Klohn Crippen Berger

Teck Highland Valley Copper Partnership

2019 Dam Safety Inspection Report

Highmont Tailings Storage Facility

FINAL

M02341B53.730

April 2020

April 3, 2020

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

Mr. Chris Anderson
Manager, Tailings and Water

Dear Mr. Anderson:

2019 Dam Safety Inspection Report
Highmont Tailings Storage Facility
FINAL

We are pleased to submit the 2019 Dam Safety Inspection final report for the Highmont 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/PU/NS:cd

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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 Highmont Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site in accordance with the requirements of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code). 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 10, 2019. Mr. Chris Anderson, P. Eng., THVCP Tailings and Water Manager, is the TSF Qualified Person (as defined by the Code) for Highmont TSF.

The Highmont 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 DSI includes the North Dam, East Dam, and South Dam, which form the tailings impoundment, as well as five seepage recovery dams (S1, S2, S3, S5 and S8).

The Highmont TSF is located 8 km southeast of the operating mill. The Highmont TSF is an inactive facility constructed in 1980 and operated from 1980 to 1984. The site has been reclaimed and is currently inactive. THVCP continues ongoing surveillance of the site including instrumentation monitoring, environmental sampling, visual inspections and maintenance activities. Under this level of site presence, the Highmont dams are considered to be in the active care closure phase as defined by the Canadian Dam Association (CDA) Mining Dam Technical Bulletin (CDA 2014).

Highmont structures are as follows:

- Highmont TSF dams comprise glacial till starter dams which were raised by the centerline method with coarse and fine filter zones separating the upstream tailings spigotted from the crest from the downstream rockfill section.
- The seepage dams are constructed of compacted glacial till with a drainage blanket downstream of the seepage cut-off, and with a sand and gravel erosion blanket on the upstream and downstream faces.

The tailings pond is located in the center of the impoundment. The Highmont TSF Spillway, installed near the left abutment of the North Dam, is designed for a storm event with a return period greater than required by the Code. The S3 Pond Spillway is plugged with glacial till to prevent discharge of water that does not meet water quality regulatory requirements. Similarly, the S5 Pond Spillway has been partially obstructed with sandbags since 2016 to increase the storage. The S5 Pond crest must be raised to accommodate storing the IDF when the spillway is blocked.

The consequence categories as defined by CDA (2014) based on a dam consequence review hosted by THVCP of the dams at the Highmont TSF area summarized in Table 1. There were no significant changes to the key geotechnical or hydrotechnical hazards during 2019.

Table 1 Dam Consequence Categories

Dam	Consequence Category[1]
Highmont Dams[2]	High
S3	High
S1, S2 and S5	Significant
S8	Low

Notes:
1. Based on CDA (2014)
2. Includes the North Dam, East Dam, and South Dam, which form the tailings impoundment.

The most recent 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 Highmont TSF is "reasonably safe"[1] with, in general, minor deficiencies and non-conformances, per CDA (2013) guidelines; and
- the Highmont TSF is a well-managed facility with a high level of technical stewardship and appropriate operating procedures.

The DSR included 29 recommendations related to dam safety for the Highmont TSF and seepage ponds. Two of the recommendations were assigned a Priority Level[2] of 2 which represents issues that, if not corrected, could likely result in a dam safety issue. Assessment of both will be prioritized over other recommendations in 2020:

- S3 Pond (ID S3-001): Insufficient data available to estimate foundation material properties, potential for liquefaction, and post-seismic strengths; and
- S5 Pond (ID S5-005): Road and crest material is slippery (high fines content / high plasticity) and is a potential safety hazard for vehicles.

The remaining (27) recommendations were assigned a Priority Level of 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. A workplan to address the recommendations from the report will be prepared by the end of April 2020.

The emergency preparedness and response Plan (EPRP) is part of Operation, Maintenance and Surveillance (OMS) manual which was issued in December 2018 (THVCP 2018); emergency contacts and other minor items were updated during 2019. The OMS manual and EPRP meets the intent of the

[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 8.1 for summary of Priority Levels.

Mining Association of Canada (MAC 2011) and CDA guidelines, is current and provides adequate coverage for existing conditions.

Visual inspections and instrument measurements were completed by THVCP at the OMS prescribed frequencies during periods of the year when dams were accessible. There was no event-driven inspection triggered by precipitation or earthquake (as defined in the OMS Manual) in 2019. Instrumentation data, piezometric and movement thresholds which monitor deviation from the established trends, were reviewed. Instrument readings where consistent with recent trends and no threshold exceedances occurred.

Water quality downstream of the Highmont 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 offsite sample sites was in compliance with permit limits.

The status of recommendations to address deficiencies and non-conformances identified during past DSIs are summarized in Table 2. Previous recommendations that are now closed are shown in *italics*. Recommendations to address deficiencies and non-conformances identified during the 2019 DSI are summarized in Table 3.

Table 2 Previous Recommendations for Deficiencies and Non-Conformances – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[2]	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2016-05	Signage	-	Signage should be added to the spillway gate controls indicating which turn direction to open and close the gate and identify which seepage pond water is being diverted to in each position.	4	Q1 2018 (Open, THVCP to schedule for 2020)
HD-2017-01	Flood Management	Spillway	THVCP should modify the spillway channel to pass the peak spillway design outflow beneath the access road (bridge or arch culvert) or regrade the road surface so that water that flows over the road will report to the downstream spillway channel.	3	Q4 2020 (Open)
HD-2018-01	*Monitoring*	-	*At completion of the DSR, THVCP and KCB will develop a workplan to investigate the cause of changing piezometric conditions, which will include a review of the need for additional instrumentation in the Highmont TSF.*	*2*	*Q3 2019* *(Closed)*
HD-2018-02	Flood Routing	10.1.8	Update flood routing assessment for Highmont TSF and associated seepage ponds based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2 2020 (Open)
HD-2018-03	*Monitoring*	-	*Survey monument P4 after snow has cleared to confirm interpretation that June 2018 horizontal movement is associated with survey error.*	*3*	*Q2 2019* *(Closed)*
S2 Pond					
S2-2018-01	Monitoring	OMS	Include monitoring of the inlet plug during high flow events in the 2019 OMS manual. When available, define the minimum till plug elevation necessary to prevent overtopping of flow from Highmont TSF Spillway channel during the S2 Pond IDF.	3	Q4 2019 (Open)
S2-2018-02	Flood Routing	10.1.8	To improve dam safety of S2 Pond, by reducing overtopping risks, KCB recommends the Highmont TSF spillway till plug be permanently relocated to the S2 Pond inlet channel and built to sufficient height such that the plug would not be overtopped during the Highmont TSF IDF.	2	Q4 2019 (Open)
S5 Pond					
S5-2018-01	Flood Routing	10.1.8	Confirm the pumping capacity of the system at S5 Pond so that the ability to route the IDF (100-year return period, 24-hour duration) assuming the pumps are functioning as intended can be confirmed.	2	Q4 2019 (Open)
S5-2018-02	Flood Routing	10.1.8	To accommodate the temporary blocking of spillway during freshet, raise the dam crest so that the IDF (100-year 72-hour duration) can be stored within the impoundment, assuming no pumping is required. (Take into consideration, HD-2019-02)	2	Q3 2021 (Open, to be reviewed pending outcome of S5-2018-01)

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[2]	Recommended Deadline
S8 Pond					
S8-2018-01	Maintenance	OMS	A pipe was observed on the slope of the S8 Pond dam that did not appear to be connected to anything. This pipe should be removed.	4	Q4 2019 (Open)
S1 Pond and S3 Pond					
No outstanding recommendations from previous DSIs.					

Notes:
1. Recommendation ID numbers from 2017 DSI have been revised as shown.
2. 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.

Table 3 2019 Recommendations for Deficiencies and Non-Conformances

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline
Highmont Tailings Storage Facility					
TD-2019-02	-	DSR Recommendations	KCB and THVCP to develop a work plan to address 2018 DSR recommendations.	3	April 2020
S2 Pond					
S2-2019-01	Flood routing	10.1.8	S2 Pond spillway channel profile has been changed due to the temporary access over the channel. Original channel profile/capacity should be restored.	3	Q1 2020
S1 Pond, S3 Pond, S5 Pond, and S8 Pond					
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 Highmont Tailings Storage Facility (TSF) on the Highland Valley Copper (HVC) mine site. The Highmont TSF is an inactive facility constructed in 1980 and operated from 1980 to 1984. The DSI includes the North Dam, East Dam, and South Dam, which form the tailings impoundment, as well as five seepage recovery dams (S1, S2, S3, S5 and S8). Two other seepage recovery dams have been intentionally breached in a controlled manner by THVCP, are no longer capable of retaining water and not classified as dams. Therefore, the facilities are not included in the scope of this DSI. The review period of this DSI is between January 2019 to September 2019[3].

The Highmont TSF has been reclaimed and the current condition of the facility was established in 2003 with construction of the spillway. THVCP continues ongoing surveillance of the site including instrumentation monitoring, environmental sampling, visual inspections and maintenance activities. Under this level of site presence, the Highmont dams are 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 survey monuments, piezometer 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 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 10, 2019. During the inspection, the weather was cloudy. Mr. Chris Anderson, P. Eng., THVCP Tailings and Water Manager, is the TSF Qualified Person (as defined by the Code) for the Highmont TSF.

[3] During 2019, THVCP and KCB agreed to modify the review period for the annual DSI to October through September (previously was 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 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 2019b).

THVCP has three primary permits for the Highmont TSF, as listed below:

- Permit PE 376 (09) – Issued under the provisions of the Waste Management Act. British Columbia Ministry of Water, Land, and Air Protection, dated January 7, 1971 and last amended on May 29, 2003.
- Permit M11 – Approving Work Systems and Reclamation Program. Department of Mines and Petroleum Resources, dated January 20, 1970, last amended (regarding Highmont) on July 16, 1998.
- Permit No. M55 – Reclamation Permit. Department of Mines and Petroleum Resources dated July 17, 1979 and amalgamated with Permit M11 on July 16, 1998 (EMPR 2019).

The Highmont dams are assigned a “High” consequence category as defined by CDA (2014) based on a dam consequence review hosted by THVCP. Seepage Recovery Pond Dam S3 is also assigned a “High” consequence category. Seepage Recovery Pond Dams S1, S2 and S5 are assigned as “Significant”, while Seepage Recovery Pond Dam S8 is assigned as “Low”.

The most recent 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 discussed further in Section 3.2. Note that 2018 DSR recommended increasing the consequence classification of the S8 Pond from “Low” to “Significant”: THVCP and KCB will take this recommendation into consideration during next consequence classification review.

2 FACILITY DESCRIPTION

2.1 Overview

The HVC site is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Highmont TSF is located 8 km southeast of the operating mill; refer to Figure 1. The Highmont TSF comprises a tailings pond retained by three perimeter dams (North, East and South) and five active perimeter seepage recovery ponds; refer to Figure 2. Typical geometry and dimensions of the dams 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.

Highmont TSF

- The Highmont dams comprise compacted glacial till starter dams which are founded on granodiorite bedrock or shallow glacial till and glaciofluvial sand and gravel outwash overlying bedrock. Organics and soft ablation deposits were removed prior to the construction of the dam. Silt and clay layers were not encountered in the foundations of the North Dam and East Dam. A 1.5 m to 3 m lacustrine silt layer about 3 m to 4 m below original ground was encountered at the South Dam (KCB 2015a).
- Dam crest raises were done following the centreline method with a glacial till core zone and downstream rockfill zone. The dam was designed and built with a 1.5H:1V downstream rockfill slope which was later shallowed as part of reclamation (~2.3H:1V to 2.5H:1V).
- Under existing conditions, at normal range of pond levels, the minimum beach width is more than 290 m along the East Dam crest, more than 360 m along North Dam crest, and more than 370 m along the South Dam crest.

Seepage Recovery Ponds

- Historically there were seven seepage recovery ponds located around the perimeter of the Highmont TSF (S1, S2, S3, S4, S5, S8 and S9) to collect seepage from the TSF and runoff from the local area. The dams at S4 and S9 have been decommissioned by breaching, leaving five remaining seepage recovery pond dams (S1, S2, S3, S5 and S8).
- The dams are constructed of compacted glacial till with a drainage blanket downstream of the seepage cutoff, and with a sand and gravel erosion blanket on the upstream and downstream faces. The dams are founded on glacial till, except for the now breached S4 Pond dam which was founded on a deep sand and gravel outwash.
- In general, water from the seepage recovery ponds is diverted to the Highland Mill for reclaim via S1 Pond (refer to Figure 4-1). Details of pumping operations, pipelines and other water management structures in these ponds are discussed in Section 4.1.

Table 2.1 Summary of Approximate Dam Geometry

Dam	Dam Raise Construction Method	Crest Elevation (m)	Maximum Height (m)	Crest Length (m)	Minimum Crest Width (m)	Downstream Slope	Upstream Slope
Main Dams							
North Dam	Centreline	1487	47	1200	30	2.5H:1V	n/a
East Dam	Centreline	1487	30	1200	15	2.3H:1V	n/a
South Dam	Centreline	1487	35	1300	9	2.3H:1V	n/a
Seepage Recovery Pond Dams							
S1 Dam	n/a	1445	9.1	60	10	2H:1V [3]	3H:1V
S2 Dam	n/a	1459	4	140	4	2.2H:1V [3]	3H:1V
S3 Dam	n/a	1459	3.4	150	4	3H:1V	3H:1V
S4 Dam	Decommissioned by breaching						
S5 Dam	n/a	1452.2	6.3	340	3	1.7H:1V [3]	3H:1V
S8 Dam	n/a	1452	5	120	9	2H:1V	Unknown
S9 Dam	Decommissioned by breaching						

Notes:
1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.
3. The downstream slope is steeper than the 2.5H:1V in the design report (KL 1980).

3 2019 ACTIVITIES

3.1 2019 Main Construction Activities

No activities, other than routine maintenance activities as required by the OMS Manual (THVCP 2018) were conducted (e.g., clearing weirs of vegetation, pumping of seepage recovery ponds).

3.2 2018 Dam Safety Review

A DSR of the Highmont 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 Highmont TSF is "reasonably safe"[4] with, in general, minor deficiencies and non-conformances, per CDA (2013) guidelines;
- the Highmont TSF is a well-managed facility with a high level of technical stewardship and appropriate operating procedures; and
- no changes to the consequence classification were recommended except for upgrading the S8 Pond dam consequence from "Low" to "Significant".

The DSR included 29 recommendations related to dam safety for the Highmont TSF and seepage ponds. Two of the recommendations were assigned a Priority Level[5] of 2 which represents issues that, if not corrected, could likely result in a dam safety issues leading to injury, environmental impact or significant regulatory enforcement:

- S3 Pond (ID S3-001): Insufficient data available to estimate foundation material properties, potential for liquefaction, and post-seismic strengths; and
- S5 Pond (ID S5-005): Road and crest material is slippery (high fines content / high plasticity) and is a potential safety hazard for vehicles.

The remaining (27) recommendations were assigned a Priority Level of 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 recommendations and discussed actions to address and resolve each. A formal work plan to address the DSR recommendations will be completed by the end of April 2020. Appendix VII includes a table of all DSR recommendations. KCB have grouped the DSR recommendations into general categories, as follows:

- four related to OMS Manual or documentation;

[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.

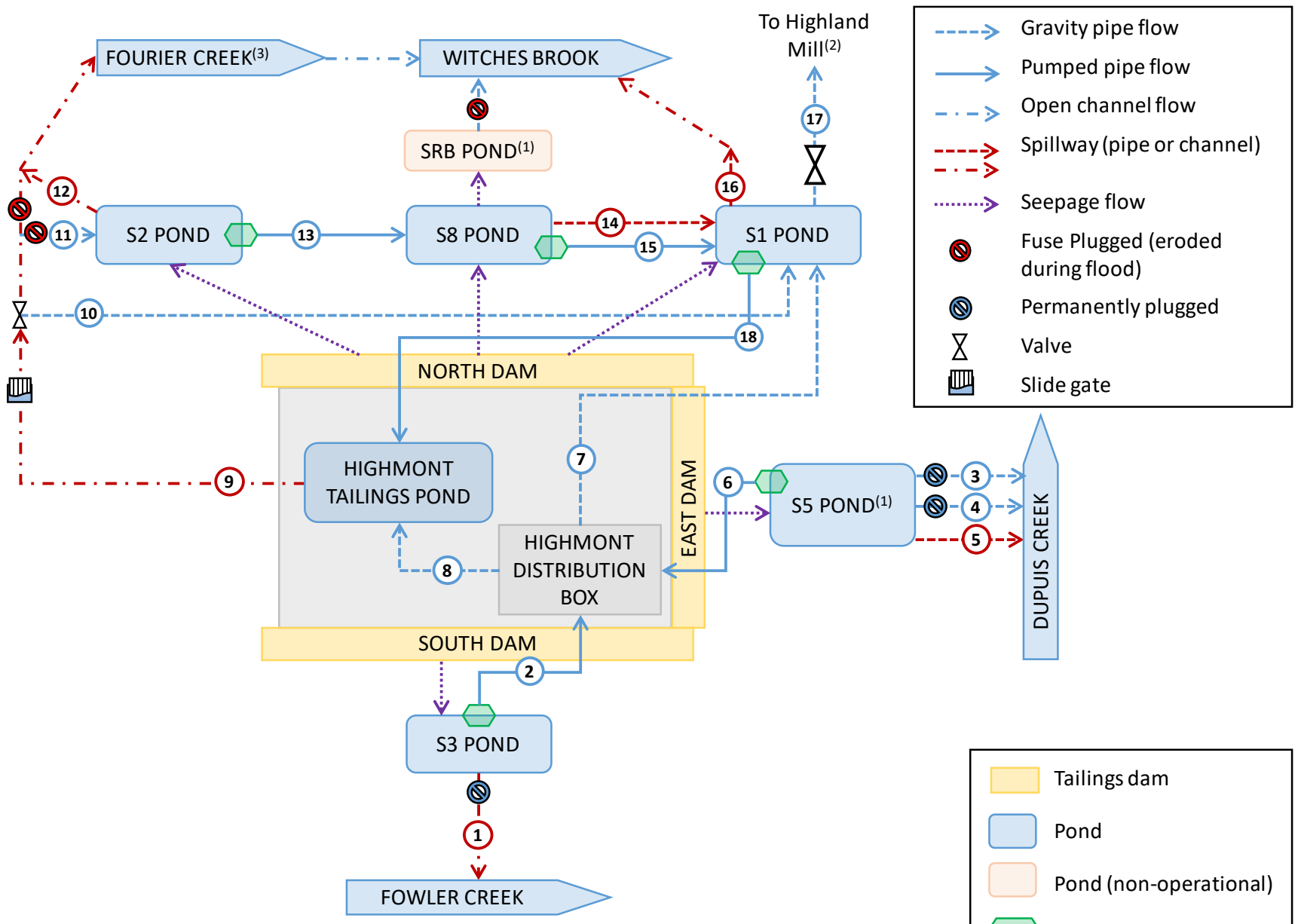
- two related to documentation of additional sensitivity stability analyses;
- two related to spillway (review of riprap sizing, and signage)
- 18 related to flood routing assessment updates (15 of which are three recommendations repeated for five structures); and
- three related to miscellaneous items.

4 WATER MANAGEMENT

4.1 Overview

The flow schematic for Highmont TSF is shown in Figure 4-1. Decommissioned structures (S4 Pond and S9 Pond) are not shown. Refer to Appendix III-A for additional information regarding Highmont TSF water management.

Figure 4.1 Flow Schematic for Highmont TSF



Notes:
1. The Sulfate Reduction Bacteria (SRB) pond at S8 is downstream of the S8 Dam. The SRB pond at S5 consists of the five ponds in series in the centre of the facility. Water quality in both ponds do not meet discharge requirements at this time.
2. See the Gnawed Lake process flow diagram for detailed flow path from S1 to the Mill.
3. Subject to water license constraints. See Environment for details.

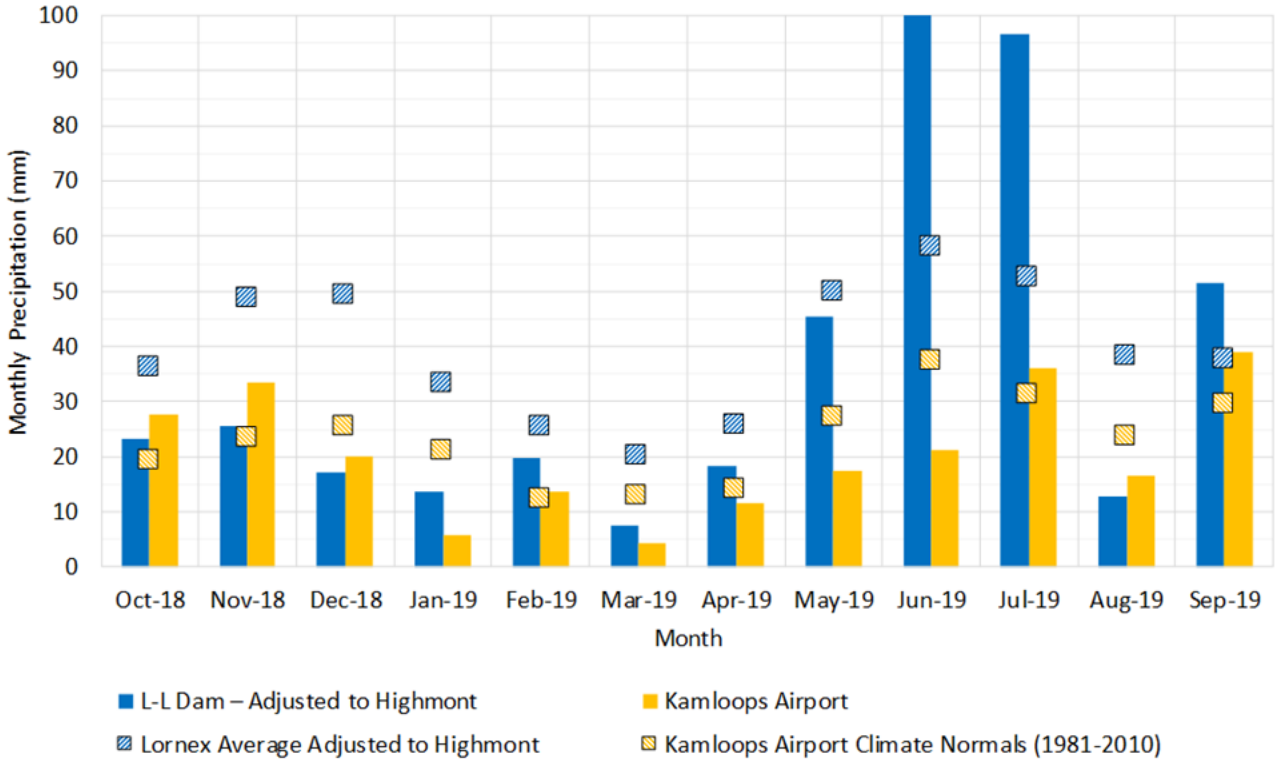
No.	Name	Description	Status
1	S3 Spillway	Open channel	Non-operational, plugged prior to 2010
2	S3 Reclaim	Seepage water pumped to the Highmont Distribution Box	Operational
3	S5 Outlet #1 (North)	2x 8”dia. HDPE pipes with control valves	Non-operational, metal plates placed at intake and pipes filled with till in 2015
4	S5 Outlet #2 (South, in S5 spillway channel)	1x 8”dia. HDPE pipes with control valve	
5	S5 Overflow (South, in S5 spillway channel)	2x 200 mm dia. HDPE pipes	Operational, partially blocked at intake
6	S5 Reclaim	Pond water pumped to the Highmont Distribution Box	Operational
7	Distribution to S1	1x 18” dia. pipeline from the Highmont Distribution Box to S1	Operational
8	Highmont Distribution Box to Tailings Pond	1x 18” dia. pipeline from the Highmont Distribution Box to the tailings pond	Operational
9	Highmont Spillway	Open channel comprised of (U/S to D/S): i) Lock-block control sill; ii) Approach channel excavated in tailings; iii) Culvert crossings; iv) Channel excavated through rock; v) Flow control structure with 4’ high slide gate and diversion to S1; and vi) During freshet, till fuse plug located across Highmont TSF Spillway channel. During non-freshet, till fuse plug located across S2 Pond inlet channel.	Operational
10	Diversion to S1	18” dia. HDPE pipeline	Operational
11	Diversion to S2	Open channel with till fuse plug across S2 Pond inlet channel (except during freshet)	Operational
12	S2 Spillway	Open channel	Operational
13	S2 Outlet	1x 18” dia. HDPE pipeline carrying water pumped from S2 to S8	Operational
14	S8 Spillway	1x 18” dia. HDPE pipe with trash rack and headwall	Operational
15	S8 Outlet	1x 14” dia. HDPE pipeline carrying water pumped from S8 to S1	Operational
16	S1 Spillway	1x 900 mm dia. HDPE pipe discharging onto a riprap-lined apron	Operational
17	S1 Outlet	600 mm dia. HDPE pipe with manually operated valve	Operational
18	S1 Reclaim	Seepage water pumped back to the tailings pond	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 at Highmont TSF was significantly less than historic normals (based on Highland Valley Lornex adjusted to Highmont 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 Highmont TSF. Table 4.1 is a summary of annual inflows and outflows, provided by THVCP. The water balance is based on simple model results and the values should be treated as indicative only.

Table 4.1 Annual Water Balance for Highmont TSF

Item	Volume in 2019 (m^3)
Inflows	
Direct precipitation and runoff	347,600
Groundwater	310
Total inflow:	*347,910*
Outflows	
Seepage	68,800
Evaporation(3)	588,600
Total outflow:	*657,400*
Balance	
Balance (inflow minus outflow)	-309,490

Notes:
1. Values received from THVCP have been rounded to the closest 100 m^3.
2. Precipitation from the Shula Flats and L-L Dam weather stations adjusted to the Highmont area was used in the water balance.
3. Evaporation assumed for Highmont TSF: 540 mm/year.

4.4 Flood Management

The flood management structures at the Highmont TSF, applicable design criteria and flood details are summarized in Table 4.2 with the following discussion points noted:

- All flood routing assessments are to be updated to confirm that facilities can safely manage the IDF based on the most recent climate information as recommended by the 2018 DSR (SRK 2019) and 2018 DSI (KCB 2019b).
- Highmont TSF: the design flood (PMF), which can be safely managed by the facility, is greater than the minimum IDF required by the Code which further reduces overtopping risks. KCB supports this approach for this type of facility.
- S2 Pond: can manage the IDF assuming the local catchment, if additional flow from the Highmont TSF spillway does not report to S2 Pond. A till plug is seasonally built across the Highmont TSF spillway channel for a temporary period during freshet to divert flow into S2 Pond in order to flush the S2 Pond reservoir which is a permit requirement. Diverting flow from the spillway increases the S2 Pond catchment sufficiently that the existing S2 Pond spillway can no longer safely route the IDF:
  - KCB recommends that the till plug be relocated out of the spillway and an alternate means of flushing the S2 pond reservoir be identified. If not, then significant modification would be required to S2 Pond to manage flows from the spillway during flood. In the interim, while the till plug is in the spillway channel, THVCP should minimize the height of the till fuse plug elevation to allow for overtopping of the plug during a high flood event and reduce water diverted to S2 Pond. This will reduce the likelihood of overwhelming the S2 Pond flood routing capacity.
- S3 Pond: the original spillway channel is blocked and therefore the IDF is stored, rather than routed. KCB (2019a) demonstrated the required 72-hour IDF could be stored within the S3 Pond with adequate freeboard.

- S5 Pond: THVCP has not been able to confirm the pumping capacity of the reclaim system at S5 Pond which is required to safely manage the IDF. Therefore, it could not be confirmed during 2019 whether the facility can safely manage the IDF. During the interim period where compliance to manage the IDF cannot be confirmed, THVCP installed a secondary pump as back-up for freshet and as an additional control against overtopping.
- S8 Pond: IDF could be routed through the overflow spillway pipe (24-hour duration) or stored (72-hour duration) if the pipe became plugged and there were no other outflows (KCB 2018).

There are three items related to the Highmont TSF spillway which require follow up:

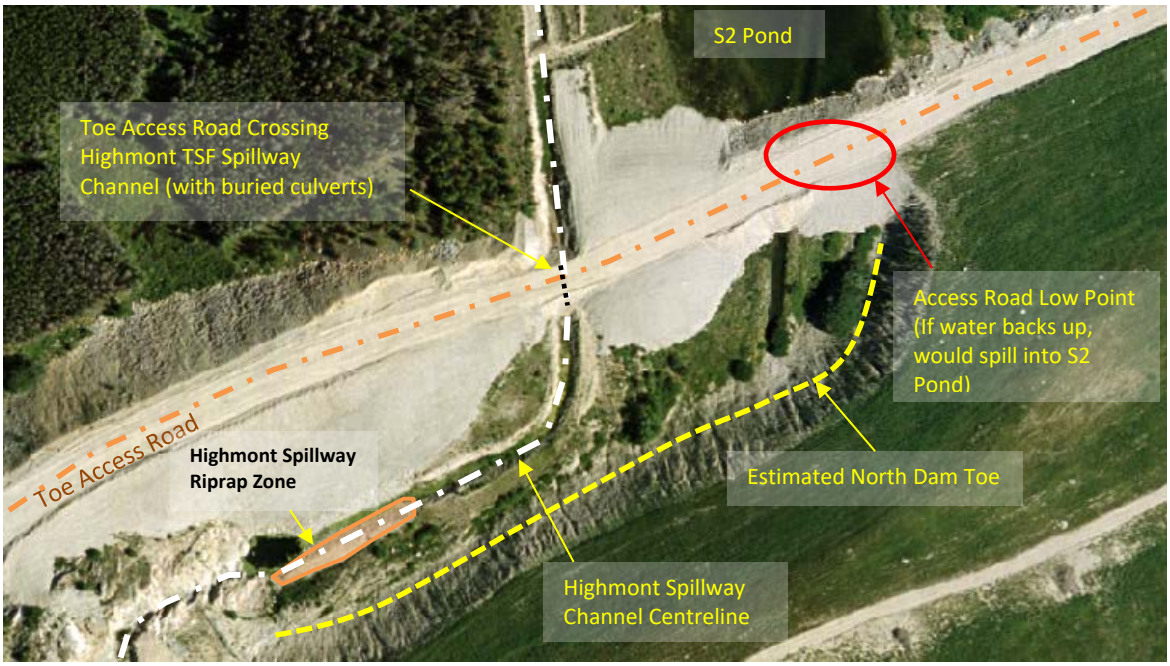
- The toe access road crosses the spillway channel downstream of the dam toe (Figure 4-3). A culvert is buried in the road crossing to pass spillway flows; however, the culvert was not included in the spillway design and is not capable of conveying the peak flow during the spillway design flood and is subject to blockage. During either event, water would pond in the area between the North Dam toe and the access road until eventually cresting over the low point in the road and spilling into S2 Pond which is not designed to manage that flow:
  - KCB recommends THVCP modify the area, where the toe access road crosses the spillway channel, to allow the peak spillway flow to pass beneath the access road (e.g. bridge or arch culvert) or regrade the road surface such that, if water that flows over the road, would report to the spillway channel as intended by design. Interim milestones dates were proposed in the 2018 DSI (KCB 2019b); however, these should be reviewed and revised, as appropriate.
- The majority of the spillway channel near the North Dam is founded in bedrock. A portion of the channel, downstream of the toe and upstream the toe access road (Figure 4-3), is excavated entirely in Glacial Till and was covered by riprap. The DSR (SRK 2019) recommended that the riprap sizing in this area be reviewed under the spillway design flood based on the most recent climate information. Schedule to complete this work will be defined in 2020 along with other DSR recommendations.
- KCB recommends THVCP regrade the crest access road that crosses the spillway approach channel such that, if the culverts became blocked, there could be a more well-defined channel to convey flow into the spillway channel and away from the access road which runs between the spillway channel and the North Dam abutment.

Table 4.2 Inflow Design Flood Requirements for Highmont TSF and Seepage Ponds

Dam	Spillway Type	Consequence Classification	Inflow Design Flood[1]	Spillway Design Flood		Spillway Design Reference
				Design Event (IDF Depth, Peak Outflow)	Peak Flood Level	
Highmont TSF	Open channel	High	1/3 between 1000-year and PMF	PMF[2] 24-hour (260 mm[3], 9.8 m^3/s)	1482.4 m[4]	(KC 2005)
S1 Pond	Open channel to pipe	Significant	Between 100-year and 1000-year	100-year 24-hour (59 mm, 0.6 m^3/s)	1444.1 m	(KCB 2015b)
S2 Pond	Open channel	Significant	Between 100-year and 1000-year	100-year 24-hour (59 mm, 0.1 m^3/s)[5]	1458.3 m	
S3 Pond	None (plugged)	High	1/3 between 1000-year and PMF	1/3 between 1000-year and PMF, 72-hour[6] (174 mm, Note 7)	1458.3 m	(KCB 2015b) (KCB 2019a)
S5 Pond	Pipes (removable plug)	Significant	Between 100-year and 1000-year	100-year 24-hour[8] (59 mm, Note 9)	To be confirmed (Note 11)	(KCB 2019a)
S8 Pond	Pipes	Low[12]	100-year	100-year 72-hour (86 mm, Note 10)	1451.7 m	(Note 13)

Notes:
1. As per the Code.
2. The spillway channel has capacity for the PMF, from a 24-hour PMP event, but the erosion protection was only designed for the 200-year 24-hour storm event. Damage during floods is expected and would require subsequent repair and maintenance.
3. 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.
4. Assumes gate is in open position.
5. Does not include any additional flow from the Highland Spillway channel which may flow into S2 Pond via deflection berm.
6. As IDF is stored, duration increased from 24-hours to 72-hours to be consistent with the Code (KCB 2019a).
7. The peak spillway discharge during the IDF was not reported as the spillway is plugged and the IDF is stored.
8. Although this assessment assumes the IDF is stored, flood routing is governed by pumping capacity and 24-hour duration storm event is a worse case scenario than 72-hour storm because the peak inflow is higher.
9. The peak spillway discharge during the IDF was not reported as the spillway was assumed to be completely blocked by the sandbags.
10. The S8 Pond overflow spillway pipe is operable, but routing was checked for both to store (i.e. spillway blocked) or to route (i.e. spillway open) the IDF and both conditions were satisfied.
11. Peak flood level during the IDF at S5 Pond requires additional flood routing and assessment of existing pumping capacity to be confirmed.
12. 2018 DSR recommended increasing the consequence classification of the S8 Pond from “low” to “significant”: THVCP and KCB will take this recommendation into consideration during next consequence classification review.
13. Review was completed as part of 2017 DSI (KCB 2018).

Figure 4.3 Potential Flood Zone Along North Dam Toe Due to Access Road



4.5 Freeboard

Where available, the minimum freeboard[6] measured during 2019 based on either the DSI site visit or regular surveys are estimated in Table 4.3. THVCP visually estimates freeboard as part of normal inspections. The key observations regarding freeboard compliance include:

- The minimum freeboard predicted during the IDF (or design spillway event for Highmont TSF) is greater than the minimum required under the Code for all ponds, except for S5 Pond which must be confirmed assuming pumping is operational (pump capacity currently not known). Refer to discussion in Section 4.4 and recommendation to upgrade S5 Pond to store the IDF when the spillways are blocked. In 2019, THVCP installed a secondary pump as back-up for freshet.
- Freeboard for Highmont TSF is reported relative to the dam crest and the spillway channel at the spillway gate, assuming the spillway gate is fully open during the spillway design flood which is larger than requirements under the Code (Section 4.4). If flood levels were to crest out of the channel near the spillway gate, water can flow downstream, potentially eroding the North Dam:
  - Freeboard within the spillway channel refers to the difference between flood level and right bank at spillway gate which is below dam crest. Flow in the spillway channel is separated from the reservoir by culverts and not subject to the same wave or run-up conditions assumed in the Code freeboard calculations. The estimated available

[6] The vertical distance between the peak flood level during a flood event and the low point of the dam crest.

freeboard, during the spillway design flood (0.6 m), assuming the spillway gate is open, is appropriate for the spillway channel.

- As discussed in Section 4.4, flood routing in S5 Pond is reliant on the pumping system. Freeboard estimates assume pumps are operating throughout the IDF.
- Freeboard at S3 Pond is reported for the 72-hour duration IDF which meets requirements of the Code.
- Freeboard at S8 Pond is greater than criteria if the IDF is routed through the spillway pipe or is stored in the pond.

