTIFIED ON THE CONSTRUCTION DRAWINGS.
2. THE LIMIT OF CONSTRUCTION FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL IS ESTIMATED TO BE APPROXIMATELY 50m IN LENGTH. HVC WILL CONDUCT A SURVEY ALONG THE EXISTING SPILLWAY CHANNEL AND WILL PREPARE A SHOP DRAWING IDENTIFYING THE LIMIT OF THIS CONSTRUCTION AND APPROXIMATE HEIGHT OF FILL PLACEMENT ALONG THE ALIGNMENT.
3. THE EXCAVATED MATERIAL FROM THE SPILLWAY EXTENSION CAN BE USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL. THE CONTRACTOR SHALL ADVISE HVC OR ITS DESIGNATE AND OBTAIN APPROVAL IF ALTERNATIVE BORROW SOURCE OF THIS COMMON FILL MATERIAL IS EXPECTED.
4. COMMON FILL MATERIAL USED FOR RAISING THE LEFT BANK OF THE EXISTING SPILLWAY CHANNEL SHALL BE PLACED IN LIFTS OF NO MORE THAN 300mm AND SHALL BE COMPACTED WITH A ROLLER TYPE OF COMPACTOR. EACH LIFT SHALL BE INSPECTED AND ACCEPTED BY THE HVC REPRESENTATIVE PRIOR TO PLACEMENT OF THE SUCCEEDING LIFT.
5. THE DESIGN SPILLWAY CHANNEL ALIGNMENT FOLLOWS THE EXISTING SPILLWAY CHANNEL ALIGNMENT. THIS ALIGNMENT MAY BE MODIFIED LOCALLY TO REDUCE SHARP TURNS AT THE DISCRETION OF THE CONTRACTOR.
6. THE CONTRACTOR MAY DISPOSE OF EXCESS EXCAVATION MATERIAL BY SPREADING AND GRADING IT WITHIN THE WORK LIMITS AS APPROVED BY HVC. ALTERNATIVELY, THE CONTRACTOR MAY DISPOSE OF THE EXCESS MATERIAL AT A LOCATION DESIGNATED BY HVC. DISPOSAL OF EXCESS MATERIAL WILL NOT BE MEASURED SEPERATELY FOR PAYMENT.
7. GEOTEXTILE MATERIAL SHALL BE NON-WOVEN AND SHALL HAVE A UNIT WEIGHT OF NO LESS THAN 540g/m².
8. THE RIPRAP MATERIAL TO BE INCORPORATED INTO WORK WILL BE SUPPLIED BY HVC FROM A SOURCE ON THE HVC SITE. THIS RIPRAP MATERIAL PROVIDED WILL CONFORM TO THE FOLLOWING APPROXIMATE GRADATION THROUGH VISUAL INSPECTION AND MEASUREMENT OF THE LARGEST ROCK SIZE.

RIPRAP MATERIAL

PERCENTAGE LESS BY WEIGHT (%)	WEIGHT (kg)	SIZE (mm)
100	750	810
70-90	500	710
40-55	250	570
0-15	25	260

CONSTRUCTION ACCESS ROAD - LEFT SIDE



SCALE: H=1:1000
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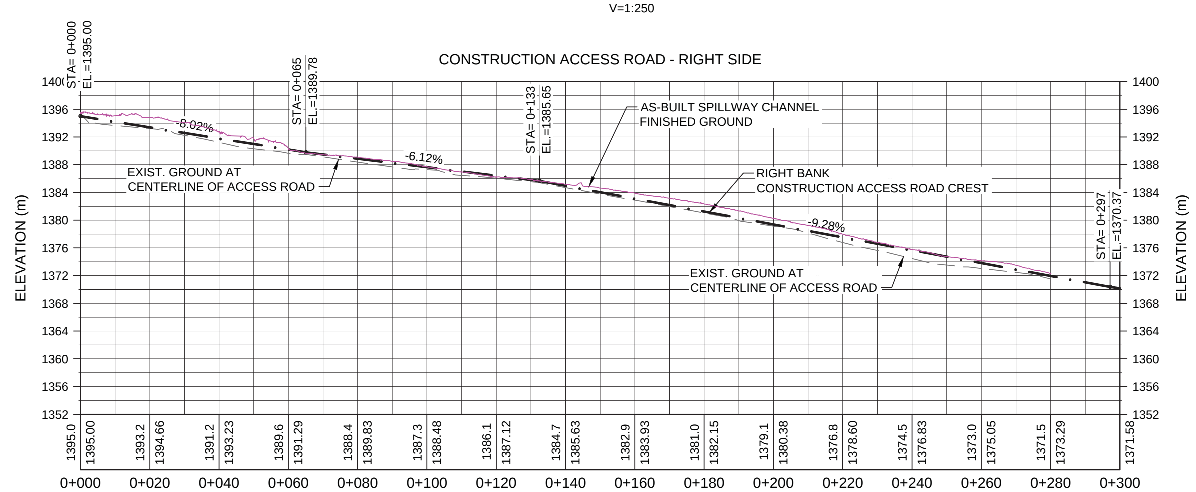
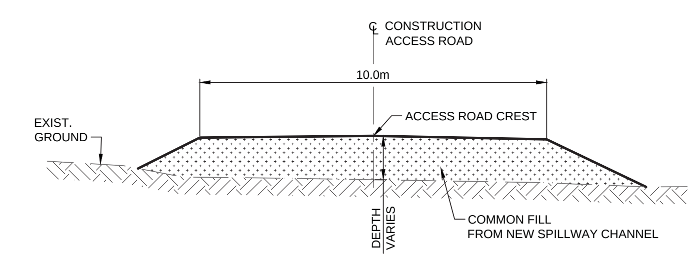
CONSTRUCTION ACCESS ROAD - RIGHT SIDE



SCALE: H=1:1000
V=1:250



4 C-003 TYPICAL 10m CONSTRUCTION ACCESS ROAD SECTION AT NEW SPILLWAY (RIGHT AND LEFT SIDES)

SCALE: 1:100

NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE NOTED.

RECORD DRAWING

NO.	DESCRIPTION

REFERENCE DRAWINGS

NO.	DATE	DESCRIPTION
5		
4		
3		
2		
0	2018 07/04	ISSUE FOR RECORD DRAWING

REVISIONS

STAMP:

CLIENT: Highland Valley Copper Teck

amec foster wheeler

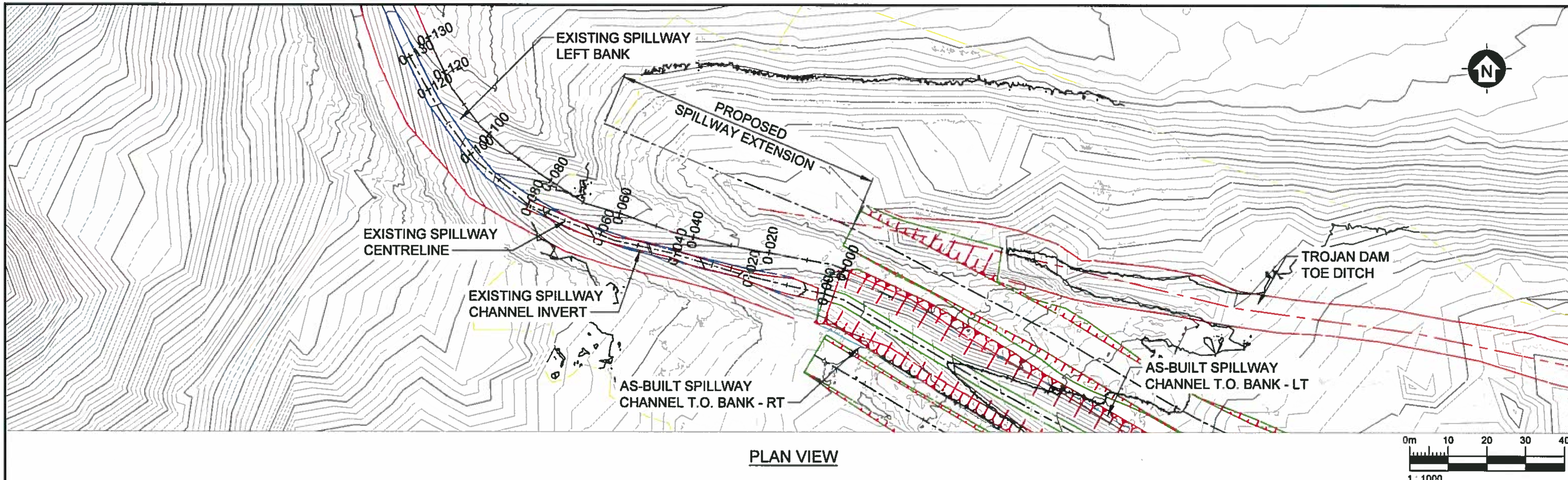
DRAWN BY:	DM/WM
DESIGNED BY:	HX
CHECKED BY :	
SCALE :	AS SHOWN
DATE :	2016-11-24

PROJECT: TROJAN SPILLWAY EXTENSION

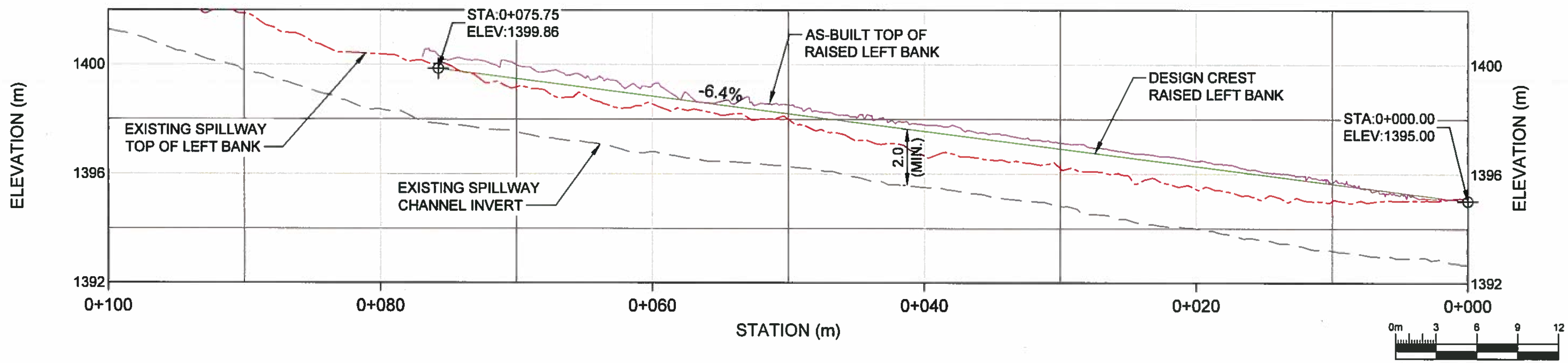
TITLE: RECORD DRAWING CONSTRUCTION ACCESS ROAD PLAN, PROFILES AND DETAIL

DATUM :	MINE GRID
PROJECTION :	
PROJECT NO. :	TE154025
REV. :	0
DRAWING NO. :	C-003

H:\PROJECTS\TE154025_Teck_HVC\DRAWINGS\154025 TECK SPILLWAY UPGRADES AS-BUILT 2018-05-15.dwg - 7/4/2018 2:12 PM - Messer, Wendell



PLAN VIEW



NOTES:

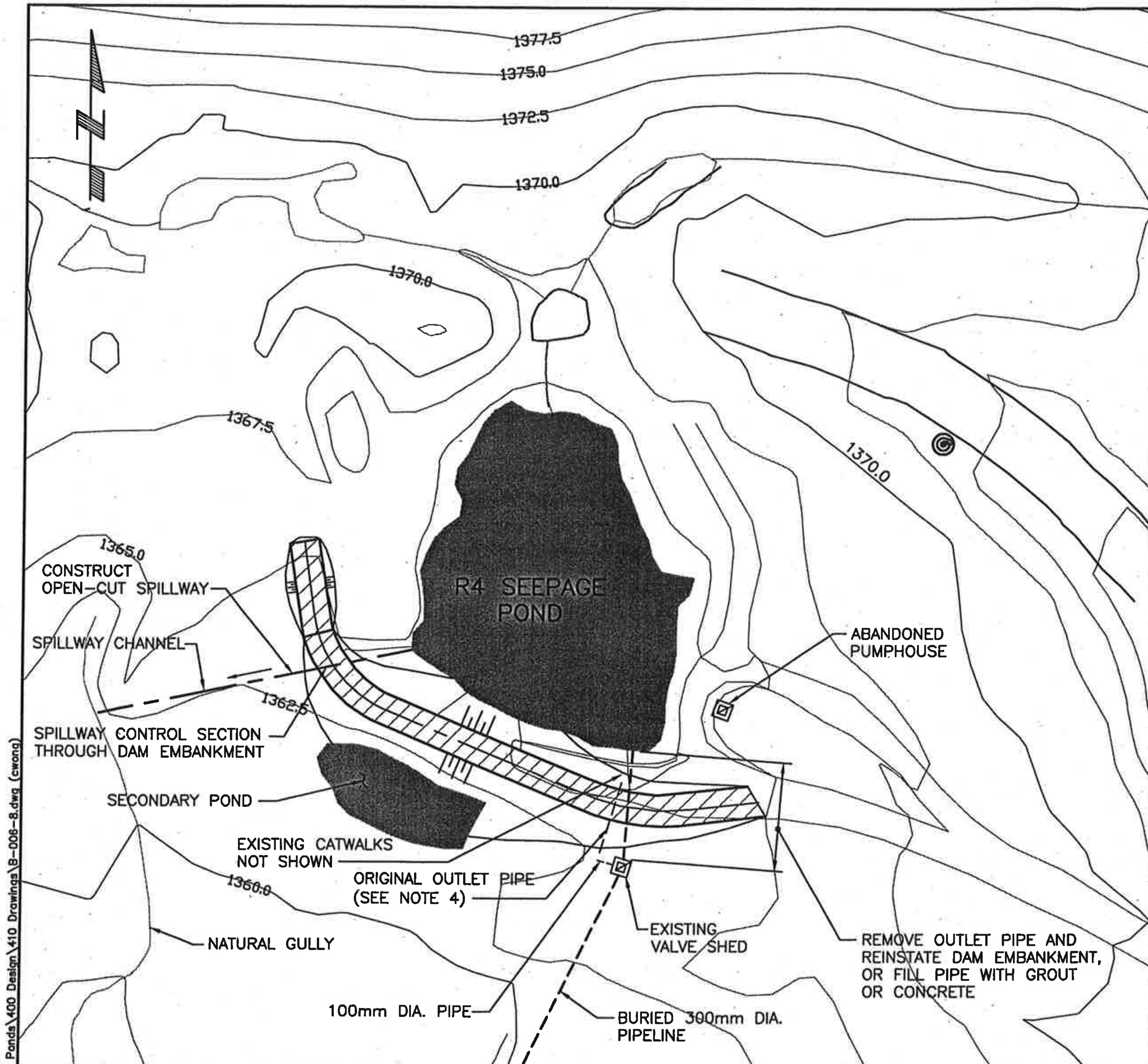
1. EXISTING FEATURES BASED ON COMPILATION OF 2014 LIDAR DATA, 2015 LIDAR DATA AND SURVEY DATA PROVIDED BY HVC.

CLIENT: Highland Valley Copper Teck	SCALE: AS SHOWN	PROJECT: TROJAN SPILLWAY EXTENSION	DWN BY: DM/WM; DSGN'D BY: HX; CHK'D BY: -; CHK'D BY (LEAD): -
amec foster wheeler	DATUM: MINE GRID	TITLE: RECORD DRAWING TROJAN SPILLWAY LEFT BANK RAISE	PROJECT NO: TE154025
	PROJECTION:		REV. DATE: 2018-07-04; REV. NO: 0
			FIGURE NO: FIG. 1

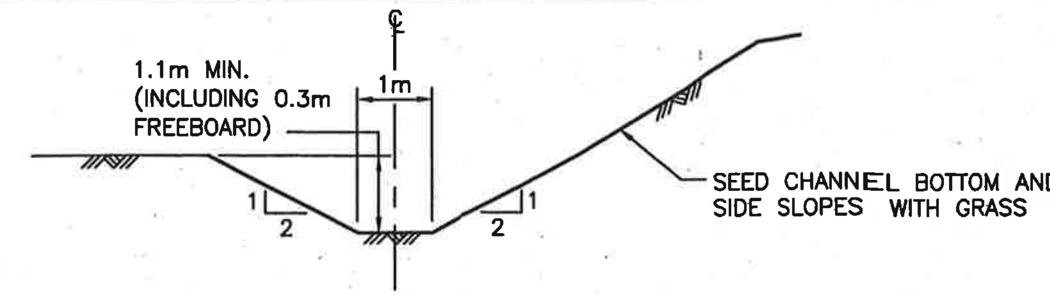
H:\PROJECTS\TE154025_Teck_HVC\DRAWINGS\154025 TECK SPILLWAY UPGRADES_FIG 1 AS-BUILT 2018-05-17.dwg - 1/23/2019 8:39 AM - Messer, Wendell

APPENDIX III-B-2

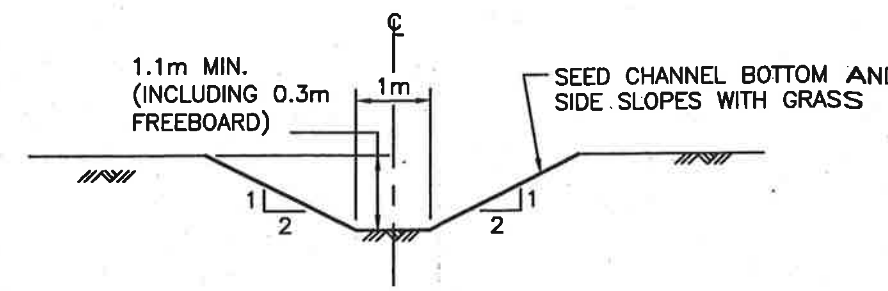
Reference Dam Design Drawings – R4 Seepage Pond Dam



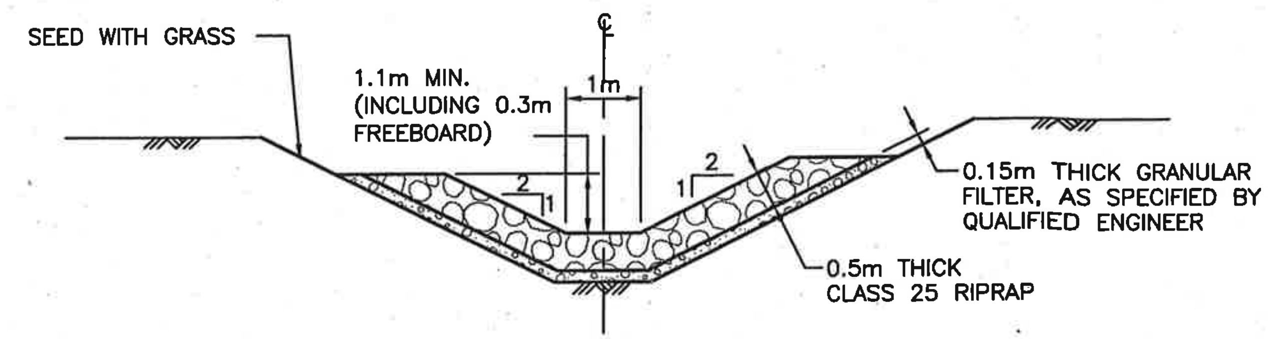
PLAN
SCALE A



SPILLWAY CONTROL SECTION THROUGH DAM
SCALE B



SPILLWAY CHANNEL SECTION FOR 0.5% OR FLATTER BED SLOPE
SCALE B



SPILLWAY CHANNEL SECTION FOR 0.6% TO 10% BED SLOPE
SCALE B

NOTES:

1. FOR LOCATION OF POND SEE FIG. B-001.
2. FOR RIPRAP GRADATION SEE FIG. B-006.
3. LOCATIONS OF BURIED PIPELINES ARE APPROXIMATE.
4. STATUS OF THE ORIGINAL OUTLET PIPE AND DECOMMISSIONING REQUIREMENTS, IF ANY, ARE TO BE DETERMINED.

SCALE B 0 — 5m

SCALE A 0 — 50m

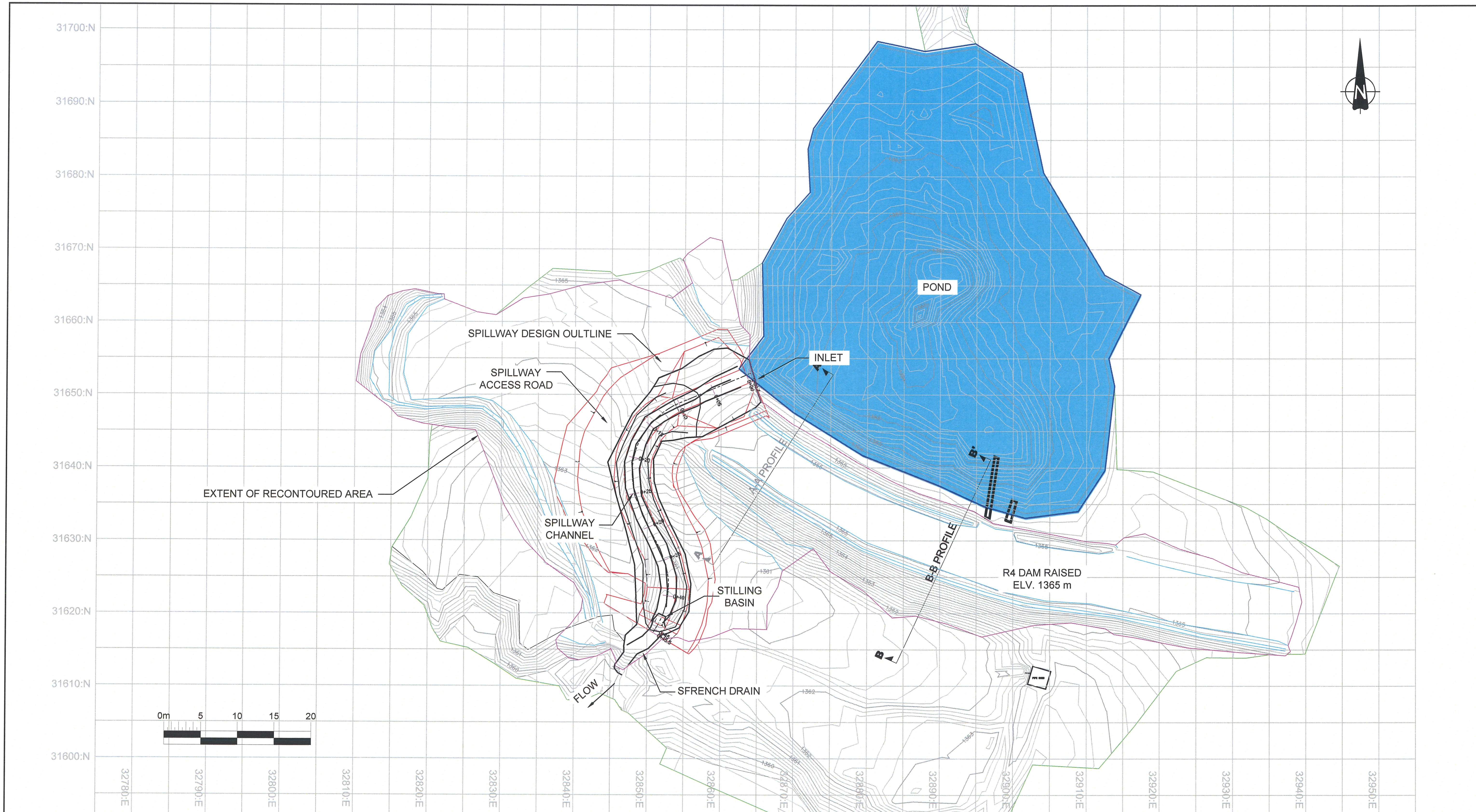
NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 10, 2005

CLIENT	HIGHLAND VALLEY COPPER
PROJECT	TROJAN CREEK PONDS
TITLE	R4 SEEPAGE POND PROPOSED DECOMMISSIONING WORK PLAN AND SECTIONS
PROJECT No.	M 02341 A3105
FIG. No.	B-007

KLOHN CRIPPEN

Time: 9:8:18
Date: 6/10/2005
Scale: 1=10(PS)
Drawing File: M:\M02341A3105 - Trojan Creek Ponds\400 Design\410 Drawings\B-006-8.dwg (cwong)



NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

CLIENT: Highland Valley Copper
Teck

AMEC Environment & Infrastructure
Suite 600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

amec

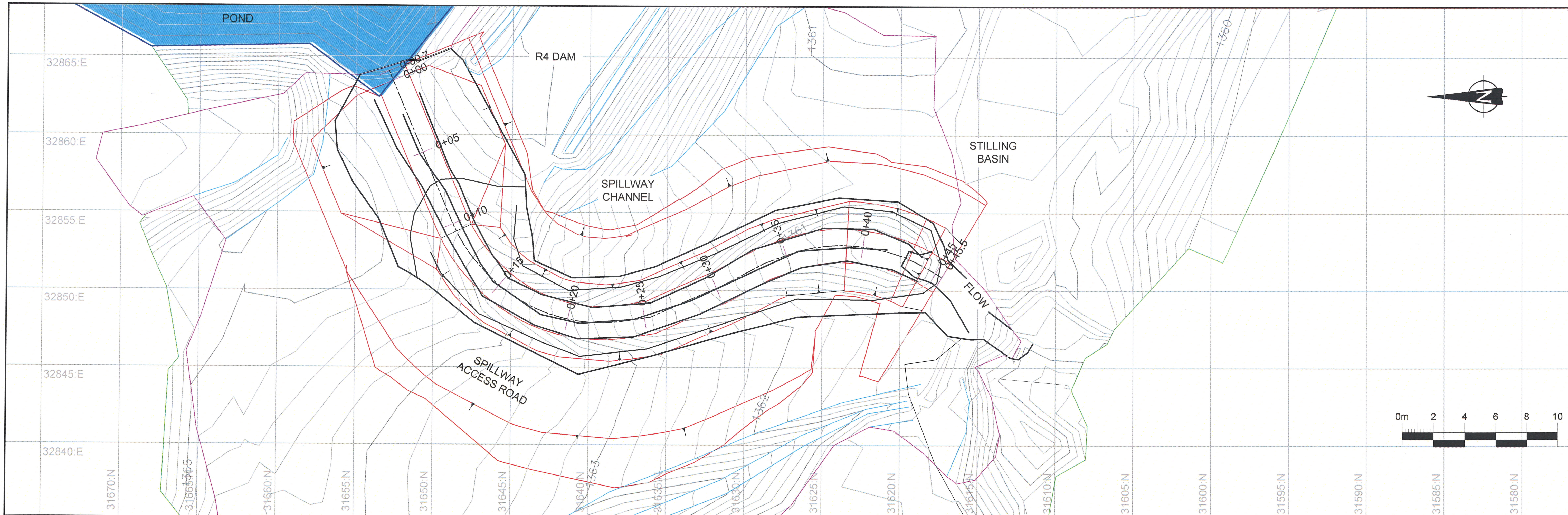
DWN BY:	YC/HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

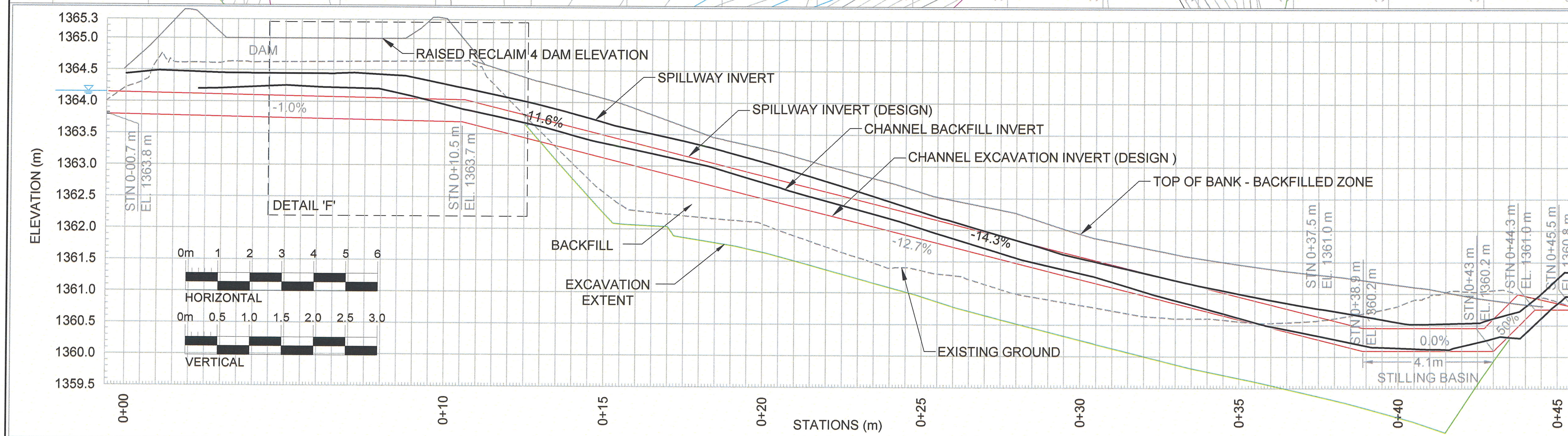
PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

TITLE: GENERAL LAYOUT

DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 2

W:\Projects\VW1035 – HVC R4 Spillway\Drawings\As-Built Drawings\FINAL\R4-Spillway-Figures-002-007 Oct. 2014.FINAL.dwg – AB-2 Plan – Nov. 26, 2014 4:32pm – hamid.yousefbeigi





Station (m)	Excavation Elevation (m)	X	Y
0+00.4	1364.3	32863.1	31652.5
0+05.0	1364.2	32858.9	31650.7
0+09.0	1364.2	32855.2	31649.2
0+10.0	1364.1	32854.2	31648.8
0+15.0	1363.4	32850.3	31645.8
0+20.0	1362.7	32848.1	31641.4
0+25.0	1362.0	32848.2	31636.4
0+30.0	1361.3	32850.1	31631.8
0+35.0	1360.6	32852.3	31627.3
0+38.9	1360.1	32852.9	31624.3
0+40.0	1360.1	32852.8	31622.4
0+43.0	1360.1	32852.3	31620.3
0+45.0	1360.9	32851.1	31617.7
0+45.5	1360.8	32850.9	31617.3

NOTE: FIELD MODIFIED DESIGN COORDINATES AND ELEVATION

NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

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Suite 600 - 4445 Lougheed Highway
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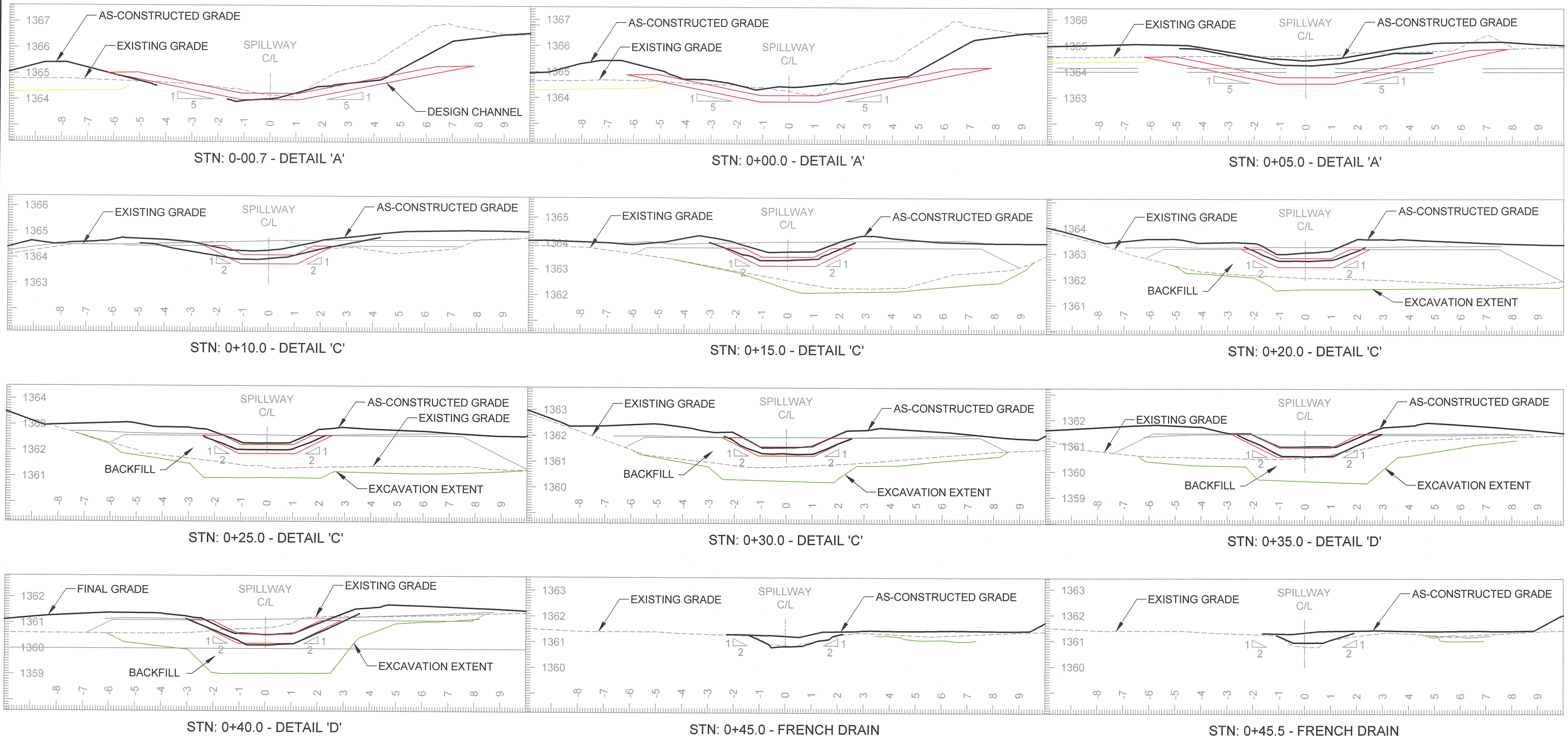
amec

DWN BY:	HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

TITLE: PLAN AND PROFILE

DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 3



SPILLWAY CROSS SECTIONS AT 5.0 m STATION INTERVALS

NOTE: CROSS SECTIONS CUT LOOKING DOWNSTREAM

NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

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Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

amec

DWN BY: HY
CHK'D BY: AF
DATUM: MINE
PROJECTION: MINE
SCALE: AS SHOWN

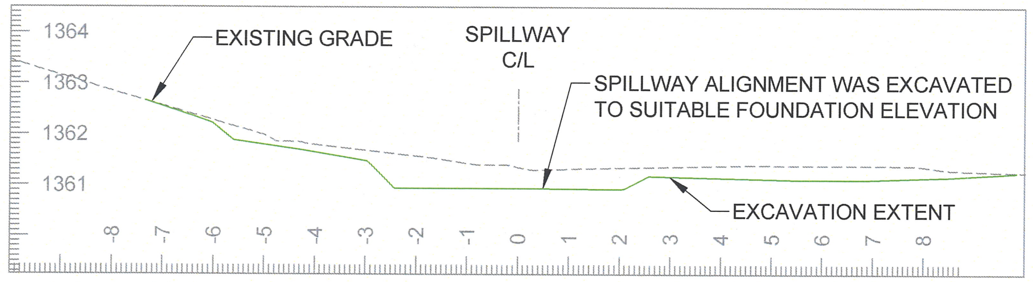
PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

TITLE: CROSS SECTIONS

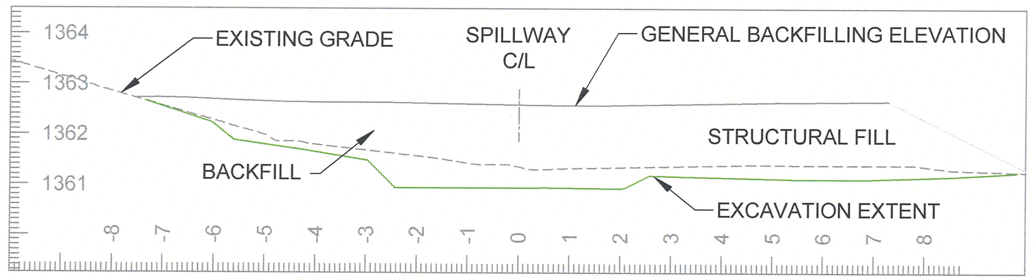
DATE: NOVEMBER 2014
PROJECT NO: VW1035
REV. NO: A
FIGURE NO: AB - 4

W:\Projects\VW1035 – HVC R4 Spillway\Drawings\As-Built Drawings\FINAL\R4-Spillway-Figures-002-007 Oct. 2014.FINAL.dwg – AB-4-Cross-Sections – Nov. 26, 2014 4:32pm – hamid.yousefbeigi