Table 4.3 Freeboard at Time of Site Inspection

Dam	Freeboard (m) – Flood Conditions			Freeboard (m) – Normal Conditions	
	Minimum Required During IDF[1]	Minimum During IDF Based on Flood Routing[2]	2019 Minimum Freeboard (freshet/flood)	Minimum Required Under Normal Conditions	2019 Freeboard (non-freshet/non-flood)
Highmont TSF	0.9 m[2,3]	4.6 m[5]) – dam crest 0.6 m[5] – spillway channel[9, 10]	6.3 m[5] – dam crest 1.2 m[5] – spillway channel[9]	Note 11	6.86 m to 7.2 m – dam crest
S1 Pond	0.5 m[4]	1.0 m[4]	2.2 m	Note 11	2.65 m to 2.85 m
S2 Pond	0.5 m[4]	0.7 m[4]	1.0 m	Note 11	2.6 m to 2.94 m
S3 Pond	0.3 m[2]	1.1 m[2, 6]	2.1 m	Note 11	2.4 m to 3.32 m
S5 Pond	0.5 m	To be confirmed (Note 7)	2.7 m	Note 11	3.88 m to 4.1 m
S8 Pond	0.5 m[4]	0.5 m[2, 8]	0.9 m	Note 11	1 m to 2.5 m

Notes:
1. As per the Code, refers to minimum vertical distance between dam crest and peak IDF level.
2. Based on KCB (2018).
3. Minimum required freeboard to accommodate wave run-up as per CDA (2014) is 0.4 m; however, minimum freeboard specified as 0.5 m to be consistent with other similar structures around the site.
4. Based on KCB (2015b).
5. Freeboard during PMF 24-hour duration spillway design flood which is larger than IDF required under the Code. Assumes spillway gate is open.
6. Freeboard reported for 72-hour duration IDF. Freeboard during operation storage condition (100-year 30-day + IDF 24-hour) is 0.4 m which still meets criteria.
7. Minimum freeboard during the IDF at S5 Pond to be confirmed assuming pumping is operational, refer to discussion in Section 4.4 recommendations to upgrade S5 Pond to store the IDF when the spillways are blocked.
8. Freeboard reported for the scenario where the IDF is stored in the pond.
9. Freeboard in spillway channel refers to difference between highest flood level and the spillway channel banks.
10. Freeboard in spillway channel during design flood is appropriate as discussed in Section 4.5.
11. 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.
12. Based on THVCP Inspection Reports.
13. 2019 freeboards are based on the 2019 transducer data of pond elevation through September.

5 REVIEW OF MONITORING RECORDS AND DOCUMENTS

5.1 Monitoring Plan

The Operation, Maintenance and Surveillance (OMS) manual, was reviewed and issued as draft by THVCP in December 2018 (THVCP 2018). The activities undertaken for inspection and monitoring of the Highmont 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]	Highmont Dams S1, S2, S3,and S5 Seepage Recovery Ponds	Monthly	Yes	THVCP	THVCP Inspection Reports (Reviewed by KCB)
	S8 Seepage Recovery 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		KCB	Inspection Report by KCB
Instrumentation Monitoring					
Piezometers	Highmont Dams Spillway, S1, and S2 Seepage Recovery Ponds	Monthly[3]	Yes	THVCP	Data reviewed by KCB as part of Annual DSI
Seepage flow instruments	S1, S3, S5,and S8 Seepage Recovery Ponds	Monthly[3]	Yes	THVCP	
Surveys					
Dam Crest	Highmont Dams	Annually	Yes	THVCP	Data reviewed by KCB as part of Annual DSI
Survey monuments	Highmont Dams	Annually	Yes	THVCP	
Pond level	All	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 inspection in response to the following threshold exceedances:
   - 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. When accessible.

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

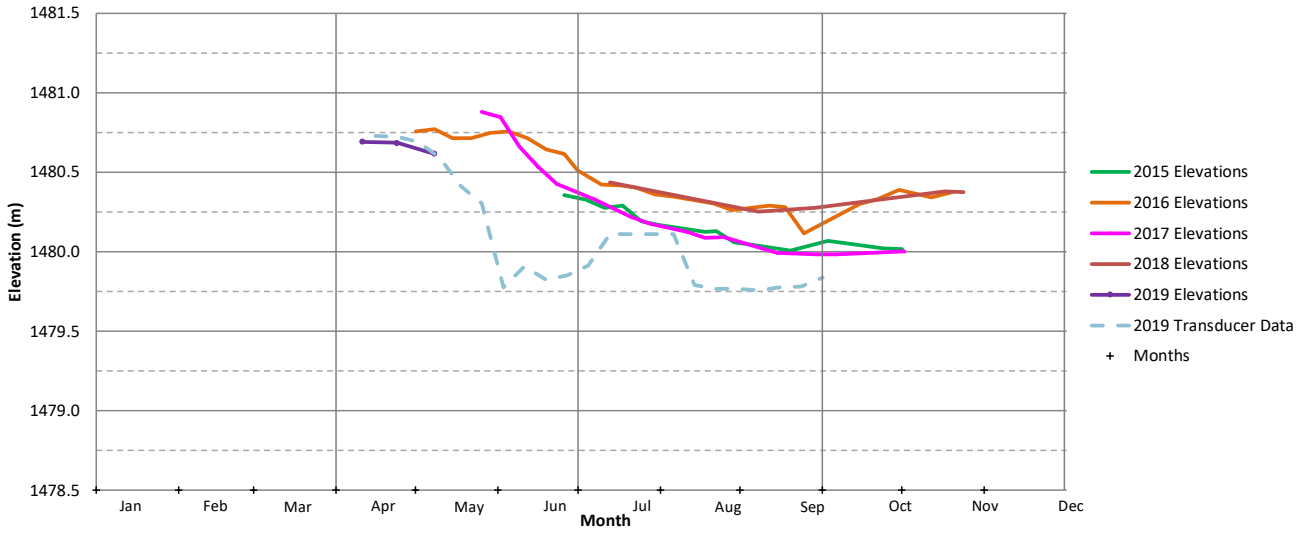
In addition to the routine and dam safety inspections referenced in Table 5.1, the Tailings Review Board toured the Highmont TSF, with KCB and THVCP, during the meeting hosted at site in August 2019. This activity is not specifically listed as a requirement of the OMS Manual but is done (typically annually)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

5.3 Reservoir Level

THVCP has a transducer installed at the Highmont TSF spillway channel, near the inlet, to monitor pond levels. In addition, the Highmont TSF pond level was surveyed twice in April and once in May 2019 during freshet. The water levels measured by the transducer are similar to the surveyed pond levels indicating it can be used to represent pond level. The pond level is also visually checked during routine inspections but not recorded.

The Highmont TSF pond level has remained relatively constant with the expected seasonal rise and fall associated with freshet, refer to Figure 5.1. The annual fluctuation in pond level is less than 1 m.

Figure 5.1 Highmont TSF Pond Water Elevations – 2015 to 2019



5.4 Piezometers

In 2019, there were 25 piezometers monitored at the Highmont TSF. Maximum and minimum piezometric levels, since 2007, instrument thresholds, as well piezometric trends are reported in Appendix IV-B. Monthly readings between May and September 2019 are available for piezometers at North Dam, along the spillway approach channel (Figure IV-B-1), at the Highmont impoundment (Figure IV-B-2 to Figure IV-B-4), as well as downstream of S1 Pond and S2 Pond Dams (Figure IV-B-5).

2019 piezometer measurements typically show similar seasonal patterns as previous years which reflects fluctuation in the Highmont TSF pond level. A summary of key observations for 2019 reporting period are as follows:

- There were no piezometric threshold exceedances in 2019.
- 2019 piezometric levels show that groundwater levels in the impoundment are highest in the beach and fall towards the Highmont TSF perimeter dams and the pond. This pattern has been persistent for the instrumentation record for the existing condition.
- Instruments in the northeast corner of the impoundment (PW-A, HM-PS-01, HM-PS-02 and HM-PS-03) showed an upward trend between May 2016 and mid-2018. The rising trend started decreasing in the last quarter of 2018 which continued in 2019, leveling off later in the year. KCB completed a walk-over of the crest, downstream slope and toe in the area of these instruments during the 2019 DSI site visit and no issue (e.g. change from previous inspections) or concern was observed. Refer to Appendix IV-B for further information:
  - Based on 2019 measurements, which did not show an increasing trend that was observed starting in 2016, DSI recommendation HD-2018-01 has been closed.

5.5 Survey Monuments

Survey monuments at the Highmont TSF are shown on Figure 3 to Figure 5. Monuments were surveyed once in October 2019. This meets the required frequency prescribed in the 2018 OMS manual. Refer to Figure IV-B-6 (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 recent trends:

- 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. This is consistent with previous years; refer to Appendix IV-B for more details.

5.6 Seepage

Seepage flows are monitored upstream of four seepage ponds (S1, S3, S5, and S8 Ponds) at instruments (weirs) and with frequencies summarized in Table 5.2. Locations are shown in Figures 3 to 5 and 2019 flow measurements are plotted on Figure IV-B-7. Monitoring frequencies for all ponds are set primarily for environmental and water balance factors, not dam safety. Monthly data was reviewed by KCB as part of this DSI and it was considered adequate from a dam safety perspective. 2019 flows were consistent with recent trends and no observations of turbid flow, related to potential piping were noted in the inspection reports.

Typically, flow rates peak in April/May during freshet. Although based on a lower number of readings, 2019 seepage measurements were generally similar to recent measurements during the same time period. The above average flows observed in all the seepage flow measurement instrumentation in 2017 was likely an early response to the freshet. This peak was not observed in 2018 or 2019, possibly influenced by the reduced frequency of readings and milder freshet.

Table 5.2 Summary of Seepage Flow Measurement Instruments

Instrument ID	Location	Instrument Type	2019 Monitoring Frequency
HM-S1-FS-02	Upstream of S1 Pond	Weir – Datalogger and Manual Reading	Monthly Manual Readings
HM-S3-FS-01	Upstream of S3 Pond	Weir – Datalogger and Manual Reading	Monthly Manual Readings
HM-S5-FS-01	Upstream of S5 Pond	Pipe and Bucket – Manual Reading	Monthly Manual Readings
HM-S8-FS-01	Upstream of S8 Pond	Pipe and Bucket – Manual Reading	Monthly Manual Readings

5.7 Water Quality

As required by permit (PE-376), water quality downstream of the Highmont 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 fourteen permitted surface water quality monitoring sites in the Highmont area, as shown on the site monitoring plan in Appendix V.
- There are two permitted performance targets in PE-376 for this site: Sample Site #264 (S5 Pond Outlet) and #279 (S8 Pond Outlet). There was no discharge from S8 Pond during 2019, therefore, no water samples were required to be collected. One sample was collected from S5 Pond Outlet in July 2019, all seepage was reclaimed for process water use and not discharge, therefore all discharge requirements were met.
- All sampling sites were in compliance with the permit levels, required sampling frequencies and parameters except for:
  - Sample Site #104 (Site Highmont Tailings Pond) which missed measurements of pH, conductivity, water temperature and dissolved oxygen in April
  - Sample Site #207 (Site Seepage Pond 2) which missed measurements of total organic carbon (TOC) and dissolved organic carbon (DOC) in April.
  - Sample Site #376 (creek below S2/S8 Pond) was sampled 3 times out of 4 required times between March and October.

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 photographs of each site are included in Appendix II. Copies of the filed inspection forms are included in Appendix I.

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

- Highmont spillway: culverts located downstream side of spillway culverts crossing dam and upstream of the flow control gate are obstructed by vegetation. Vegetation should be cleared as part of THVCP routine maintenance.
- Highmont spillway channel downstream of the road is vegetated. Vegetation should be cleared as part of THVCP routine maintenance before 2020 freshet.
- S1 Seepage Recovery Pond: Low-Level Outlet trash rack should be cleared during routine maintenance.
- S2 Seepage Recovery Pond:
  - spillway channel is partially obstructed by vegetation. Vegetation should be cleared as part of THVCP routine maintenance before freshet; and
  - the inlet channel profile has been changed due to the temporary access built over the channel. The design dimensions should be restored, and trees cleared from the inlet area before 2020 freshet.
- Minor rutting was noted on the crest surface of S5 Seepage Recovery Pond and should be maintained as part of THVCP routine maintenance.

7 ASSESSMENT OF DAM SAFETY

7.1 Dam Classification Review

The dam consequence classifications are summarized in Table 7.1. No change in consequence classification was recommended for any of dam sites during the most recent dam consequence review hosted by THVCP on January 23, 2019. No changes to the consequence classification were recommended in the 2018 DSR except for upgrading the S8 Pond dam consequence from “Low” to “Significant”; this recommendation will be considered by THVCP and KCB for the next dam consequence review in 2020.

Table 7.1 Summary of Highmont Dam Consequence Classifications

Name of Dam	Consequence Classification (CDA 2013)
Highmont TSF Dams	High[1]
S1	Significant
S2	Significant
S3	High
S4	N/A (Breached; no longer a dam structure)
S5	Significant
S8	Low
S9	N/A (Breached; no longer a dam structure)

Note:
1. The East Dam was assigned a "Significant" consequence classification in AMEC (2014a). However, THVCP has adopted an increased standard and is managing all Highmont dams as "High" consequence classification.

7.2 Failure Mode Review

KCB reviewed the potential failure modes included in the Canadian Dam Safety Guidelines (CDA 2014) for Highmont TSF which is summarized in Appendix VI. Discussion of the interpreted key failure modes are summarized as follows:

7.2.1 Highmont Dams

- 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 away from the dam crest (minimum 290 m) by the tailings beach. Both are effective controls to prevent overtopping.
- Slope Stability: the structural integrity of the dams is typically 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. Stability analyses have been completed for various foundation conditions to confirm factor of safety criteria is met.

7.2.2 Seepage Recovery Pond Dams

Overtopping:

- The open channel spillways of S1 and S2 ponds are designed to safely pass a flood (PMF, 24-hour duration) significantly greater than the minimum IDF recommended under the Code (100-year flood). This is an effective control to manage overtopping risks.
- The spillway at S3 Pond has been plugged and the impoundment can store the IDF (72-hour duration) with adequate freeboard.
- Overtopping of S5 Pond is influenced by the pumping systems. THVCP has installed a secondary pump to decrease the likelihood of overtopping.
- The IDF can either be stored within S8 Pond or routed through the existing overflow spillway pipe. The likelihood of overtopping during the IDF is considered low.

7.3 Emergency Preparedness and Response

The emergency preparedness and response plan (EPRP) for the Highmont 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 presentation which outlines dam safety warning signs that all staff should 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. External emergency response groups have been provided a copy of the EPRP prepared specifically for them by THVCP. 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 the representative of the Communities of Interest (COIs), KCB staff on site and the EoR on the phone, on November 26, 2019.

8 SUMMARY

The Highmont 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. Previous recommendations that are now closed 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 Recommendations for Deficiencies and Non-Conformances – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[2]	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2016-05	Signage	-	Signage should be added to the spillway gate controls indicating which turn direction to open and close the gate and identify which seepage pond water is being diverted to in each position.	4	Q1 2018 (Open, THVCP to schedule for 2020)
HD-2017-01	Flood Management	Spillway	THVCP should modify the spillway channel to pass the peak spillway design outflow beneath the access road (bridge or arch culvert) or regrade the road surface so that water that flows over the road will report to the downstream spillway channel.	3	Q4 2020 (Open)
HD-2018-01	*Monitoring*	-	*At completion of the DSR, THVCP and KCB will develop a workplan to investigate the cause of changing piezometric conditions, which will include a review of the need for additional instrumentation in the Highmont TSF.*	*2*	*Q3 2019 (Closed)*
HD-2018-02	Flood Routing	10.1.8	Update flood routing assessment for Highmont TSF and associated seepage ponds based on the most recent site wide hydrology information for consistency and to confirm compliance.	3	Q2 2020 (Open)
HD-2018-03	*Monitoring*	-	*Survey monument P4 after snow has cleared to confirm interpretation that June 2018 horizontal movement is associated with survey error.*	*3*	*Q2 2019 (Closed)*
S2 Pond					
S2-2018-01	Monitoring	OMS	Include monitoring of the inlet plug during high flow events in the 2019 OMS manual. When available, define the minimum till plug elevation necessary to prevent overtopping of flow from Highmont TSF Spillway channel during the S2 Pond IDF.	3	Q4 2019 (Open)
S2-2018-02	Flood Routing	10.1.8	To improve dam safety of S2 Pond, by reducing overtopping risks, KCB recommends the Highmont TSF spillway till plug be permanently relocated to the S2 Pond inlet channel and built to sufficient height such that the plug would not be overtopped during the Highmont TSF IDF.	2	Q4 2019 (Open)
S5 Pond					
S5-2018-01	Flood Routing	10.1.8	Confirm the pumping capacity of the system at S5 Pond so that the ability to route the IDF (100-year return period, 24-hour duration) assuming the pumps are functioning as intended can be confirmed.	2	Q4 2019 (Open)
S5-2018-02	Flood Routing	10.1.8	To accommodate the temporary blocking of spillway during freshet, raise the dam crest so that the IDF (100-year 72-hour duration) can be stored within the impoundment, assuming no pumping is required. (Take into consideration, HD-2019-02)	2	Q3 2021 (Open, to be reviewed pending outcome of S5-2018-01)

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[2]	Recommended Deadline
S8 Pond					
S8-2018-01	Maintenance	OMS	A pipe was observed on the slope of the S8 Pond dam that did not appear to be connected to anything. This pipe should be removed.	4	Q4 2019 (Open)
S1 Pond and S3 Pond					
No outstanding recommendations from previous DSIs.					

Notes:
1. Recommendation ID numbers from 2017 DSI have been revised as shown.
2. 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.

Table 8.2 2019 Recommendations for Deficiencies and Non-Conformances

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority[1]	Recommended Deadline
Highmont Tailings Storage Facility					
TD-2019-02	-	DSR Recommendations	KCB and THVCP to develop a work plan to address 2018 DSR recommendations.	3	April 2020
S2 Pond					
S2-2019-01	Flood routing	10.1.8	S2 Pond spillway channel profile has been changed due to the temporary access over the channel. Original channel profile/capacity should be restored.	3	Q1 2020
S1 Pond, S3 Pond, S5 Pond, and S8 Pond					
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

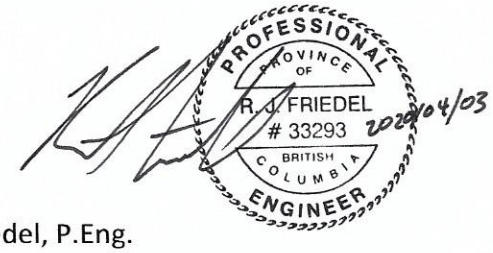
This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Teck Highland Valley Copper Partnership (Client) for the specific application to the 2019 Dam Safety Inspection Project, and it may not be relied upon by any other party without 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.

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

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

KLOHN CRIPPEN BERGER LTD.



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

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FIGURES

Legend

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

0 5km

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

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: MINE SITE PLAN

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

Date: 2020-01-20
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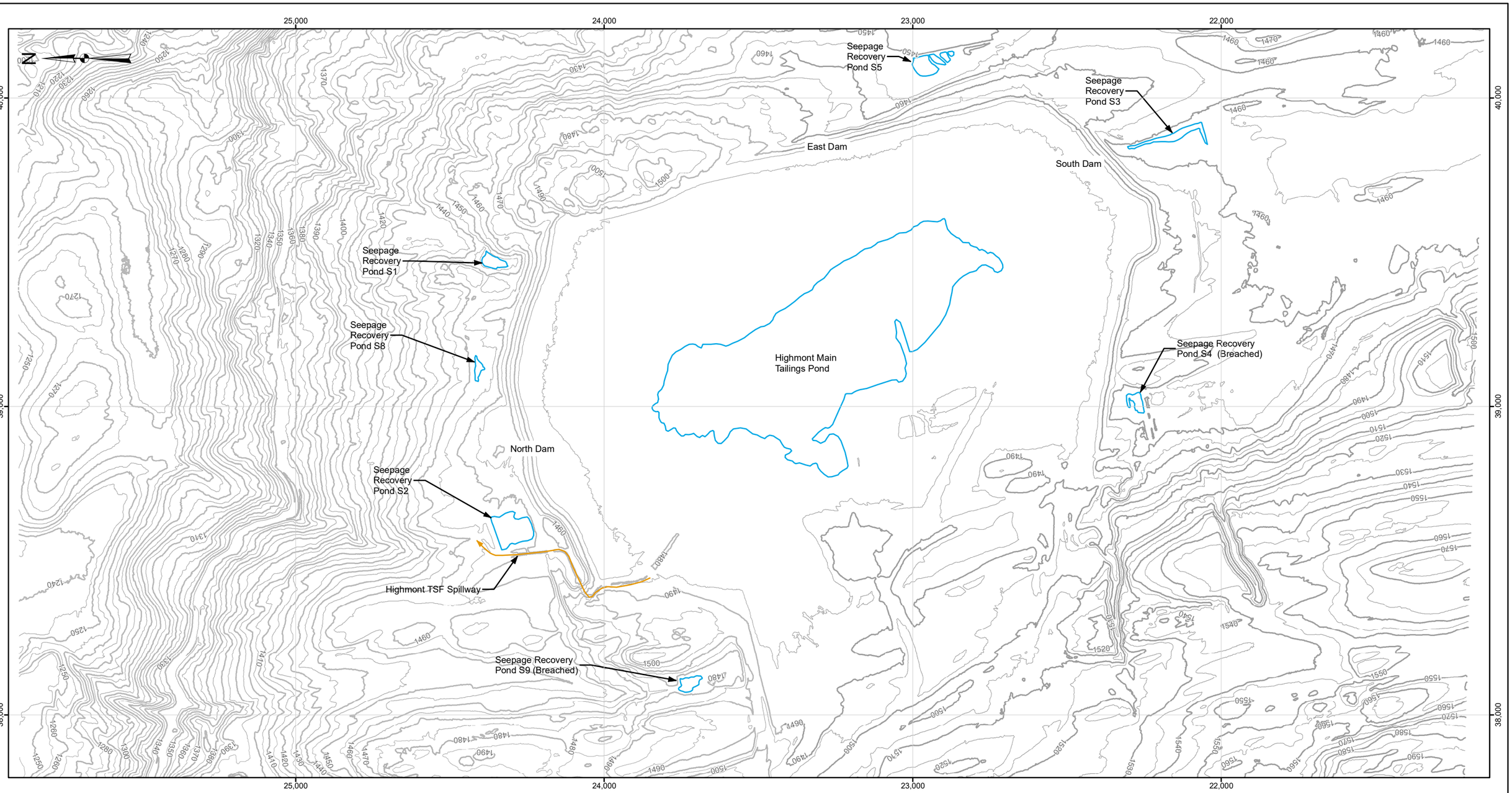

Legend

- Spillway
- Index Contour (10 m)
- Intermediate Contour (5 m)
- Waterbody

0 500m

Notes:
1. Projection: HVC Mine Grid.
2. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE
HIGHMONT TAILINGS STORAGE FACILITY
OVERVIEW

SCALE	PROJECT No.	FIG No.
1:12,000	M02341B53	2

Date: 2020-01-20
Document Path: Z:\MVCR\M02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Highmont\Fig2_Highmont_Overview.mxd

38,000 38,400 38,800 39,200 39,600

24,000 23,600

Seepage Recovery Pond Dam S2
Seepage Recovery Pond Dam S8
Seepage Recovery Pond Dam S1
Seepage Recovery Pond Dam S9 (Breached)
Highmont TSF Spillway
North Dam
Highmont Main Tailings Pond
S2 Pond
S8 Pond
S1 Pond
S9 Pond
S2
S1
HGH-2019-28
HGH-2019-29
HGH-2019-20
HGH-2019-19
HGH-2019-06
HGH-2019-18
HGH-2019-07
HGH-2019-17
HGH-2019-16
HGH-2019-15
HGH-2019-14
HGH-2019-40
HGH-2019-41
HGH-2019-26
HGH-2019-24
HGH-2019-25
HGH-2019-22
HGH-2019-21
HGH-2019-27
HGH-2019-11
HGH-2019-23
HGH-2019-10
HGH-2019-13
HGH-2019-09
HGH-2019-12
HGH-2019-01
HGH-2019-03
HM-S8-FS-01
HM-S1-FS-01
HM-S1-FS-02
HM-S9-FS-1
P5
P3
P2
P-O
S2-1
S2-2
S2-3
S2-4
PW-A
PW-C
P-B
P-D
P-K
P-G
P-F
P-E

N

Legend

Instrument Type (Active)
- Standpipe Piezometer
- Survey Monument
- Pipe/Bucket Flow Reading
- Weir

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (HGH-2019-xx)
- Spillway
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2019
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
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PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE
NORTH DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:5,000	M02341B53	3

Date: 2020-01-20
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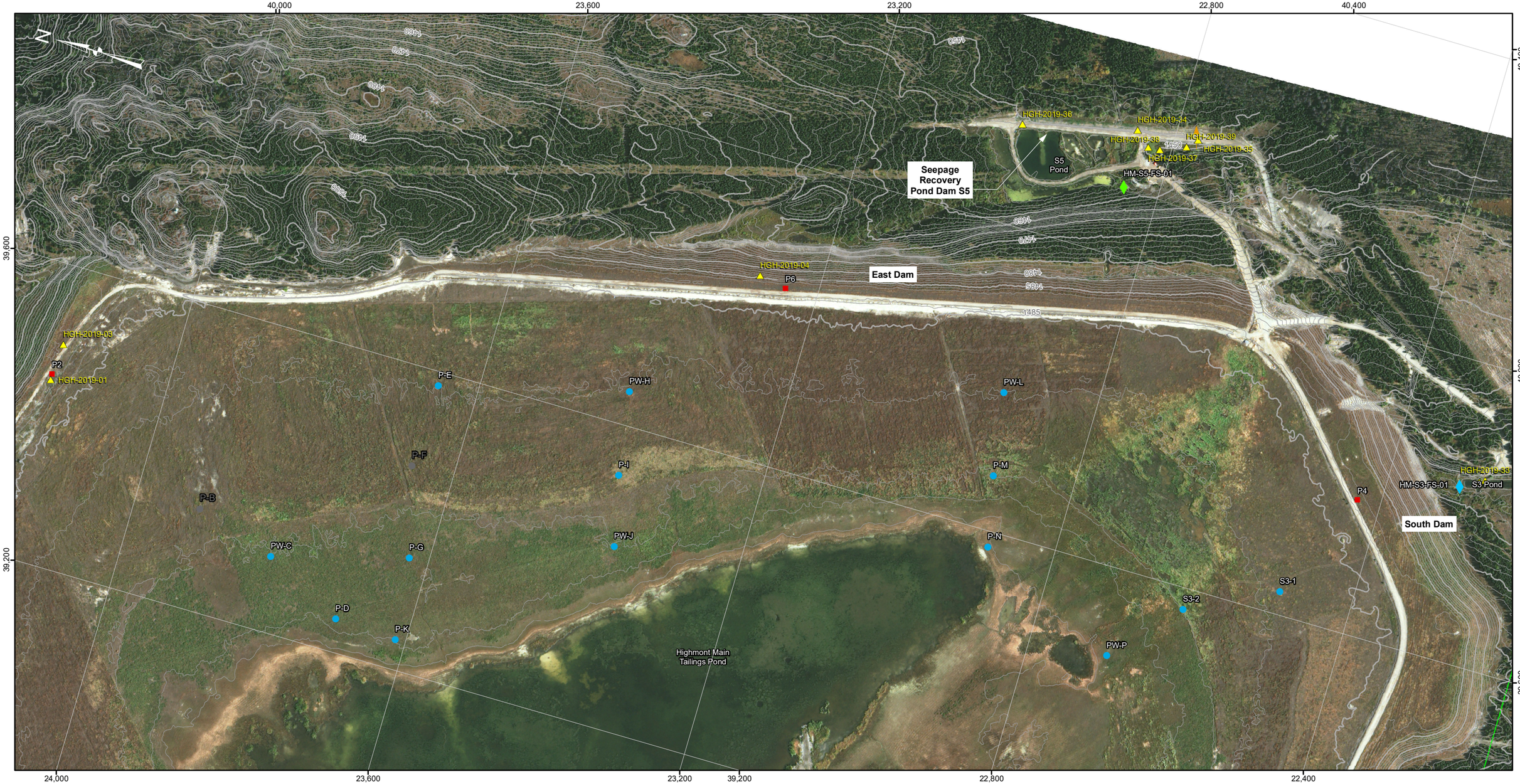


Legend

Instrument Type (Active)
- Standpipe Piezometer
- Survey Monument
- Weir
- Pipe/Bucket Flow Reading

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (HGH-2019-xx)
- Spillway
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2019
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE
EAST DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:5,000	M02341B53	4

Date: 2020-01-20
Document Path: Z:\MVCR\M02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02_Maps\Reports\DSI\Highmont\Fig4_Highmont_EastDamPlan.mxd

Legend

Instrument Type (Active)
- Standpipe Piezometer
- Survey Monument
- Weir

Waypoint (HGH-2019-xx)
Spillway
Spillway (Plugged)

Index Contour (5 m)
Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained September, 2019
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE
SOUTH DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:5,000	M02341B53	5

Date: 2020-01-20
Document Path: Z:\MVCR\M02341B53 - HVC-2019 Dam Safety Support\400 Drawings\GIS\02. Maps\Reports\DS\Highmont\Fig5. Highmont_SouthDamPlan.mxd

APPENDIX I

Dam Safety Inspection Checklist

APPENDIX I-A

Dam Safety Inspection Checklist – North, East, and South Dams

2019 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont North, East, and South Dam	**Inspection Date:**	June 10th, 2019
Weather:	Cloudy	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	Large freeboard 6.4 m based on May 7th survey		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate
Spillway Channel	Control gate (closed)	☐ Yes ☒ No	N/A

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

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Slope	☒ Yes ☐ No	Culverts crossing dam	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Channel Invert	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No	Culverts	☐ Yes ☒ No
PIPELINE DIVERSION	**Yes/No**		
Trash Rack	☒ Yes ☐ No		

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

INDICATOR	EMBANKMENT	SPILLWAY
Piping	☐ Yes ☒ No	
Sinkholes	☐ Yes ☒ No	
Seepage	☐ 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

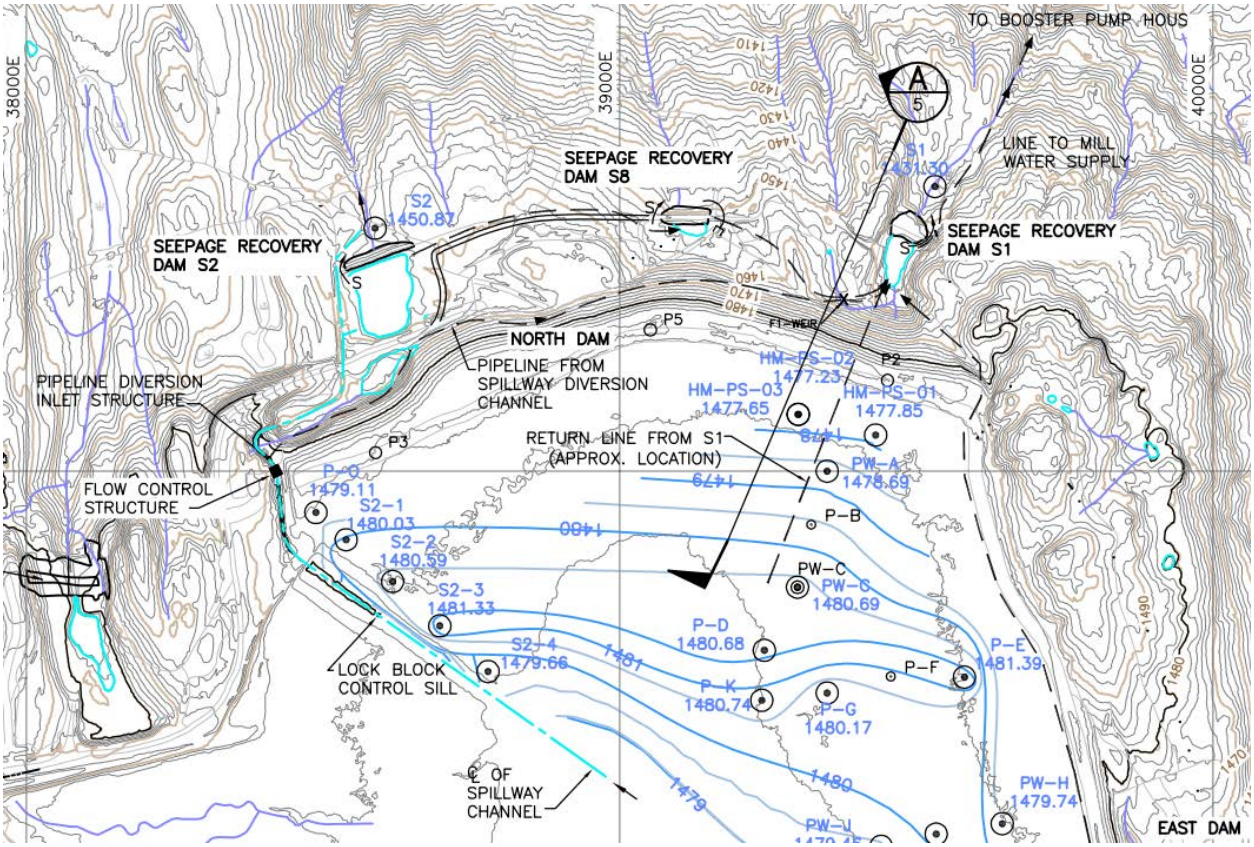
List and describe any deficiencies:

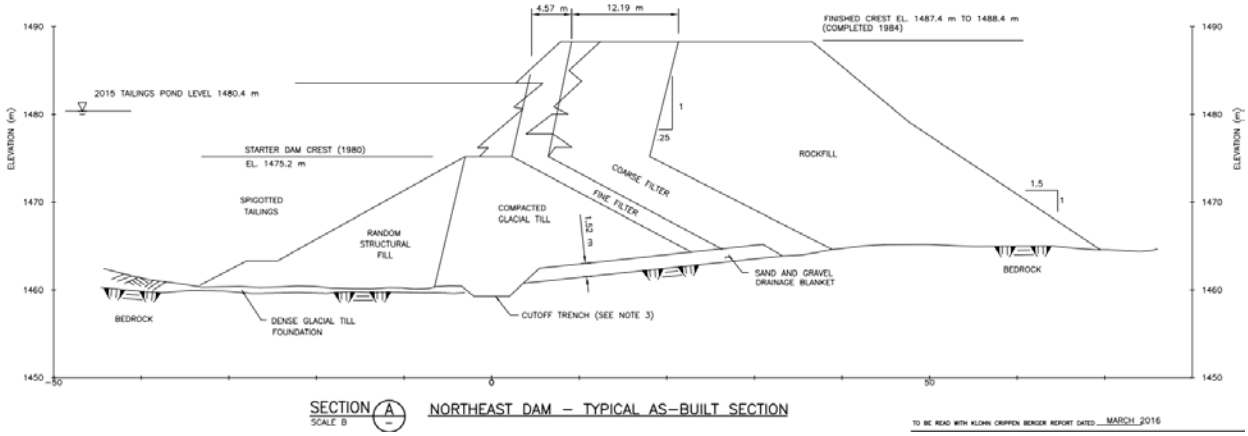
- No dam safety deficiencies observed

Comments:

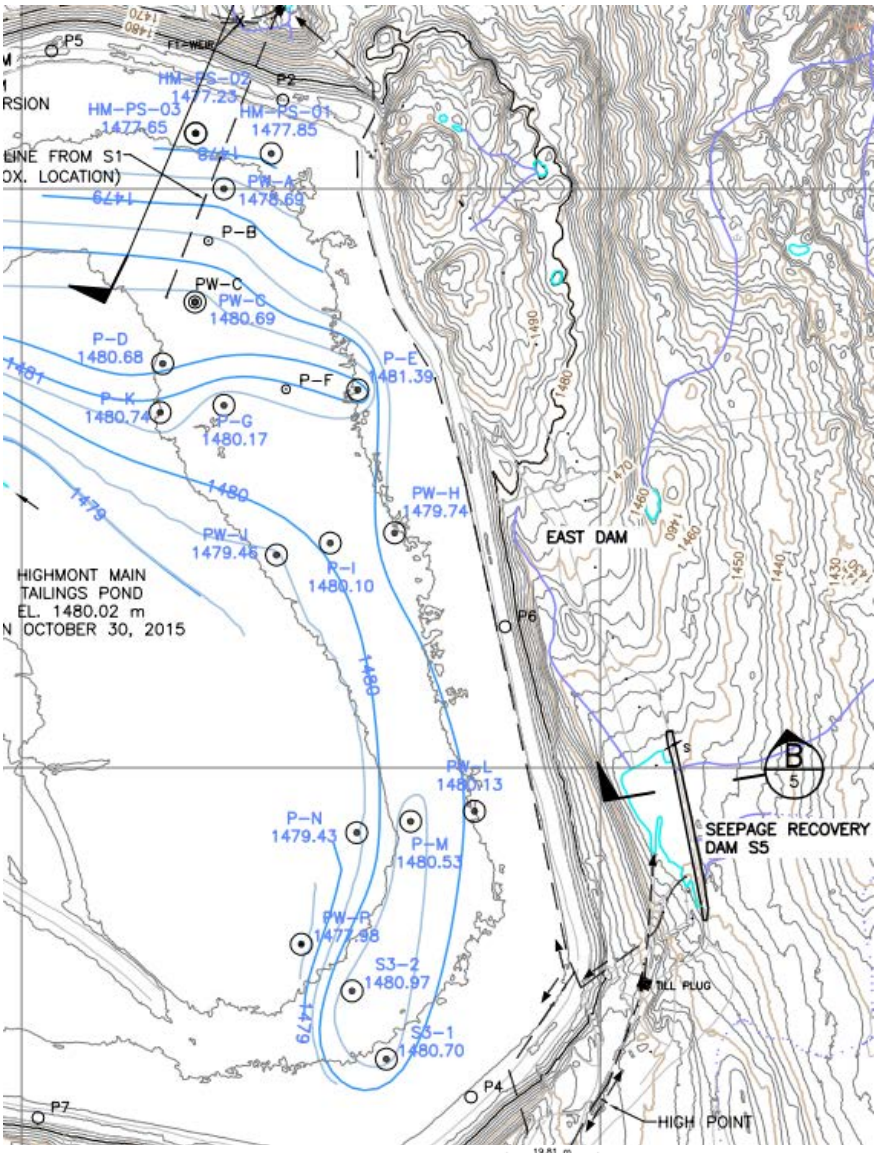
- There is vegetation growth at Highmont spillway channel (downstream of approach channel, and rock chute) which should be cleared as part of routine maintenance before freshet, including vegetation obstructing culverts crossing dam.
- Spillway flow control gate – No signage or safety grating is present at valve
- Completed walk-over of North Dam, near S1 Pond, where elevated piezo levels had been measured in 2017 and 2018. No visual indicators showing distress or concern observed. No seepage faces on downstream slope other than at toe, as expected.