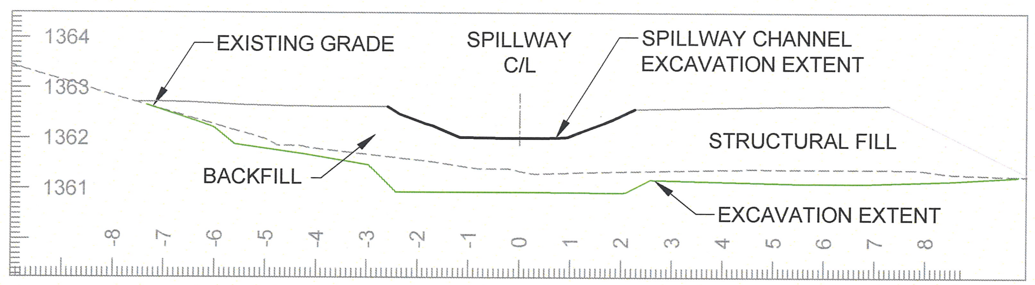
CONSTRUCTION SEQUENCING AND STAGING SHOWN AT STATION 0+25



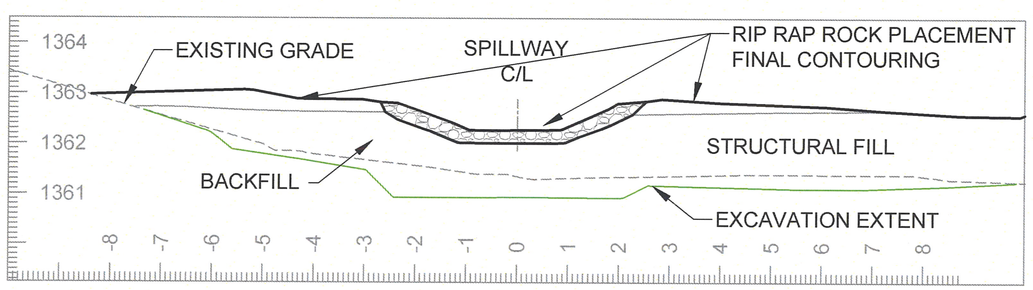
STAGE 1 - FOUNDATION EXCAVATION



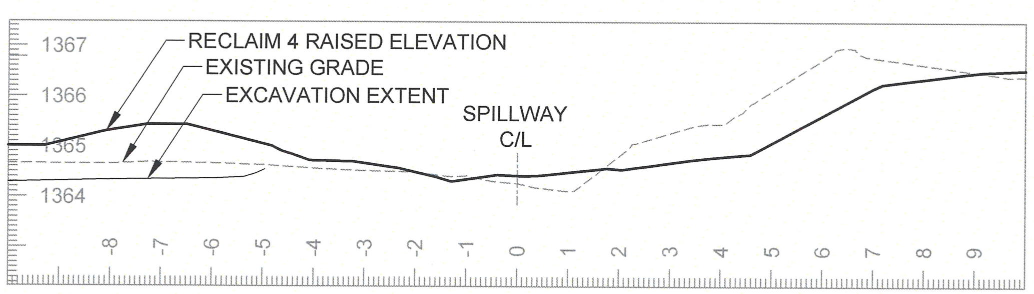
STAGE 2 - GENERAL BACKFILLING OF THE SPILLWYA AND ACCESS ROAD



STAGE 3 - SPILLWYA CHANNEL WAS EXCAVATED TO THE DESIGN ALIGNMENT

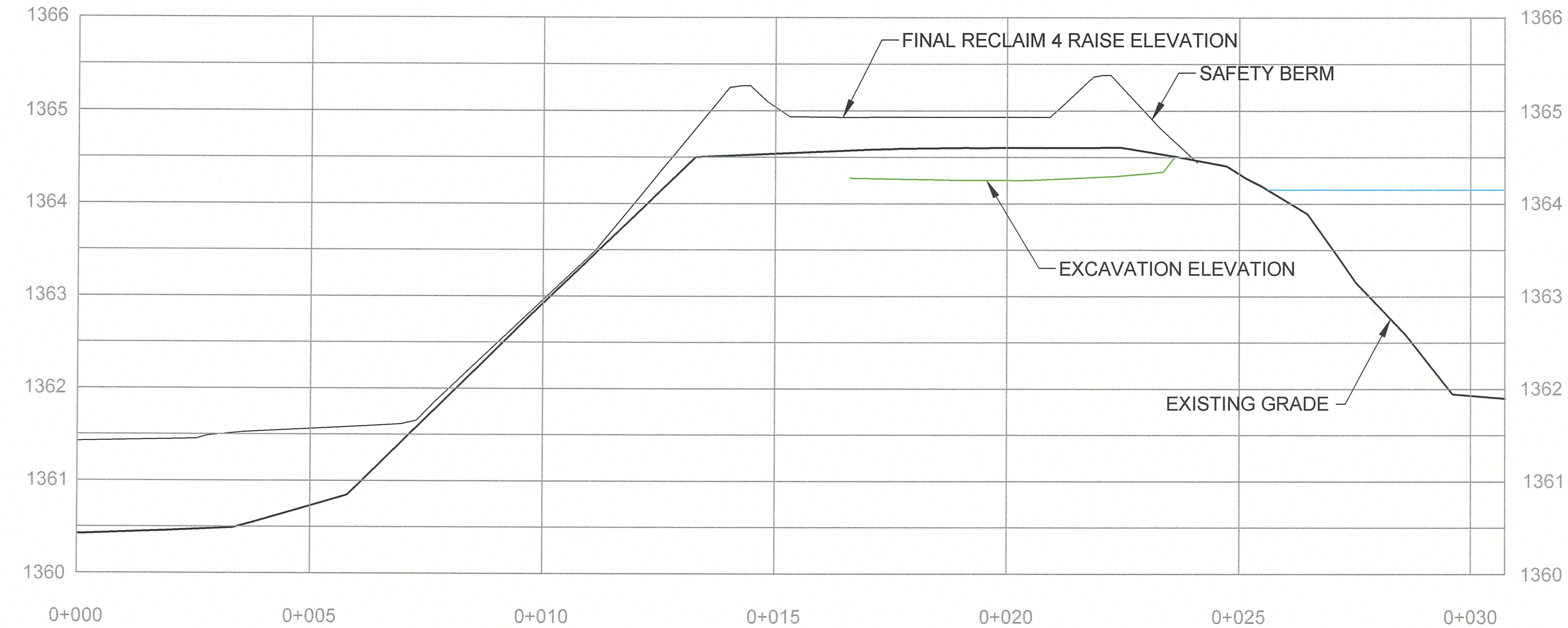


STAGE 4 - RIP RAP ROCK PLACEMENT IN THE CHANNEL AND CONTOURING

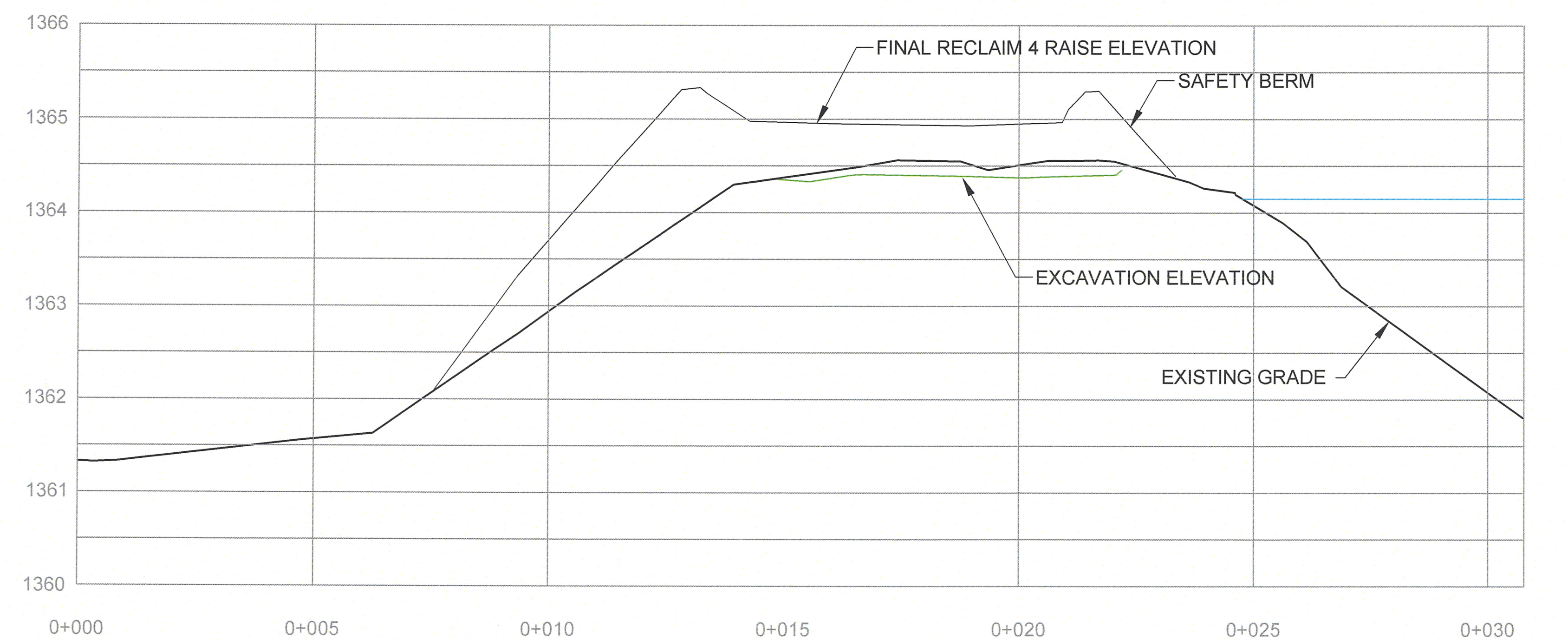


STN: 0+00.0 - DAM RAISE SECTION

A-A PROFILE



B-B SECTION



NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

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AMEC Environment & Infrastructure
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Burnaby, BC V5C 0E4
Tel. 604-294-3811 Fax 604-294-4664

amec

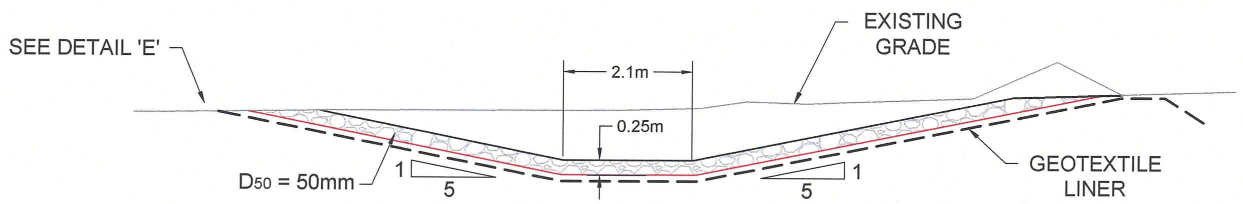
DWN BY:	HY
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN

PROJECT: SPILLWAY DESIGN - TROJAN RECLAIM DAM 4

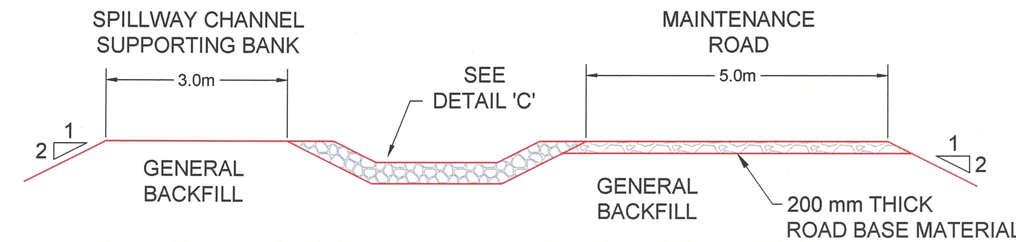
TITLE: DETAILS AND DETAIL SECTIONS

DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 5

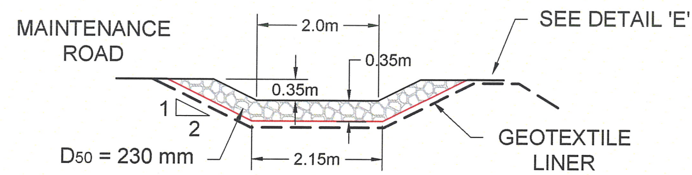
W:\Projects\VW1035 – HVC R4 Spillway\Drawings\As-Built Drawings\FINAL\R4-Spillway-Figures-002-007 Oct. 2014.FINAL.dwg – AB-5-Cross-Sections Dam – Nov. 26, 2014 4:32pm – hamid.yousefbeigi



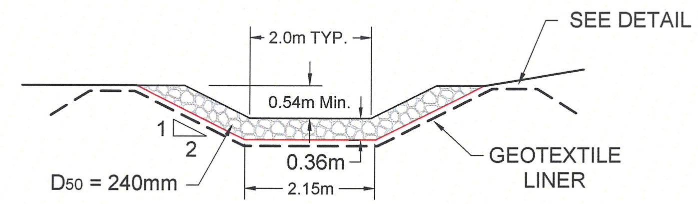
DETAIL 'A'
SECTION - SPILLWAY CHANNEL - 1% GRADE
STATION 0+05.0m



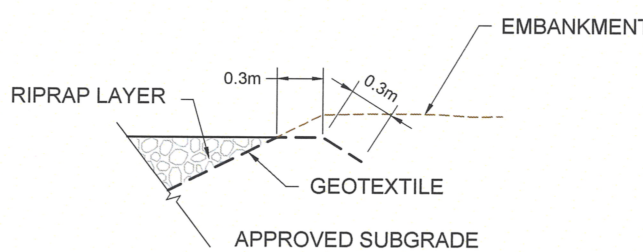
DETAIL 'B'
TYPICAL BACKFILL ZONE AND SPILLWAY CHANNEL
(LOOKING DOWNSTREAM)



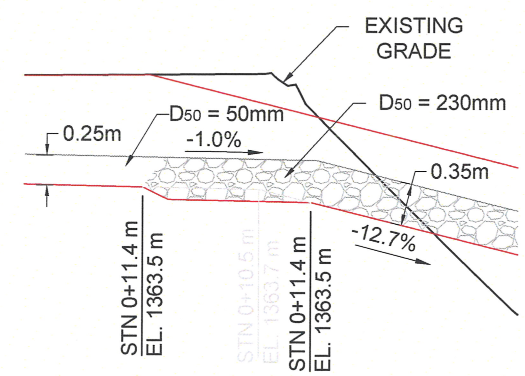
DETAIL 'C'
TYPICAL SECTION - SPILLWAY CHANNEL -12.7% GRADE



DETAIL 'D'
SECTION - STILLING BASIN
STATION 0+40.0m



DETAIL 'E'
TYPICAL SECTION - ANCHOR DETAIL
(NTS)



DETAIL 'F'
SLOPE TRANSITION
NTS

NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE LETTER (FILE No. VW1035) DATED NOVEMBER 2014.

RECORD DRAWINGS

CLIENT:	Highland Valley Copper Teck
AMEC Environment & Infrastructure Suite 600 - 4445 Lougheed Highway Burnaby, BC V5C 0E4 Tel. 604-294-3811 Fax 604-294-4664	amec
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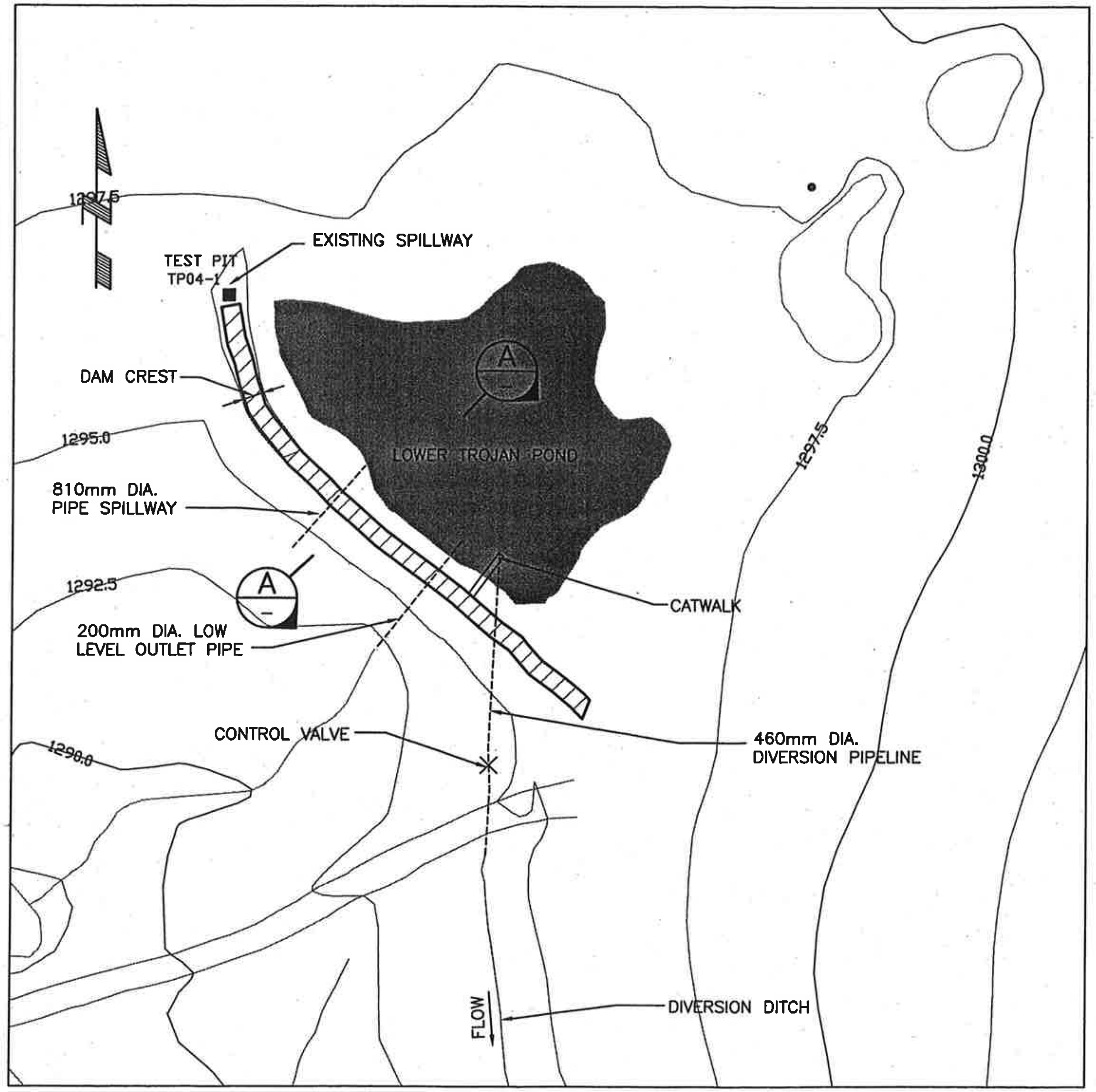
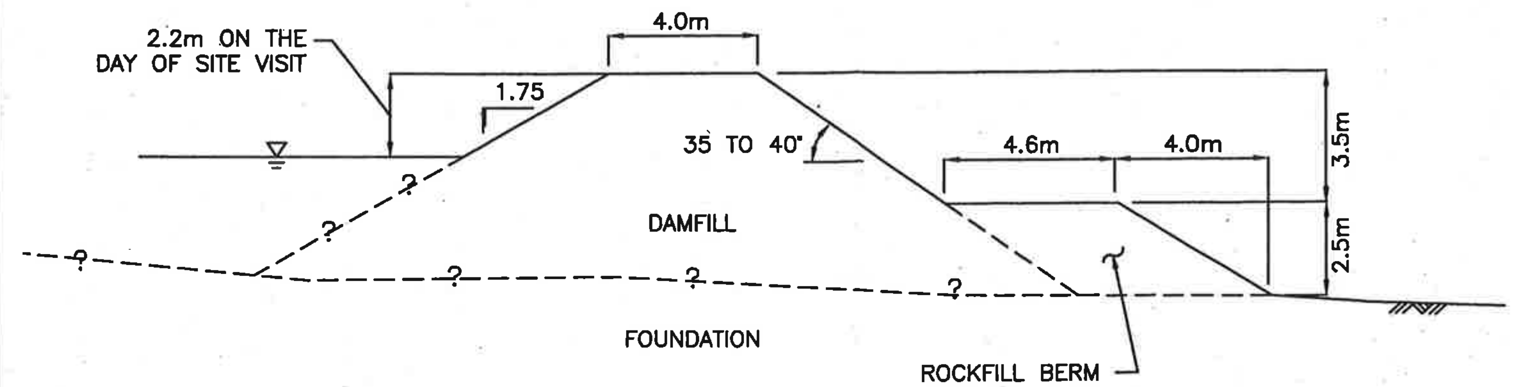
CHK'D BY:	AF
DATUM:	MINE
PROJECTION:	MINE
SCALE:	AS SHOWN
PROJECT:	SPILLWAY DESIGN - TROJAN RECLAIM DAM 4
TITLE:	DESIGN DETAILS AND SECTIONS
DATE:	NOVEMBER 2014
PROJECT NO:	VW1035
REV. NO:	A
FIGURE NO:	AB - 6

APPENDIX III-B-3

Reference Dam Design Drawings – Lower Trojan Dam



PLAN
SCALE A



LOWER TRAJAN POND DAM
APPROX. SECTION AT HIGHEST POINT IN DAM
(MEASURED 17 NOV/04)
SCALE B

NOTES:
1. FOR LOCATION OF POND SEE FIGURE B-001.
2. LOCATION OF BURIED PIPES ARE APPROXIMATE.