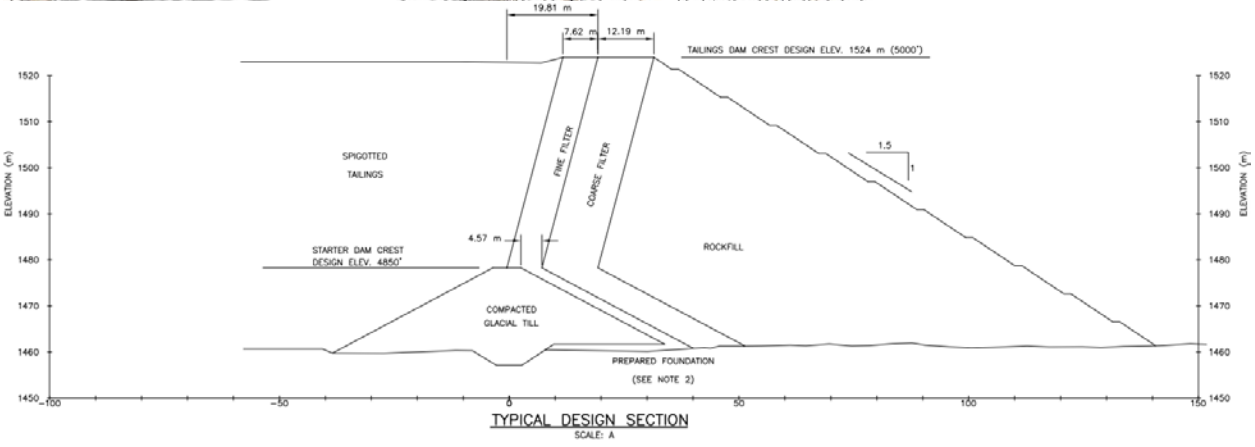
SITE PLAN (North Dam)



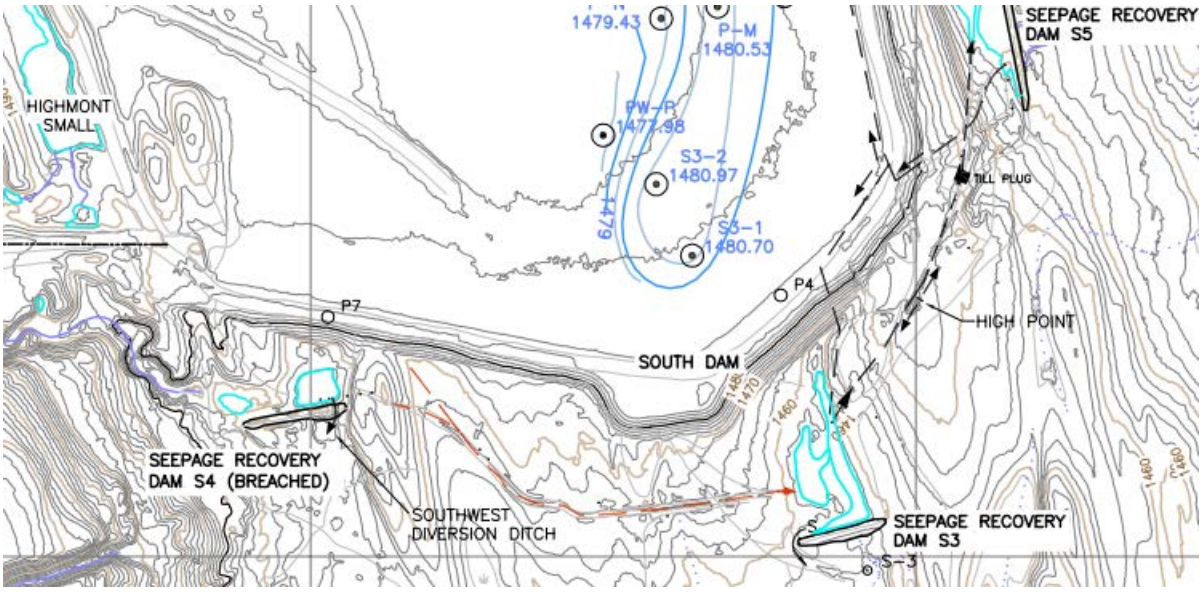


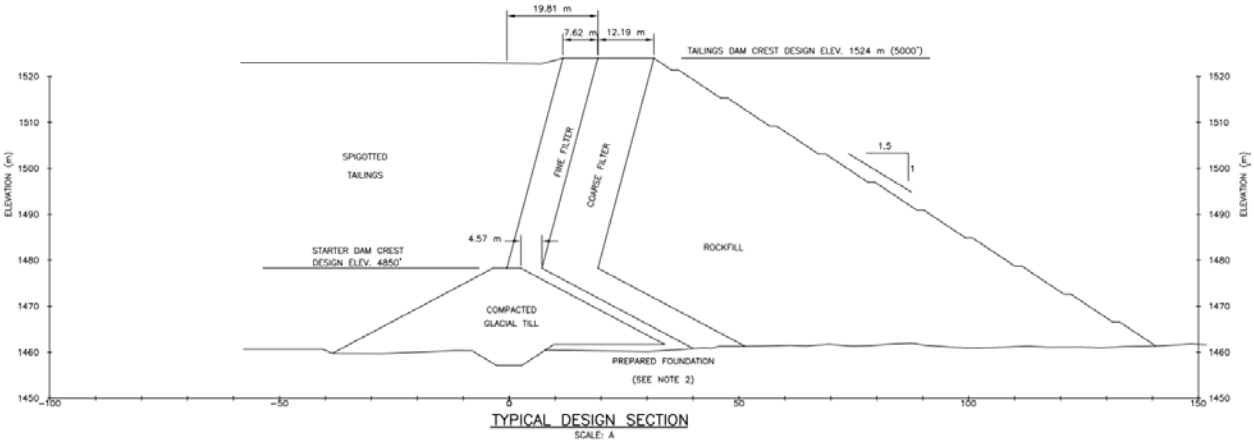
SITE PLAN (East Dam)





SITE PLAN (South Dam)





APPENDIX I-B

Dam Safety Inspection Checklist – Seepage Recovery Dams

2019 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S1	**Inspection Date:**	June 10th, 2019
Weather:	Cloudy	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	2.75 m on May 30 (based on THVCP Dam Inspection Weekly Report – Week 22, Ending June 4)		

Outlet Condition Survey

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

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

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Slope	☒ Yes ☐ No	Entrance	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Walls	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No	Channel	☒ Yes ☐ No
D/S Toe	☒ Yes ☐ No	Channel Slopes	☒ Yes ☐ No

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

INDICATOR	EMBANKMENT	SPILLWAY
Piping	☐ Yes ☒ No	
Sinkholes	☐ Yes ☒ No	
Seepage	☐ 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

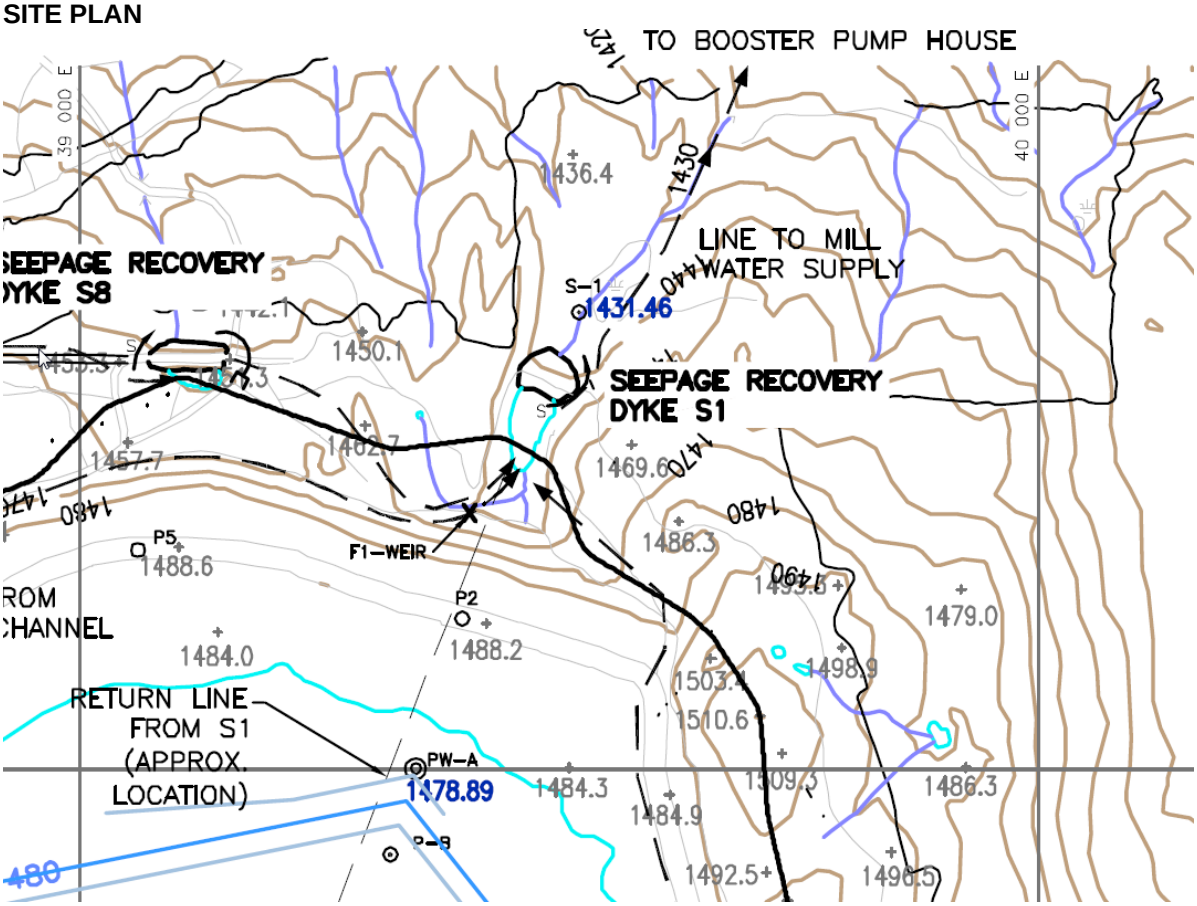
List and describe any deficiencies:

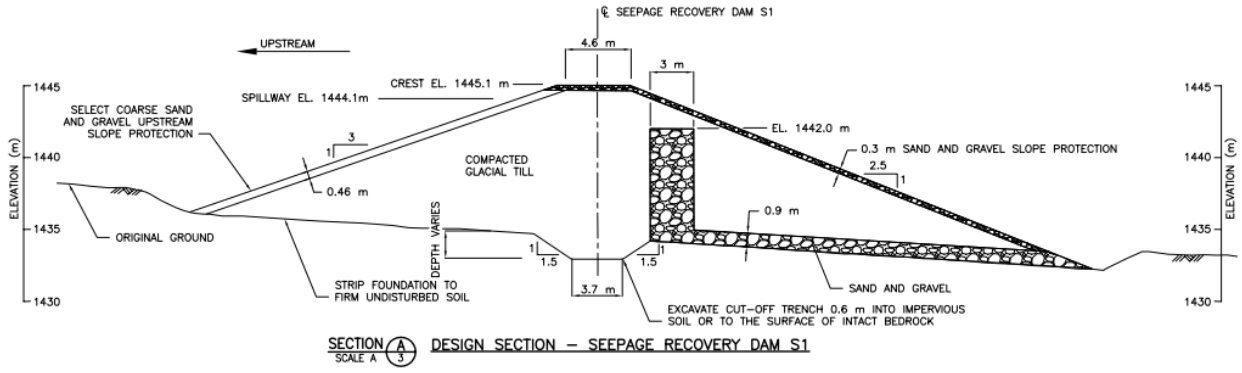
- No dam safety deficiencies observed

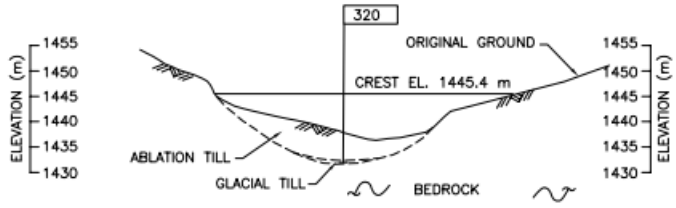
Comments:

- Low level outlet intake is partially obstructed and should be cleared as part of THVCP routine maintenance. If obstructed, does not impact flood routing assumptions.

SITE PLAN







PROFILE OF SEEPAGE RECOVERY DAM S1
SCALE B

2019 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S2	**Inspection Date:**	June 10th, 2019
Weather:	Cloudy	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	2.8 m on May 30, 2019 (as per THVCP Weekly Inspection Report of Week 22, ending June 4, 2019)		

Outlet Condition Survey

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

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

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

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

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

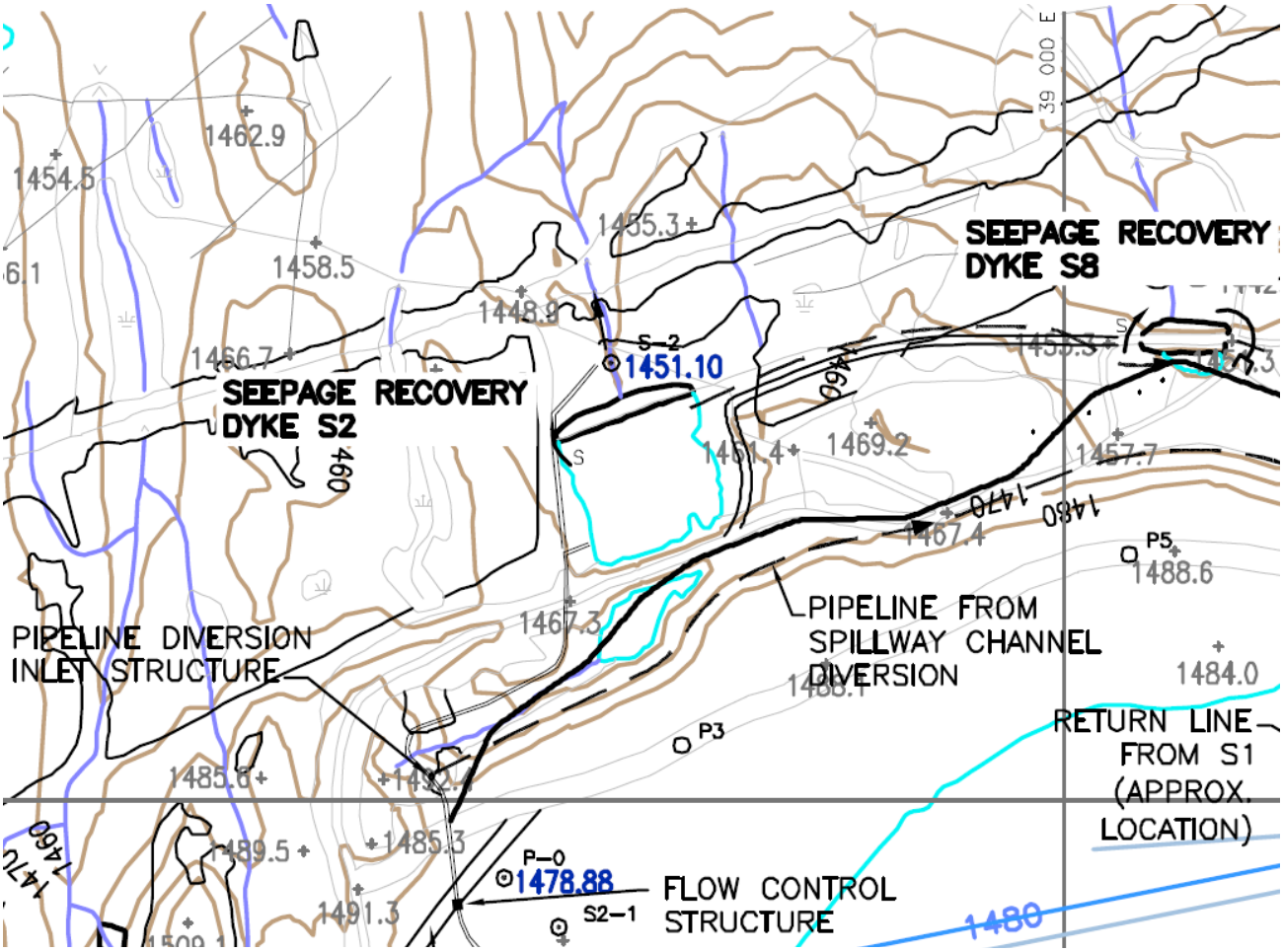
List and describe any deficiencies:

- No dam safety deficiencies observed

Comments:

- Plug across inlet S2 channel to prevent flow from Highmont spillway channel from reporting to S2 Pond
- S2 Spillway is partially blocked (appears to be from a temporary access over the channel) and trees upstream of inlet. This do not pose an immediate dam safety concern but should be removed as part of regular maintenance by THVCP before freshet. Vegetation along spillway should be monitored and removed if reduces the outlet capacity.

SITE PLAN



PROFILE OF SEEPAGE RECOVERY DAM S2
SCALE B

2018 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S3	**Inspection Date:**	June 10th, 2019
Weather:	Cloudy	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	2.5 m on May 30, 2019 (as per THVCP Weekly Inspection Report of Week 22, ending June 4, 2019)		

Outlet Condition Survey

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

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

EMBANKMENT	Yes/No	SPILLWAY	Yes/No
U/S Slope	☒ Yes ☐ No	Entrance	☐ Yes ☐ No ☒ N/A
Crest	☒ Yes ☐ No	Walls	☐ Yes ☐ No ☒ N/A
D/S Slope	☒ Yes ☐ No	Channel	☐ Yes ☐ No ☒ N/A
D/S Toe	☒ Yes ☐ No	Channel Slopes	☐ Yes ☐ No ☒ N/A

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

INDICATOR	EMBANKMENT	SPILLWAY
Piping	☐ Yes ☒ No	
Sinkholes	☐ Yes ☒ No	
Seepage	☐ 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

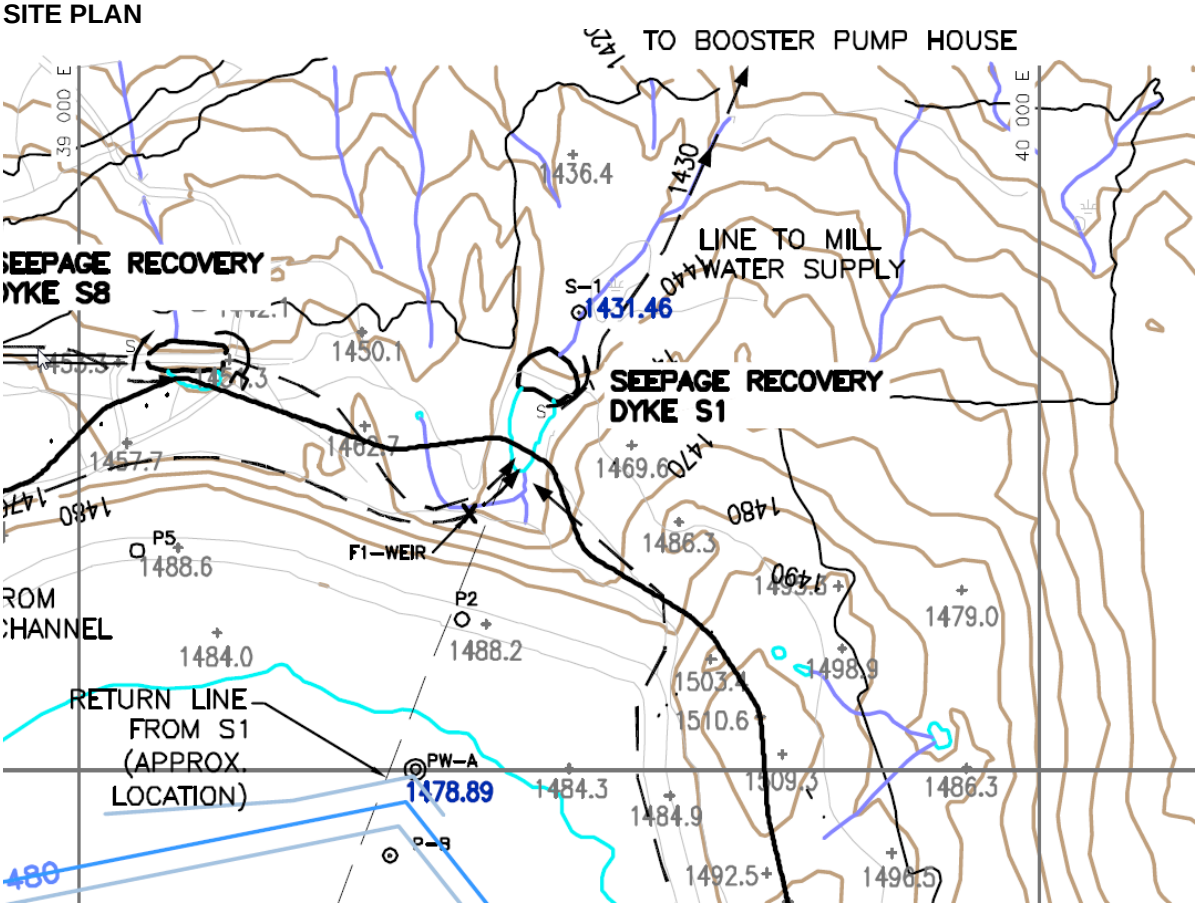
List and describe any deficiencies:

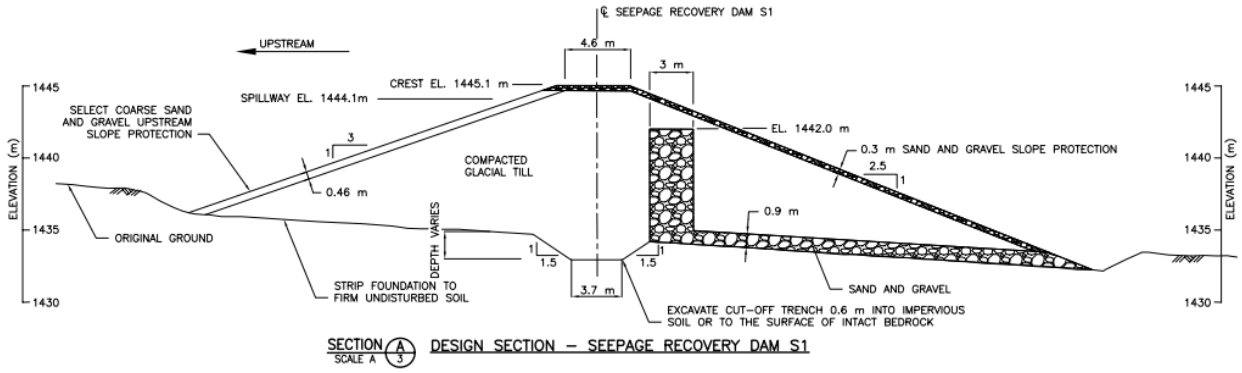
- No dam safety deficiencies observed

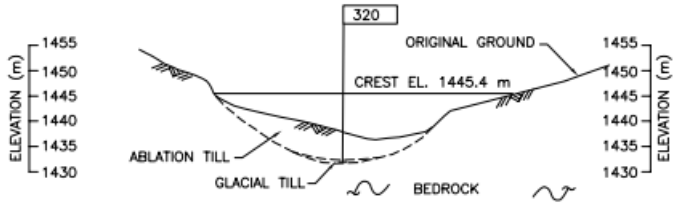
Comments:

- Spillway intake is blocked with glacial till to prevent discharge of water during the IDF.
- Area around outlet control is heavily vegetated and may cause safety concern to personnel who require access to the outlet control.

SITE PLAN







PROFILE OF SEEPAGE RECOVERY DAM S1
SCALE B

2019 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S5	**Inspection Date:**	June 10th, 2019
Weather:		**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):		1.5 m on May 30, 2019 (as per THVCP Weekly Inspection Report of Week 22, ending June 4, 2019)	

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	OUTLET Pipe - north	Yes/No	OUTLET Pipe - south	Yes/No
U/S slope	☒ Yes ☐ No	Inlet	Closed/Plugged	Inlet	Closed/Plugged
Crest	☒ Yes ☐ No				
D/S Slope	☒ Yes ☐ No				
D/S Toe	☒ Yes ☐ No				

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

INDICATOR	EMBANKMENT	OUTLET - north	OUTLET - south
Seepage	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
External Erosion	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Cracks	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Settlement	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Sloughing/Slides	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Animal Activity	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Growth	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Excessive Debris	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No

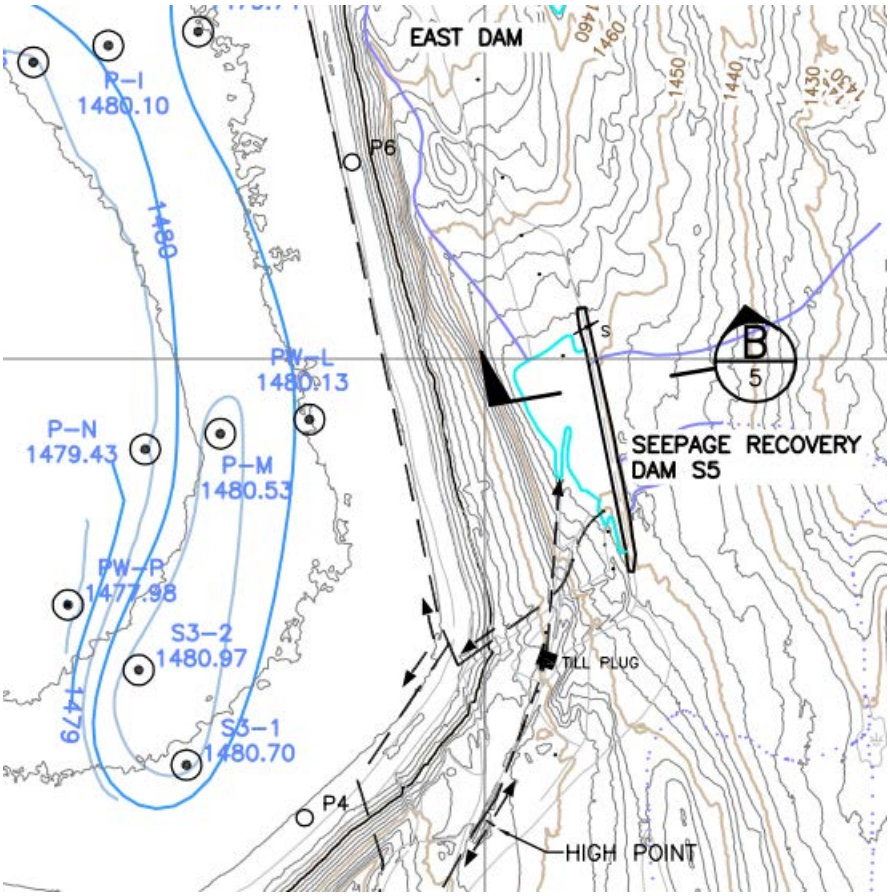
List and describe any deficiencies:

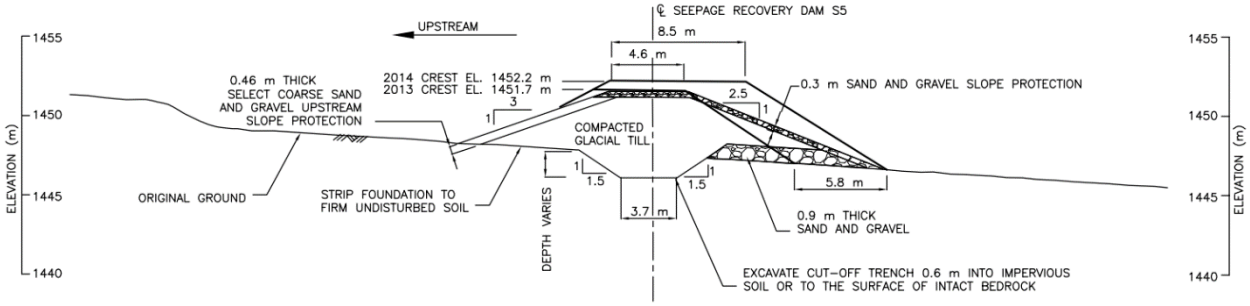
- No dam safety deficiencies observed

Notes:

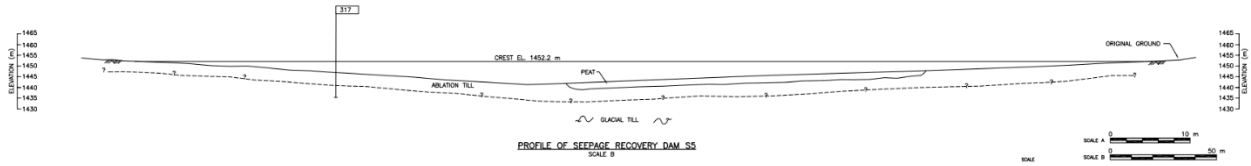
- Outlet pipes from pump sump sub-cell are sealed.
  - Refer to outstanding DSI recommendation RE: flood routing.
- Ruts observed on crest
- Spillway pipe valve is blocked and too low. It will not be accessible during a flood event
- Area around outlet control into the sub-cell where inflow reports to S5 Pond is heavily vegetated

SITE PLAN





SECTION B / 3 SCALE A DESIGN SECTION – SEEPAGE RECOVERY DAM S5



2019 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S8	**Inspection Date:**	June 10th, 2019
Weather:	Cloudy	**Inspector(s):**	Rick Friedel, P.Eng. Pablo Urrutia, P.Eng. Narges Solgi, EIT
Freeboard (pond level to dam crest):	1.7 m on May 30, 2019 (as per THVCP Weekly Inspection Report of Week 22, ending June 4, 2019)		

Outlet Condition Survey

Description	Outlet Controls?	Was it flowing?	Flow rate
Outflow Pipe	N/A	☐ Yes ☒ No	N/A

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

EMBANKMENT	Yes/No	OUTLET	Yes/No
U/S Slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No
Crest	☒ Yes ☐ No	Outlet Controls	☒ Yes ☐ No
D/S Slope	☒ Yes ☐ No		
D/S Toe	☒ Yes ☐ No		

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

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

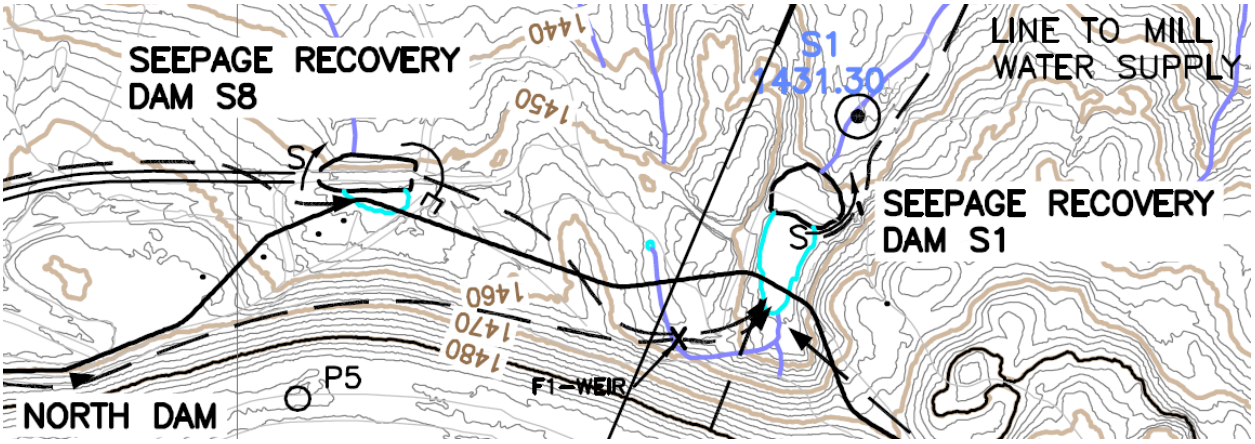
List and describe any deficiencies:

- No dam safety deficiencies observed

Comments:

- Muddy low point observed on crest of the road.
- Pipe in place on downstream slope, not connected to anything, but should be removed.

SITE PLAN


SEEPAGE RECOVERY
DAM S8
1440
1450
S1
431.30
LINE TO MILL
WATER SUPPLY
SEEPAGE RECOVERY
DAM S1
1460
1470
1480
P5
F1-WEIR
NORTH DAM

APPENDIX II

Visual Observations and Inspection Photographs

APPENDIX II-A

Visual Observations and Inspection Photographs – North, East, and South Dams

Appendix II-A
Visual Observations and Inspection Photographs – North, East, and South Dams

VISUAL OBSERVATIONS

Impoundment

- **Tailings Beach**: The tailings beach upstream of the downstream slope crest is well vegetated and the pond was well setback from the dam crest (>250 m) based on reservoir level, typical for this time of year (Photo II-A-1).
- **Pond**: At the time of the inspection the pond was centrally located in the impoundment similar to the image on Figure 1 through Figure 3.

Dam

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-A-2).
- **Left and Right Abutments**: Good physical condition. No signs of erosion, deterioration, horizontal displacement, or cracking.
- **Downstream Slope**:
  - Good physical condition. Downstream slope well vegetated throughout, providing adequate erosion protection for future service life (Photo II-A-3 to Photo II-A-6).
  - The steepened lower portion of the North Dam downstream slope near the dam spillway is noticeably less vegetated. This portion was constructed with rockfill and a steeper grade. Aerial imagery from 2003, and contour records from 1994 indicate that in this more susceptible section no significant adverse change has been observed compared to 2018 DSI (Photo II-A-8).
- **Seepage**:
  - Small observed ponded seepage from western underdrains of the North Dam was clear. The pond did not reach the toe of the dam and no flow was seen through the road culverts to S2 Pond. There are no signs of recent ponding or issues related to seepage flow through the road fill.
  - Small pond formed by runoff and seepage of eastern underdrains of the North Dam was observed at the toe of the dam upstream of S1 pond. Ponded water reports to S1 Pond. No dam safety concern (Photo II-A-6).
  - No seepage was observed along downstream toe of East Dam.
  - No seepage was observed along downstream toe of South Dam.

INSPECTION PHOTOGRAPHS

LEGEND:

- HGH= Highmont Tailings Facility.
- HGH-2019-## refers to 2019 DSI waypoint shown on Figure 3, Figure 4, and Figure 5.
- Photographs taken during inspection on June 10, 2019

Photo II-A-1 Overview of North Dam tailings beach, covered by vegetation. No signs of distress, settlement or depression. (HGH-2019-01)

Photo II-A-2 Overview of North Dam crest. No signs of distress, settlement or depression. (HGH-2019-01)

Photo II-A-3 Low spot on crest visible around P2 also demonstrated by contours on the plan view. No signs of distress, settlement or depressions. (HGH-2019-01)

Photo II-A-4 Overview of North Dam downstream toe and S1 Pond. No signs of distress or deformations (HGH-2019-02)

Photo II-A-5 Overview of North Dam downstream slope downstream of P2. No signs of distress or deformations. (HGH-2019-03)

Photo II-A-6 Overview of East Dam downstream slope, looking northeast. Slope covered by vegetation (HGH-2019-04)

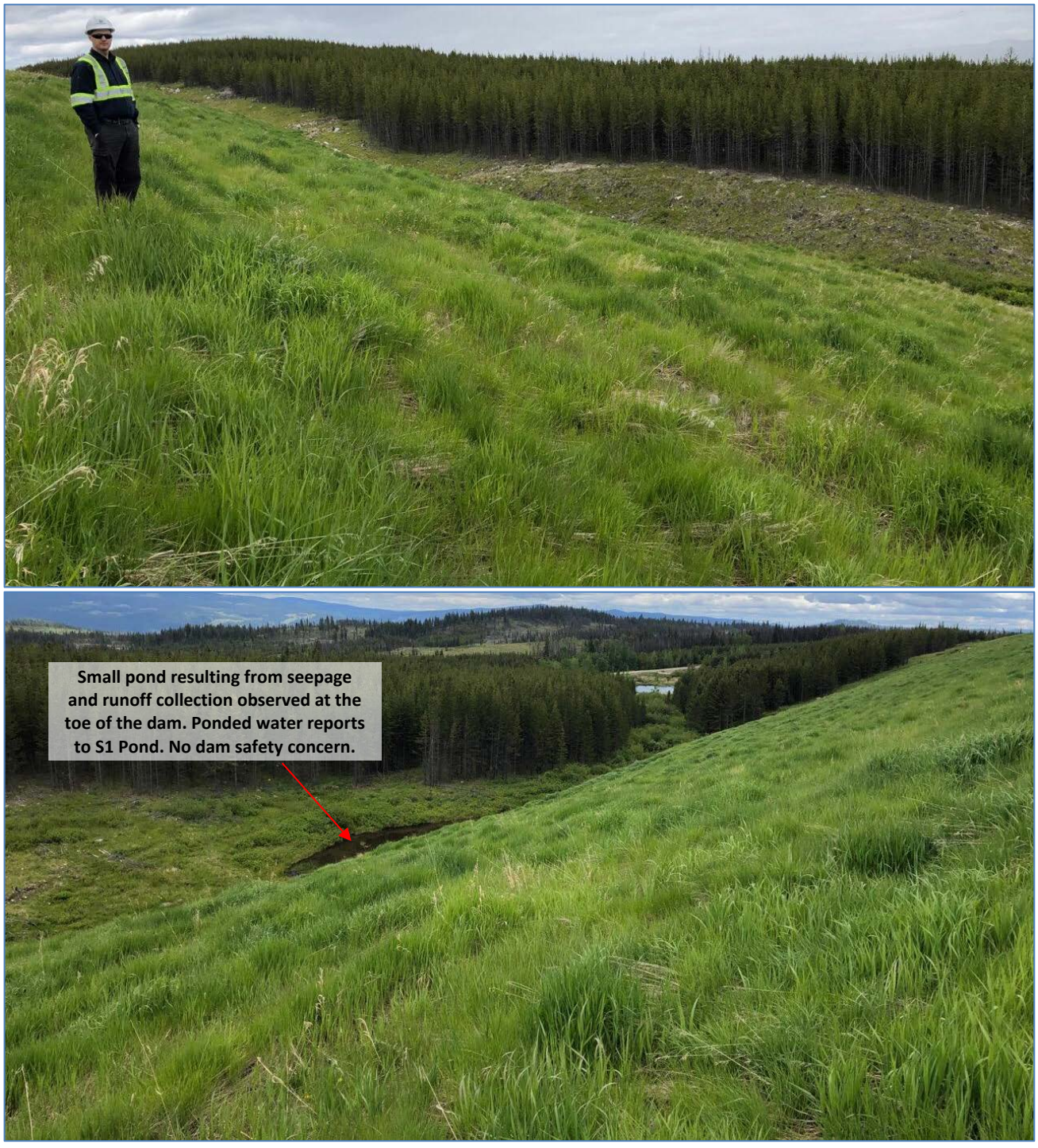


Photo II-A-7 Overview of South Dam downstream slope. Slope covered by vegetation (HGH-2019-05)

Photo II-A-8 Overview of North Dam downstream slope and toe, downstream of Highmont Spillway (HGH-2019-06)

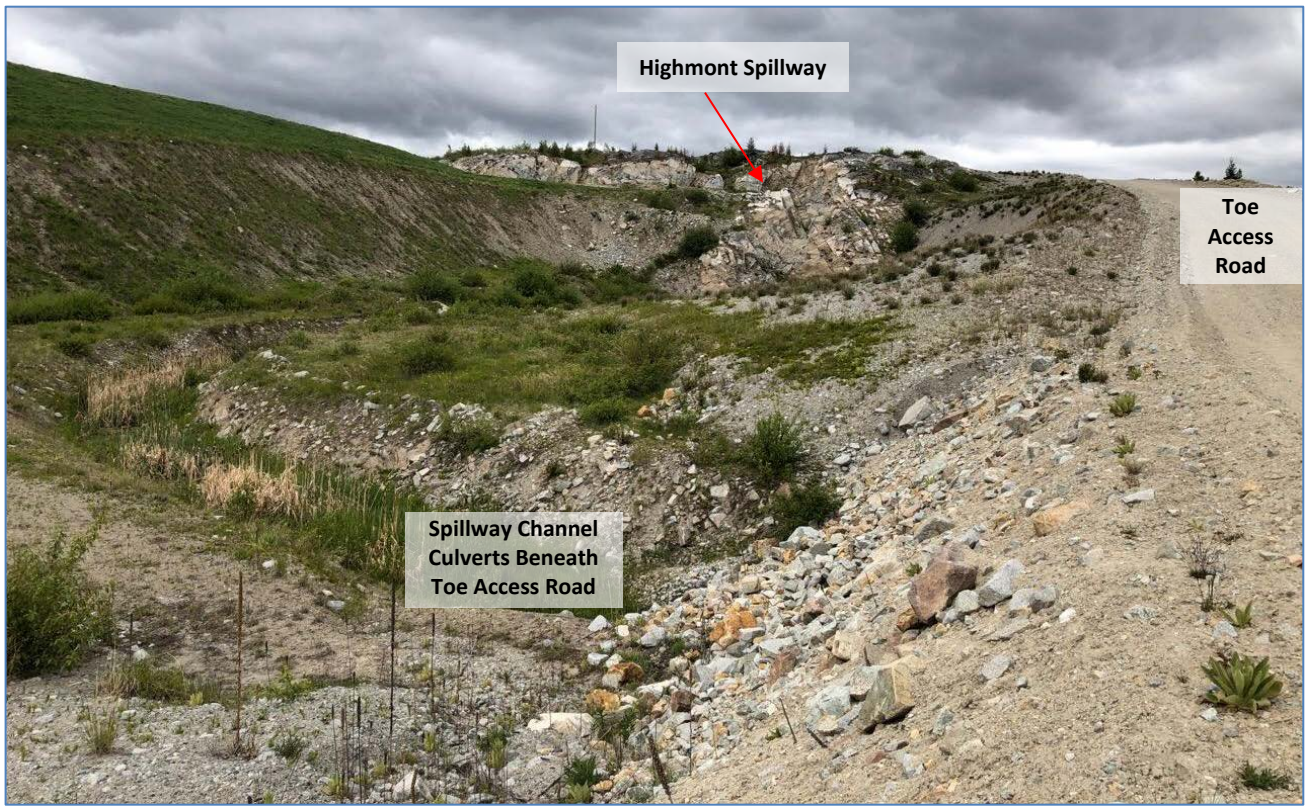


Photo II-A-9 Overview of South Dam downstream toe and S4 Pond breached embankment (HGH-2019-08)

Photo II-A-10 Overview of the South Dam downstream sloe and seepage weir upstream of S3 Pond. Flow is clear. No seepage face observed on dam slope (HGH-2019-09)

Photo II-A-11 Highmont Spillway diversion pipe to S1 Pond. Water flowing (HGH-2019-10 and HGH-2019-11)

Photo II-A-12 Seepage flow measurement weir at toe of Highmont Dam (HM-S1-FS-02). Water flowing. (HGH-2019-12 and HGH-2019-13)

Photo II-A-13 Overview of the North Dam downstream toe upstream of S1 Pond. No signs of seepage face on slope (HGH-2019-10 and HGH-2019-13)

Photo II-A-14 Highmont Spillway approach channel, concrete lock-block control sill – Spillway is inactive. Water ponded downstream of sill is controlled by level at spillway flow control gate (HGH-2019-14)

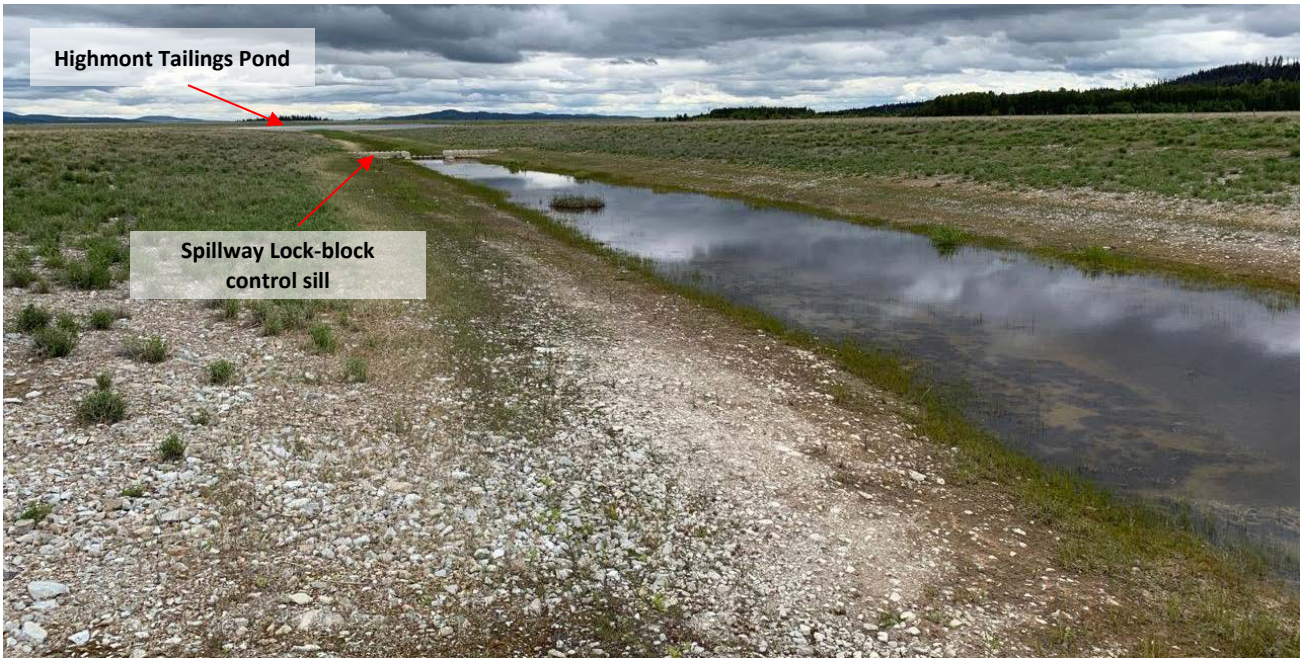


Photo II-A-15 Approach channel - Road culverts are partially submerged, clear of debris and vegetation. (HGH-2019-14)

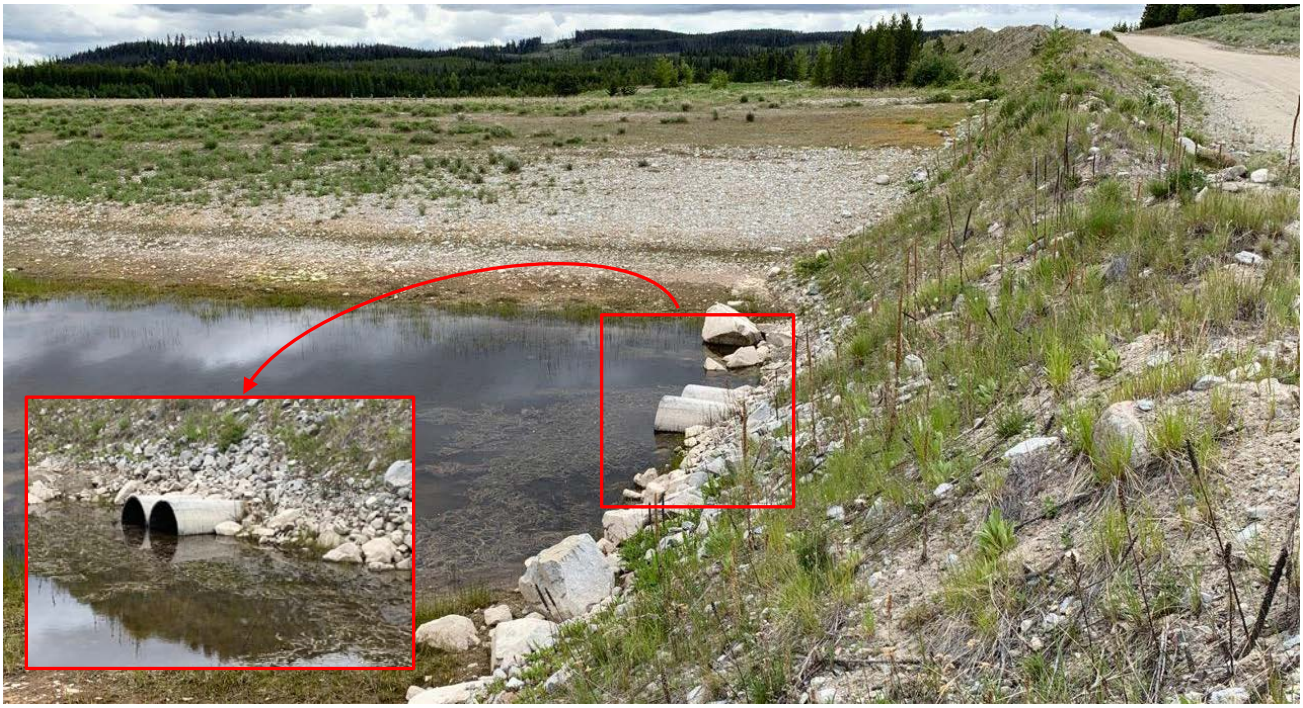


Photo II-A-16 Area downstream of approach channel culverts and upstream of flow control gate – Culverts are obstructed by vegetation which should be removed as part of routine maintenance (HGH-2019-15)

Photo II-A-17 Spillway flow control gate – No signage or safety grating is present at valve. (HGH-2019-15)

Photo II-A-18 Highmont Spillway channel, looking downstream of S1 Pond diversion. No flow downstream in spillway. (HGH-2019-16)

Photo II-A-19 Highmont Spillway channel looking at inlet to S1 Pond diversion – Trash rack on invert is clear of debris and water is flowing through diversion (HGH-2019-16)

Photo II-A-20 Overview of Highmont Spillway channel and rock chute downstream of North Dam. Channel is heavily vegetated near the culverts crossing road downstream of North dam (HGH-2019-06)

Photo II-A-21 Highmont Spillway channel downstream of rock chute, portion of channel where base is not in bedrock and has been covered with riprap (HGH-2019-17)

Photo II-A-22 No visible seepage through road downstream of North Dam and no evidence of excessive ponding or high-water level on dam toe (HGH-2019-18)

Photo II-A-23 Inlet of 33" ID Highmont Spillway culverts crossing toe access road. Channel is vegetated in this area. No flow was observed through the culverts. (HGH-2019-07)

Photo II-A-24 Highmont road-crossing culverts, downstream side of the road. Culverts are clear but misshapen. Vegetation similar to 2018 DSI (HGH-2019-19)

Photo II-A-25 Highmont Spillway channel downstream of road. There is vegetation growth which will be cleared as part of routine maintenance (HGH-2019-19)

Photo II-A-26 Highmont Spillway plug across S2 Pond inlet channel. No sign of recent flow in spillway or inlet channel (HGH-2019-20)

APPENDIX II-B

Visual Observations and Inspection Photographs – Seepage Recovery Dams

Appendix II-B
Visual Observations and Inspection Photographs
Seepage Recovery Dams

VISUAL OBSERVATIONS

Seepage Recovery Pond S1

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B-1).
- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B-1).
- **Downstream Slope**: Good physical condition. Slope covered in gravel and moderately vegetated. This combination provides adequate erosion protection based on performance over the service life (Photo II-B-2).
- **Pond**: At the time of inspection was about 1.6 m below the spillway invert which is typical for this time of the year (Photo II-B-3 and Photo II-B-4).
- **Spillway**: Good physical condition. Minor vegetation present downstream of spillway pipe and in riprap outfall. No immediate dam safety concern due to this, however should be monitored and removed during routine inspections (Photo II-B-5 through Photo II-B-9).
- **Low-level Outlet**: The outlet pipe trash rack was clear of large debris. Algae build-up on the trash rack is cleared as part of THVCP routine monitoring and maintenance (Photo II-B-9).
- **Seepage**: None observed.

Seepage Recovery Pond S2

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Downstream Slope**: Good physical condition. Well vegetated near left abutment, and sparsely vegetated throughout the rest of the downstream slope. Gravel and vegetation provides adequate erosion protection based on performance over the service life (Photo II-B-11).
- **Pond**: Pond level was more than 2 m below the invert of the spillway which is typical for this time of the year (Photo II-B-12).
- **Spillway**: Good physical condition. The inlet is partially obstructed by vegetations. This does not pose an immediate dam safety concern but should be removed as part of THVCP routine monitoring and maintenance before freshet. Vegetation along spillway should be monitored and removed if reduces the outlet capacity (Photo II-B-12 to Photo II-B-13).

- **S2 Inlet Channel – Highmont TSF Spillway Diversion**: A plug was in place across the inlet to S2 Pond so no flow is diverted from the Highmont TSF spillway into S2 Pond except under large flows. Spillway inlet channel is partially blocked (appears to be from a temporary access over the channel) and trees upstream of inlet. It is recommended THVCP remove blockage and trees.
- **Seepage**: Seepage is not monitored downstream of the dam. However, a small pond of water at the downstream toe was observed. The pond is similar is size to the pond noted during the 2015, through 2018 DSI, and is likely to consist of surface runoff and seepage (Photo II-B-14).

Seepage Recovery Pond S3

- **Crest**: Good physical condition. No indicators of significant concern observed (e.g. cracking, slumping, horizontal displacement) (Photo II-B-15 and Photo II-B-16).
- **Left and Right Abutment**: Good physical condition. No observations of significant scour or other indicators of potential concern (e.g. cracking, slumping, horizontal displacement).
- **Downstream Slope**: Good physical condition. Slope is sparsely vegetated over the layer of gravel which provides adequate erosion protection based on performance over the service life (Photo II-B-16).
- **Pond**: At the time of the inspection was more than 2 m below the crest of the dam which is typical for this time of the year (Photo II-B-17 and Photo II-B-18).
- **Seepage**: Seepage is not monitored downstream of the dam. No pond was observed at the downstream toe in a low point.
- **Spillway**: Spillway intake is blocked with glacial till to prevent discharge of water that does not meet water quality regulatory requirements (Photo II-B-19 and Photo II-B-20).

Seepage Recovery Pond S5

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B-21). The low point downstream of the outlet just south of Viewpoint HGH-2019-36 should be levelled and ruts on crest should be maintained (Photo II-B-22)
- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Downstream Slope**: Good physical condition. Minor vegetation present throughout slope. No signs of erosion, deterioration, or animal activity (Photo II-B-24).
- **Pond**: During inspection pond observed to be more than 10 m below crest of dam which is typical for this time of the year. Pond was highly vegetated during the site visit and requires dredging (Photo II-B-25 to Photo II-B-28).
- **Low-level Outlet and Spillway**: As observed during the 2016 through 2018 DSI, the Low-Level Outlet valves were closed and the inlet of the spillway pipes were obstructed by sand bags (Photo II-B-29 and Photo II-B-30).
- **Seepage**: None observed.

Seepage Recovery Pond S8

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-B-31).
- **Left and Right Abutment**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking.
- **Downstream Slope**: Good physical condition. Moderate vegetation throughout slope and large wood debris present. No observed signs of erosion, deterioration, or adverse displacement. A pipe was observed on the slope that did not appear to be connected to anything. This pipe should be removed (Photo II-B-32).
- **Pond**: At the time of inspection the pond appeared lower in elevation when compared to the 2018 inspection. Less then 2 m below the crest of the dam (Photo II-B-33 and Photo II-B-34).
- **Spillway**: The outlet pipe was clear of debris (Photo II-B-35).
- **Seepage**: None observed.

INSPECTION PHOTOGRAPHS

LEGEND:

- HGH = Highmont Tailings Facility.
- HGH-2019-## refers to 2019 DSI waypoint shown on Figure 3, Figure 4, and Figure 5.
- All photographs taken during inspection on June 10, 2019

Seepage Recovery Pond S1

Photo II-B-1 S1 Pond: Overview of crest looking west towards left abutment (HGH-2019-21)

Photo II-B-2 S1 Pond: Overview of S1 Pond dam downstream slope (HGH-2019-22)

Photo II-B-3 S1 Pond: Overview of pond and upstream slope of dam, looking north. (HGH-2019-23)

Photo II-B-4 S1 Pond: Overview of upstream slope and Highmont North Dam (HGH-2019-23)

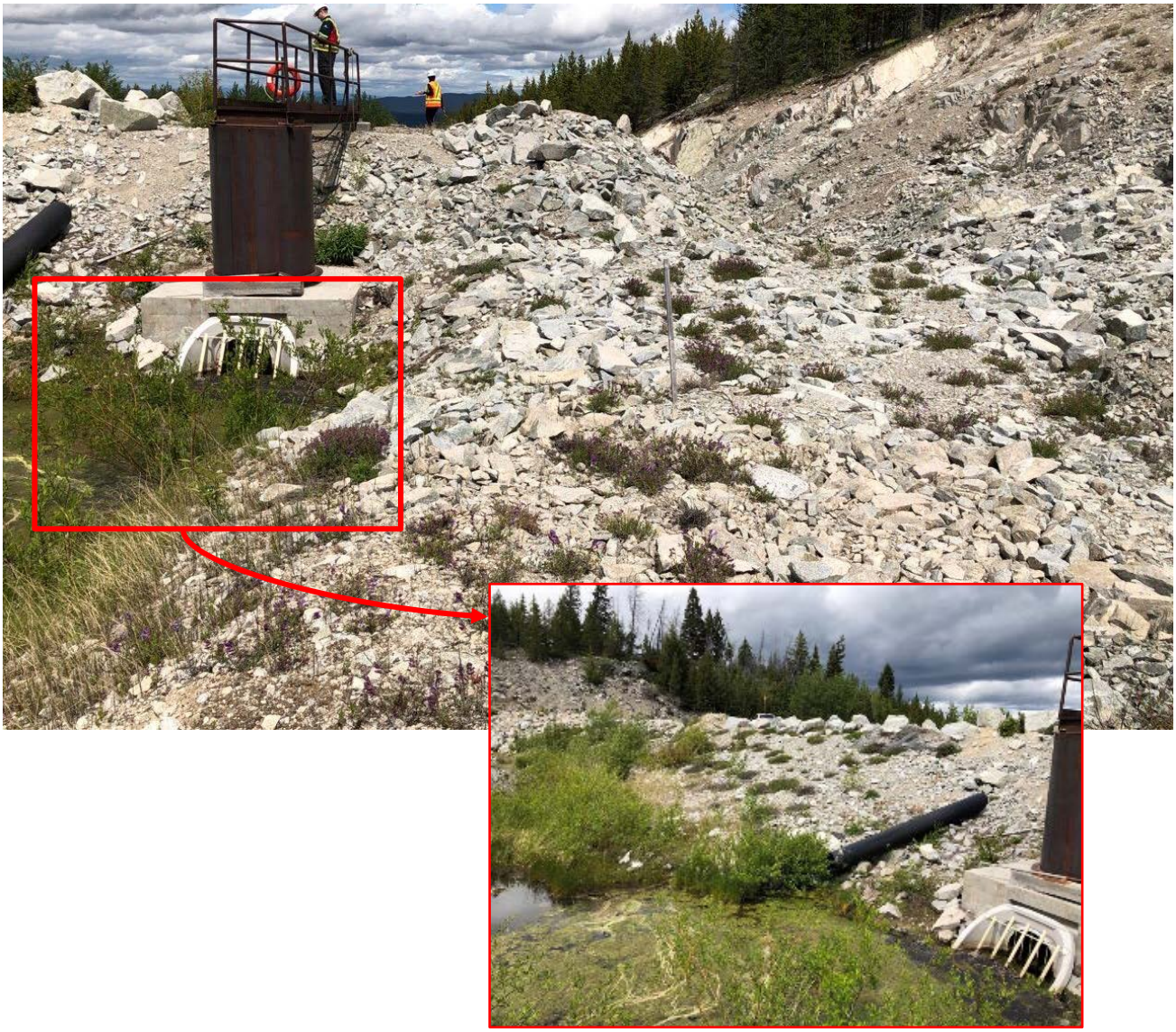
Photo II-B-5 S1 Pond: Overview of upstream slope and S1 Pond Spillway intake. (HGH-2019-23)

Photo II-B-6 S1 Pond: Spillway channel and pipe intake looking downstream. Pipe intake is clear with no sign of vegetation or any other obstructions. (HGH-2019-24)

Photo II-B-7 S1 Pond: Spillway channel looking towards pond. No significant obstructions observed in channel (HGH-2019-25)

Photo II-B-8 S1 Pond: Spillway pipe outlet with no obstruction (HGH-2019-26)

Photo II-B-9 S1 Pond: Low-Level Outlet (LLO) to the left of spillway intake. Vegetation partially obstructing intake; will be cleared during routine maintenance. (HGH-2019-27)



Seepage Recovery Pond S2

Photo II-B-10 S2 Pond: Overview of upstream slopes and LLO (HGH-2019-28)

Photo II-B-11 S2 Pond: downstream slope (HGH-2019-28)

Photo II-B-12 S2 Pond: S2 Pond Spillway intake. Intake is vegetated; vegetation should be monitored and removed if reduces the spillway capacity (HGH-2019-29)

Photo II-B-13 S2 Pond: S2 Pond Spillway invert and channel; remnant of a temporary access built over the channel remains in place has reduced the spillway flow channel and should be removed as part of routine maintenance before freshet (HGH-2019-29)

Photo II-B-14 S2 Pond: Ponded water at downstream toe, similar in size to the pond noted during previous year DSIs (HGH-2019-28)

Seepage Recovery Pond S3

Photo II-B-15 S3 Pond: Overview of downstream slope and crest looking towards right abutment, from left abutment (HGH-2019-30)

Photo II-B-16 S3 Pond: Overview of dam crest, upstream slope and impoundment looking towards left abutment, from right abutment (HGH-2019-31)

Photo II-B-17 S3 Pond: impoundment and Highmont South Dam slope in the background; view from S3 Pond left abutment, looking Northwest (HGH-2019-30)

Photo II-B-18 S3 Pond: Catwalk and outlet pump to Highmont Distribution Box; personal flotation devices are in place (HGH-2019-32)

Photo II-B-19 S3 Pond: Overview of upstream slope, pond and blocked spillway inlet. (HGH-2019-31)

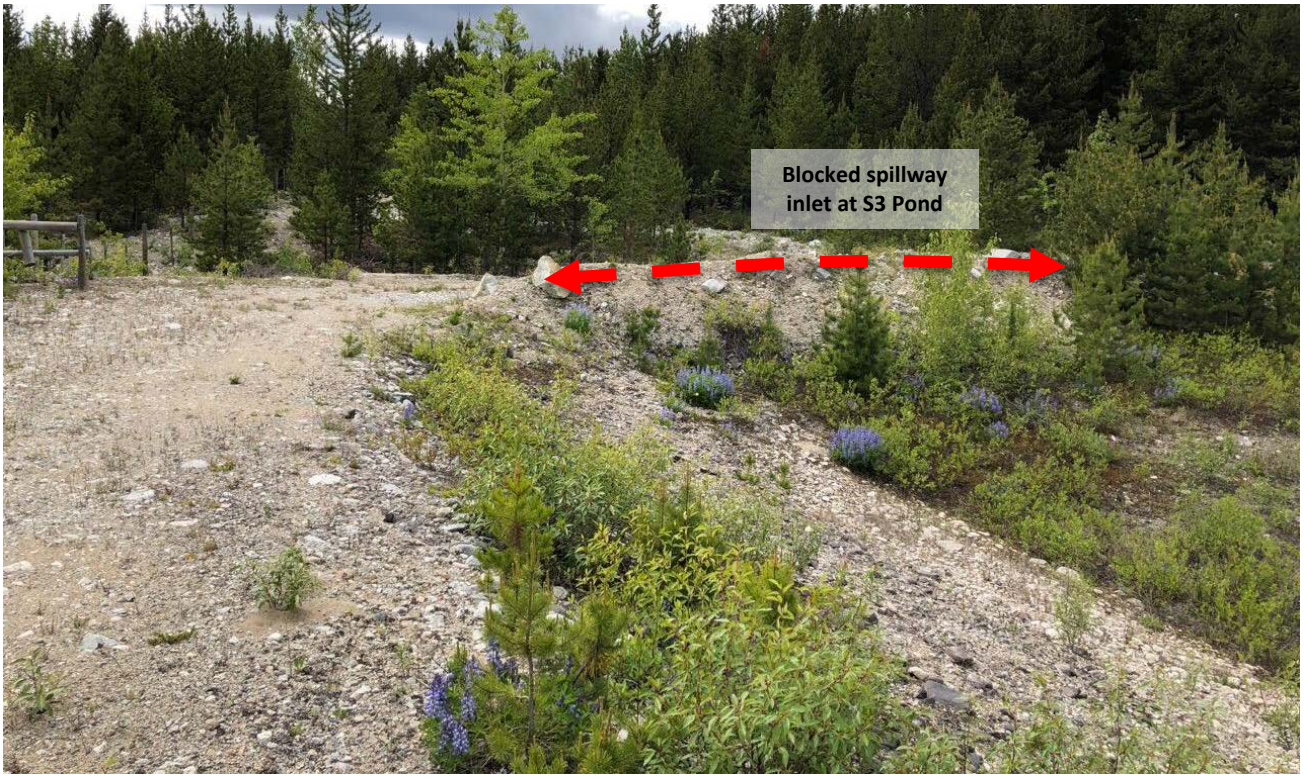


Photo II-B-20 S3 Pond: Overview of right abutment and blocked spillway inlet Spillway intake is blocked (HGH-2019-32)

Seepage Recovery Pond S5

Photo II-B-21 S5 Pond: Overview of crest (HGH-2019-34)

Photo II-B-22 S5 Pond: perimeter crest of pumping sub-cell, looking south, both outlet pipes are blocked and the low point of the crest is the right (south) abutment (HGH-2019-35)

Photo II-B-23 S5 Pond: Overview of upstream slope and impoundment (HGH-2019-36)


Photo II-B-24 S5 Pond: Downstream slope of perimeter crest, looking north (left hand side) and South (right hand side) (HGH-2019-34)


Photo II-B-25 S5 Pond: Overview of S5 Pond basin (HGH-2019-37)

Photo II-B-26 S5 Pond: Overview of Pumping Sub-cell (HGH-2019-38)

Photo II-B-27 S5 Pond: Overview of Pumping Sub-cell catwalk and pump intake (HGH-2019-37)

Photo II-B-28 S5 Pond: Overview of Pumping Sub-cell and overflow point over internal dyke which is below perimeter crest (HGH-2019-37)

Photo II-B-29 S5 Pond: Pumping Sub-cell North outlet pipe is blocked (HGH-2019-39)

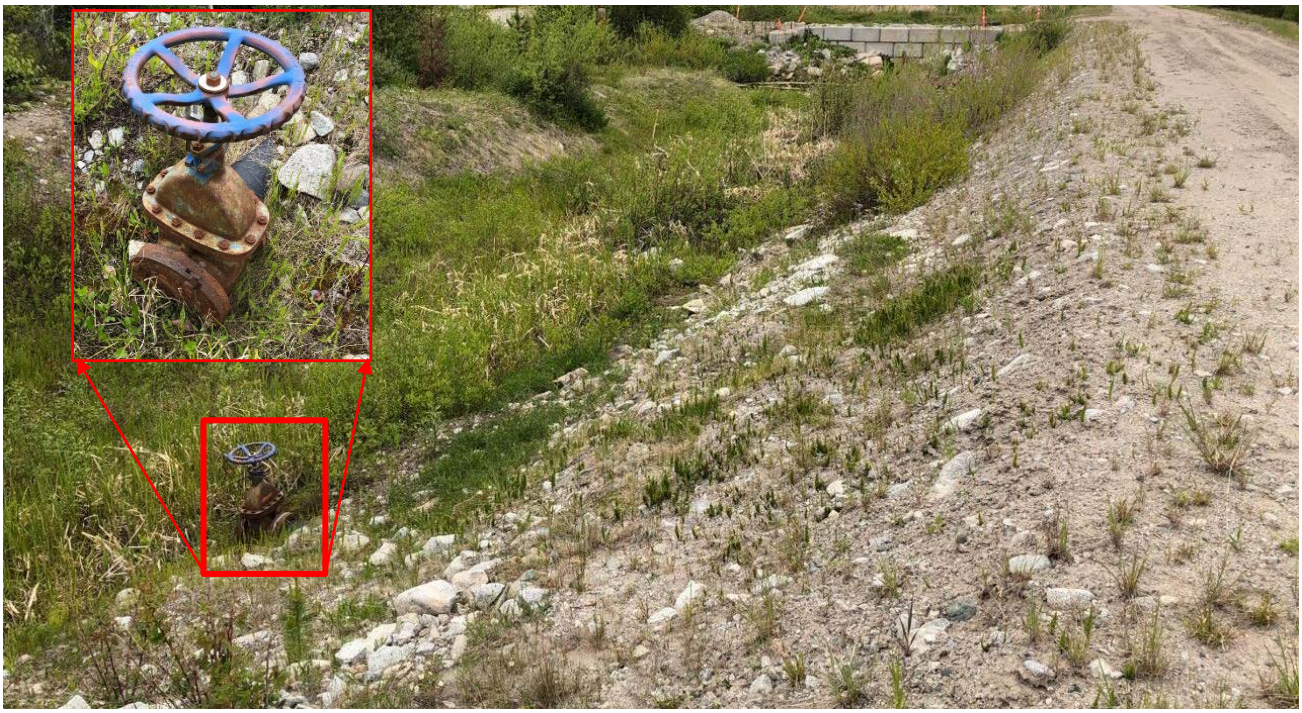
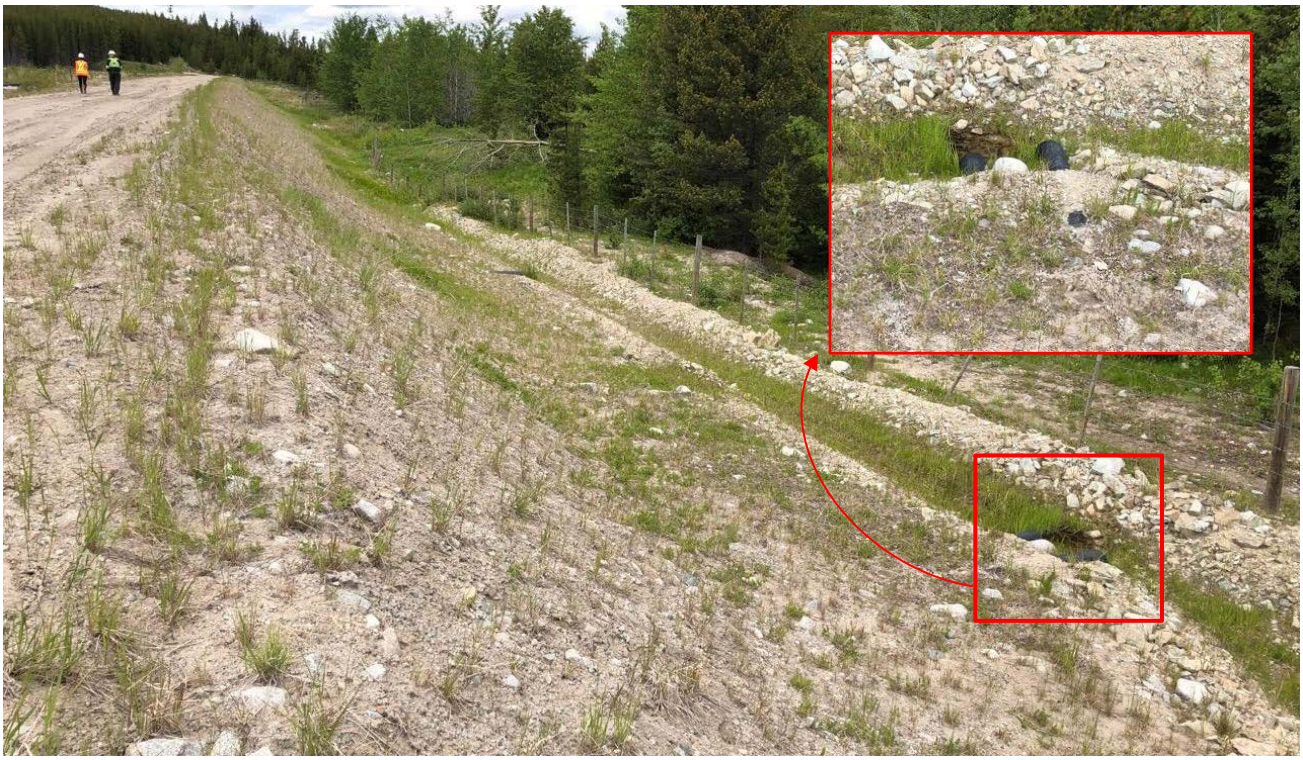


Photo II-B-30 S5 Pond: Overview of downstream slope and blocked outlet pipe daylighting at toe, looking north (HGH-2019-35)



Seepage Recovery Pond S8

Photo II-B-31 S8 Pond: Overview of crest from left abutment. Muddy road surface and rutting to be repaired as part of routine maintenance activities (HGH-2019-40)

Photo II-B-32 S8 Pond: Downstream slope; looking east from left abutment. Pipe on slope is not connected to anything and should be removed (HGH-2019-40)

Photo II-B-33 S8 Pond: Overview of S8 Pond impoundment and upstream slope. Highmont North Dam downstream slope is visible on right hand side of picture (HGH-2019-40)

Photo II-B-34 S8 Pond: Overview of impoundment, catwalk and outlet pump to S1 Pond (HGH-2019-41)

Photo II-B-35 S8 Pond: Overview of overflow pipe. Trash rack is clear of debris; and water level observed below invert. Second pipe discharges into pond from east ditch. (HGH-2019-39)

APPENDIX III

APPENDIX III-A

Overview, History, and Water Management

Appendix III-A
Overview, History, and Water Management

OVERVIEW

The HVC site is located near Logan Lake, approximately 45 km south of Kamloops, in the interior of British Columbia. The Highmont TSF is located 8 km southeast of the operating mill; refer to Figure 1. The Highmont TSF comprises a tailings pond retained by three perimeter dams (North, East and South) and five active perimeter seepage recovery ponds; refer to Figure 2.