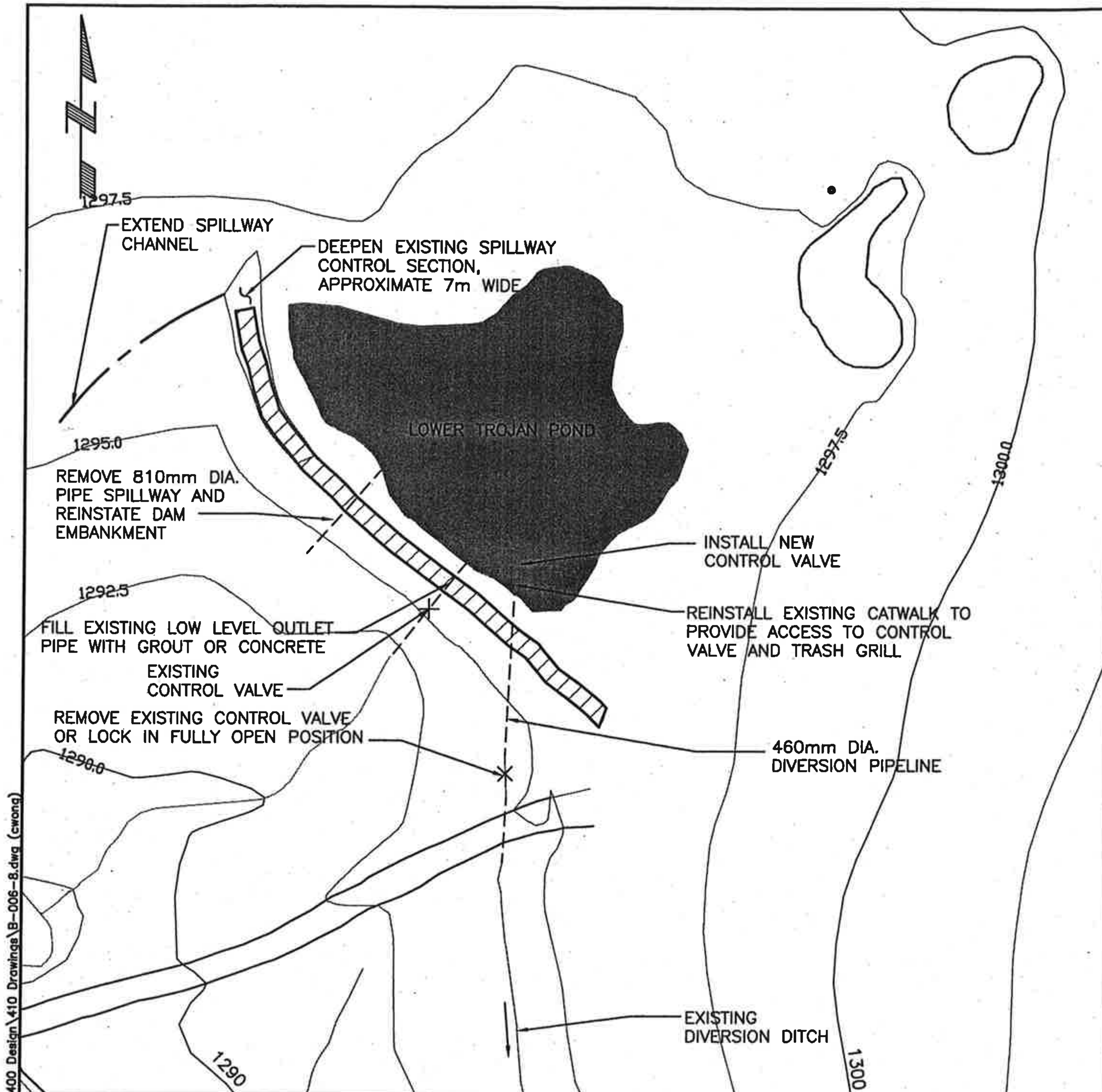
SCALE B 0 — 10m
SCALE A 0 — 50m

NOT FOR CONSTRUCTION
TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 10, 2005

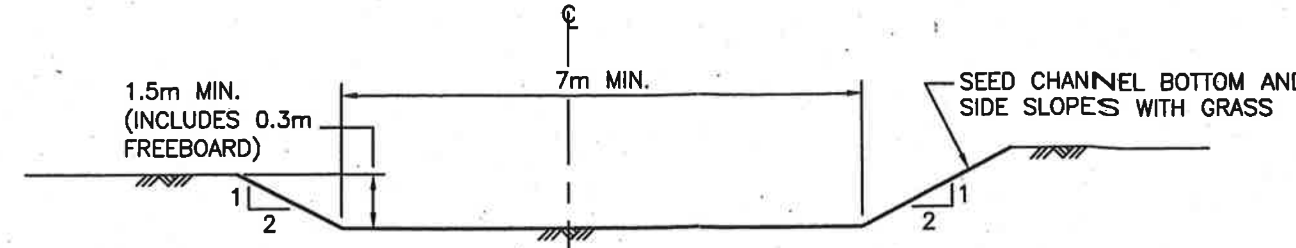
CLIENT	HIGHLAND VALLEY COPPER
PROJECT	TROJAN CREEK PONDS
TITLE	LOWER TROJAN POND PLAN AND DAM SECTION
PROJECT No.	M 02341 A3105
FIG. No.	B-004

KLOHN CRIPPEN

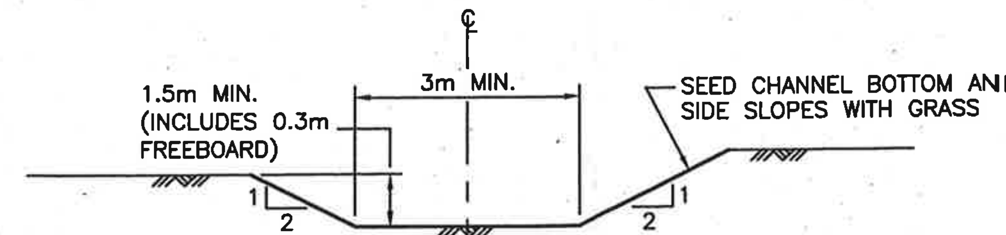
Time: 15:27:53
Date: 3/9/2005
Scale: 1=5(PS)
Drawing File: M:\M02341A3105 - Trojan Creek Ponds\400 Design\410 Drawings\B-001-5.dwg (cwong)
Xrefs: FIG-BASE



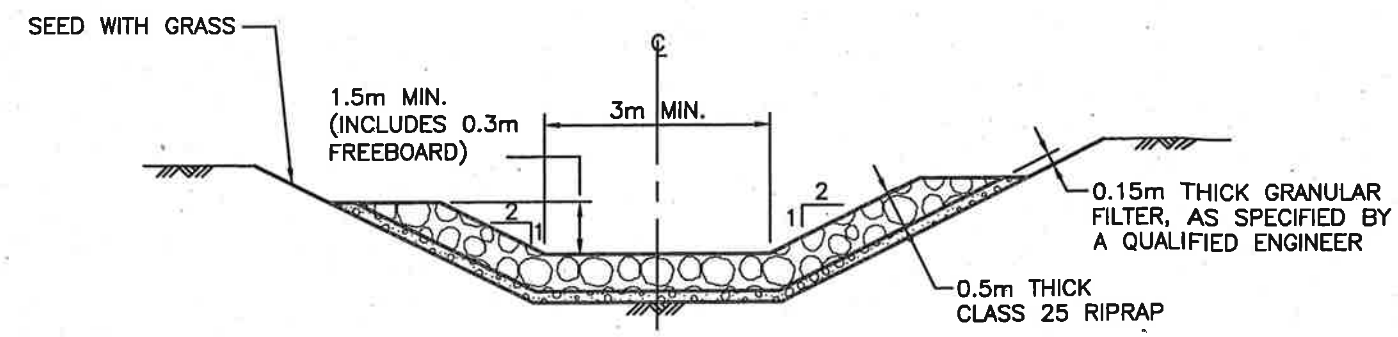
PLAN
SCALE A



SPILLWAY CONTROL SECTION
SCALE B



SPILLWAY CHANNEL SECTION DOWNSTREAM OF DAM
FOR 0.5% OR FLATTER BED SLOPE
SCALE B



SPILLWAY CHANNEL SECTION DOWNSTREAM OF DAM
FOR 0.6% TO 10% BED SLOPE
SCALE B

NOTES:

1. FOR LOCATION OF POND SEE FIG. B-001.
2. FOR RIPRAP GRADATION SEE FIG. B-006.
3. LOCATIONS OF BURIED PIPELINES ARE APPROXIMATE.

SCALE B 0 — 5m

SCALE A 0 — 50m

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 10, 2005

CLIENT: HIGHLAND VALLEY COPPER

KLOHN CRIPPEN

PROJECT: TROJAN CREEK PONDS

TITLE: LOWER TROJAN POND PROPOSED DECOMMISSIONING WORK PLAN AND SECTIONS

PROJECT No. M 02341 A3105

FIG. No. B-008

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Date: 6/10/2005
Scale: 1=10(PS)
Drawing File: M:\M02341A3105 - Trojan Creek Ponds\400 Design\410 Drawings\B-006-8.dwg (cwong)

APPENDIX IV

APPENDIX IV-A

Climate Data

Appendix IV-A
Climate Data

THVCP provided weather data from the L-L Dam climate station (El. 1186 m) which is the nearest climate station to the site but is at a lower elevation than Trojan TSF catchment (>El. 1477 m, i.e. dam crest). Climate data was adjusted for elevation, using the recommended adjustment factor from L-L Dam to Bethlehem and Trojan Area (El. 1400 m to 1570 m), from Golder (2016). To support key precipitation trends and impacts on observed dam performance, data from Kamloops Airport (Environment Canada Station No. 1163781, El. 345 m) was reviewed for comparison. Precipitation records from L-L Dam (adjusted) and Kamloops Airport between October 2018 and September 2019 are tabulated and plotted with average monthly values or climate normals in Table IV-A-1 and Figure IV-A-2, respectively. Normal precipitation data, reported in Table IV-A-1, is based on the Highland Valley Lornex climate station, adjusted for elevation to Bethlehem and Trojan Area using Golder (2016).

Seasonal snowpack depth is not measured at the L-L Dam weather station. Instead, monthly measurements at the Highland Valley snow survey station (Station No. 1C09A) near the Trojan TSF are used by THVCP to monitor snowpack. 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 2019 snowpack depths based on available records are summarized in Table IV-A-2.

The following observations were noted for 2019:

- January through April, precipitation measured at Trojan TSF was significantly less than historic normals (based on Highland Valley Lornex adjusted to Bethlehem and Trojan Area) which, along with reduced snowpack, contributed to a less sever freshet than recent years.
- June and July 2019 were noticeably wetter than normal.
- Snowpack depths were not measured in January and February 2019. Snowpack was significantly shallower than average in April and May 2019.

Table IV-A-1 Monthly Precipitation

Month	Precipitation (mm)			
	L-L Dam Weather Station Data Adjusted to Bethlehem and Trojan Area[(1)]	1976-2011 Highland Valley Lornex Normals Adjusted to Bethlehem and Trojan Area[(2)]	Kamloops Airport Weather Station[(3)]	1981-2010 Kamloops Airport Weather Station Normals[(4)]
Oct 2018[(5)]	21.3	33.3	27.5	19.4
Nov 2018[(5)]	23.4	44.8	33.5	23.3
Dec 2018[(5)]	15.6	45.3	20.2	25.4
Jan 2019	12.3	30.5	5.7	21.1
Feb 2019	18.0	23.3	13.8	12.4
Mar 2019	6.8	18.5	4.3	12.8
Apr 2019	16.8	23.6	11.5	14.2
May 2019	41.4	45.8	17.4	27.3
Jun 2019	95.7	53.2	21.2	37.4
Jul 2019	88.3	48.3	36.0	31.4
Aug 2019	11.6	35.2	16.7	23.7
Sep 2019	47.2	34.6	39.1	29.4
Annual Total	398.4	436.4	246.9	277.6

Notes:
1. Available data from L-L Dam climate station was adjusted by a L-L Dam-to-Bethlehem and Trojan adjustment factor of 1.05 (Golder 2016).
2. Estimated by Golder (2016) using appropriate adjustment factors and average precipitation measured at Highland Valley Lornex climate station (Environment Canada ID No. 1123469 at El. 1268 m).
3. 2019 data from Kamloops Airport station with ID No. 1163781. Kamloops Airport Climate Station was relocated 500 m in 2013 from station ID No. 1163780.
4. Climate normals from data collected at previous Kamloops Airport station location (ID No. 1163780).
5. October to December 2018 were reported in 2018 DSI and outside of 2019 DSI reporting period but are included for reference.

Figure IV-A-1 Monthly Precipitation

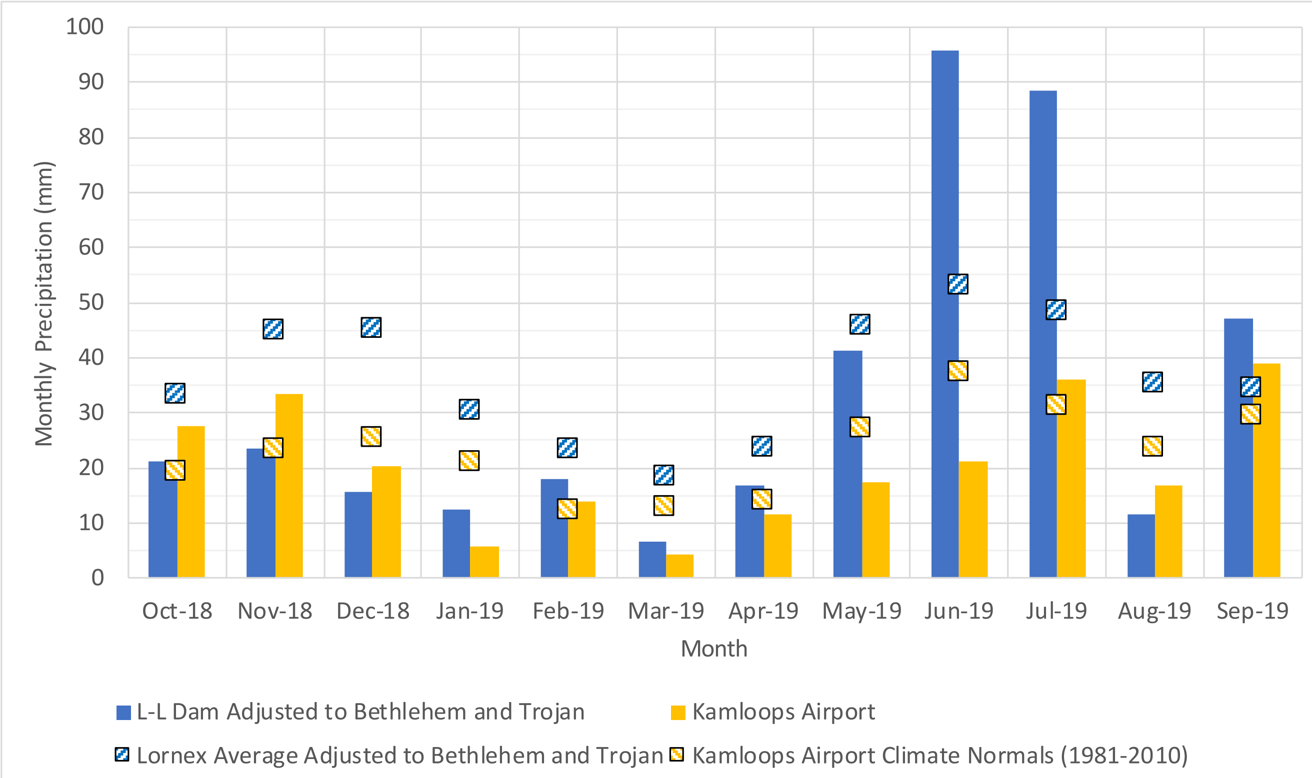


Table IV-A-2 Historical Average and 2019 Snowpack Depths

Survey Period	Years of Record(1)	Historic Average Snowpack Depth(2) (mm SWE(3))	2019 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	53	90.8	90	-1%
April 1st	52	100.8	54	-46%
May 1st	52	28.6	Trace	-100%
May 15th	25	2.4	Not surveyed (assumed to be 0)	-
June 1st	8	0.0	Not surveyed (assumed to be 0)	-

Notes:

1. At the Highland Valley snow survey station (Station No. 1C09A) near the Bethlehem TSF. Data prior to 1966 was not included as the station was moved to its current location in 1965.
2. Calculated based on available period on record. 2019 surveys were completed within 48-hours of the Survey Period date.
3. SWE = snow water equivalent.

APPENDIX IV-B

Instrumentation Summary and Plots

Appendix IV-B
Instrumentation Summary and Plots

IV-B-1 PIEZOMETERS

Historic piezometric readings are shown in Figure IV-B-1 to Figure IV-B-3. Key observations for readings up to end of October 2019, are:

- Functional piezometers were read monthly from April to September 2019 when the piezometers were safely accessible.
- In July 2019, 4 additional vibrating wire piezometers were installed within the tailings during the 2019 cone penetration testing (CPT) program. Initial readings of these instruments have been collected but are not reported in this DSI. Once a baseline of readings is available (~6 to 12 months), initial thresholds will be established. The pore pressure readings collected by the CPT agree with assumed conditions of an unsaturated cycloned sand beach during the dam and piezometric pressures agreed with nearby piezometers, where present.
- The piezometric levels at VW16-2A has shown a rising trend since installation in 2016; refer to Figure IV-B-3. This, however, is not considered a dam safety concern as the current piezometric levels are approximately 12 m below the phreatic surface considered in the design (design assumes piezometric level at ground surface at 1378 m) and is still below the elevation of other piezometers in the foundation beneath the crest.
- Piezometers within the tailings beach (between the pond and the dam crest) showed a continued downward trend from approximately 2014 (~0.5 m/yr to 0.75 m/yr). However, this trend reversed over the past 2 years and 2019 piezometric levels are similar to 2014 readings. The same general pattern is observed in pond level over this period which agrees with assumptions that pond level is primary controller of piezometric levels in the tailings under existing conditions.
- Instruments P95-4 is located about 40 m upstream of dam centreline and inferred to be installed in cycloned sand based on its tip elevation and design cross section from KC (1996). A sudden increase in water level was measured during the extended wet period in 2011. This response was not observed in other instruments. Between 2011 and 2015, piezometric level declined by approximately 8.5 m to El. 1411.5 m. In 2015, P95-4 was slug tested as indicated by the spike in Figure IV-B-2. Following that test, piezometric measurements showed a steady decrease, until 2019 when the piezometric level was relatively constant at El. 1407.5 m which is below the crest of the starter dam (El. 1414 m). Assuming the 2019 levels are representative for this location, there is no dam safety concern as the current level is below the piezometric level assumed in design.

- Piezometers installed in the glacial till and sand and gravel fill zones of the starter dam at the upstream toe close to low point of the valley (TB-PS-04/P13-3 and TB-PS-03/P13-4) measure low piezometric heads. This supports the assumed downward gradient into the foundation. There was one piezometric threshold exceedances in 2019 (i.e. measured reading was higher than maximum value for closure condition): May 2019 reading for TB-PS-03/P13-4 was 0.13 m above threshold. These thresholds are just intended to identify change from normal patterns and not a tailings dam safety concern.

Thresholds for piezometers were updated and reported in the 2016 DSI (KCB 2017a). The thresholds were set at 0.5 m above the maximum elevation head to identify any deviations from established trends. Questionable readings (e.g., where there was a spike that has not been repeated) were not used when defining thresholds. 2019 maximum and minimum water levels and Notification Level (NL) thresholds were reviewed as part of 2019 DSI (Refer to Table IV-B-1). One threshold value revision is proposed for 2020 (Refer to Table IV-B-1). The NL thresholds are equivalent to Notification Level (threshold levels, and response if exceeded) similar to the dam safety threshold terminology adopted at the Highland TSF.

Table IV-B-1 2019 Piezometric Levels and 2020 Thresholds

Instrument ID	Foundation Unit	2019 Piezometric Levels (m)		Proposed 2020 Threshold Value (m)[(1)]
		Maximum	Minimum	
P86-7	Sandfill	p/d	p/d	n/a
P95-3	n/a	p/d	p/d	n/a
P95-4	Sandfill	n/a	n/a	Note 2
P85-1A	Foundation	1397.8	1396.8	1399.2
TB-PS-02/P13-1	Cycloned Sand	1421.9	1420.6	1423.4
TB-PS-01/P13-2	Cycloned Sand	1417.7	1417.1	1418.6
TB-PS-04/P13-3	Sand and Gravel	1383.9	1383.6	1385.4
TB-PS-03/P13-4	Glacial Till	1389.3[(3)]	1389.3	***1390.5***
P86-1	Sandfill	p/d	p/d	1408.2
VW16-2A	Glacial Sediments / Debris	1366.1	1365.8	1367.2
VW16-2B	Glacial Till	1379.4	1379.2	1379.9

Notes:
1. ***Bold Italics*** indicate revised threshold for 2020.
2. Piezometric level continues trending downward since 2015 falling head test; no threshold set until water level reaches steady state.
3. Maximum piezometric level at TB-PS-04/P13-4 in 2019 was 1389.8 m (recorded in May which is exceeding 2019 NL), but the value appears to be a likely error in data entry.

Based on the review of the available instrumentation data, the current suite of instruments is sufficient for the Trojan TSF. No follow up actions regarding any of the instrumentation is recommended.

IV-B-2 SURVEY MONUMENTS

Monument surveys, horizontal displacement and settlement (vertical displacement) are plotted on Figure IV-B-4. The incremental change between November 2018 and October 2019 surveys, and the change from initial surveys, are summarized in Table IV-B-2. Consistent with recent years, in 2019:

- There were no horizontal or vertical displacement threshold exceedances.
- The surveys do not indicate trend of significant movements in the downstream direction or significant crest settlement which is consistent with previous years; refer to Table IV-B-2.

THVCP surveys since 2014 use a total station with an estimated accuracy of 10 mm to 25 mm for horizontal measurements, and a digital level with an estimated accuracy of 10 mm for vertical measurements.

Table IV-B-2 2019 Survey Monument Incremental Displacement Summary

Monument	Incremental[1]		Change from Initial Survey	
	Vector Horizontal Displacement (mm)	Vertical Displacement (mm)	Vector Horizontal Displacement(1) (mm)	Vertical Displacement(2) (mm)
TD-1	11, upstream	-2.0	12.0, upstream	-8..4
TD-2A	17.2, upstream	-1.4	13.0, parallel to dam centreline	-9.2
TD-3	9.5, upstream	-3.4	3.9, downstream	-78.2
TD-4	8.2, upstream	-2.6	14.3, downstream	-79.0
TD-5	8.1, upstream	-1.3	11.3, upstream	-50.2
TD-6	9.1, upstream	-1.7	11.2, parallel to dam centreline	-30.2

Notes:
1. October 2019 survey compared to November 2018 survey.
2. Earliest historic reading is 2014 for TD-2A, all other monuments earliest historic readings are in 1998. Cumulative displacements are calculated as difference from October 2019 survey and earliest historical reading.

Movement thresholds (horizontal and settlement) have been established for the survey monuments; refer to Table IV-B-3. The thresholds were set based on the following criteria:

- Horizontal vector displacement threshold was set at 80 mm from the original location, based on the typical scatter in the available data which is most likely related to a survey or datum issue rather than movements.
- Incremental settlement between readings was set at 20 mm based on a review of the typical variation between readings (regardless of period between readings).
- Total settlement was set 50 mm greater than the most recent reading, based on the observed settlement trends.

Table IV-B-3 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

Notes:
1. No change recommended t 2019 threshold values for 2020.

IV-B-3 INCLINOMETERS

The single inclinometer at Trojan Dam (IB16-2) which was installed in 2016, is to be read monthly, when accessible, as defined in the 2018 OMS manual.

Cumulative displacements measured at IB16-2 are plotted on Figure IV-B-5. Based on the readings, there have been no significant movements in the downstream direction and no discrete zones of movement observed to date.

There is no construction at or significant change to the existing condition of the facility planned. Therefore, the development of significant movements in the foundation at this time are not expected. Based on measurements to date, KCB proposes the following thresholds for ongoing monitoring:

- Notification Level: 1 mm/month over any 3 m vertical section.

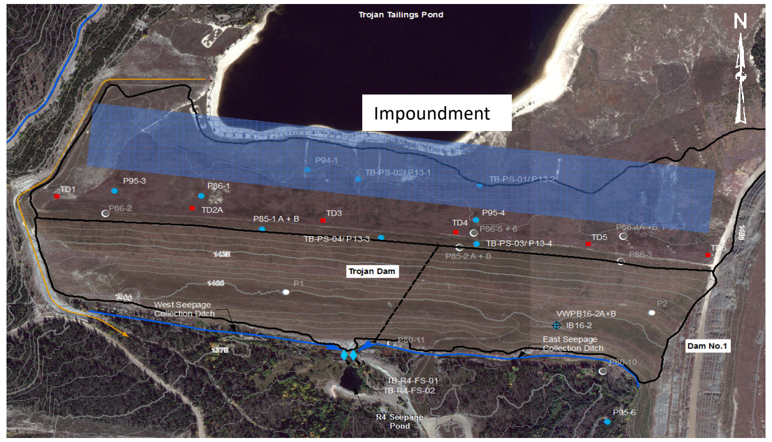
IV-B-4 SEEPAGE

Seepage is recorded, typically between April and November when accessible, on a monthly basis from two weirs located at R4 Seepage Pond, and two weirs located at Lower Trojan Pond. For this DSI, data up to end of September 2019 were reviewed. 2019 readings were taken in January, and monthly between April and September. This is consistent with the requirements in the 2018 OMS manual.

Weir TB-R4-FS-01 is a 60° V-notch weir installed on the west toe drain. Weir TB-R4-FS-02 is a 90° V-notch weir installed on the east toe drain. Weir flows from 2008 to September 2019 are plotted on Figure IV-B-6. 2019 seepage flows are generally consistent with historical trends.

Weirs TB-LT-FS-01 and TB-LT-FS-02 are located downstream and upstream, respectively, of Lower Trojan Pond. Weir flows from the available data record, 2016 to 2019, are plotted on Figure IV-B-7. The TB-LT-FS-01 weir readings from early July 2019 correlate with the significant precipitation reported in June and July 2019 (refer Appendix IV-A).

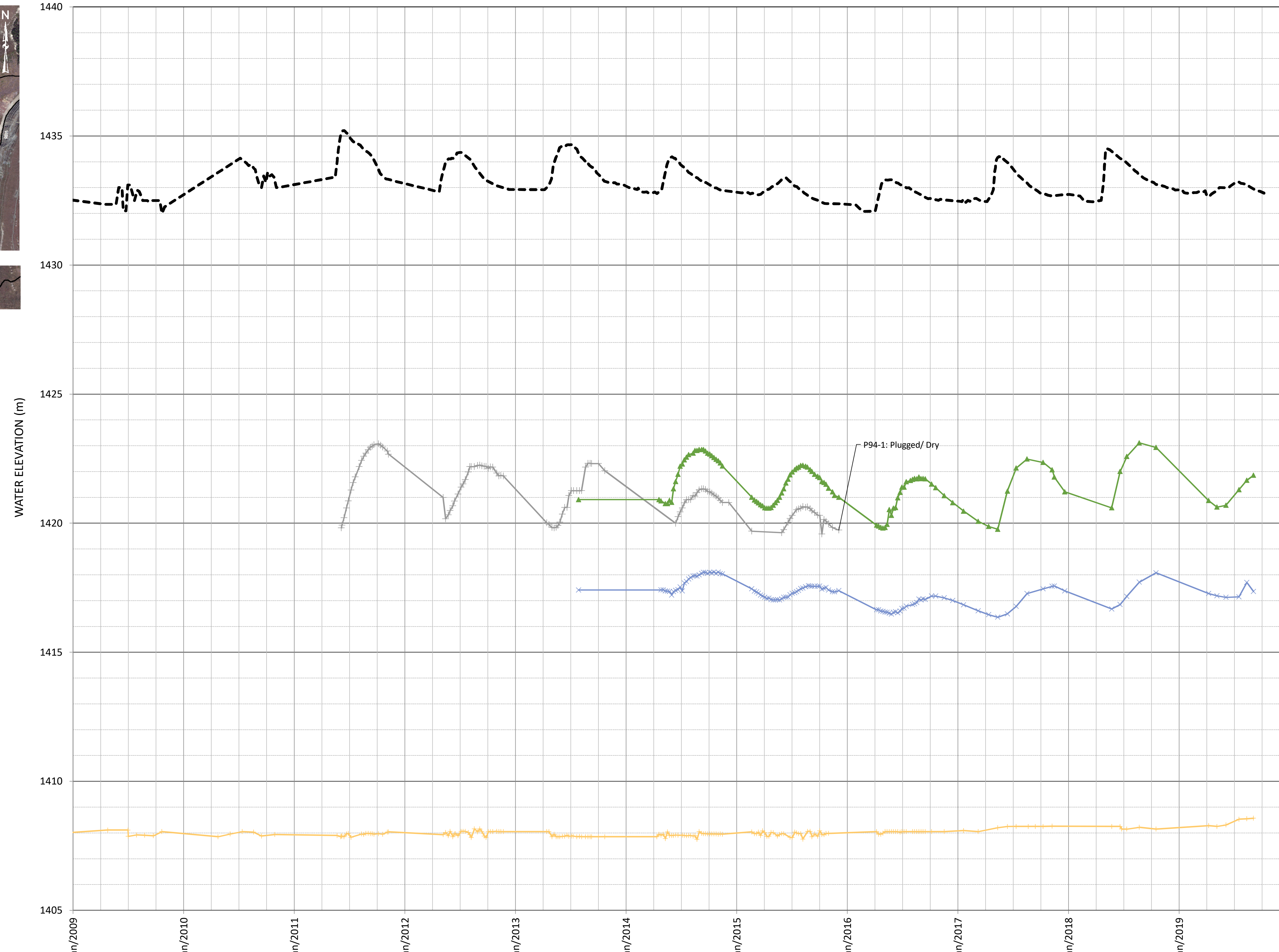
FIGURES



LEGEND:

- P94-1 (Tip El. unknkown m, Sandfill)
- TB-PS-02/P13-1 (Tip El. 1409.5 m, Cycloned Sand)
- TB-PS-01/P13-2 (Tip El. 1413 m, Cycloned Sand)
- P86-1 (Tip El. 1407.65 m, Sandfill)
- Trojan Pond Level

PIEZOMETER ID	2019 THRESHOLD EL. (m)
TB-PS-02/P13-1	1423.4
TB-PS-01/P13-2	1418.6



CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

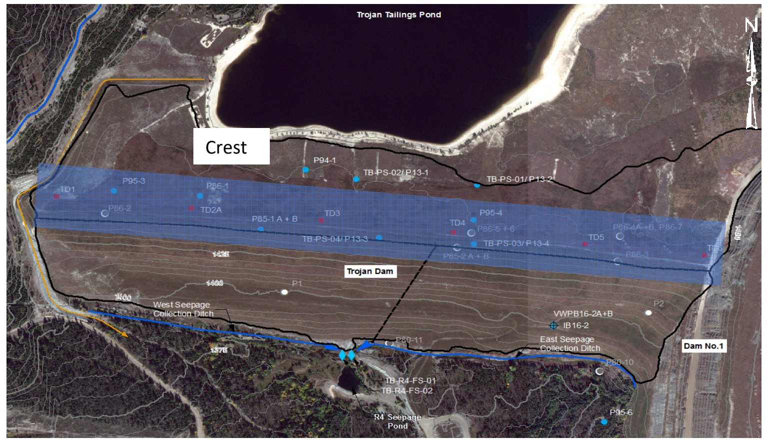
TITLE: TROJAN DAM PIEZOMETRIC DATA
2009-2019

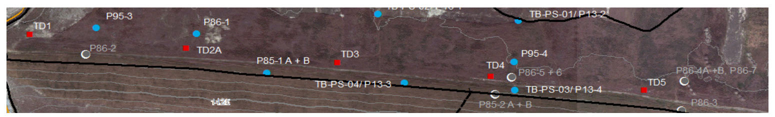
IMPOUNDMENT

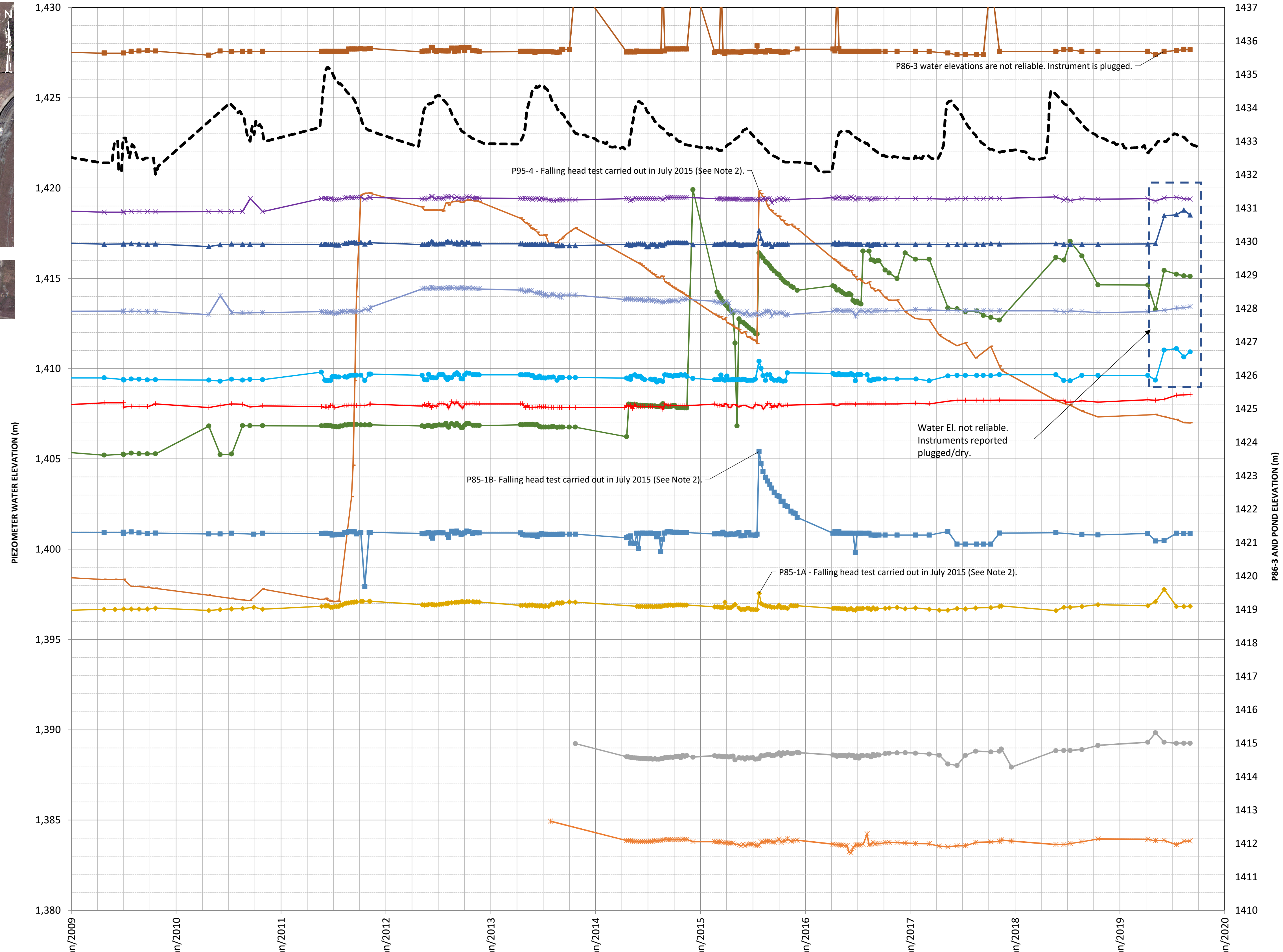
PROJECT No. M02341B53

FIG No. IV-B-1

January 30, 2020
Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\300 Design\330 Piezometer Data\Trojan\200130a Trojan Piezo.xlsx|IV-B-3 DOWNSTREAM SLOPE







LEGEND:

- P85-2A (Tip El. 1374.19 m, Foundation)
- P95-4 (Tip El. 1389.09 m, Unknown)
- 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, Till)
- P86-7 (Tip El. 1416.07 m, Sandfill)
- P86-4B (Tip El. 1391.99 m, Foundation)
- P86-4A (Tip El. 1393.72 m, Sandfill)
- P95-3 (Tip El. 1412.7 m, Foundation)
- P86-1 (Tip El. 1407.65 m, Sandfill)
- P86-3 (Tip El. 1395.83 m, Sandfill)
- Trojan Pond Level

PIEZOMETER ID	2019 THRESHOLD EL. (m)
P85-1A	1399.2
P86-1	1408.2
P86-7	1419.8
P95-3	1415.0
TB-PS-04/P13-3	1385.4
TB-PS-03/P13-4	1389.7

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

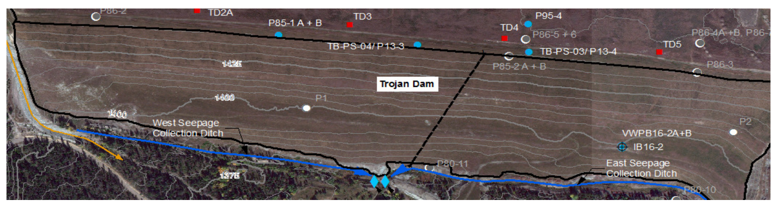
PROJECT: TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION

TITLE: TROJAN DAM PIEZOMETRIC DATA 2009-2019

CREST

PROJECT No. M02341B53 | FIG No. IV-B-2

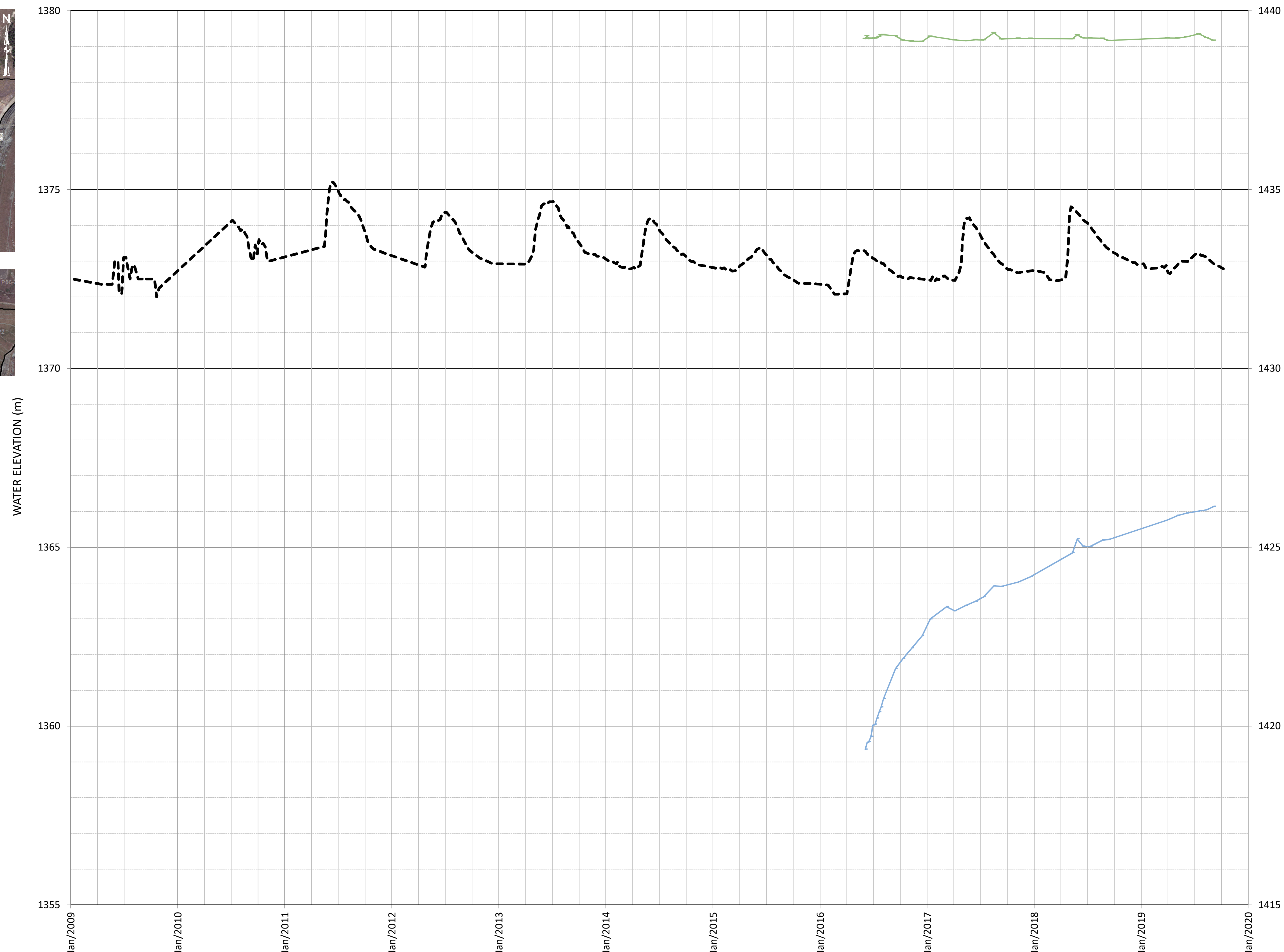
January 30, 2020
Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\300 Design\330 Piezometer Data\Trojan\200130a Trojan Piezo.xlsx|IV-B-3 DOWNSTREAM SLOPE



LEDGEND:

- VW16-2A (Tip El. 1321.85 m, Glacial Sediments / Debris)
- VW16-2B (Tip El. 1373.35 m, Glacial Till)
- Trojan Pond Level

PIEZOMETER ID	2019 THRESHOLD EL. (m)
VW16-2A	1367.2
VW16-2B	1379.9



NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.

CLIENT: Highland Valley Copper / Teck

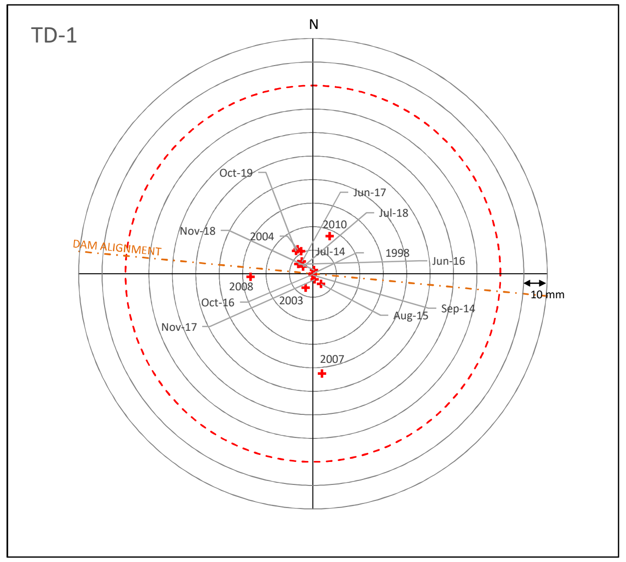
Klohn Crippen Berger

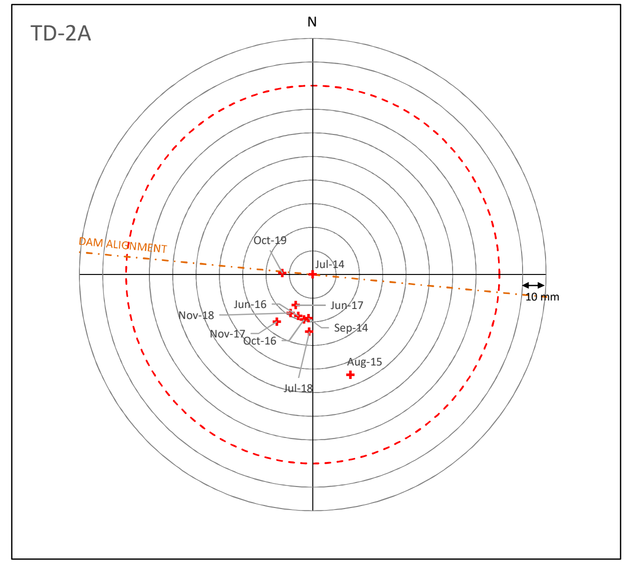
PROJECT: TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION

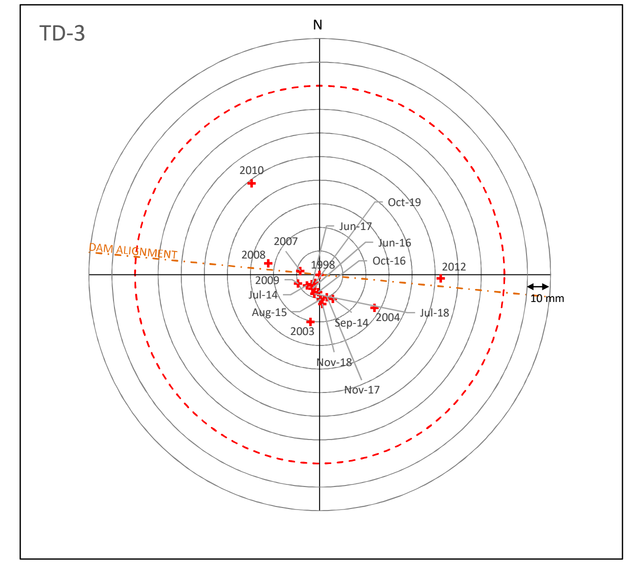
TITLE: TROJAN DAM PIEZOMETRIC DATA 2009-2019

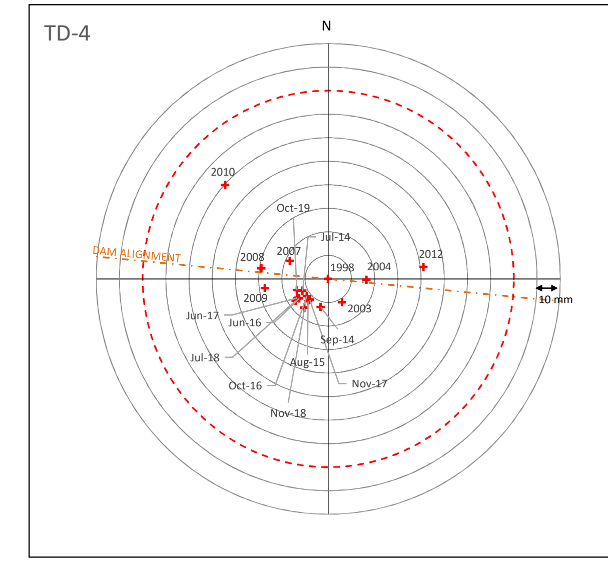
DOWNSTREAM SLOPE

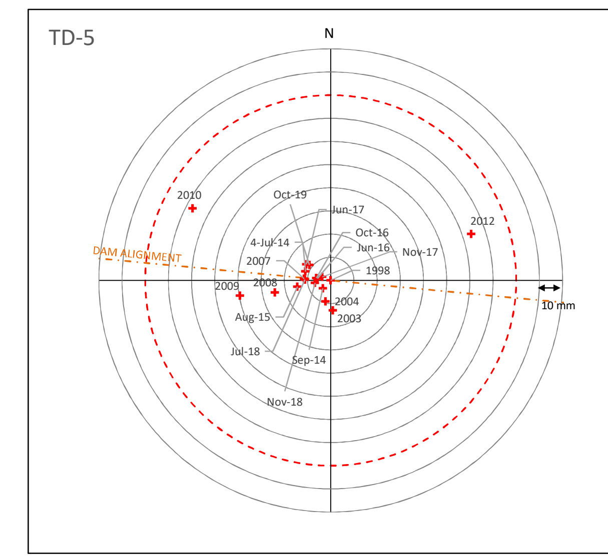
PROJECT No. M02341B53 | FIG No. IV-B-3

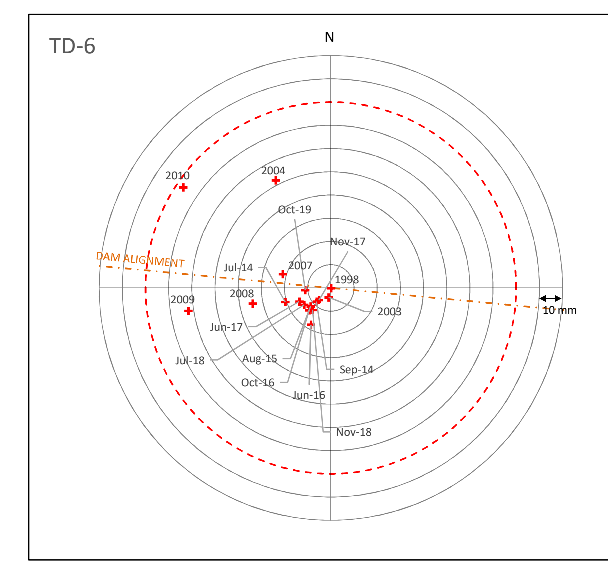






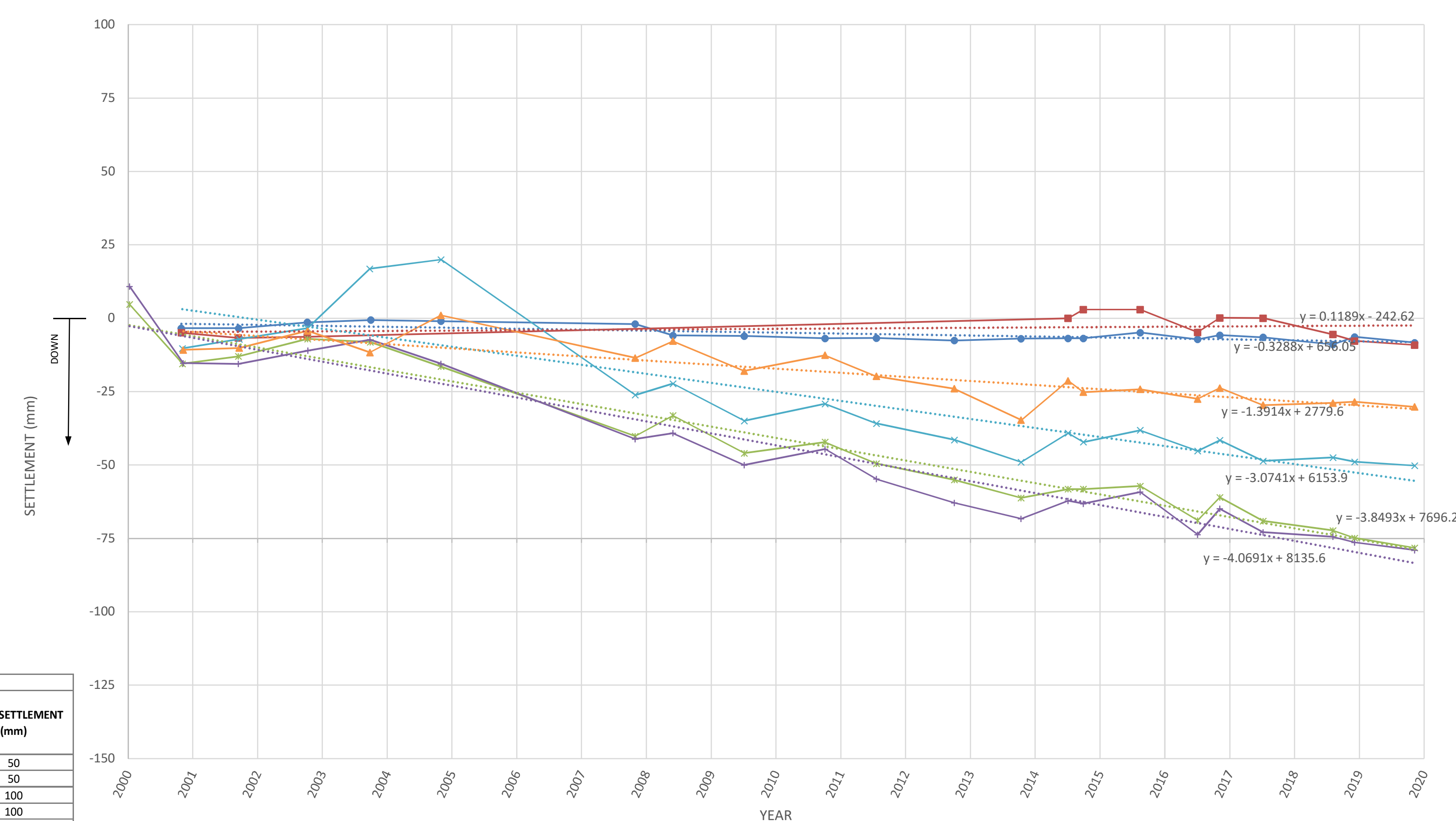






LEGEND:

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



MONUMENT ID	2019 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

NOTES:

1. TROJAN DAM MOVEMENT MONITORING DATA PRIOR TO 2000 NOT SHOWN.
2. REFER TO FIGURE 3 FOR MONUMENT LOCATIONS IN PLAN VIEW.
3. TD-1 RELOCATED AFTER OCT 2001.
4. 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.