Highmont Dams

The layout of the Highmont dams is shown in Figure 3 through Figure 5, and the typical geometry and dimensions are summarized in Table 1. Refer to Appendix III-B for relevant design drawings.

General information regarding the dam is as follows:

- Construction record reports for the starter dams (KL 1981) and subsequent raises (HOC 1982, 1984a, 1984b and 1984c) were available.
- The Highmont dams are founded on granodiorite bedrock or shallow glacial till and glaciofluvial sand and gravel outwash overlying bedrock. Organics and soft ablation deposits were removed prior to the construction of the dam. A 2015 review of foundation conditions by KCB noted that silt and clay foundations were not encountered at the North Dam and East Dam, but a 1.5 m to 3 m lacustrine silt layer about 3-4 m below original ground was encountered at the South Dam (KCB 2015a).
- The dams incorporate a compacted glacial till starter dam approximately 17 m high, with an upstream random fill zone and a downstream sand and gravel drainage blanket. Construction materials came from local glacial till, local pockets of sand and gravel, and rockfill from Highmont Pit.
- The dams were raised by the centerline method with coarse and fine filter zones separating the upstream tailings spigotted from the crest from the downstream rockfill section. Before a wide tailings beach had been established, if required, glacial till facings were placed on the upstream face of the dam wherever water could accumulate against the dam.
- Seepage through the dams are collected by seepage collection ditches at their toe and directed to the perimeter seepage recovery ponds.
- An open channel spillway is located on the North Dam left[1] abutment. The spillway starts as a 640 m long approach channel excavated in tailings to a lock-block control sill, then crosses under the dam crest access road via twin HDPE culverts leading to a channel excavated through rock. A slide gate (the Highmont Spillway Flow Control Structure) regulates flow in the channel. Under normal operating conditions and smaller storm events, flows are typically

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

diverted by an inlet structure via a HDPE pipe to S1 Pond. Larger flows continue along the spillway channel which discharges downstream of S2 Pond and eventually to Witches Brook.

Seepage Recovery Ponds

The layout of perimeter seepage dams is shown in Figure 2 and the typical geometry and dimensions are summarized in Table 1. Refer to Appendix III for relevant design drawings.

General information regarding the seepage recovery pond dams is as follows:

- A construction record report for ponds S1 and S2 (KL 1981) and a design report showing details for ponds S1 through S5 (KL 1980) are available. No records are available for ponds S8 and S9.
- Historically, there have been seven seepage recovery ponds located around the perimeter of the Highmont TSF (S1, S2, S3, S4, S5, S8 and S9) which manage seepage from the TSF, as well as runoff from the TSF and local catchments. The dams at S4 and S9 have been decommissioned by breaching, leaving five remaining seepage recovery pond dams (S1, S2, S3, S5 and S8).
- A 1980 design report shows preliminary locations for ponds S6 and S7 (KL 1980), which appear to be in the vicinity of S9 Pond (which was not in the design report). There are no records that indicate S6 Pond or S7 Pond were ever constructed.
- The dams are constructed of compacted glacial till with a drainage blanket downstream of the seepage cutoff, and with a sand and gravel erosion blanket on the upstream and downstream faces. The dams are founded on glacial till, except for the now breached S4 Pond dam which was founded on a deep sand and gravel outwash.
- In general, water from the seepage recovery ponds are ultimately pumped to the Highland Mill for reclaim via S1 Pond (refer to Figure II-A-1). Details of pumping operations, pipelines and other water management structures in these ponds are discussed in Water Management Section.

Table III-A-1 Summary of Approximate Dam Geometry

Dam	Dam Raise Construction Method	Crest Elevation (m)	Maximum Height (m)	Crest Length (m)	Minimum Crest Width (m)	Downstream Slope	Upstream Slope
Main Dams							
North Dam	Centreline	1487	47	1200	30	2.5H:1V	n/a
East Dam	Centreline	1487	30	1200	15	2.3H:1V	n/a
South Dam	Centreline	1487	35	1300	9	2.3H:1V	n/a
Seepage Recovery Pond Dams							
S1 Dam	n/a	1445	9.1	60	10	2H:1V [3]	3H:1V
S2 Dam	n/a	1459	4	140	4	2.2H:1V [3]	3H:1V
S3 Dam	n/a	1459	3.4	150	4	3H:1V	3H:1V
S4 Dam	Decommissioned by breaching						
S5 Dam	n/a	1452.2	6.3	340	3	1.7H:1V [3]	3H:1V
S8 Dam	n/a	1452	5	120	9	2H:1V	Unknown
S9 Dam	Decommissioned by breaching						

Notes:
1. Dimensions are estimated from 2014 LiDAR data unless otherwise noted.
2. Height measured as the vertical distance between downstream toe and crest.
3. The downstream slope is steeper than the 2.5H:1V in the design report (KL 1980).

HISTORY

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

- In 1980, the Highmont starter dams and Seepage Recovery Ponds S1 through S5 were completed. It is not known whether the ponds S8 and S9 were constructed at this time or at a later date. The 1980 design report by Klohn Leonoff does not mention ponds S8 or S9 (KL 1980).
- In 1984, the final crest elevations of the TSF dams reached to El. 1487 m (well below the ultimate design elevation of 1524 m). There has been no tailings disposal since 1984.
- In 1996, a permit was received to release water from Seepage Recovery Ponds S4 and S9 as the quality of water in these ponds met the discharge criteria. THVCP breached these two dams in 1997 (AMEC 2014a).
- In 2003, the permanent spillway in the Highmont TSF was constructed (AMEC 2014a).
- In 2005, THVCP winterized the pumping systems for Seepage Recovery Ponds S1, S2, S3, S5 and S8 so that water could be pumped from these ponds throughout the year.
- In response to a flood event that overflowed S1 Pond in 2006 (KCB 2007), a 1.2 m high slide gate was installed at the Highmont spillway flow control structure in 2007, along with Highmont Distribution Box which allows flow from S3 Pond and S5 Pond to be stored in the Highmont tailings pond instead of to S1 Pond.

- The S3 Pond spillway was plugged to prevent discharge to Fowler Creek. The exact date of plugging is not known but was completed prior to 2010.
- In 2014, a 1.0 m raise was built on the S5 Pond dam crest (i.e. no change to the downstream toe). In 2015 the dam was raised by an additional 0.6 m, which included widening of the crest and downstream toe area.
- The Highmont TSF spillway channel design included a till plug across the channel, downstream of the dam, which diverts low flows into S2 Pond. In 2018, this plug was temporarily relocated from the Highmont TSF spillway channel to the S2 Pond inlet channel; see Figure II-A-1. Fill material was locally sourced and placed using an excavator. No compaction efforts were applied. Refer to Section 4.4 of the main report regarding KCB's support of making this a temporarily relocation permanent.

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 Highmont TSF is shown in Figure II-A-1. Decommissioned structures (S4 Pond and S9 Pond) are not discussed.

Highmont TSF

- The tailings pond is located in the centre of the impoundment as shown on Figure 2. The water level variation is discussed further in Section 5.3 of the main report.
- Inflows include precipitation on the pond, surface runoff from upstream catchments, pumpback from S1 Pond, and pumpback from seepage recovery S3 Pond and S5 Pond via the Highmont Distribution Box.
- Outflows include seepage, evaporation and when necessary, flow through the spillway. Seepage is collected by five seepage recovery dams downstream of the TSF. Flow from the open channel spillway at the left abutment of the North Dam is diverted to S1 Pond under normal operations. Flows exceeding the capacity (>2,000 m^3/h) of the diversion to S1 Pond, flow along the Highmont TSF Spillway channel to Fourier Creek.

Seepage Recovery Pond S3 (S3 Pond) downstream of the South Dam

- Inflows include seepage from the South Dam, precipitation on the pond, and surface runoff from upstream catchments.
- Outflows include seepage, pumpback to the TSF during winter or freshet, and pumping to S1 for the remainder of the year, controlled by the Highmont Distribution Box. The open channel spillway for S3 Pond was plugged with glacial till to prevent release into Fowler Creek.

Seepage Recovery Pond S5 (S5 Pond) downstream of the East Dam, between S1 and S3

- Inflows include seepage from the East Dam, precipitation on the pond, and surface runoff from upstream catchments.

- S5 is unique as it is made up of three ponds, one of which is further subdivided into as many as five ponds depending on the water level (Figure 4). Surface water flows into the western "bow" shaped pond where it is stored and then flows to the southeast pond which has the pumping reclaim system, via two 8" dia. HDPE pipes. There is minimal (~270 m^3) retention capacity in the southeast (pumping) pond below the spillway; therefore, ability to prevent spilling is highly dependent on pump capacity and operability, as described below. In 2019, THVCP installed a secondary pump as a back-up during freshet.
- Outflows typically include pumpback to the tailings pond during winter or freshet and pumping to S1 for the remainder of the year, controlled by the Highmont Distribution Box. The low-level outlet pipes at the north and south ends of the ponds are closed.
- Spillway pipes (2x 200 mm dia.) which are buried through the eastern retention berm in the southeast pond, were partially blocked by THVCP during freshet, to increase the storage capacity in the pond before discharging into Dupuis Creek. This action was driven by environmental requirements related to the water quality of the pond, not dam safety.

Seepage Recovery Pond S2 (S2 Pond) downstream of the North Dam and west of S8

- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, and low flows from the Highmont TSF spillway during freshet. During non-freshet, the inlet channel from the Highmont TSF Spillway is blocked by a till plug. Refer to discussion in Section 4.4 of the main report regarding recommended permanent relocation of the till plug.
- Outflows include pumping to S8 Pond, an open channel spillway located at the dam's left abutment that discharges into the Highmont TSF spillway, and ultimately reports to Fourier Creek.

Seepage Recovery Pond S8 (S8 Pond) downstream of the North Dam, between S2 and S1

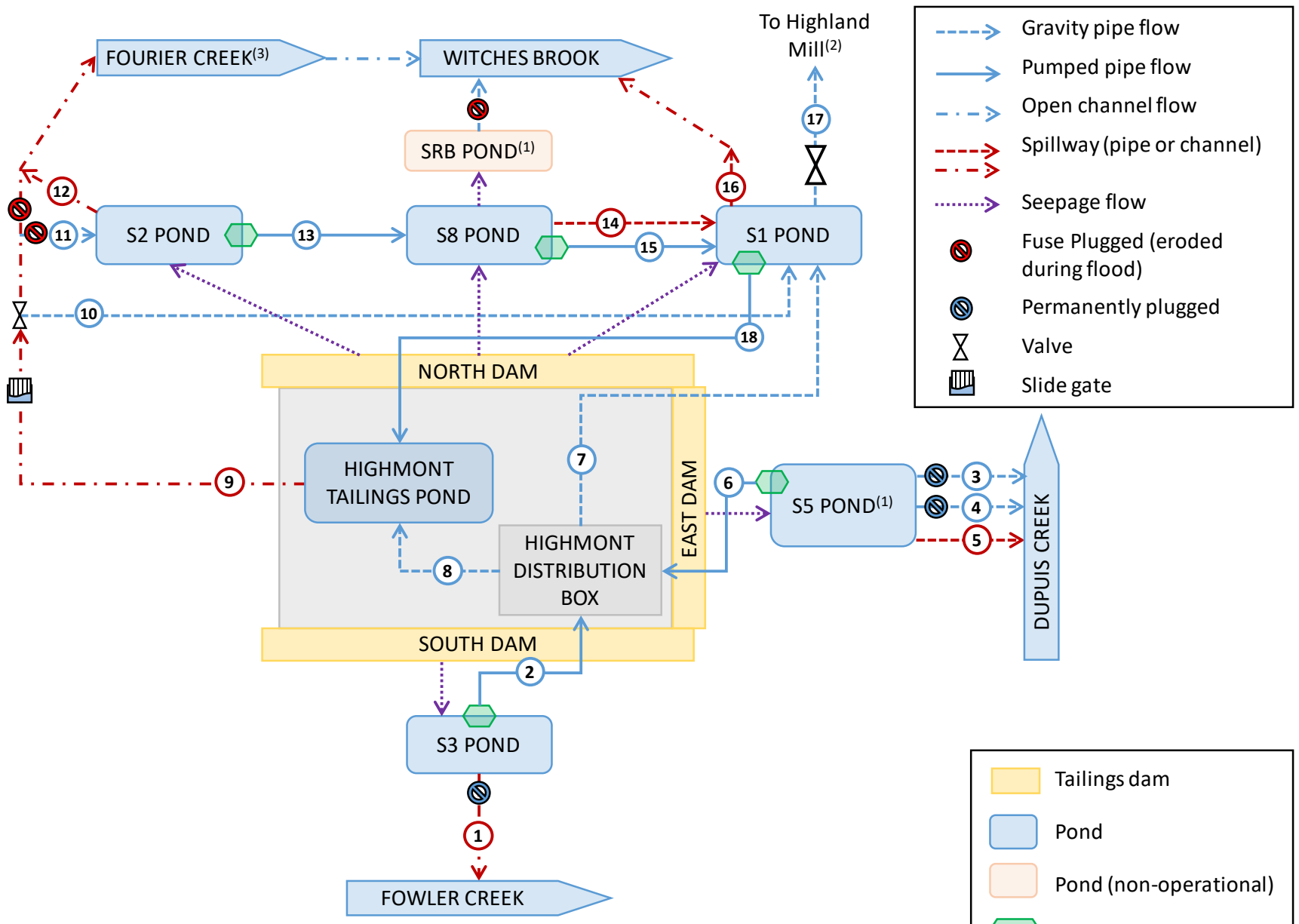
- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, and pumping from S2 Pond.
- Outflows include seepage to the Sulfate Reduction Bacteria Pond (SRB), gravity flow through a 14" dia. pipeline to S1. Water can also be pumped to S1 Pond if required. When necessary, there is an emergency spillway pipe which discharges to S1 Pond.

Seepage Recovery Pond S1 (S1 Pond) downstream of the North Dam

- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, diversion flows from the Highmont TSF spillway, gravity or pumped flow from S8 Pond, and pumping from S3 Pond and S5 Pond via the Highmont Distribution Box. This is the point of seepage and runoff collection convergence under normal flows at Highmont TSF.
- Outflows include discharge to the Highland Mill (conveyed via a 600 mm dia. gravity flow pipeline to a booster pumphouse then to the Mill), emergency pumpback to the Highmont

tailings pond if water cannot be diverted to the mill, and when necessary, flow through the spillway. The spillway, located at the right abutment, is an open channel leading to a 900 mm dia. pipe that discharges onto a riprap apron downstream of the dam, then continues to an unnamed tributary which drains into Witches Brook.

Figure II-A-1 Flow Schematic for Highmont TSF



Notes:
1. The Sulfate Reduction Bacteria (SRB) pond at S8 is downstream of the S8 Dam. The SRB pond at S5 consists of the five ponds in series in the centre of the facility. Water quality in both ponds do not meet discharge requirements at this time.
2. See the Gnawed Lake process flow diagram for detailed flow path from S1 to the Mill.
3. Subject to water license constraints. See Environment for details.

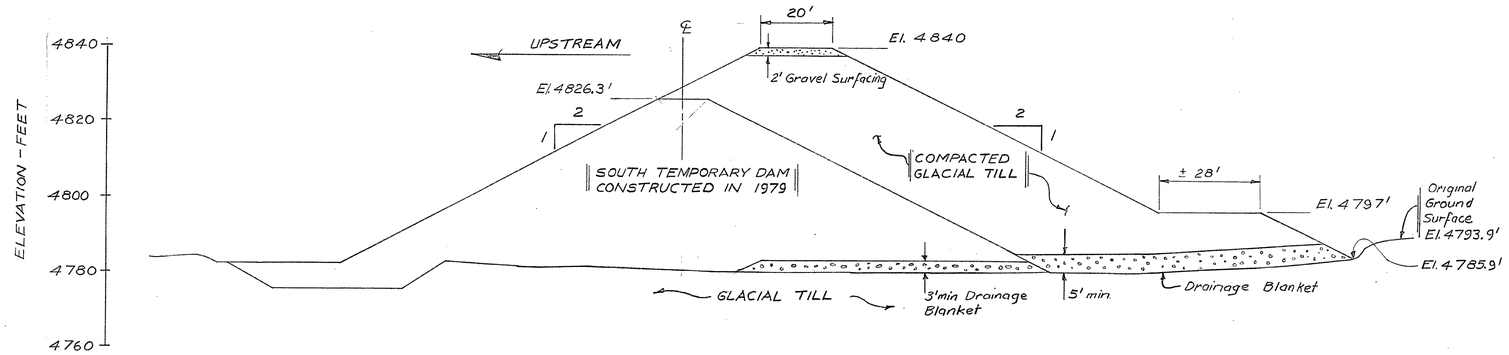
No.	Name	Description	Status
1	S3 Spillway	Open channel	Non-operational, plugged prior to 2010
2	S3 Reclaim	Seepage water pumped to the Highmont Distribution Box	Operational
3	S5 Outlet #1 (North)	2x 8”dia. HDPE pipes with control valves	Non-operational, metal plates placed at intake and pipes filled with till in 2015
4	S5 Outlet #2 (South, in S5 spillway channel)	1x 8”dia. HDPE pipes with control valve	
5	S5 Overflow (South, in S5 spillway channel)	2x 200 mm dia. HDPE pipes	Operational, partially blocked at intake
6	S5 Reclaim	Pond water pumped to the Highmont Distribution Box	Operational
7	Distribution to S1	1x 18” dia. pipeline from the Highmont Distribution Box to S1	Operational
8	Highmont Distribution Box to Tailings Pond	1x 18” dia. pipeline from the Highmont Distribution Box to the tailings pond	Operational
9	Highmont Spillway	Open channel comprised of (U/S to D/S): i) Lock-block control sill; ii) Approach channel excavated in tailings; iii) Culvert crossings; iv) Channel excavated through rock; v) Flow control structure with 4’ high slide gate and diversion to S1; and vi) During freshet, till fuse plug located across Highmont TSF Spillway channel. During non-freshet, till fuse plug located across S2 Pond inlet channel.	Operational
10	Diversion to S1	18” dia. HDPE pipeline	Operational
11	Diversion to S2	Open channel with till fuse plug across S2 Pond inlet channel (except during freshet)	Operational
12	S2 Spillway	Open channel	Operational
13	S2 Outlet	1x 18” dia. HDPE pipeline carrying water pumped from S2 to S8	Operational
14	S8 Spillway	1x 18” dia. HDPE pipe with trash rack and headwall	Operational
15	S8 Outlet	1x 14” dia. HDPE pipeline carrying water pumped from S8 to S1	Operational
16	S1 Spillway	1x 900 mm dia. HDPE pipe discharging onto a riprap-lined apron	Operational
17	S1 Outlet	600 mm dia. HDPE pipe with manually operated valve	Operational
18	S1 Reclaim	Seepage water pumped back to the tailings pond	Operational

APPENDIX III-B

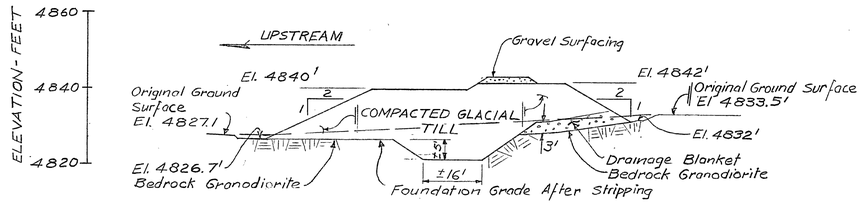
Reference Dam Design Drawings

APPENDIX III-B-1

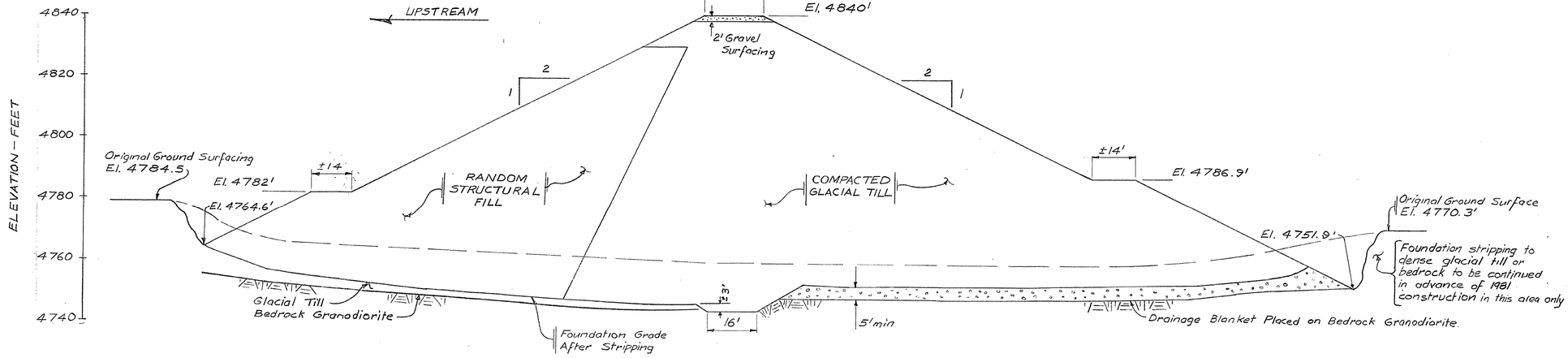
Reference Dam Design Drawings – Highmont TSF



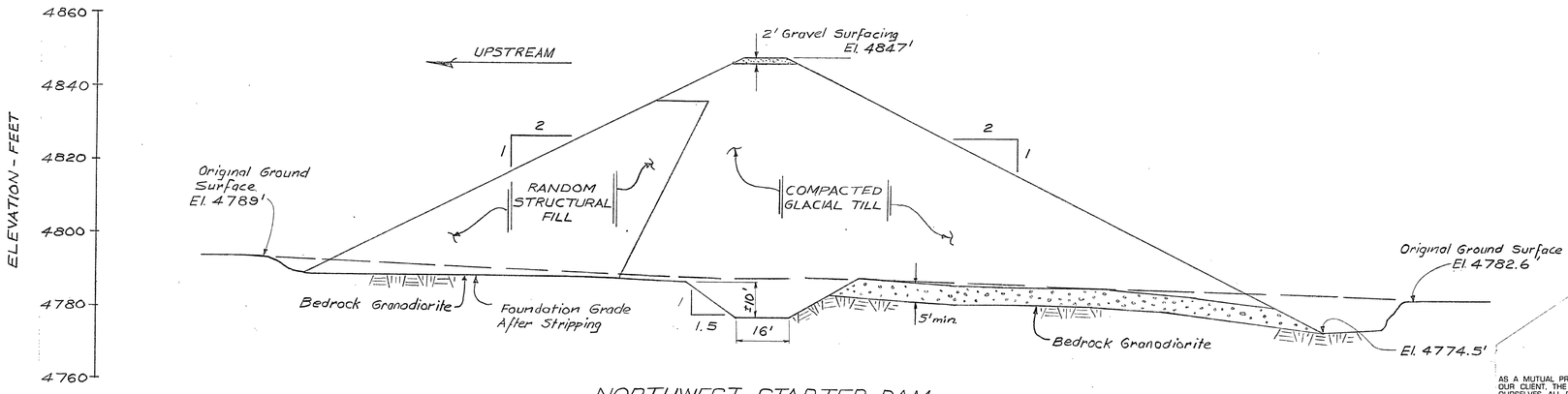
SOUTH STARTER DAM
STATION 104+00



EAST STARTER DAM
STATION 67+30



NORTHEAST STARTER DAM
STATION 39+00



NORTHWEST STARTER DAM
STATION 11+00

NOTES

1. All dam foundations stripped to firm undisturbed soil or bedrock.
2. Cutoff trenches excavated a minimum of 2' into dense impervious soil or to the surface of intact bedrock, except for the east dam where the excavation was a maximum of 5' deep. Cutoff trenches in bedrock were hand cleaned.
3. Berms on the northeast and south dams resulted from a reduction in starter dam elevation from 4847' to 4840'. The berm on the upstream side of the east dam was cut, to maintain the tailings pipeline at elevation 4840'.
4. For general arrangement and location of sections see drawing E-1526-45.

TO BE READ WITH KLOHN LEONOFF REPORT DATED MAR. 27, 1981

SCALE: 20 0 20 40 ft.

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
S.R.	C.P.V	MAR. 1981	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

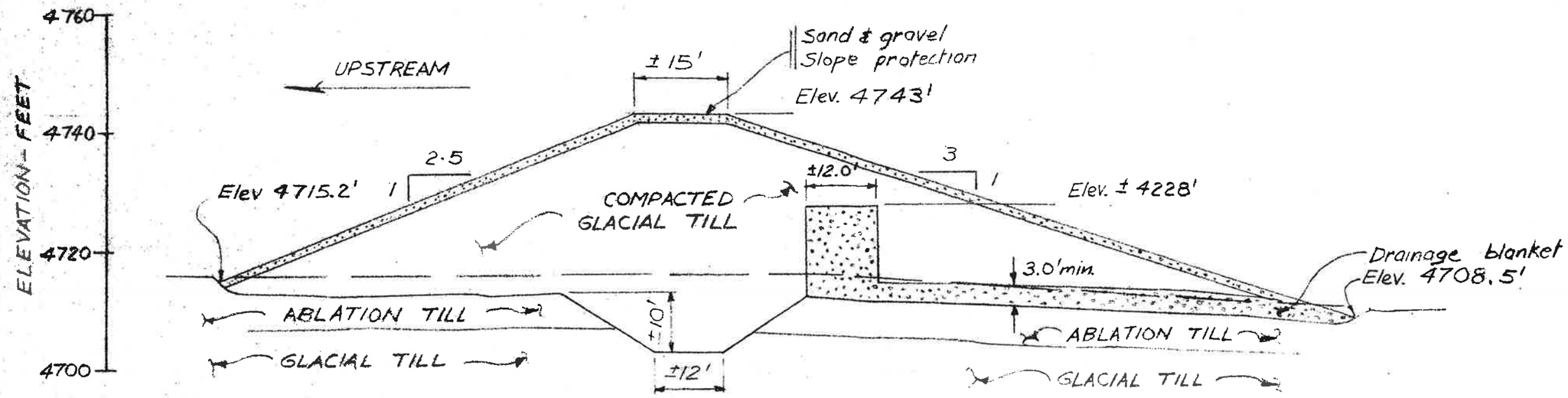
PROJECT: TAILINGS DISPOSAL DAMS

TITLE: STARTER DAM AS-BUILT SECTIONS

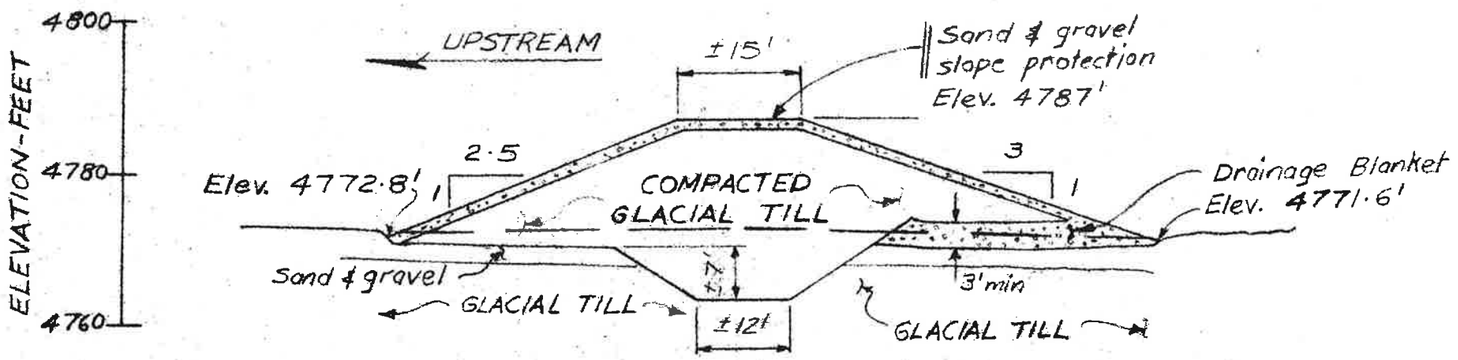
CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
MAR. 27, 1981	VA1526	D-1526-46	

APPROVED



SEEPAGE RECOVERY DAM S1
STATION 2+00



TYPICAL SECTION SEEPAGE
RECOVERY DAMS S2 & S3
(Section on S3, ST. 1+38)

REFERENCE

1. For notes see drawing D-1526-46
2. For location of dams see drawing D1526 - 45

20 0 20 40 ft.
SCALE

TO BE READ WITH KLOHN LEONOFF REPORT DATED MAR. 27, 1981

SCALE As Shown.

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

CLIENT: HIGHMONT OPERATING CORP.

PROJECT: TAILINGS DISPOSAL DAMS

TITLE: SEEPAGE RECOVERY DAMS AS-BUILT SECTIONS

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA S. LIGHTHALL

DATE OF ISSUE: MAR 1981

APPROVED

PROJECT No.: VA1526

DWG. No.: B-1526-47

REV.