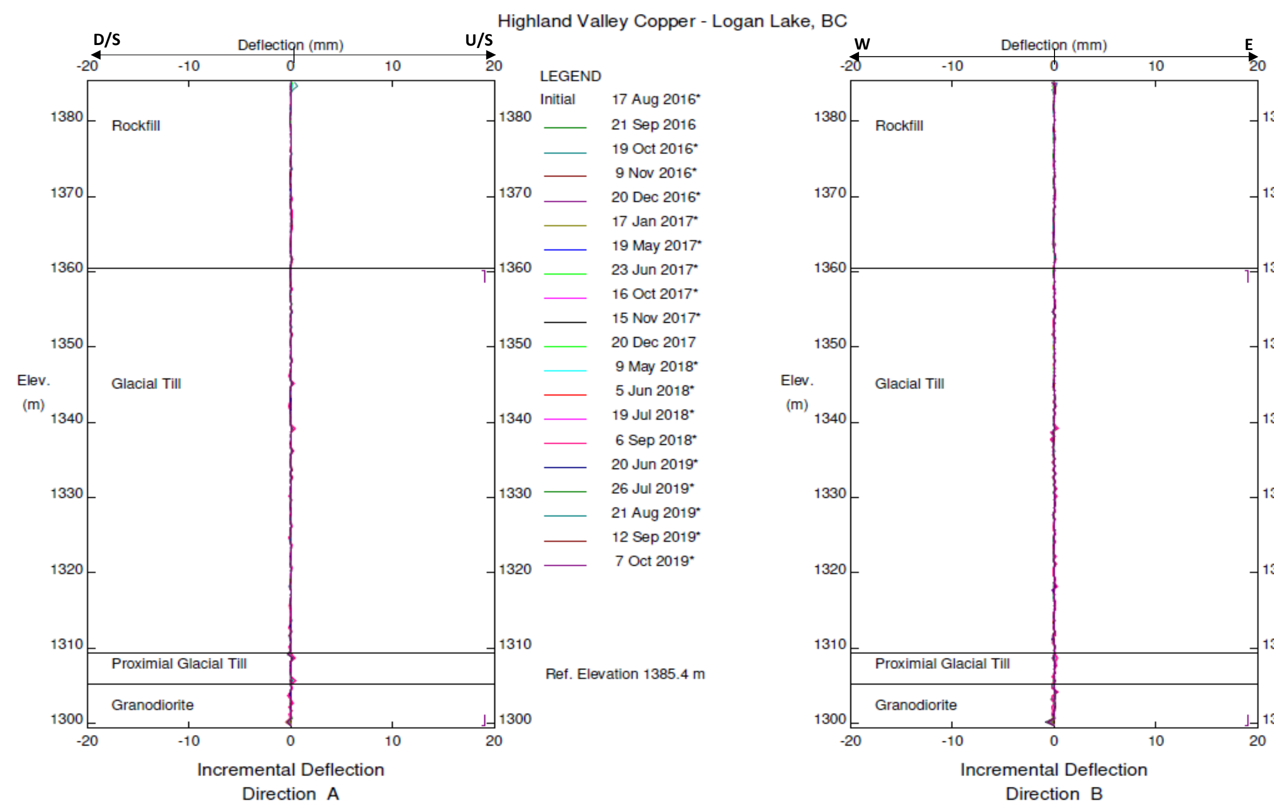
CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

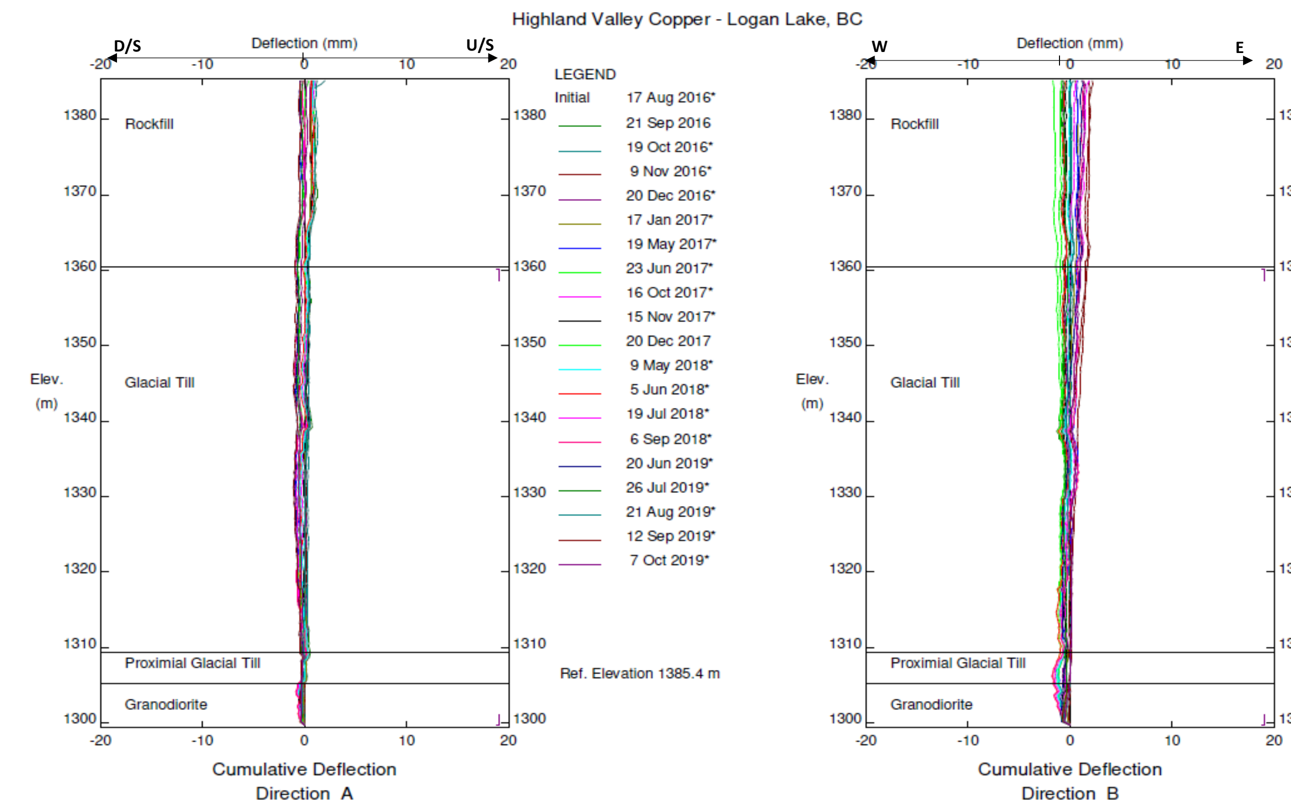
PROJECT: TROJAN TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: TROJAN DAM
SURVEY MONUMENT READINGS

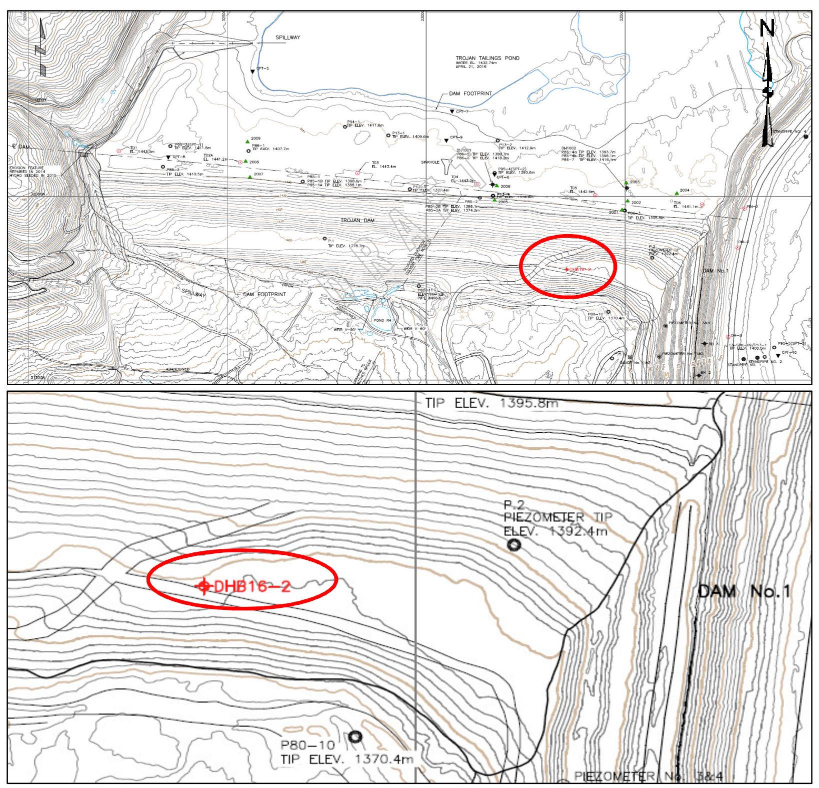
PROJECT No. M02341B53 | FIG No. IV-B-4

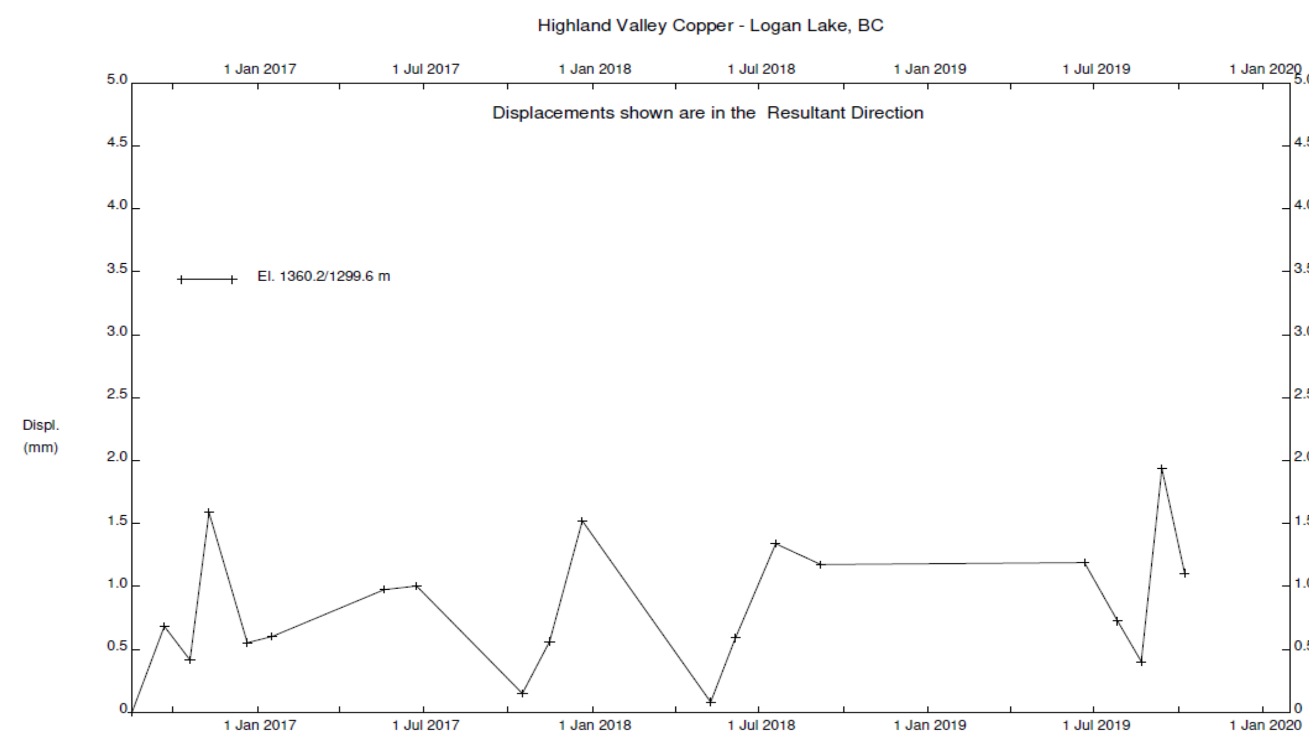


Incremental Displacement Profile



Cumulative Displacement Profile





Cumulative Displacement Profile vs. Time (Foundation)

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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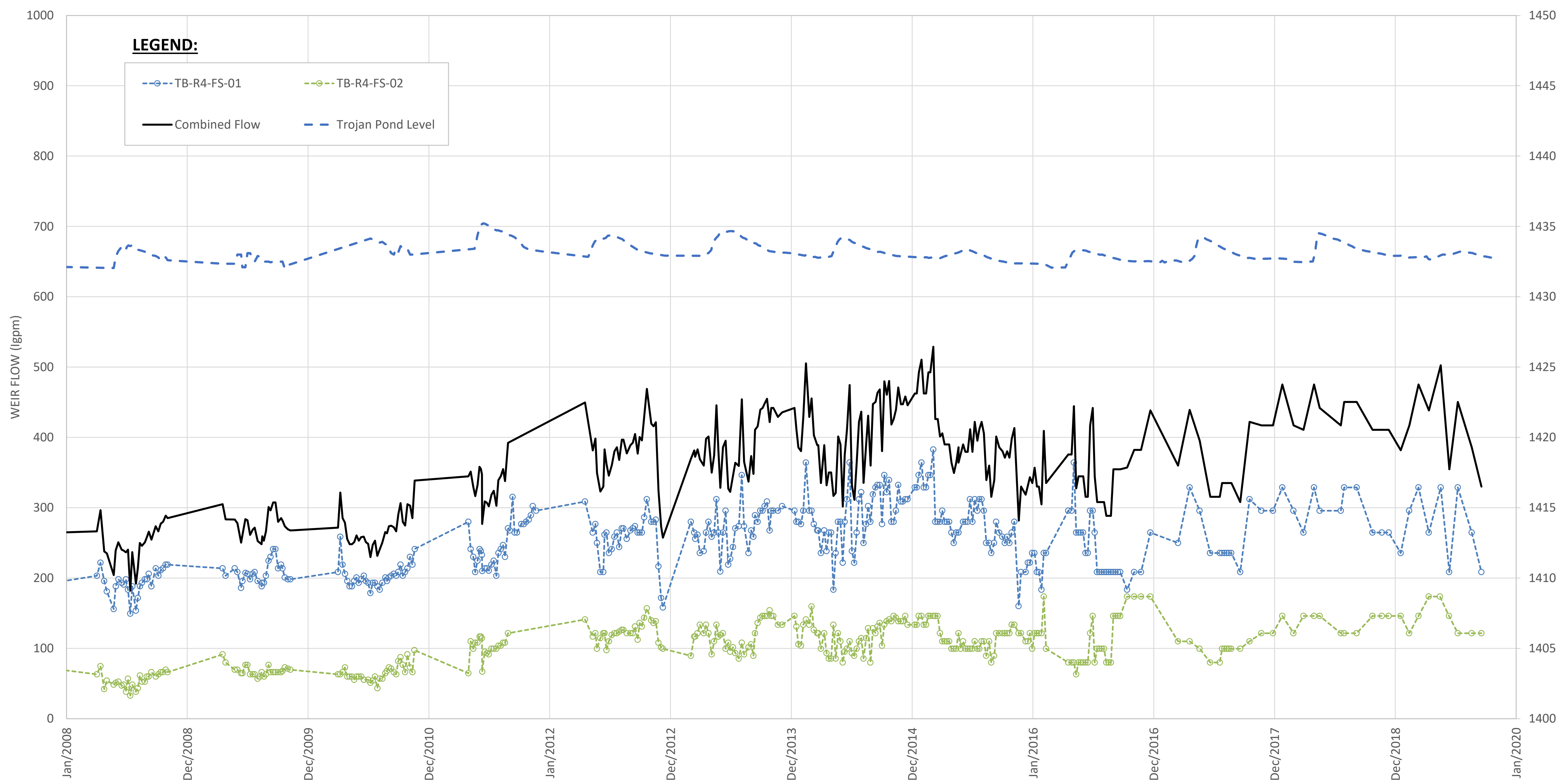
PROJECT: TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION

TITLE: INCLINOMETER DISPLACEMENT PROFILE IB16-2

PROJECT No. M02341B53

FIG No. IV-B-5



NOTES:

1. WEIR FLOW PLOTTED ON PRIMARY (LEFT) AXIS, TROJAN POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. POND WATER LEVEL RECORDED ON NOVEMBER 8, 2009 HAD A 10 m JUMP AND IS NOT PLOTTED AS IT IS ALMOST CERTAINLY A MEASUREMENT OR DATA ENTRY ERROR.

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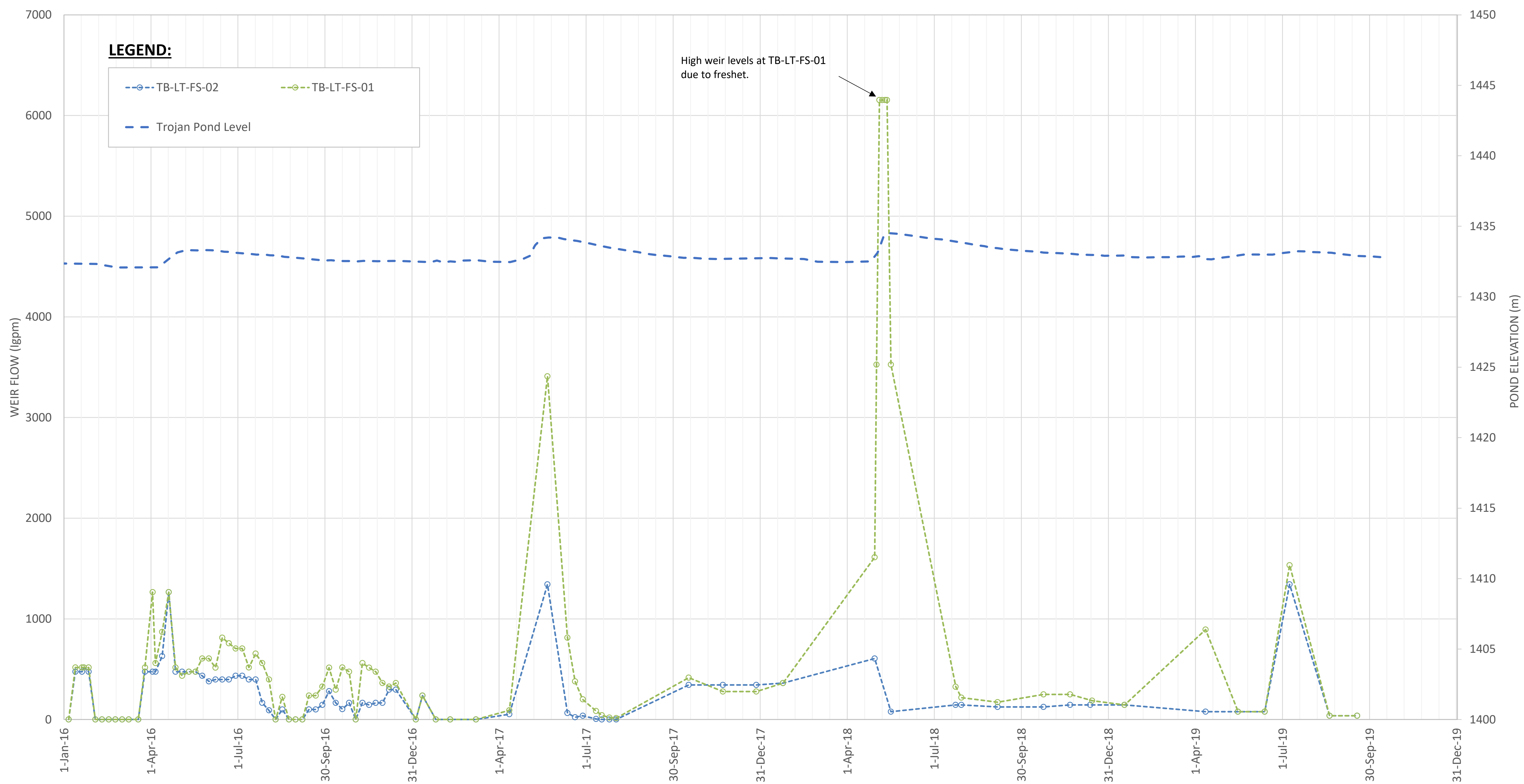
Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: TROJAN DAM
WEIR FLOWS

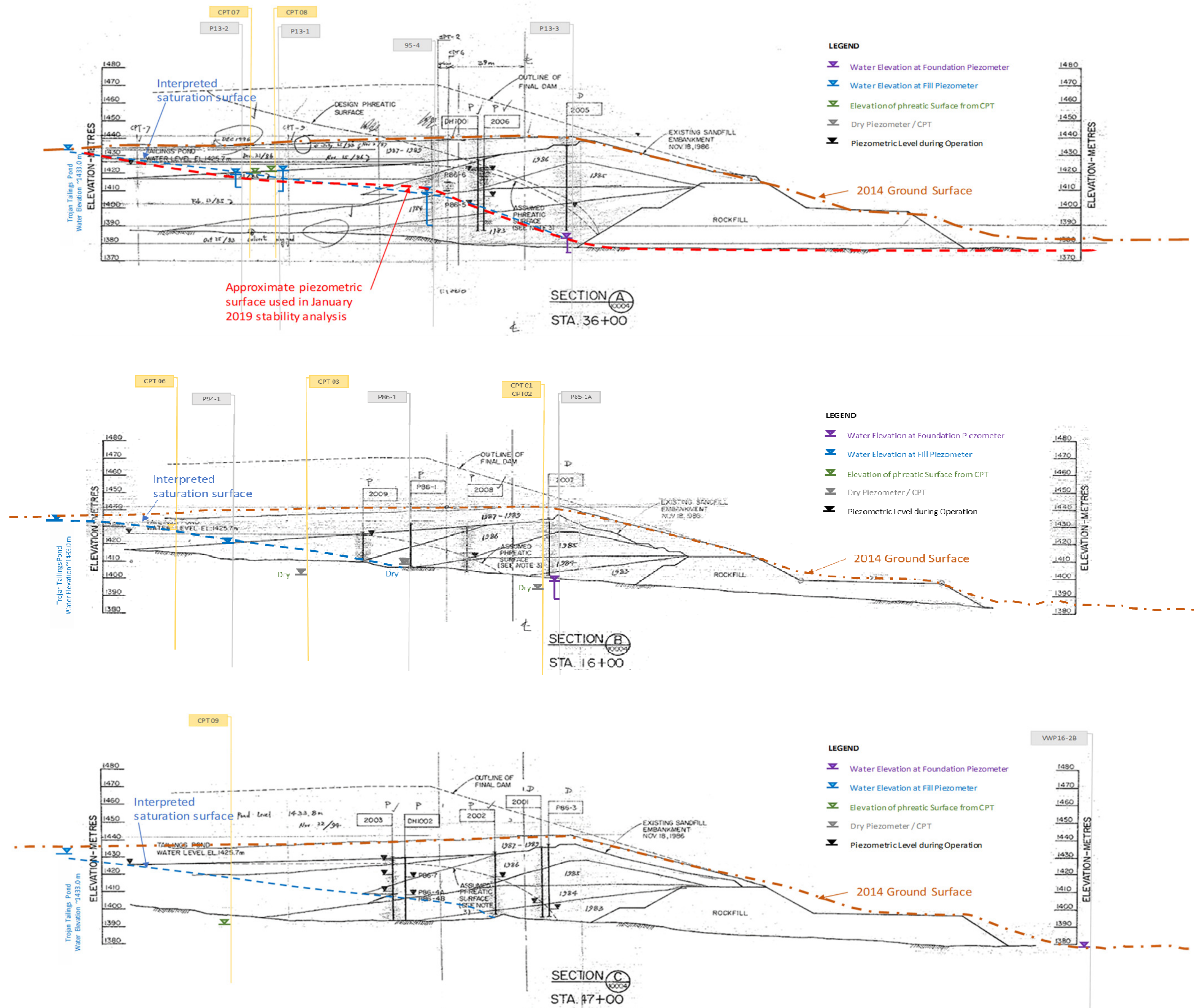
PROJECT No. M02341B53 | FIG No. IV-B-6

January 22, 2020
Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\300 Design\360 Seepage Data\Trojan\[191031 Trojan Weir.xlsx]Fig. V-6 R4 Weir



AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.	CLIENT: Highland Valley Copper / Teck Klohn Crippen Berger	PROJECT: TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION TITLE: LOWER TROJAN POND WEIR FLOWS PROJECT No. M02341B53 FIG No. IV-B-7

January 22, 2020
Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\300 Design\360 Seepage Data\Trojan\[191031 Trojan Weir.xlsx]Fig. V-6 R4 Weir



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 June 2019 Readings.

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: TROJAN TAILINGS STORAGE FACILITY 2019 DAM SAFETY INSPECTION

TITLE: TROJAN DAM INSTRUMENTATION SECTIONS

DOWNSTREAM SLOPE

PROJECT No. M02341B53 | FIG No. IV-B-8

January 30, 2020

Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\300 Design\340 Instrumentation Sections\Trojan Dam Sections\200130 Figure IV-8.xlsx|IV-B-3 DOWNSTREAM SLOPE

APPENDIX V

Map of Water Quality Monitoring Points

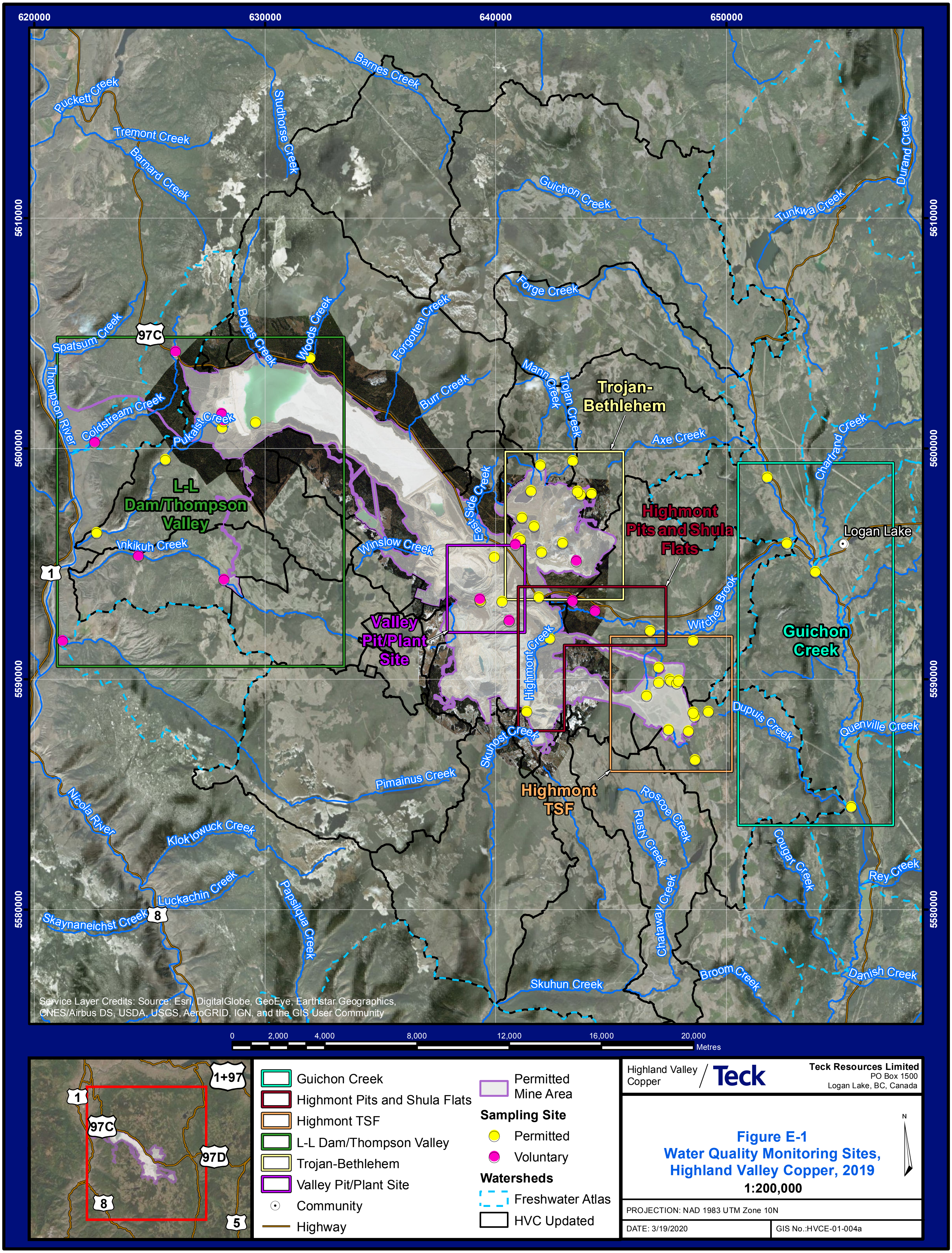
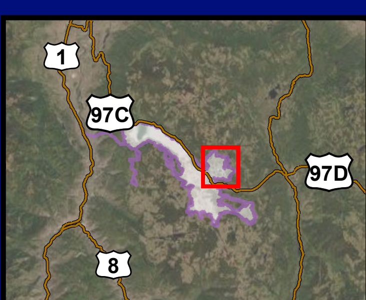


Figure E-1
Water Quality Monitoring Sites, Highland Valley Copper, 2019



Sampling Site

- Permitted
- Voluntary
- Permitted Mine Area
- Wetland
- Highway

Highland Valley Copper / Teck

Teck Resources Limited
PO Box 1500
Logan Lake, BC, Canada

Figure 3.2-26
Water Quality Monitoring Sites in the Trojan-Bethlehem Area, Highland Valley Copper, 2019
1:30,000

N

PROJECTION: NAD 1983 UTM Zone 10N

DATE: 2/7/2020

GIS No.:HVCE-01-004d

APPENDIX VI

Failure Mode Review

Appendix VI
Failure Mode Review

VI-1 OVERVIEW

Based on the DSI and review of available documents regarding Trojan Tailings Storage Facility, the key failure modes included in the Canadian Dam Safety Guidelines (CDA 2013) were reviewed.

VI-2 TROJAN DAM

Overtopping

The Trojan TSF has an open channel spillway designed (AMEC 2014a) to safely pass a flood (PMF, 24-hour duration) greater than the minimum IDF recommended under the Code. The spillway, freeboard and presence of a wide tailings beach between the pond and crest while discharging the IDF through the spillway are effective controls to manage overtopping risks.

Internal Erosion and Piping

Based on a 2015 review of filter adequacy (KCB 2015), the likelihood of piping related failure through the dam developing at this stage is very low.

A 24-inch diameter corrugated steel culvert provided drainage of Trojan Creek flows through the original rockfill dam in the natural channel until 1983 when tailings storage began and the pipe was backfilled with concrete (AMEC 2014a). No indicators of piping related failure (e.g., turbid water) have been observed in seepage from this area. The likelihood of a piping related failure developing around the culvert at this stage is considered very low.

Slope Stability – Static Loading

The structural integrity of the dam is based on a competent Glacial Till foundation with a rockfill starter dam and upstream unsaturated cycloned sand beach. Each of these units have relatively high shear strength and not subject to significant strength loss during earthquake loading. SCPTs and piezometers installed in the cycloned sand beach are relied upon to monitor the phreatic surface within the tailings upstream of the dam to demonstrate it remains below design assumptions. As discussed in Section 3.3 of the main report, a due diligence review of the softer layer at the base of the tailings, upstream of the crest, at the right abutment encountered during the 2019 SCPT program will be completed in 2020.

Slope Stability – Earthquake Loading

Dam performance during the design earthquake event is reliant on the upstream cycloned sand remaining unsaturated and thus, not susceptible to significant strength loss due to excess pore pressure (i.e. liquefaction). Some piezometers have been installed in the cycloned sand beach since operations and show that the material is unsaturated and piezometric levels have dropped since operations. In 2019, a cone penetration test (CPT) program was undertaken to further characterize the upstream tailings, including the cycloned sand beach. Pore pressure measurements from the CPT and subsequent readings from piezometers installed during the program demonstrated that the cycloned sand beach is unsaturated as assumed.

Assuming the cycloned sand beach to be unsaturated, the post-earthquake FOS is similar to static conditions. Pseudo-static analyses are not intended to simulate limit equilibrium conditions but, have been undertaken as a preliminary seismic deformation screening analysis. Given that the pseudo-static FOS for the Trojan Dam is greater than 1.0 assuming up to 75% of design earthquake load (KC 1996), more rigorous deformation analyses is not deemed necessary and the potential dynamic deformations relatively small (< 1 m) and could be managed by the structure.

Surface Erosion

The downstream slope is well vegetated with grass with no significant erosion features. Progressive erosion that develops over time or multiple events are managed through routine monitoring and maintenance. The likelihood of surface erosion over the downstream slope resulting in a failure from a single event is considered negligible.

VI-3 R4 SEEPAGE DAM

Overtopping

The R4 Seepage Pond has an open channel spillway designed to safely pass a flood (PMF, 24-hour duration) significantly greater than the minimum IDF recommended under the Code (100-year flood) and provides an effective control to manage overtopping risks.

Internal Erosion and Piping

The absence of suspended solids in observed seepage water during routine inspections over the service life of the dam suggests the likelihood of failure by internal erosion under existing conditions is low.

Slope Stability – Static Loading

Based on a stability analysis completed by KCB to support this DSI, the FOS of a deep-seated failure through the dam fill or foundation was greater than the minimum FOS (1.5) required by the Code.

Slope Stability – Earthquake Loading

The design seismic load of the dam used in previous stability analysis, which indicated satisfactory FOS, is greater than the minimum earthquake design ground motion (EDGM) required by the Code, 100-year. Therefore, the likelihood of seismic induced failure during the EDGM is considered low.

Surface Erosion

The downstream slopes have some coarse rock and are lightly vegetated, combined with the short slope lengths and small catchment areas (restricted to primarily the slope area itself) the likelihood of surface erosion resulting in a failure is very low.

VI-4 LOWER TROJAN DAM

Overtopping

Flood routing conducted for the Lower Trojan Dam in 2017 (AMEC 2017) indicates that upgrades are required so the facility can safely pass the IDF event, as required by the Code. KCB recommended upgrades are discussed in Section 4.4 of the main report and included in the recommendation summary (Table 8.2).

The consequence of such overtopping during the IDF is limited to release of contact water to the environment with no safety concern to a permanent downstream population.

The facility records do not indicate the facility has approached an overtopping condition under typical seasonal conditions, including larger freshet events over the past 4 years. A larger flood event is necessary to develop a risk of overtopping. To mitigate overtopping risks for the interim period when the facility is out of compliance with the IDF, THVCP have implemented threshold values to increase monitoring periods during period of high flow and initiate pumping as discussed in Section 4.4 of the main report.

Internal Erosion and Piping

The absence of suspended solids noted in observed seepage water during routine inspections over the service life of the dam suggests failure by internal erosion under existing conditions is low.

Slope Stability – Static Loading

Slope stability analyses conducted in 2005 showed the FOS for downslope stability is greater than the minimum FOS (1.5) required by the Code. A shallow surficial (~2 m deep) failure surface within the upstream dam fill had a FOS of 1.3 (KC 2005); but there have been no incidents of instability or adverse displacement (e.g., sloughing) along the upstream slope observed in the available monitoring records nor observed during the DSI site inspection.

Slope Stability – Earthquake Loading

The design seismic load is greater than the minimum EDGM required by the Code, 100-year.

Surface Erosion

The downstream slopes have some coarse rock and are lightly vegetated, therefore combined with the short slope lengths and small catchment areas (restricted to primarily the slope area itself), the likelihood of surface erosion resulting in a failure is considered very low.

APPENDIX VII

2018 DSR Recommendations

Appendix VII
Dam Safety Review Recommendations

Table VII-1 2018 Trojan Dam Safety Review Recommendations

ID	Priority[1]	2018 DSR Comment	Topic
SRK19- GEN-001	4	THVCP 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 THVCP's SharePoint site. Ideally, a list of all available documents is appended or referenced in the OMS manual.	OMS
SRK19- GEN-002	4	There is a discrepancy in dam crest elevation for all TSF dams (Trojan dam and seepage pond dams) among various documents from the Tailings Management System, such as the latest DSIs (KCB 2016, 2017) and the current version of the OMS manual (THVCP 2016). The OMS manual should have the latest information on dam crest elevations and note the reason for the recent use of different values.	Survey
SRK19- TD-01	2	Recent failures of upstream dams in Brazil have reminded the mining community of the elevated risks of upstream dams compared to dams constructed using centerline and downstream methods. Although analyses to date indicate the dam is stable under seismically induced liquefaction, the risk of static liquefaction under a wide range of "worst case conditions" has apparently not been evaluated. In view of its Very High consequence classification, a re-evaluation of potential liquefaction triggers and consequences should be undertaken. The basis of this assessment should be a sensitivity analysis which considers more conservative assumptions than have been used to date including, for example, significant increases in phreatic levels and increases in the extent of liquefiable tailings.	Stability / Trojan Dam
SRK19- TD-02	4	KCB (2015b) has indicated that the phreatic surface that would drive the FOS to values of less than 1.2 is unreasonably high, but does not report such values Evaluate the effect variance in the phreatic surface has on the stability of the dam. Based on the findings from this evaluation, update as necessary the trigger levels and their corresponding action (s) and then update the OMS manual.	Stability / Trojan Dam
SRK19- TD-03	4	THVCP 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.	Safety / Trojan Dam
SRK19- TD-04	4	There is a developing erosion gully in the dam at the right abutment at a steeper section in the cycloned sand. A similar occurrence developed in the past and will most likely develop again if the area is not modified. Repair the erosion gully and evaluate the feasibility of reshaping this area to mitigate the risk of erosion	Erosion / Trojan Dam
SRK19- TD-05	3	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). Update the inflow design flood and flood routing analysis.	Hydrotechnical / Trojan TSF
SRK19- TD-06	3	Required and available normal freeboards have not been reported. Evaluate and report required and available normal freeboards.	Hydrotechnical / Trojan TSF

ID	Priority[1]	2018 DSR Comment	Topic
SRK19- TD-07	4	Instrumentation location and measured data information for the Trojan Dam are not included in the OMS manual (THVCP 2018) Include reference to where instrumentation location and measured data information for the Trojan Dam can be located in the OMS manual	OMS / Instrumentation
SRK19- TD-08	3	The OMS manual does not indicate operational parameters for the Trojan Diversion. Update OMS manual to include operating protocols for the Trojan Diversion – i.e. at what water level in the Trojan TSF pond should valves be closed.	OMS / Trojan Diversion
SRK19- TD-09	3	The OMS manual should include a maintenance protocol for the log boom at the inlet of the Trojan spillway channel. Include maintenance requirements for the log boom in the OMS manual.	OMS / Log Boom
SRK19- R4-01	3	The required normal freeboard as per CDA (2013) guidelines has not been evaluated. Evaluate required and available normal freeboards.	Hydrotechnical / R4
SRK19- R4-02	3	KCB (2018) reports that a stability analysis carried out to support the DSI indicated that the FOS for a deep-seated failure was compliant with the Code, but there is no reference for such analysis. Include the references for the stability assessments of R4 Reclaim Pond in the OMS manual.	Stability
SRK19- LTD-01	3	Risk of overtopping. The minimum freeboard requirement set by THVCP (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).	Hydrotechnical / LTD
SRK19- LTD-02	3	The spillway inlet and channel are full of woody debris and the channel flow path is no longer visible. As recommended in the 2017 DSI (LTD-2017-01), the spillway channel should be cleared.	Hydrotechnical / LTD
SRK19- LTD-03	3	The required normal freeboard as per CDA (2013) guidelines was not evaluated. Evaluate required and available normal freeboards.	Hydrotechnical / LTD

Notes:

1- Priority guidelines are defined as follows (MEM 2016):
- 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- Deficiency: an inadequacy, or uncertainty in the adequacy, of the dam system to meet its performance goals in accordance with good dam safety practices.

3- Non-Conformance: an inadequacy in the nonphysical controls (procedures, processes and management systems) necessary to maintain the safety of the dam.