NCI-456-K.L

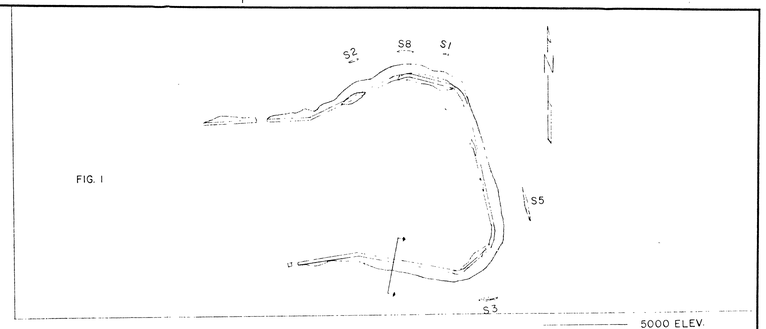
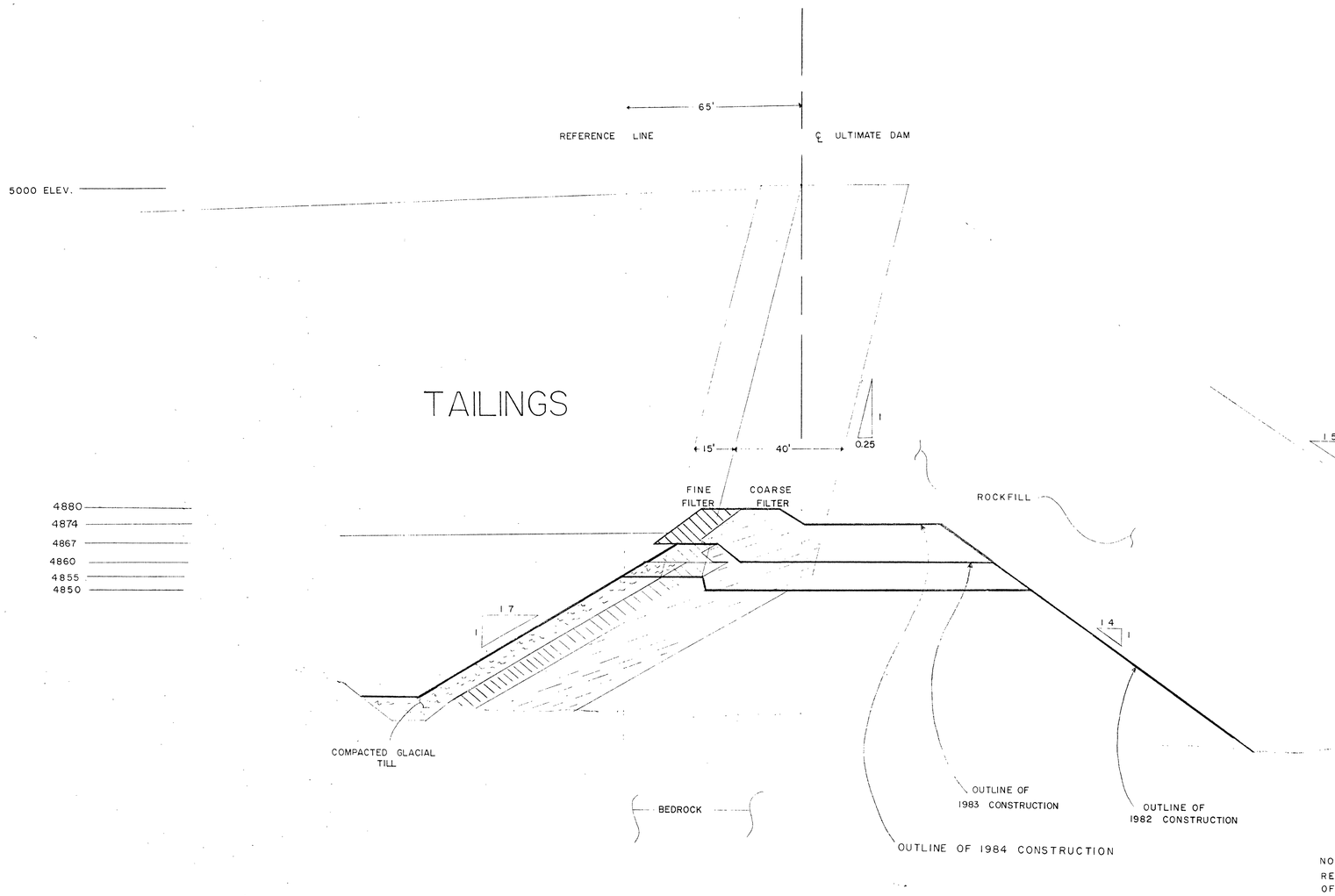


FIG. 1



NOTE,
REFER TO FIG 1 FOR LOCATION OF SECTION

LEGEND
FINE FILTER
COARSE FILTER
COMPACTED GLACIAL TILL

SCALE,
VERTICAL 1"=20'
HORIZONTAL 1"=20'

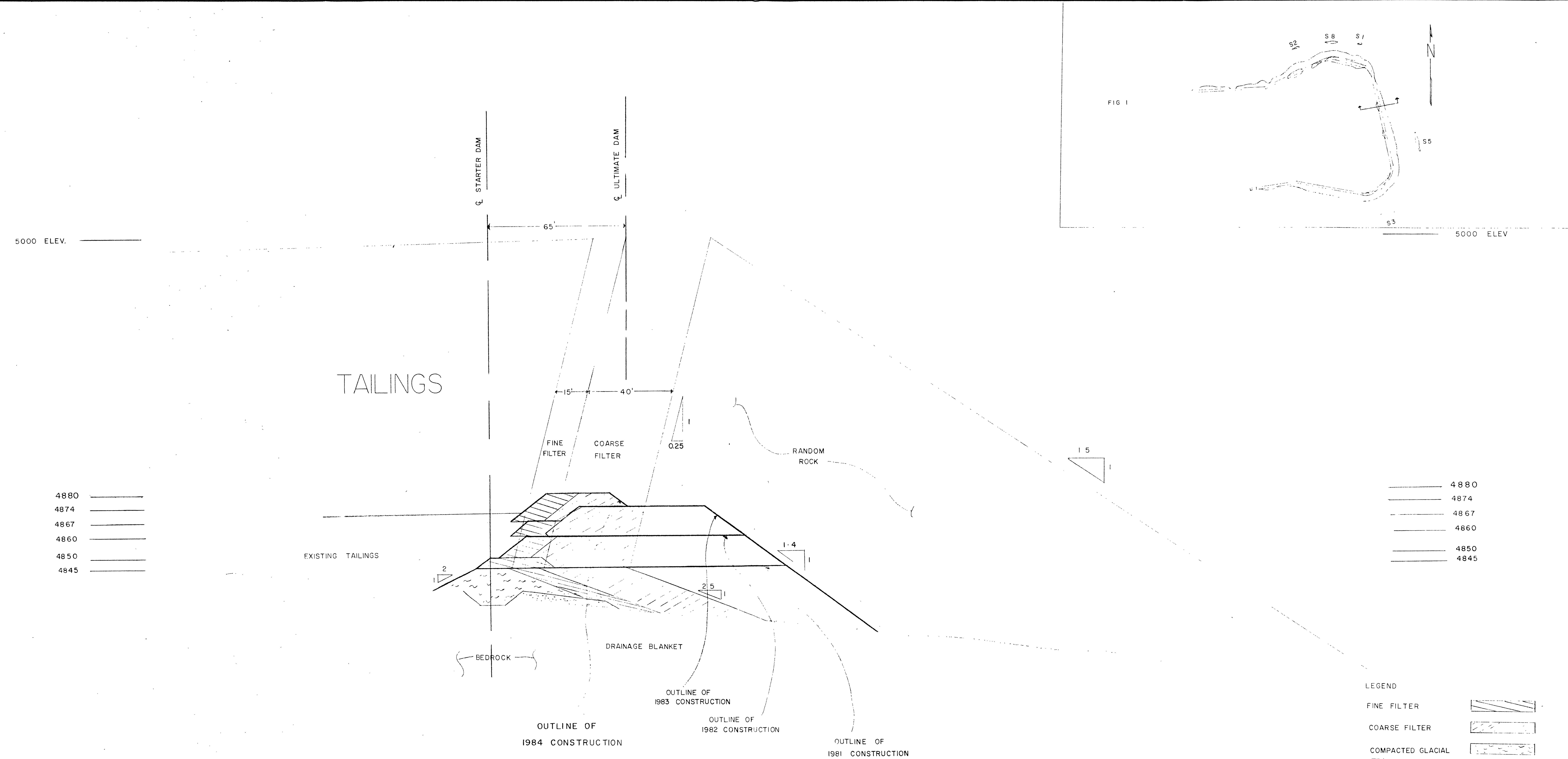
A ISSUED FOR CONSTRUCTION

HIGHMONT OPERATING CORP.
LOGAN LAKE, B.C.

TYPICAL SECTION
OF SOUTHWEST DAM

SCALE AS SHOWN	DESIGNED	DAY	MO	YR
	DRAWN			
	CHECKED			
	APPROVED			
DRAWING NO. TD-23-5				ISSUE A

BCEL-7931-A60



NOTE

REFER TO FIG I FOR LOCATION OF SECTION

SCALE

HORIZONTAL 1" = 20'

VERTICAL 1" = 20'

REVISION

HIGHMONT OPERATING CORP.
LOGAN LAKE, B.C.

TYPICAL SECTION
OF EAST DAM

SCALE: AS SHOWN	DESIGNED / DRAWN / CHECKED / APPROVED	06 09 84
DRAWING NO: TD-23-4		ISSUE: A

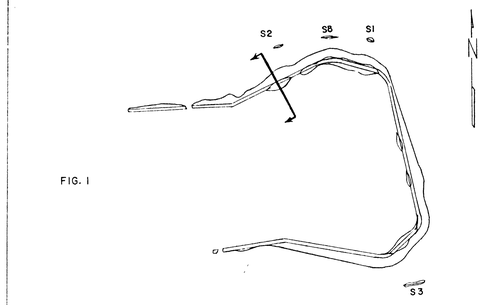


FIG. 1

NOTE:

REFER TO FIG.1 FOR LOCATION OF SECTION

LEGEND:

- FINE FILTER
- COARSE FILTER
- COMPACTED GLACIAL TILL
- RANDOM STRUCTURAL FILL

SCALE:

VERTICAL - 1" = 20'

HORIZONTAL - 1" = 20'

QTY	PART	ITEM	DESCRIPTION

ISSUE	D/M/Y	REVISION	DR	CH	APP
B	7/8/84	1983 CONSTRUCTION	GW	KJ	
A	7/8/84	1982 CONSTRUCTION			

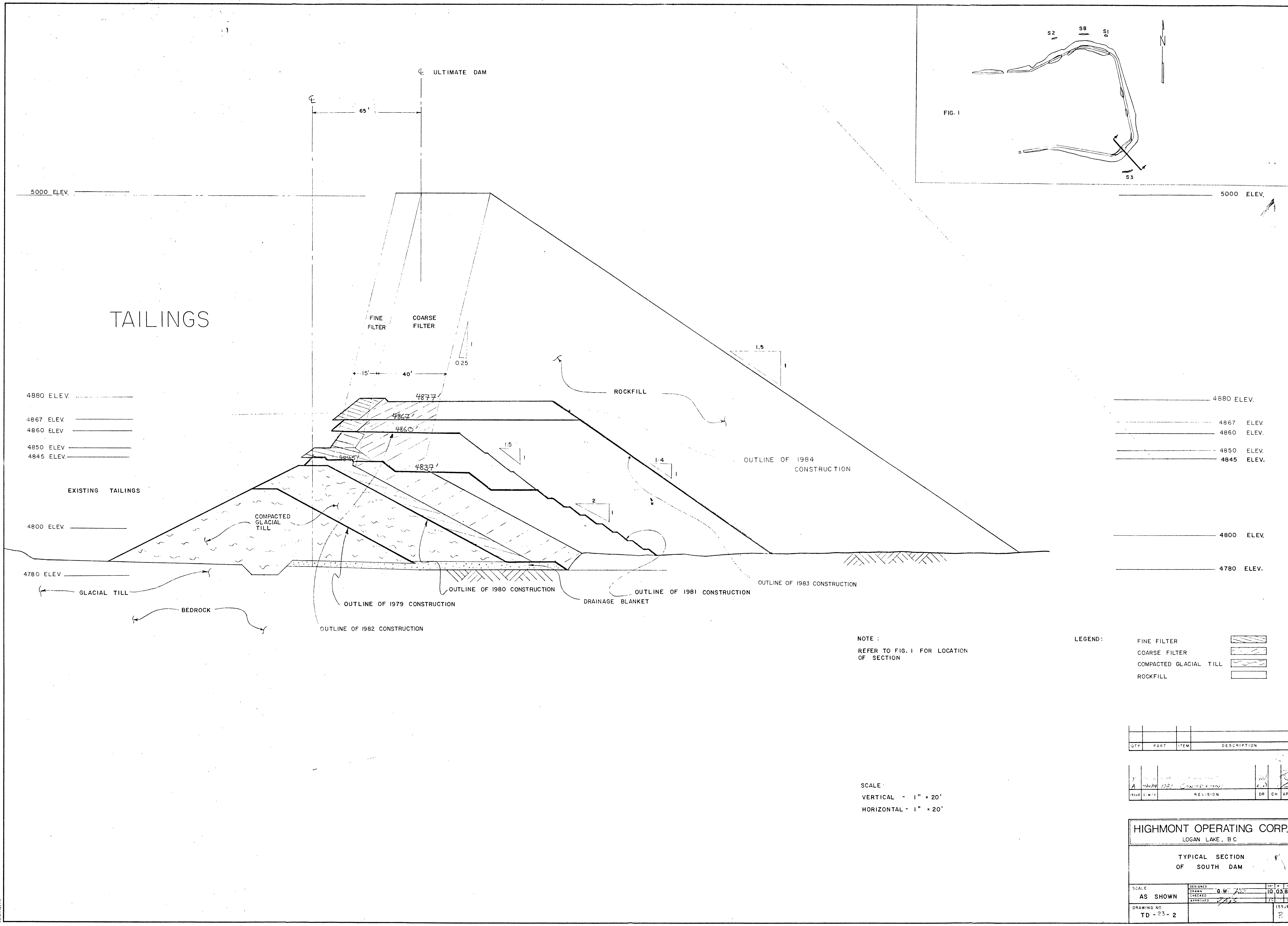
HIGHMONT OPERATING CORP.

LOGAN LAKE, B.C.

TYPICAL SECTION OF NORTHWEST DAM

SCALE	DESIGNED	DAY	MO	YR
AS SHOWN	DRAWN G.W. KJ	10	03	82
	CHECKED			
DRAWING NO	APPROVED			ISSUE
TD-23-3				B

RCG-7181-HE



℄ ULTIMATE DAM
℄
65'
FIG. 1
S2
S8
S1
S3
N
5000 ELEV.
TAILINGS
FINE FILTER
COARSE FILTER
0.25
1
15'
40'
4880 ELEV.
4867 ELEV.
4860 ELEV.
4850 ELEV.
4845 ELEV.
4800 ELEV.
4780 ELEV.
4877'
4867'
4860'
4845'
4837'
ROCKFILL
1.5
1
1.4
2
OUTLINE OF 1984 CONSTRUCTION
EXISTING TAILINGS
COMPACTED GLACIAL TILL
GLACIAL TILL
BEDROCK
OUTLINE OF 1979 CONSTRUCTION
OUTLINE OF 1980 CONSTRUCTION
OUTLINE OF 1981 CONSTRUCTION
OUTLINE OF 1982 CONSTRUCTION
OUTLINE OF 1983 CONSTRUCTION
DRAINAGE BLANKET
NOTE:
REFER TO FIG. 1 FOR LOCATION OF SECTION
LEGEND:
FINE FILTER
COARSE FILTER
COMPACTED GLACIAL TILL
ROCKFILL
SCALE:
VERTICAL - 1" = 20'
HORIZONTAL - 1" = 20'
QTY PART ITEM DESCRIPTION
ISSUE DATE REVISION DR CH APP
HIGHMONT OPERATING CORP.
LOGAN LAKE, B.C.
TYPICAL SECTION OF SOUTH DAM
SCALE AS SHOWN
DESIGNED DRAWN G.W. CHECKED APPROVED
10 03 82
DRAWING NO. TD-23-2
ISSUE 2

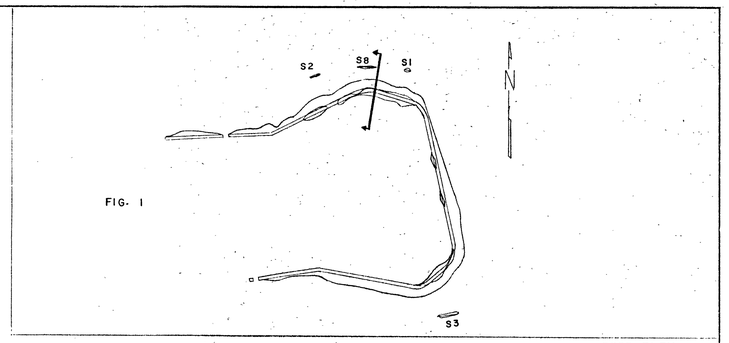


FIG. 1

NOTE:

REFER TO FIG: 1 FOR LOCATION OF SECTION

LEGEND:

- FINE FILTER
- COARSE FILTER
- COMPACTED GLACIAL TILL
- RANDOM STRUCTURAL FILL

SCALE:

VERTICAL - 1" = 20'
HORIZONTAL- 1" = 20'

QTY	PART	ITEM	DESCRIPTION

ISSUE	D/M	REVISION	DR	CH	APP
B	12	1984 CONSTRUCTION	MK		
A	16/11	82 CONSTRUCTION	MS		

HIGHMONT OPERATING CORP.

LOGAN LAKE, B.C.

TYPICAL SECTION
OF NORTHEAST DAM

SCALE	DESIGNED	DAY	MO	YR
AS SHOWN	DRAWN G.W.	10	03	82
	CHECKED			
DRAWING NO. TD - 23 - 1	APPROVED			ISSUE B

BCIL 7931HE

LEGEND

- TAILINGS PIPELINE
- DITCHES
- CREST LINE
- TOE
- SEEPAGE DAM AND SPILLWAY
- BEACH-WATER CONTACT (1994)
- SEEPAGE RETURN PIPELINE
- INSTRUMENTATION LINE
- POWER POLE

NOTES

1. DRAWING TAKEN FROM TECK CORPORATION DRAWING No TP-E3C.
2. TAILINGS BEACH-WATER CONTACT SHOWN IS THAT WHICH EXISTED IN 1994, WITH THE TAILINGS POND LEVEL AT 4867.4 m

SOURCE

KLOHN LEONOFF PROJECT No PB 2916 18, DWG No. E-16001 REV A, DATED NOV 13, 1992.

400 0 800m

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

SCALE

KLOHN-CRIPPEN		DATE
DESIGNED		
DRAWN		
CHECKED		
RECOMMENDED		
APPROVED	RJT	DEC. 96

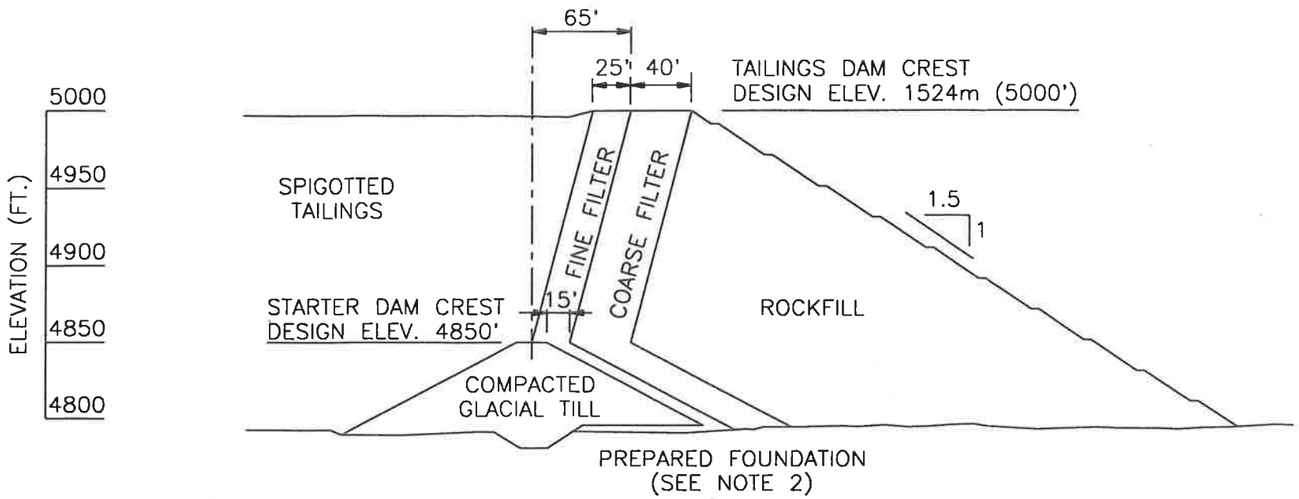
KLOHN-CRIPPEN

CLIENT: HIGHLAND VALLEY COPPER

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: GENERAL ARRANGEMENT HIGHMONT DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
DEC. 9, 1996	PM2916 23	B-23 022	



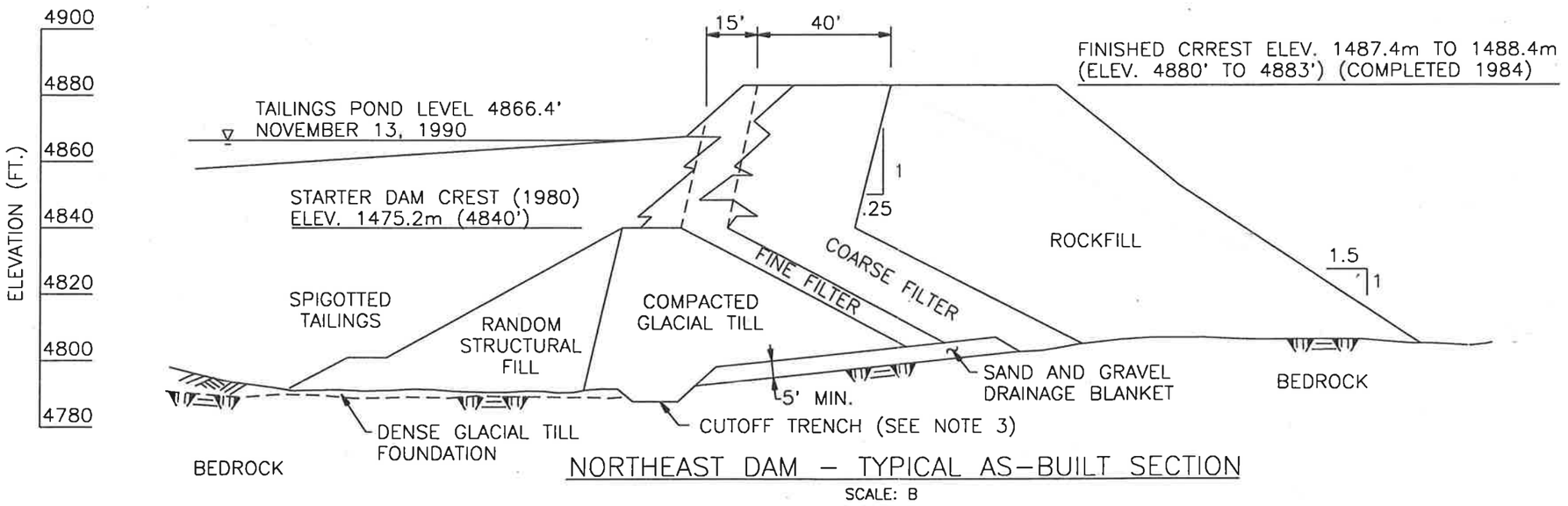
TYPICAL DESIGN SECTION

SCALE: A

NOTES:

1. AS-BUILT SECTION TAKEN FROM DWG. TD-23-1, PERPARED BY TECK CORPORATION, 1984.
2. ALL DAM FOUNDATIONS EXCAVATED TO DENSE UNDISTRURBED SOIL OR TO BEDROCK.
3. CUTOOF TRENCHES EXCAVATED TO A MINIMUM OF 2 FT. INTO DENSE, IMPERVIOUS SOIL OR TO THE SURFACE OF INTACT BEDROCK, EXCEPT FOR THE EAST DAM WHERER THE EXCAVATION DEPTH WAS 5 FT. MAXIMUM. CUTOFF TRENCHES IN BEDROCK WERE HAND-CLEANED.
4. FOR GENERAL ARRANGEMENT OF DAMS AND LOCATION OF NORTHEAST DAM AS-BUILT, SEE DWG. E-16001.

SOURCE
KLOHN LEONOFF PROJECT No.PB2916 16,
DWG No.B-16002, DATED JULY 2, 1992.



NORTHEAST DAM – TYPICAL AS-BUILT SECTION

SCALE: B

SCALE: B 0 40 FT.

SCALE: A 0 100 FT.

SCALE

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

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

KLOHN-CRIPPEN

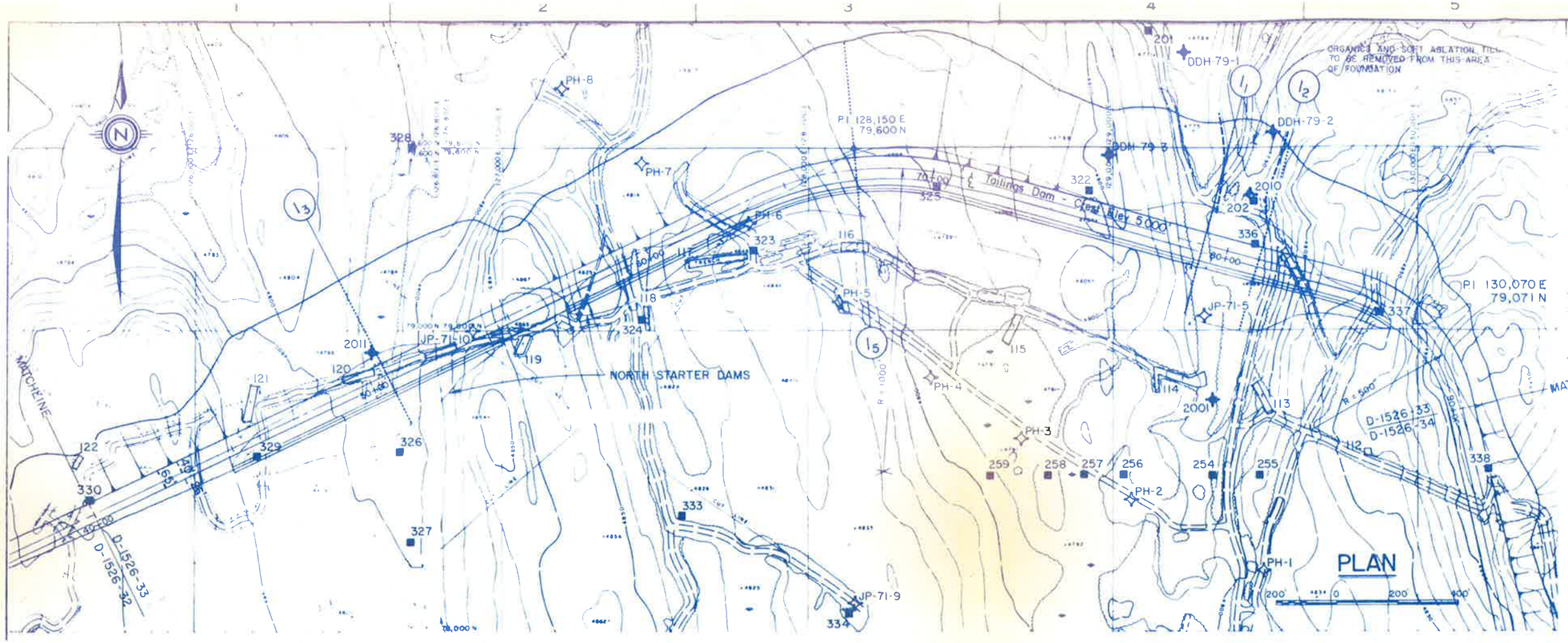
CLIENT
HIGHLAND VALLEY COPPER

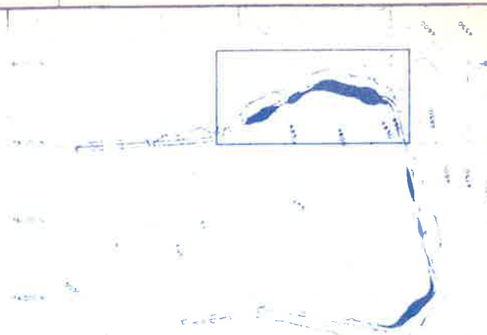
PROJECT
LONG-TERM STABILITY ASSESSMENT

TITLE
TYPICAL SECTION
HIGHMONT DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23023	

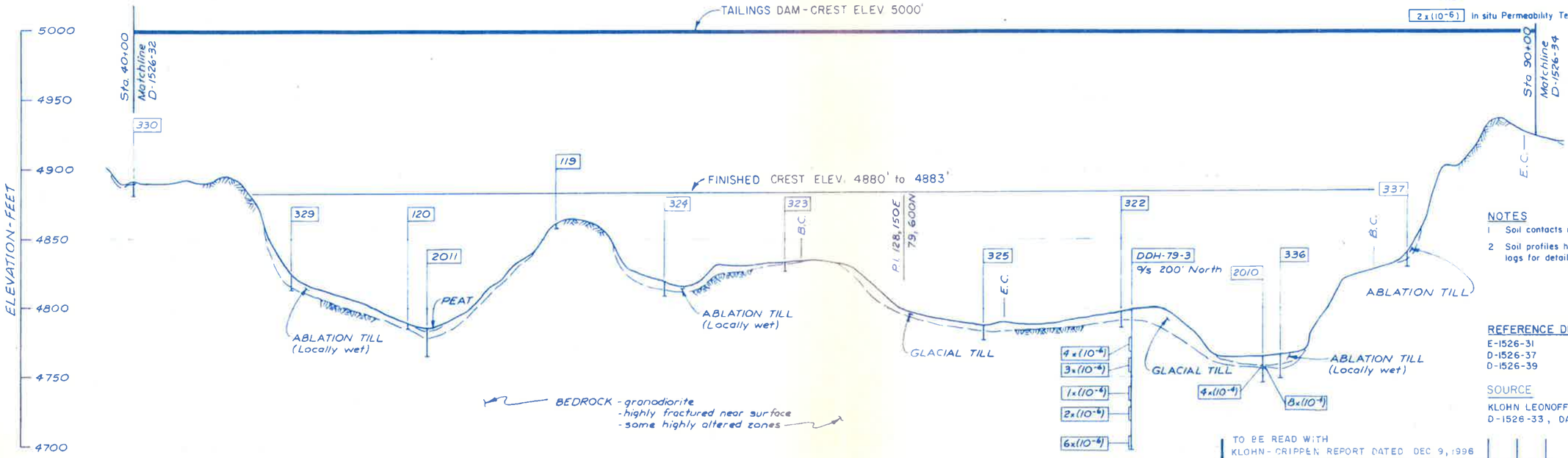
N:\M\M2916\CADD\23
B-23023.DWG





LEGEND

- 124 — 1971 Ripley, Klohn & Leonoff International Ltd. Test Pit
- 1001 — " " " " " " Test Hole
- PH — Percussion Drill Hole by Others
- JP — 1971 Diamond Drill Hole by Others
- 202 — 1979 Klohn Leonoff Consultants Ltd. Test Pit
- 2001 — " " " " " " Test Hole
- DDH — " " " " " " Diamond Drill Hole
- I_1 — Instrumentation Location
- 2 x (10⁻⁶) — In situ Permeability Test. Coefficient of Permeability k in cm/sec.



NOTES

1. Soil contacts inferred between test holes.
2. Soil profiles have been simplified. Refer to test hole logs for detailed descriptions of subsoil conditions

REFERENCE DRAWINGS

E-1526-31	General Arrangement
D-1526-37	Typical Dam Design Sections
D-1526-39	Instrumentation Layout, Schedule and Details

SOURCE

KLOHN LEONOFF PROJECT No. VA1526, DWG. No. D-1526-33, DATED NOV. 7, 1980.

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

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L.	J.K.	April, 1980	As Shown

KLOHN-CRIPPEN

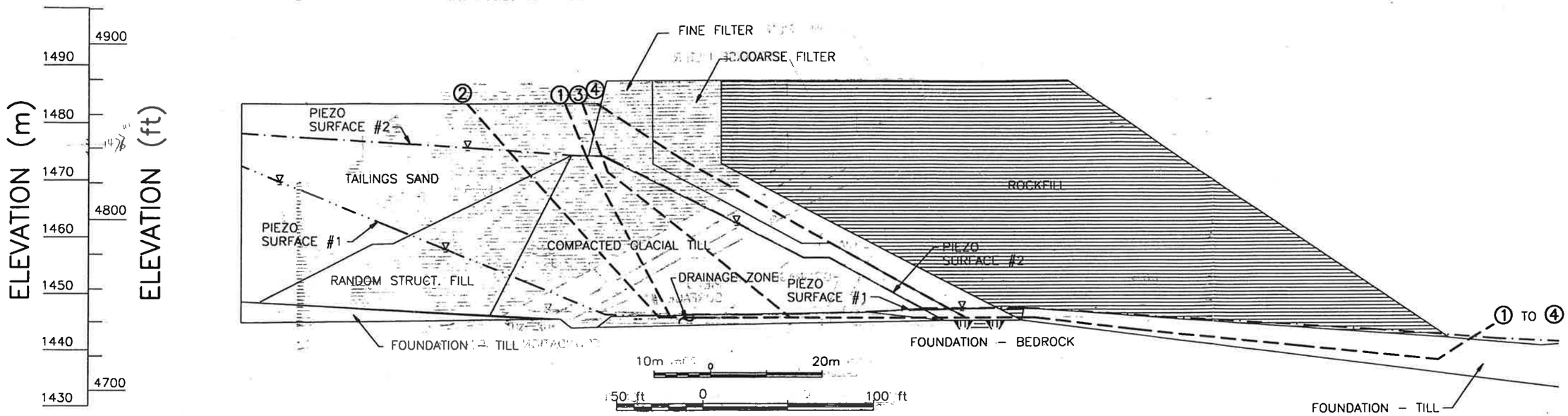
PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: REPRESENTATIVE SUBSOIL DATA HIGHMONT DAM

CLIENT: HIGHLAND VALLEY COPPER

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
DEC. 9, 1996	PM2916 23	B-23024	

APPROVED



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	3.63	2.36	0.45 – 0.5
②	3.70	2.34	0.45
③	3.15	2.11	0.4 – 0.45
④	2.50	1.78	0.35

(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 γ_{moist} (kN/m³)	UNIT WEIGHT γ_{sat} (kN/m³)	EFFECTIVE SHEAR STRENGTH(1) FRICTION ANGLE ø' (degree)
TAILINGS SAND	–	18.9	33
COMPACTED GLACIAL TILL	–	21.5	35
FOUNDATION TILL	–	22.8	35
FINE FILTER	18.9	–	32
COARSE FILTER	18.9	–	32
ROCKFILL	18.9	–	37
DRAINAGE ZONE	18.9	–	32
RANDOM STRUCTURAL FILL	18.9	–	32

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

LEGEND

④ – – – ④ FAILURE SURFACE No.4

– · ▽ · – PIEZOMETRIC SURFACE #1

— · ▽ · — PIEZOMETRIC SURFACE #2

NOTES

1. ELEVATION IN METRES AND FEET REFERS TO HIGHLAND VALLEY COPPER DATUM.
2. PIEZOMETRIC SURFACE #1 APPLIED TO FOUNDATION TILL AND DRAINAGE ZONE.
3. PIEZOMETRIC SURFACE #2 APPLIED TO TAILINGS SAND, RANDOM STRUCTURAL FILL AND COMPACTED GLACIAL TILL.

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

SCALE

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

KLOHN-CRIPPEN

CLIENT: HIGHLAND COPPER VALLEY

PROJECT: LONG-TERM STABILITY ASSESSMENT

TITLE: STABILITY ANALYSES – HIGHMONT DAM

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
DEC. 9, 1996	PM2916 23	B-23025	

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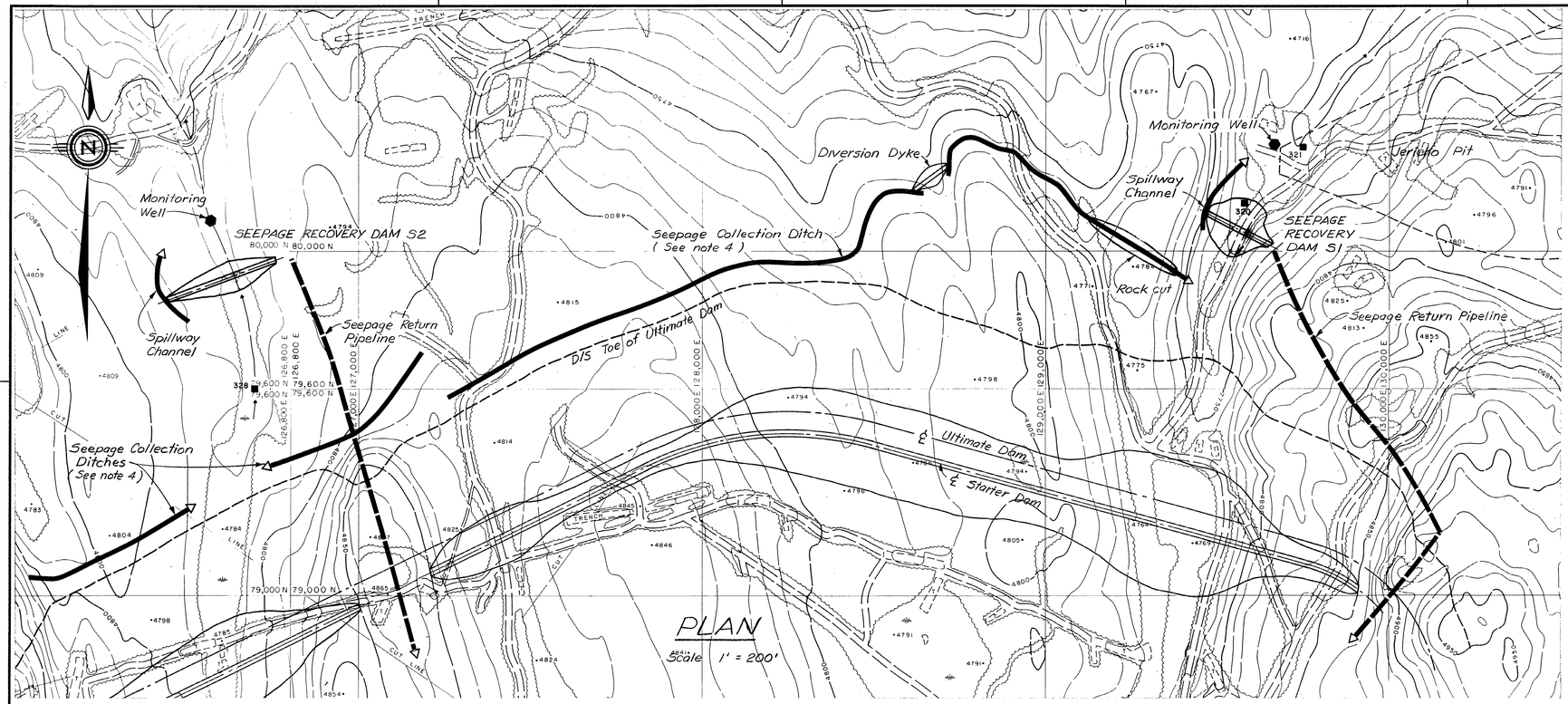
08/23/96 TIME: 4:35

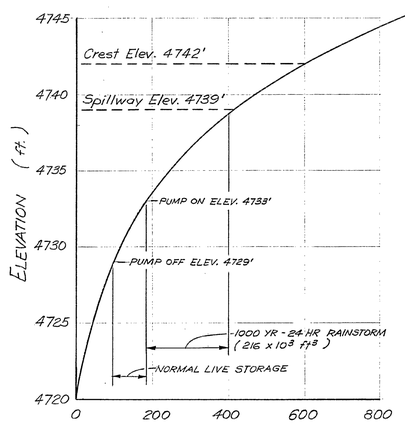
APPENDIX III-B-2

Reference Dam Design Drawings – Seepage Dams

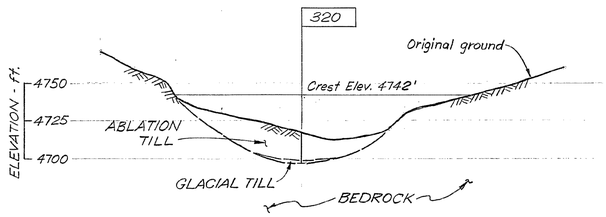


PLAN

Scale 1" = 200'

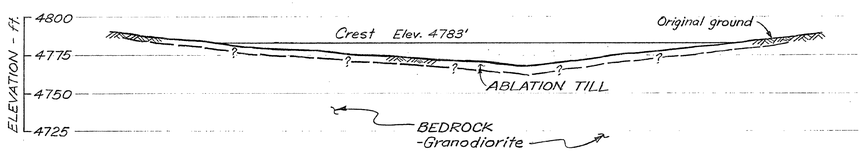


VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S1



PROFILE OF SEEPAGE RECOVERY DAM S1

Scale 1" = 50'

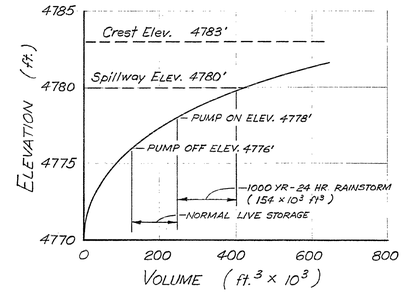


PROFILE OF SEEPAGE RECOVERY DAM S2

Scale 1" = 50'

NOTES:

1. Refer to Drawing E-1526-25 for General Arrangement of Seepage Network.
2. Refer to Drawings D-1526-29 and -30 for typical design sections of dams, ditches and spillways.
3. Subsurface profiles are inferred from preliminary test hole information. More detailed investigation will be performed prior to construction.
4. Small dumped rockfill check dams may be required for erosion protection where glacial deposits are exposed in seepage collection ditches.
5. Location of seepage return pipelines are included for illustration only. Final design of pipelines by others.



VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S2

TO BE READ WITH KLOHN LEONOFF CONSULTANTS REPORT DATED Apr. 3, 1980

SCALE:

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L., S.R.	F.C.	MAR., 1980	As shown

Klohn Leonoff Consultants Ltd.

CIVIL • GEOTECHNICAL • HYDRAULIC

VANCOUVER - CALGARY - WINNIPEG - DENVER

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

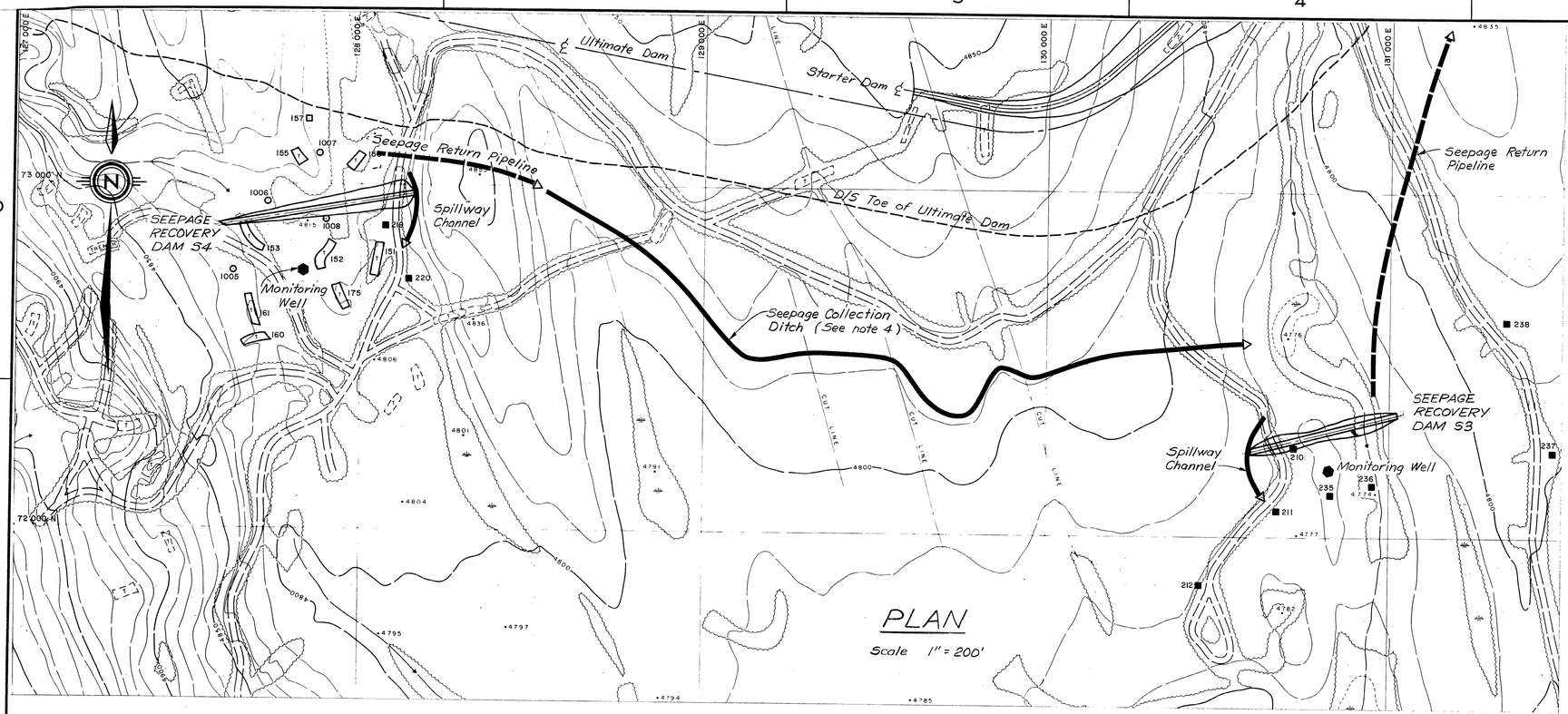
TITLE: SEEPAGE RECOVERY DAMS S1 & S2 PLAN, PROFILES & STORAGE CURVES

CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-26	

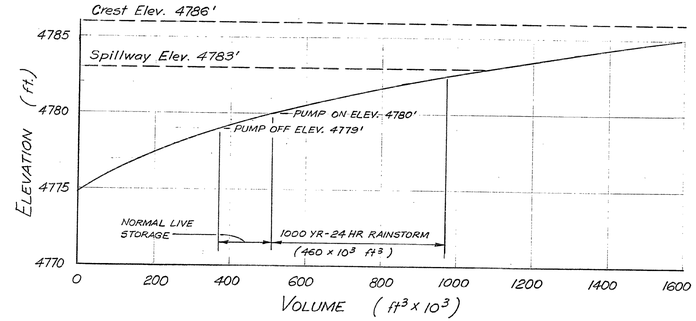
APPROVED

NCI 317 — K.L.C.L.

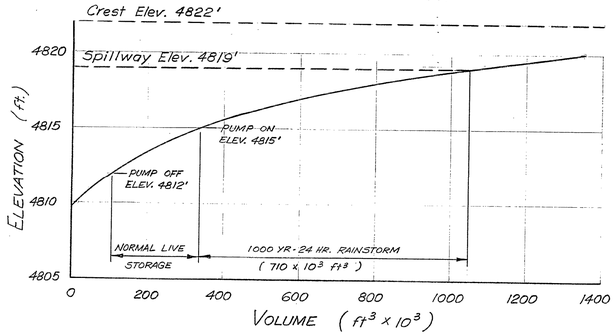


PLAN

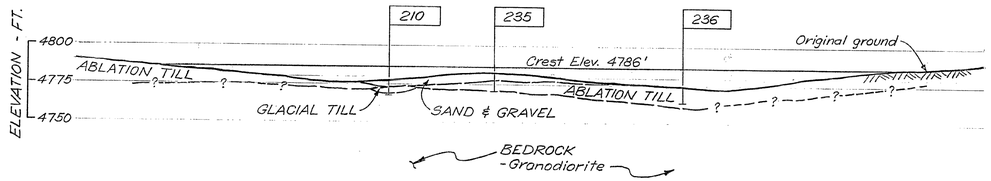
Scale 1" = 200'



VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S3

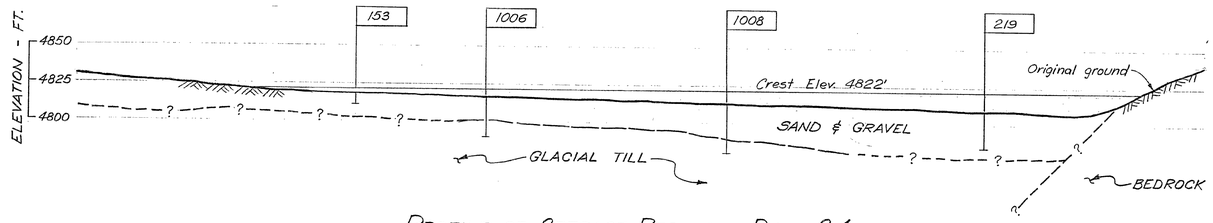


VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S4



PROFILE OF SEEPAGE RECOVERY DAM S3

Scale 1" = 50'



PROFILE OF SEEPAGE RECOVERY DAM S4

Scale 1" = 50'

NOTES:

1. Refer to Drawing E-1526-25 for General Arrangement of Seepage Network.
2. Refer to Drawings D-1526-29 and -30 for typical design sections of dams, ditches and spillways.
3. Subsurface profiles are inferred from preliminary test hole information. More detailed investigation will be performed prior to construction.
4. Small dumped rockfill check dams may be required for erosion protection where glacial deposits are exposed in seepage collection ditches.
5. Location of seepage return pipelines are included for illustration only. Final design of pipelines by others.

TO BE READ WITH KLOHN LEONOFF CONSULTANTS REPORT DATED Apr. 3, 1980

SCALE:

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L., S.R.	F.C.	MAR., 1980	As shown

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VANCOUVER - CALGARY - WINNIPEG - DENVER

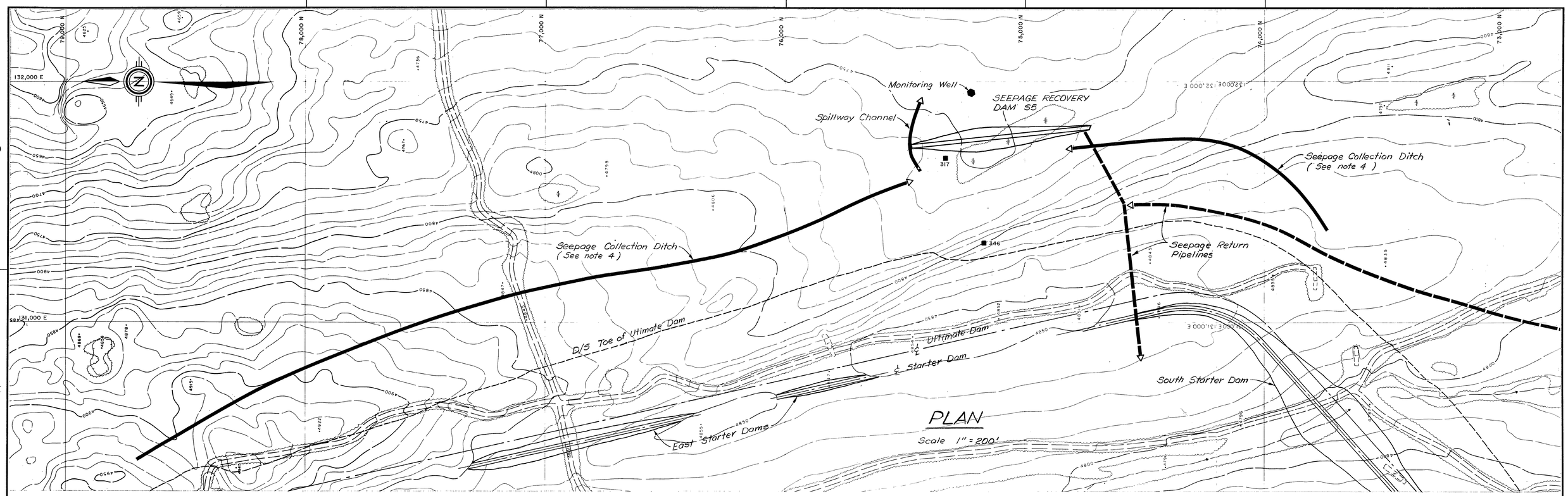
PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: SEEPAGE RECOVERY DAMS S3 & S4 PLAN, PROFILES & STORAGE CURVES

CLIENT: HIGHMONT OPERATING CORP.

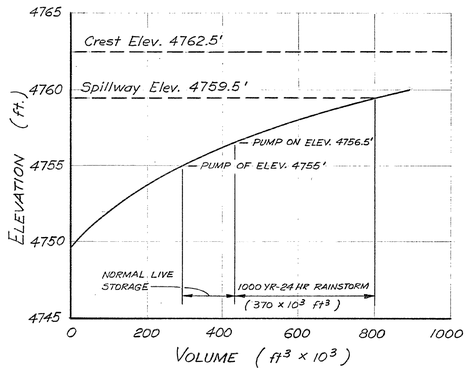
DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-27	

APPROVED

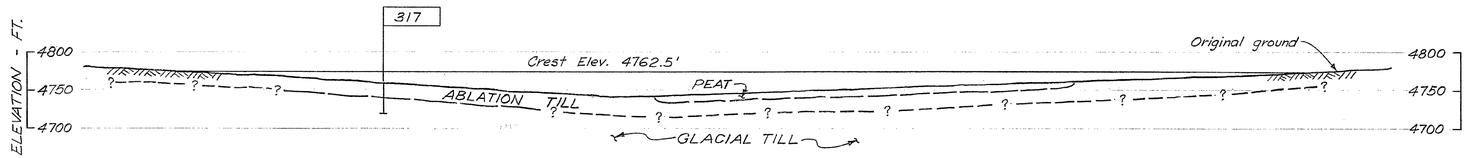


PLAN

Scale 1" = 200'



VOLUME ELEVATION CURVE
SEEPAGE RECOVERY S5



PROFILE OF SEEPAGE RECOVERY DAM S5

Scale 1" = 50'

NOTES:

1. Refer to Drawing E-1526-25 for General Arrangement of Seepage Network.
2. Refer to Drawings D-1526-29 and -30 for typical design sections of dams, ditches and spillways.
3. Subsurface profiles are inferred from preliminary test hole information. More detailed investigation will be performed prior to construction.
4. Small dumped rockfill check dams may be required for erosion protection where glacial deposits are exposed in seepage collection ditches.
5. Location of seepage return pipelines are included for illustration only. Final design of pipelines by others.

TO BE READ WITH KLOHN LEONOFF CONSULTANTS REPORT DATED Apr. 3, 1980

SCALE:

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L., S.R.	F.C.	MAR., 1980	As shown

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VANCOUVER - CALGARY - WINNIPEG - DENVER

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: SEEPAGE RECOVERY DAM S5
PLAN, PROFILE & STORAGE CURVE

CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE Apr. 3, 1980

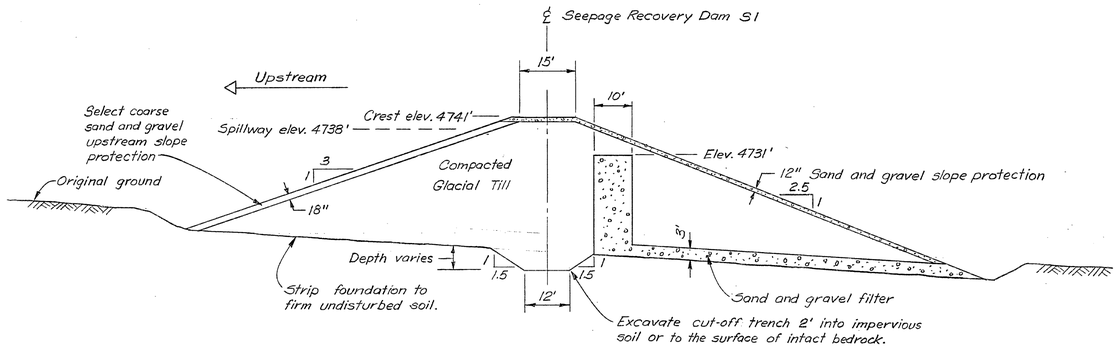
APPROVED

PROJECT No. VA 1526

DWG. No. D-1526-28

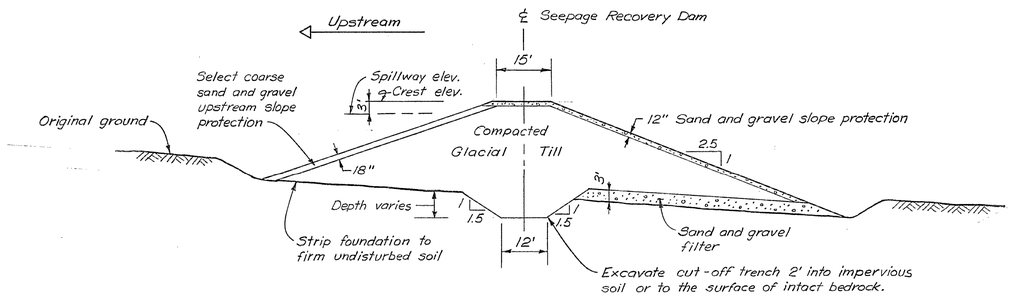
REV.

NCI 317 – K.L.C.L.



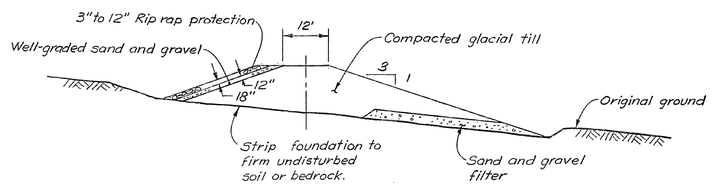
Design Section - Seepage Recovery Dam S1

Scale 1" = 20'



Typical Section - Seepage Recovery Dams S2 to S7

Scale 1" = 20'

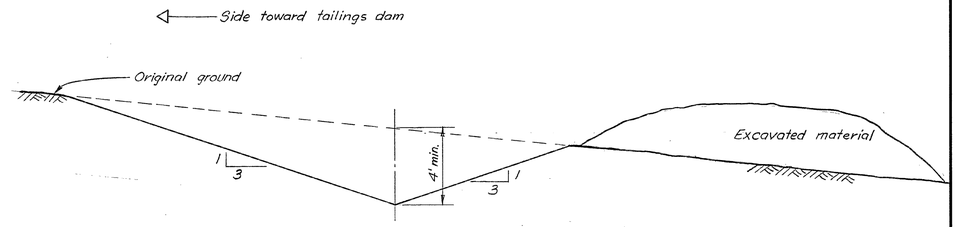


Typical Section - Diversion Dyke

Scale 1" = 20'

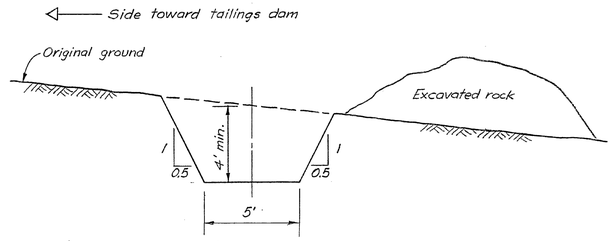
Gradation Requirements For Upstream Slope Protection

U.S. Standard Sieve Size	Percent Passing By Weight
8"	70 - 100
3"	55 - 80
3/4"	25 - 55
# 4	10 - 35
#40	0 - 15
#200	0 - 3



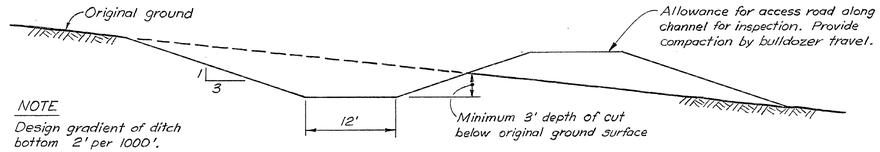
Seepage Collection Ditch Excavated In Soil

Scale 1/4" = 1'-0"



Seepage Collection Ditch Excavated In Bedrock

Scale 1/4" = 1'-0"



NOTE
Design gradient of ditch bottom 2' per 1000'.

Run-off Diversion Ditch

Scale 1" = 10'

TO BE READ WITH KLOHN LEONOFF CONSULTANTS REPORT DATED Apr. 3, 1980

SCALE:

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L., S.R.	F.C.	MAR., 1980	As shown

Klohn Leonoff Consultants Ltd.
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VANCOUVER - CALGARY - WINNIPEG - DENVER

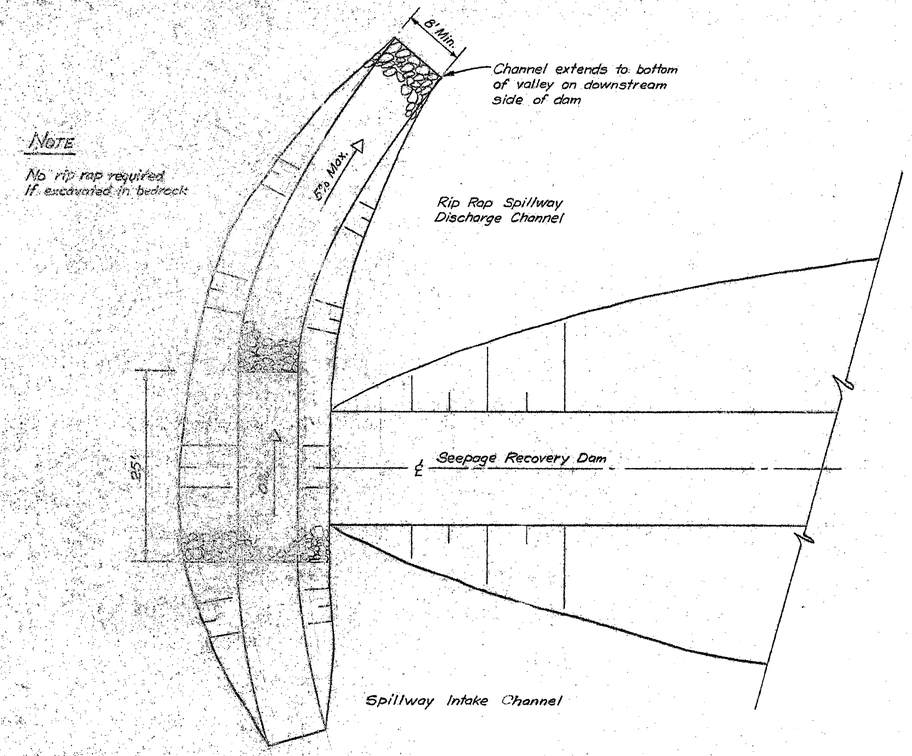
PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: TYPICAL DESIGN SECTIONS

CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-29	

APPROVED

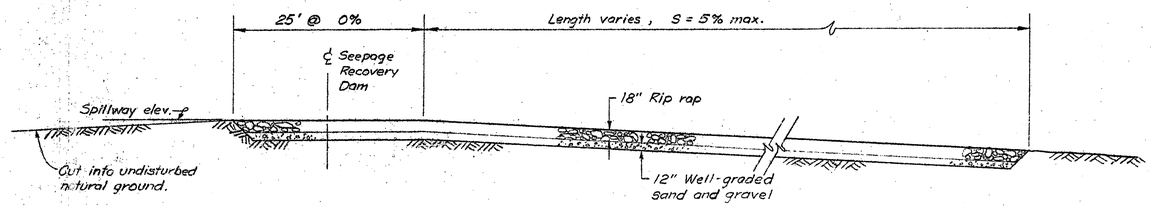


NOTE

No rip rap required if excavated in bedrock.

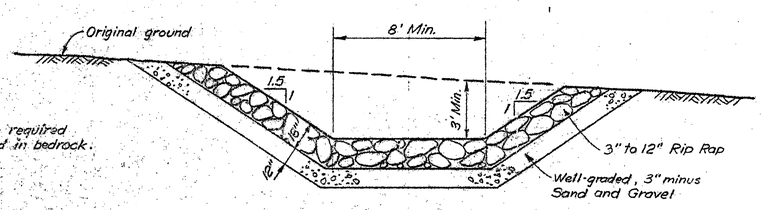
TYPICAL PLAN OF SPILLWAYS FOR SEEPAGE RECOVERY DAMS

Scale 1" = 10'



LONGITUDINAL PROFILE OF SPILLWAY CHANNEL

Scale 1" = 10'



NOTE

No rip rap required if excavated in bedrock.

TYPICAL SPILLWAY DISCHARGE CHANNEL

Scale 1/4" = 1'0"

TO BE READ WITH KLOHN LEONOFF CONSULTANTS REPORT DATED Apr. 3, 1980.

SCALE:

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
P.C.L., S.R.	F.C.	MAR., 1980.	As shown

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VANCOUVER - CALGARY - WINNIPEG - DENVER

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

TITLE: TYPICAL SPILLWAY DETAILS

CLIENT: HIGHMONT OPERATING CORP.

DATE BY ISSUED FOR APPROVED: Apr. 3, 1980 P.C.L.

PROJECT NO. VA 1528

DWG. NO. D-1526-30

REV.

NCI 317 - K.L.C.L.

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 Highmont TSF catchment (>El. 1487 m, i.e. dam crest). Climate data was adjusted for elevation, using the recommended adjustment factor from L-L Dam to Highmont Area (El. 1,500 m to 1,700 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-1 respectively. Normal precipitation data, reported in Table IV-A-1, is based on the Highland Valley Lornex climate station, adjusted for elevation to Highmont 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 at Highmont TSF was significantly less than historic normals (based on Highland Valley Lornex adjusted to Highmont 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.

Table IV-A-1 Monthly Precipitation

Month	Precipitation (mm)			
	L-L Dam Weather Station Data Adjusted to Highmont Area[1]	1976-2011 Highland Valley Lornex Normals Adjusted to Highmont Area[2]	Kamloops Airport Weather Station[3]	1981-2010 Kamloops Airport Weather Station Normals[4]
Oct 2018[5]	23.3	36.3	27.5	19.4
Nov 2018[5]	25.6	48.9	33.5	23.3
Dec 2018[5]	17.1	49.4	20.2	25.4
Jan 2019	13.5	33.3	5.7	21.1
Feb 2019	19.7	25.4	13.8	12.4
Mar 2019	7.4	20.2	4.3	12.8
Apr 2019	18.4	25.8	11.5	14.2
May 2019	45.4	50.0	17.4	27.3
Jun 2019	104.8	58.0	21.2	37.4
Jul 2019	96.8	52.6	36.0	31.4
Aug 2019	12.7	38.4	16.7	23.7
Sep 2019	51.6	37.8	39.1	29.4
Annual Total	436.4	475.9	246.9	277.6

Notes:
1. Available data from L-L Dam climate station was adjusted by a L-L Dam-to-Highmont adjustment factor of 1.15 (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

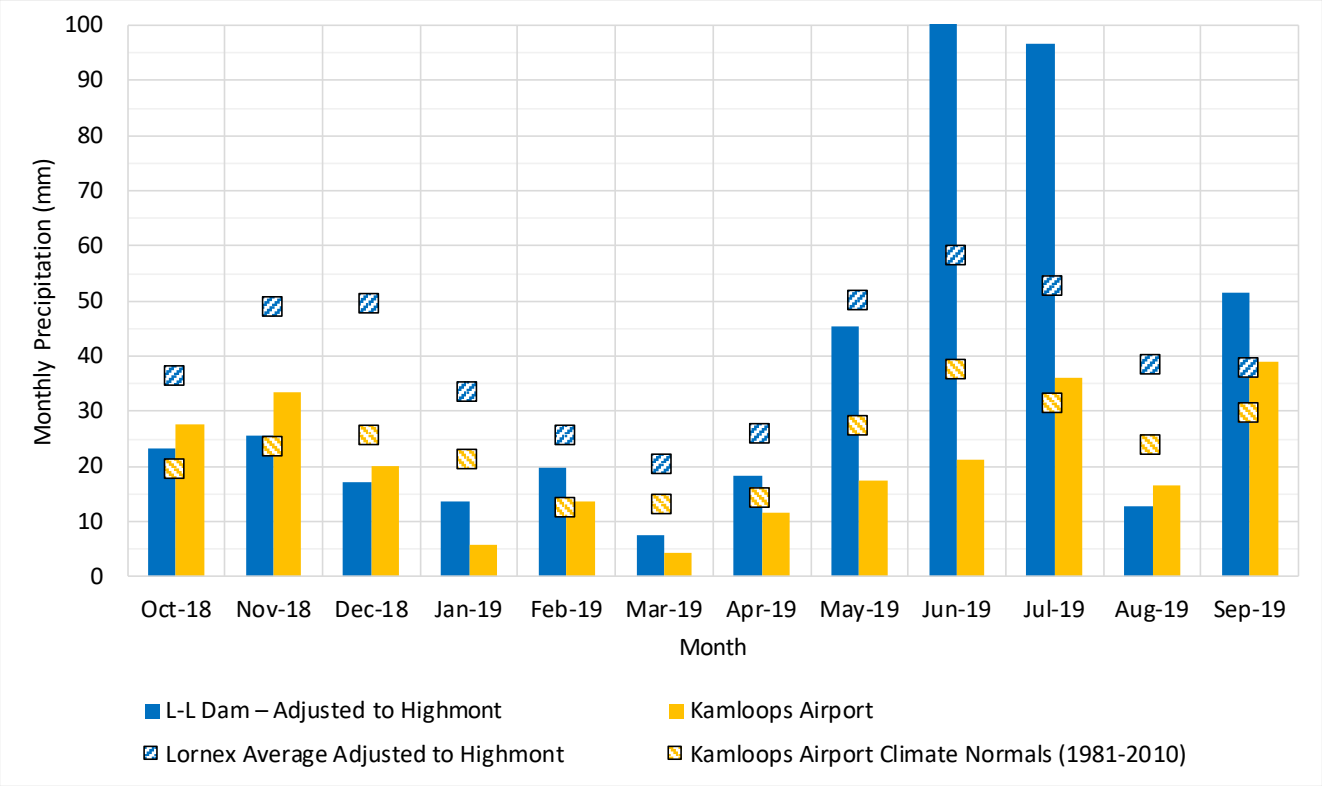


Table IV-A-2 Historical Average and 2019 Snowpack Depths

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

Piezometric readings from 2007 to 2019 are shown on Figure IV-B-1 to Figure IV-B-5. 2019 piezometer measurements typically show similar seasonal pattern as previous years which reflects fluctuation in the Highmont TSF pond level.

The following observations are noted:

- There were no piezometric threshold exceedances in 2019.
- A groundwater mound between the Highmont TSF dams and the pond where piezometric levels are higher in the middle of the beach, indicating radial drainage to the perimeter and some drainage towards the pond, has been persistent for the instrumentation record and continued in 2019.
- Instruments in the northeast corner of the impoundment (PW-A, HM-PS-01, HM-PS-02 and HM-PS-03) showed an upward trend between May 2016 and mid-2018. The rising trend started decreasing in the last quarter of 2018 which continued in 2019, leveling off later in the year:
  - The reason for the mid-2016 to mid-2018 rise in piezometric levels within this section of the dam is unknown; in 2018, THVCP investigated to confirm these observations are not due to something other than rising piezometric levels (e.g. surveyed tip elevation or data entry). KCB completed a walk-over of the crest, downstream slope and toe in the area of these instruments during the 2019 DSI site visit and no issue (e.g. change from previous inspections) or concern was observed.
  - The elevated phreatic levels were near piezometric lines, assumed in design analyses, but did not exceed. In general, the stability of the dam is not sensitive to small changes in the piezometric level upstream of the dam.
  - Increasing seepage downstream of this area would be an indicator of increasing piezometric levels and gradient in the downstream portion of the dam and foundation. However, available weir flow data downstream of the North Dam and upstream of Seepage Pond 1 (HM-01-FS-02) showed relatively stable seepage rates.
- Southeast piezometers show seasonal patterns similar to previous years which reflects fluctuation in the Highmont TSF pond level.

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. As part of annual dam safety inspection, 2019 maximum and minimum water levels and piezometric thresholds were reviewed (Refer to Table IV-B-1). No change of threshold values is proposed for 2020.

Table IV-B-1 2019 Piezometric Levels

Instrument ID	2019 Piezometric Levels (m)		2019 Threshold Values (see Note 1)
	Maximum	Minimum	
S1	1431.7	1431.5	1432.4
S2	1451.8	1451.1	1452.5
S2-1	1479.9	1479.8	1481.4
S2-2	1480.4	1480.2	1482.0
S2-3	1482.0	1481.6	1483.4
S2-4	1481.6	1480.2	1482.9
S3-1	1481.4	1481.1	1482.0
S3-2	1482.5	1481.8	1483.0
PW-A	1479.4	1479.3	1480.5
PW-C (TALL)	1482.0	1480.8	1482.6
P-D	1481.5	1479.8	1482.2
P-E	1481.1	1481.0	1482.6
P-G	1481.7	1480.4	1482.4
PW-H	1480.6	1480.4	1481.1
P-I	1481.1	1481.0	1482.7
PW-J	1481.2	1480.0	1481.9
P-K	1481.3	1479.9	1482.2
PW-L	1481.1	1481.0	1481.5
P-M	1482.1	1481.3	1483.5
P-N	1481.0	1480.8	1481.9
P-O	1479.7	1479.4	1482.4
PW-P	1481.0	1480.7	1481.5
HM-PS-01 (13-SRK-14)	1478.5	1478.4	1480.5
HM-PS-02 (13-SRK-13)	1477.9	1477.8	1480.5
HM-PS-03 (13-SRK-13)	1478.2	1478.1	1480.5

Notes:
1. No change of threshold values is proposed for 2020.

IV-B-2 SURVEY MONUMENTS

Monument surveys, horizontal displacement and settlement (vertical displacement) are plotted on Figure IV-B-6. 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.
- In 2018 and 2017, P4 (South dam) exceeded its horizontal movement threshold relative to 2007 original location (threshold was set as 80 mm). The movement however was in the northeast direction perpendicular to the dam orientation, slightly in the upstream direction, which aligns with the variance observed at this location. No accompanying change in vertical settlement was observed. No significant indicators of distress in the dam observed in this area during site visit. Therefore, this was not considered a dam safety concern. 2019 readings are

below threshold, confirming that the 2018 horizontal movement exceedance was likely due to a survey error.

- 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 have used a total station with an estimated accuracy of 25 mm for horizontal measurements, and a high precision digital level with an estimated accuracy of 10 mm for vertical measurements. Monument surveys, horizontal displacement and settlement since 2008 are plotted on Figure IV-6.

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

Monument	Incremental[1]		Change from Initial Survey[2]	
	Vector Horizontal Displacement (mm)	Vertical Displacement (mm)	Vector Horizontal Displacement (mm)	Vertical Displacement (mm)
P2	46.4, downstream	+1.3	67, downstream	-6.5
P3	38.0, downstream	+3.1	48.7, downstream	-1.8
P4	107, downstream	+3.0	59.8, downstream	-27.1
P5	42.2, downstream	+2.1	66.5, downstream	+2.9
P6	51.1, downstream	+0.4	50.3, downstream	-28.2
P7	Not measured[3]	+0.44	Not measured[3]	-33.9

Notes:
1. October 2019 survey compared to November 2018 survey.
2. All monuments earliest historic readings are in 2007. Cumulative displacements are calculated as difference from the June 2017 survey and earliest historical reading.
3. P7 is surveyed for elevation only and no horizontal vector displacements can be estimated.

Movement thresholds for 2020 remain unchanged from 2019; refer to Table IV-B-3.

Table IV-B-3 2020 Survey Monument Displacement Thresholds

Instrument ID	Horizontal Vector Displacement from Original Position (mm)	Incremental Settlement Between Readings (mm)	Total Settlement (mm)
P2	80	20	50
P3			50
P4			75
P5			150
P6			75
P7	n/a		75

Notes:
1. There is no change from 2019 to 2020 threshold values for horizontal displacement from original position, incremental vertical displacement between readings, or total vertical displacement between readings.

IV-B-3 SEEPAGE

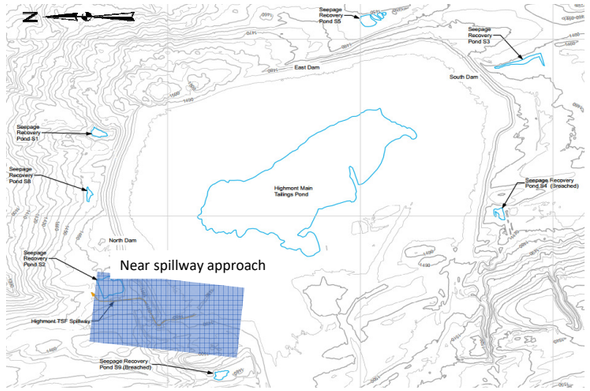
Table IV-B-4 summarizes seepage flows, monitored upstream of four seepage ponds at the instruments (weirs), along with frequencies at which these instruments are read. Monitoring frequencies for all ponds are set primarily for environmental and water balance factors, not dam safety. Monthly data was reviewed by KCB as part of this DSI and it was considered adequate from a dam safety perspective. Instrument locations are shown in Figures 3 to 5 and 2019 flow measurements are plotted on Figure IV-B-7. 2019 flows were consistent with recent trends and no observations of turbid flow, related to potential piping were noted in the inspection reports.

Typically, the peak flow rates are recorded in April/May during freshet. Although based on a lower number of readings, 2019 seepage measurements were generally similar to recent measurements during the same time period. The above average flows observed in all the seepage flow measurement instrumentation in 2017 was likely an early response to the freshet. This peak was not observed in 2018 or 2019, possibly influenced by the reduced frequency of readings and milder freshet.

Table IV-B-4 Summary of Seepage Flow Measurement Instruments

Instrument ID	Location	Instrument Type	2019 Monitoring Frequency
HM-S1-FS-02	Upstream of S1 Pond	Weir – Datalogger and Manual Reading	Monthly Manual Readings
HM-S3-FS-01	Upstream of S3 Pond	Weir – Datalogger and Manual Reading	Monthly Manual Readings
HM-S5-FS-01	Upstream of S5 Pond	Pipe and Bucket – Manual Reading	Monthly Manual Readings
HM-S8-FS-01	Upstream of S8 Pond	Pipe and Bucket – Manual Reading	Monthly Manual Readings

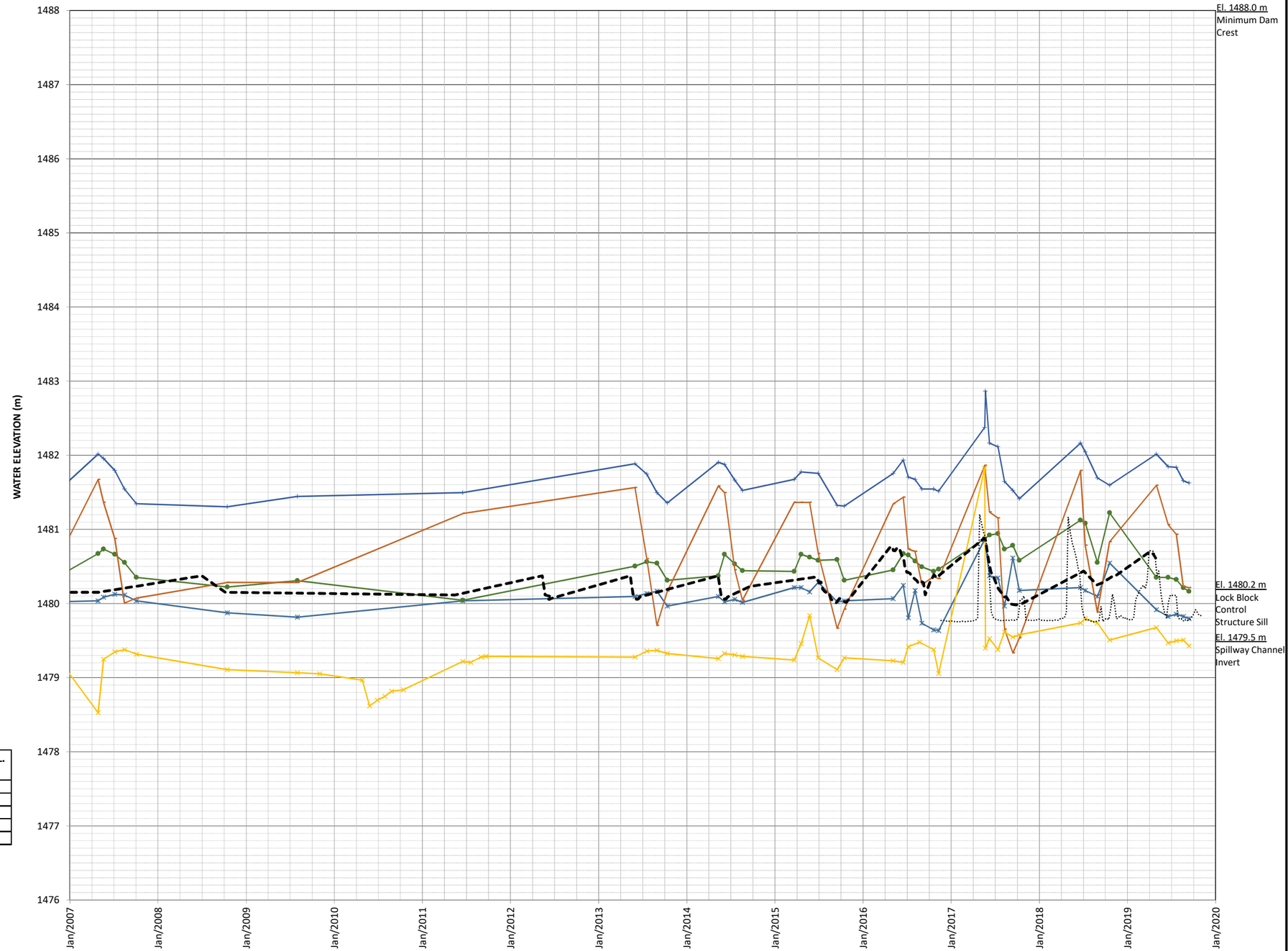
INSTRUMENTATION PLOTS



LEGEND:

- S2-1 (Tip El. 1477.5 m,)
- S2-2 (Tip El. 1479.2 m,)
- S2-3 (Tip El. 1476.7 m,)
- S2-4 (Tip El. 1477.8 m,)
- P-O (Tip El. 1478.8 m,)
- Highmont Pond Level
- Highmont Spillway (Tranducer Data)

PIEZOMETER ID	2019 THRESHOLD EL. (m)
P-O	1480.8
S2-1	1482.8
S2-2	1483.1
S2-3	1483.9
S2-4	1483.2



CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2019

NEAR SPILLWAY APPROACH

PROJECT No. M02341B53

FIG No. IV-B-1

January 13, 2020
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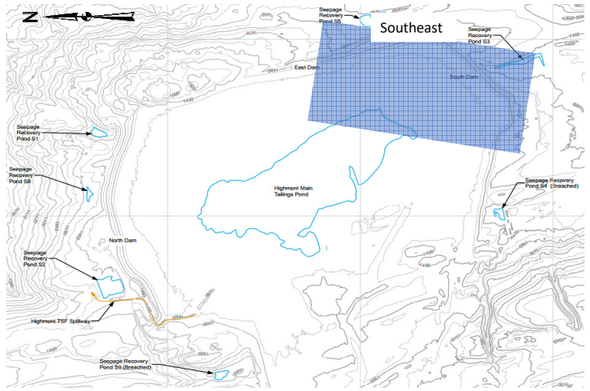
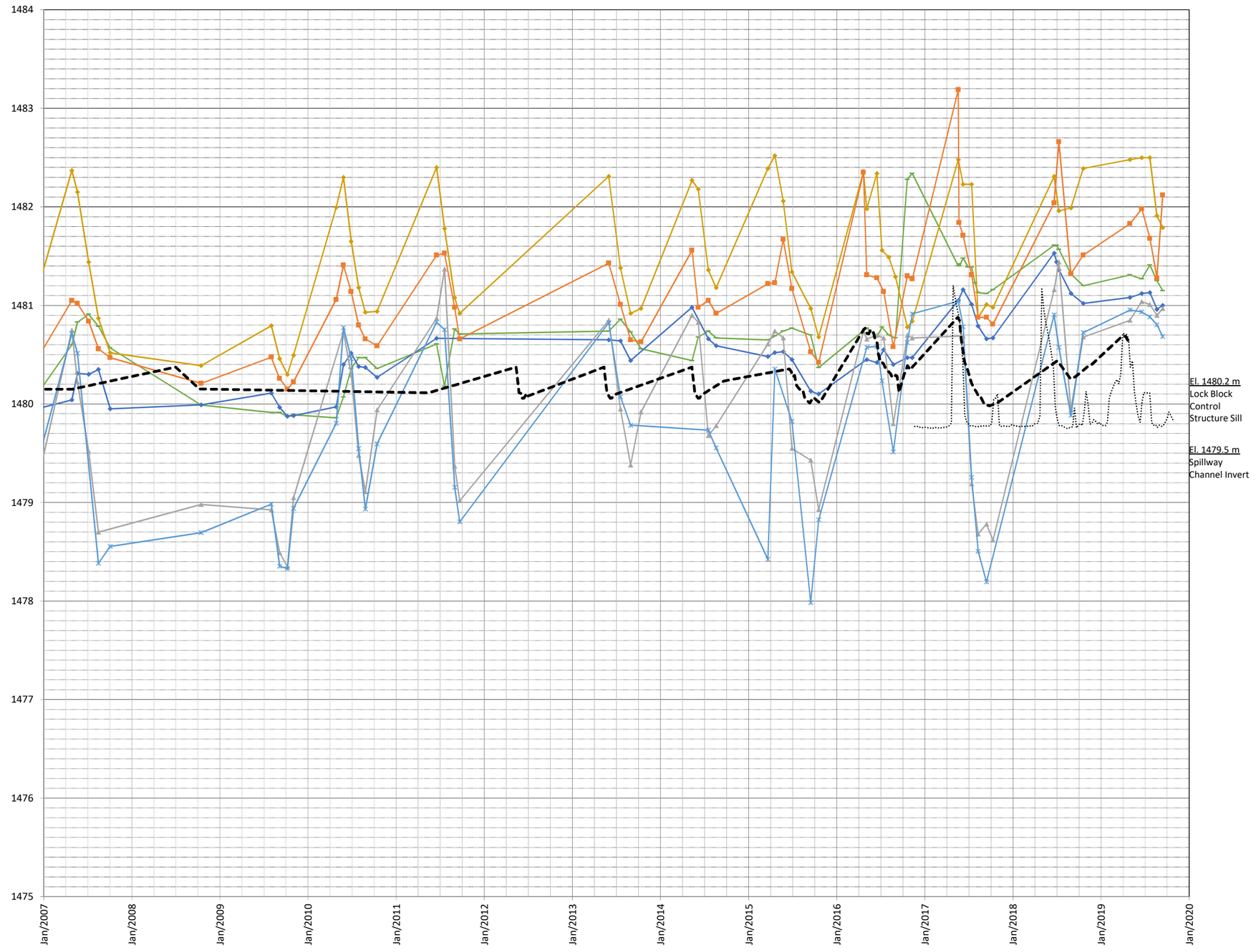


LEGEND:

- S3-1 (Tip El. 1476.3 m,)
- S3-2 (Tip El. 1477.4 m,)
- PW-L (Tip El. 1473.5 m,)
- P-M (Tip El. 1474.3 m,)
- P-N (Tip El. 1473.6 m,)
- PW-P (Tip El. 1473.5 m,)
- Highmont Pond Level
- Highmont Spillway (Tranducer Data)

PIEZOMETER ID	2019 THRESHOLD EL. (m)
PW-L	1481.5
P-M	1482.8
P-N	1481.9
S3-1	1482.0
S3-2	1483.0
PW-P	1482.2



CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

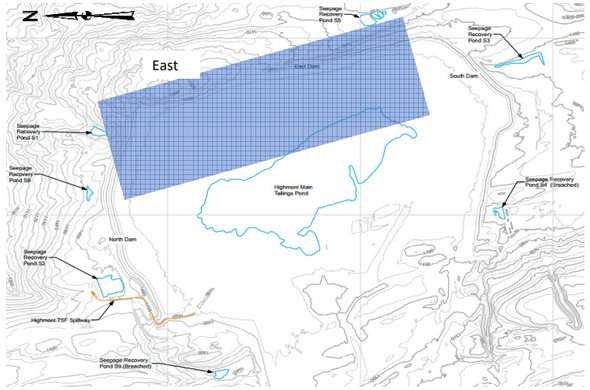
TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2019

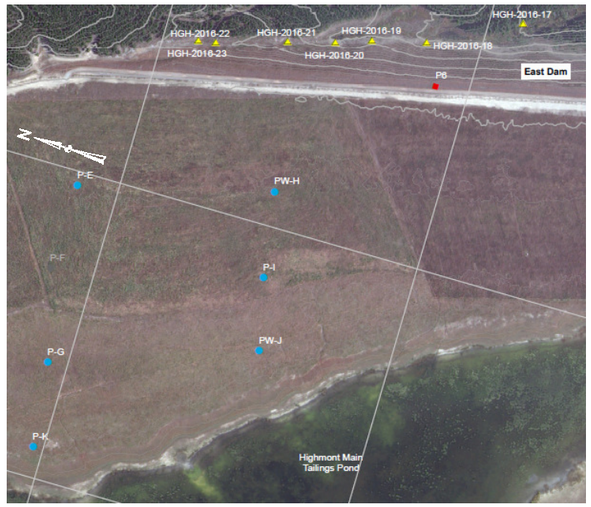
SOUTH EAST

PROJECT No. M02341B53

FIG No. IV-B-2

January 13, 2020
Z:\MVC\PRM02341B53 - HVC-2019 Dam Safety Support\300 Design\330 Piezometer Data\Highmont\200113 Highmont Piezo.xlsx\SEEPAGE PONDS





LEGEND:

- P-E (Tip El. 1473.4 m,)
- P-G (Tip El. 1475 m,)
- PW-H (Tip El. 1473.4 m,)
- P-I (Tip El. 1474.6 m,)
- PW-J (Tip El. 1475.4 m,)
- P-K (Tip El. 1474.9 m,)
- Highmont Pond Level
- Highmont Spillway (Tranducer Data)

PIEZOMETER ID	2019 THRESHOLD EL. (m)
P-E	1483.6
P-G	1482.4
P-K	1482.2
PW-H	1481.1
P-I	1481.5
PW-J	1481.9

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2019

EAST

PROJECT No. M02341B53

FIG No. IV-B-3

January 13, 2020
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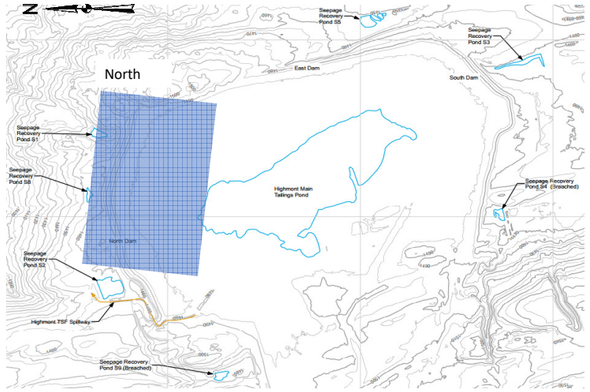
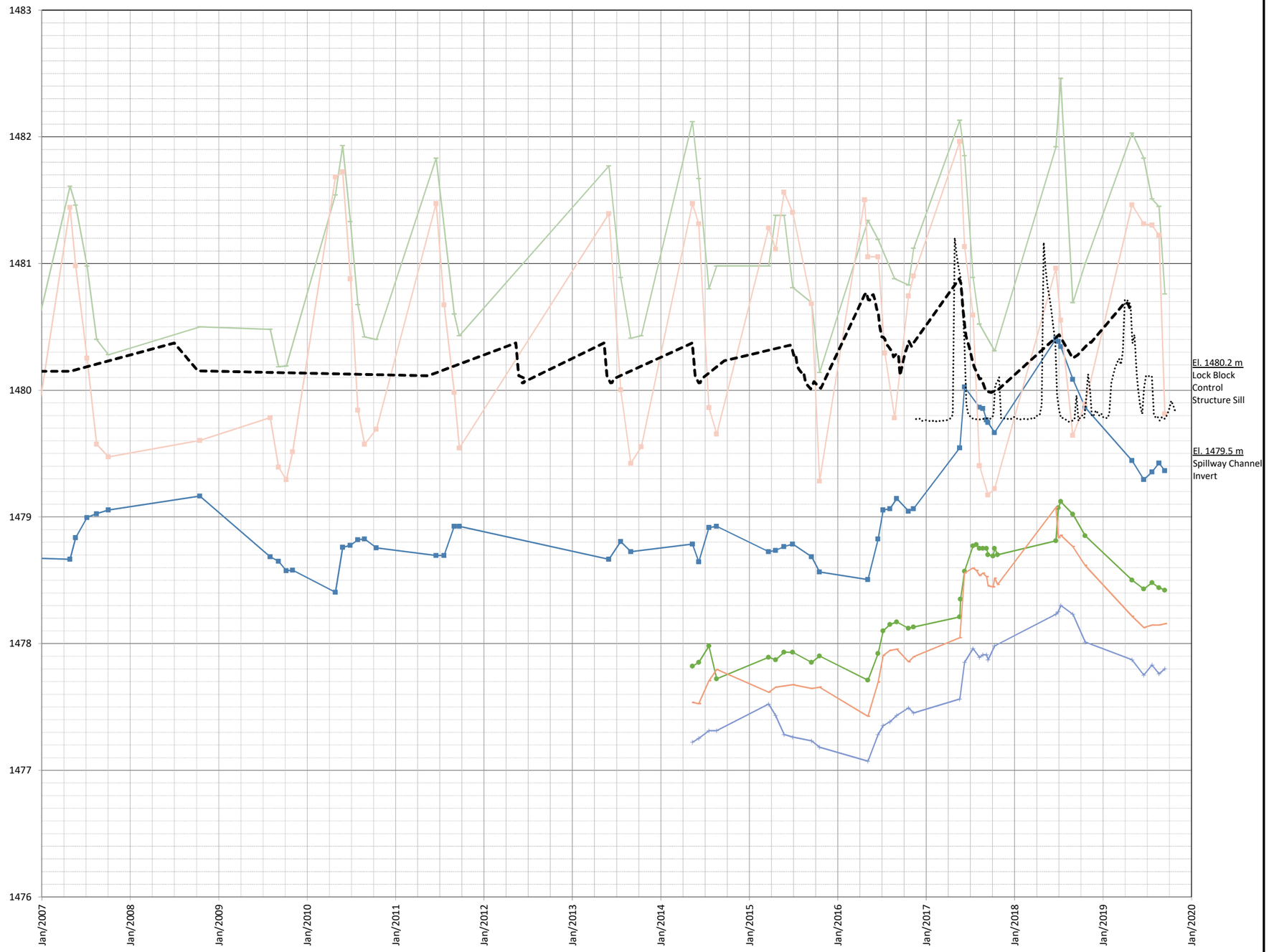


LEGEND:

- PW-A (Tip El. 1473.3 m,)
- PW-C (TALL) (Tip El. 1475.8 m,)
- P-D (Tip El. 1476.6 m,)
- HM-PS-01 (13-SRK-14) (Tip El. 1466.8 m,)
- HM-PS-02 (13-SRK-14) (Tip El. 1456.55 m,)
- HM-PS-03 (13-SRK-13) (Tip El. 1456.9 m,)
- Highmont Pond Level
- Highmont Spillway (Tranducer Data)

PIEZOMETER ID	2019 THRESHOLD EL. (m)
PW-A	1480.5
PW-C (TALL)	1482.6
P-D	1482.2
HM-PS-01 (13-SRK-14)	1480.5
HM-PS-02 (13-SRK-14)	1480.5
HM-PS-03 (13-SRK-13)	1480.5



CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2019

NORTH

PROJECT No. M02341B53

FIG No. IV-B-4

January 13, 2020
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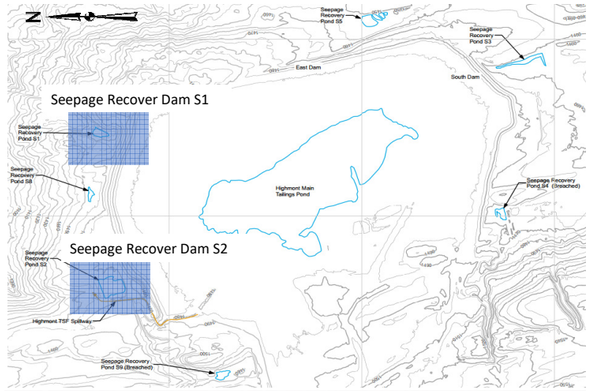

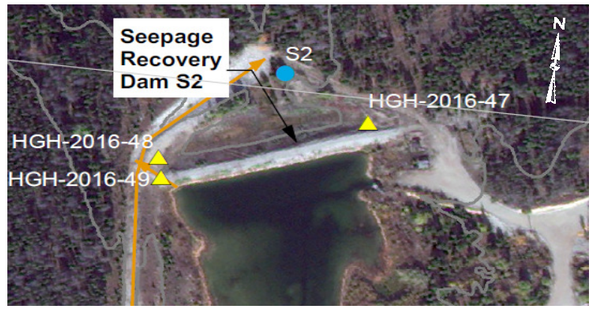

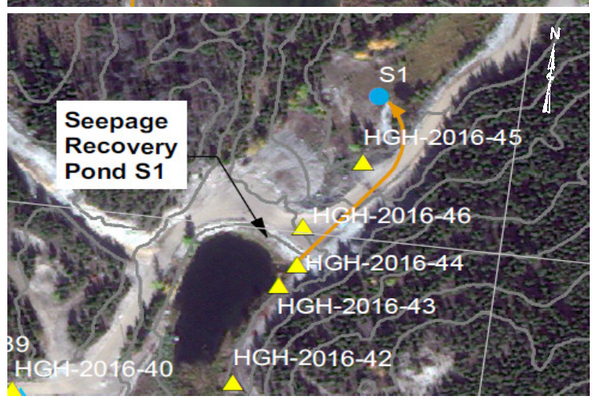

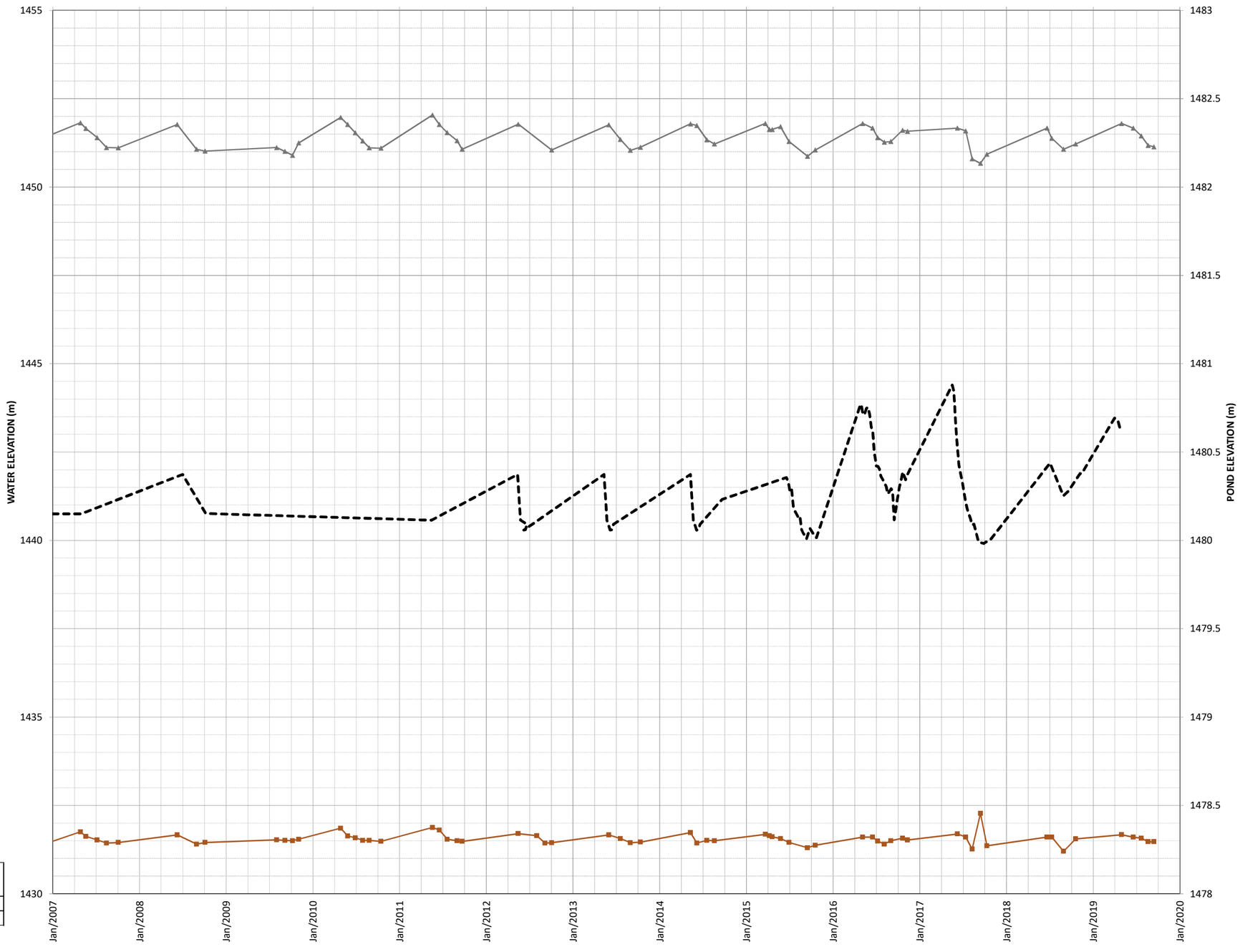

LEGEND:

- Highmont Pond Level
- S1 (Tip El. unknown m,)
- S2 (Tip El. unknown m,)

PIEZOMETER ID	2019 THRESHOLD EL. (m)
S1	1432.4
S2	1452.5

NOTES:

1. PIEZOMETER WATER ELEVATIONS PLOTTED ON PRIMARY (LEFT) AXIS, POND ELEVATION PLOTTED ON SECONDARY (RIGHT) AXIS.
2. TIP ELEVATIONS FOR S-1 AND S-2 ARE UNAVAILABLE.

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2019

SEEPAGE PONDS

PROJECT No. M02341B53

FIG No. IV-B-5

January 13, 2020
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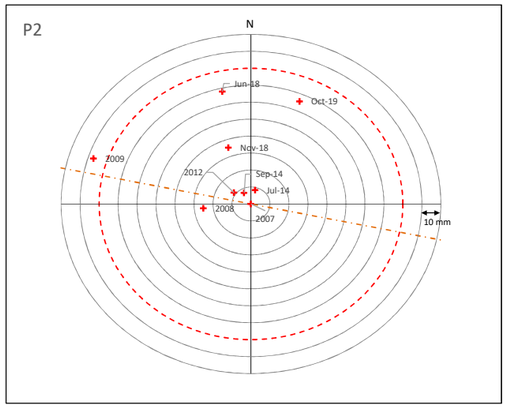
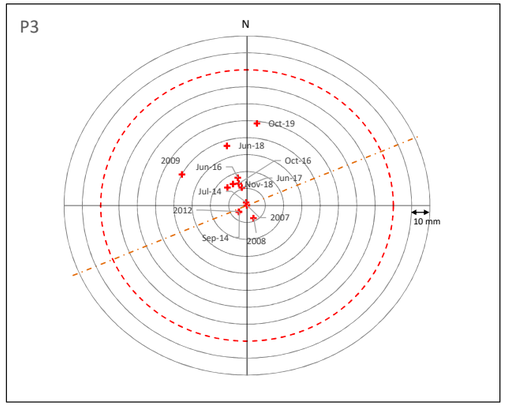
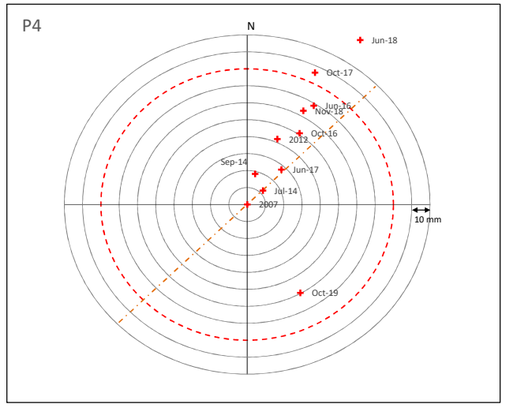
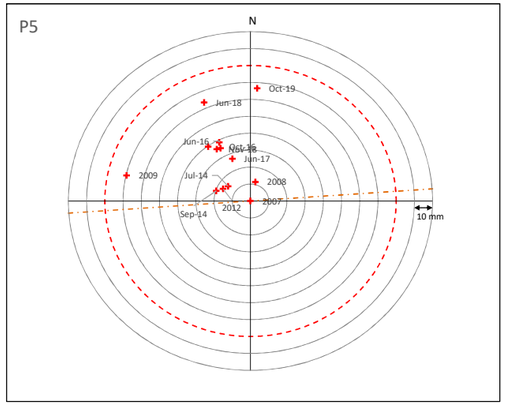
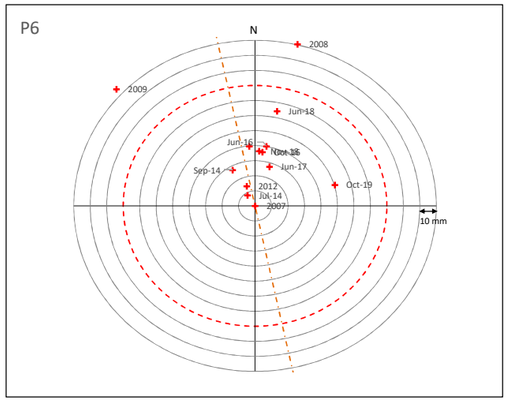
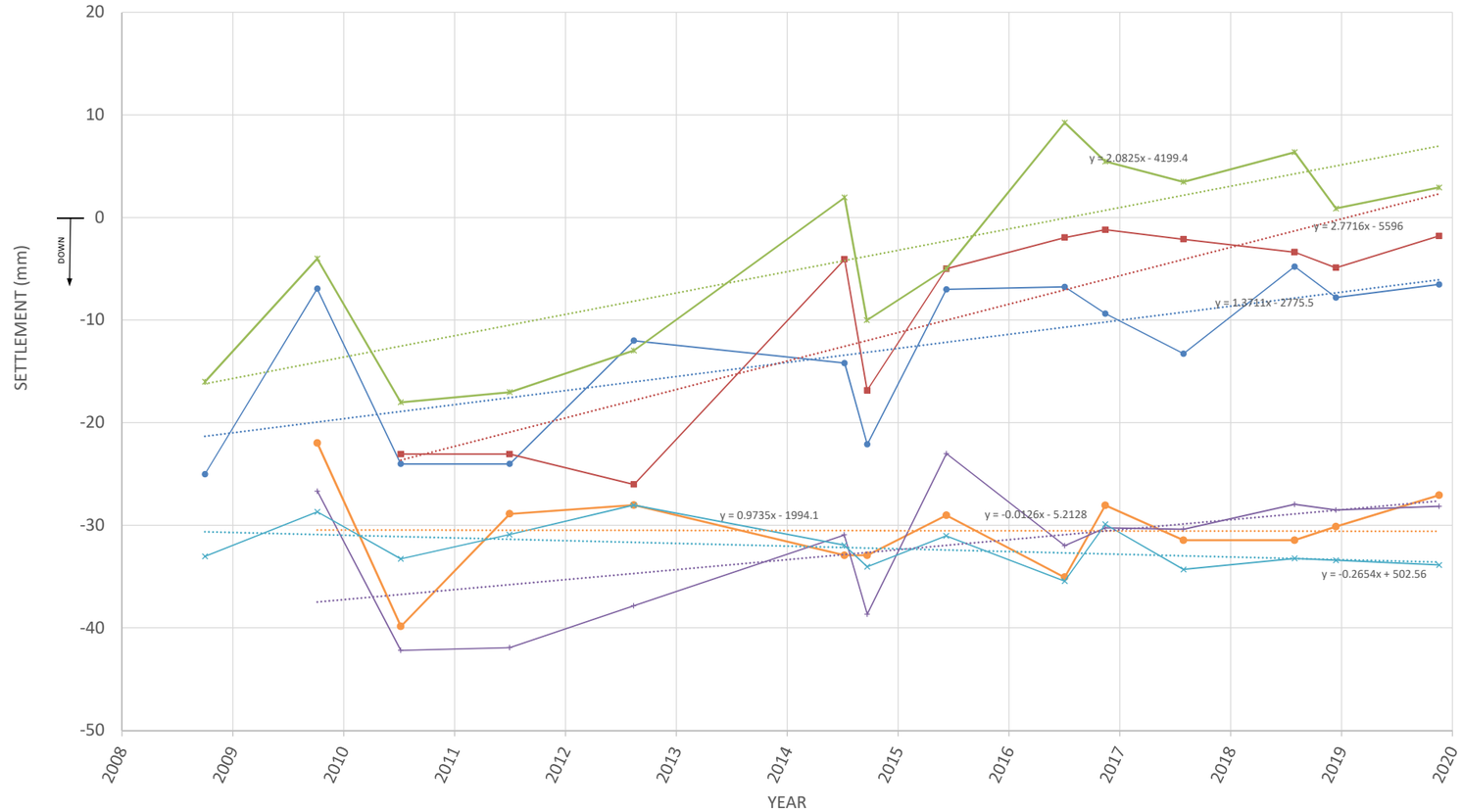












LEGEND:

- P2
- P3
- P4
- P5
- P6
- P7

DAM CENTERLINE ORIENTATION

THRESHOLD HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION

MONUMENT ID	2019 THRESHOLDS		
	HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION (mm)	INCREMENTAL SETTLEMENT BETWEEN READINGS (mm)	TOTAL SETTLEMENT (mm)
P2	80	20	50
P3			50
P4			75
P5			50
P6			75
P7			75

NOTES:

1. HIGHMONT DAM CREST MOVEMENT MONITORING DATA PRIOR TO 2007 NOT SHOWN.
2. P2 JUNE 2016 READING (NOT SHOWN IN PLAN PLOT) LOCATED 139 MM FROM INITIAL 2007 READING. READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT. DISPLACEMENT WAS MOSTLY IN A NORTHWEST DIRECTION PERPENDICULAR TO THE DAM ORIENTATION, BUT SLIGHTLY IN THE DOWNSTREAM DIRECTION.
3. P4 2008, AND 2009 READINGS (NOT SHOWN IN PLAN PLOT) LOCATED 240 mm and 167 mm FROM INITIAL 2007 READING, RESPECTIVELY. READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT.

CLIENT: Highland Valley Copper / Teck

Klohn Crippen Berger

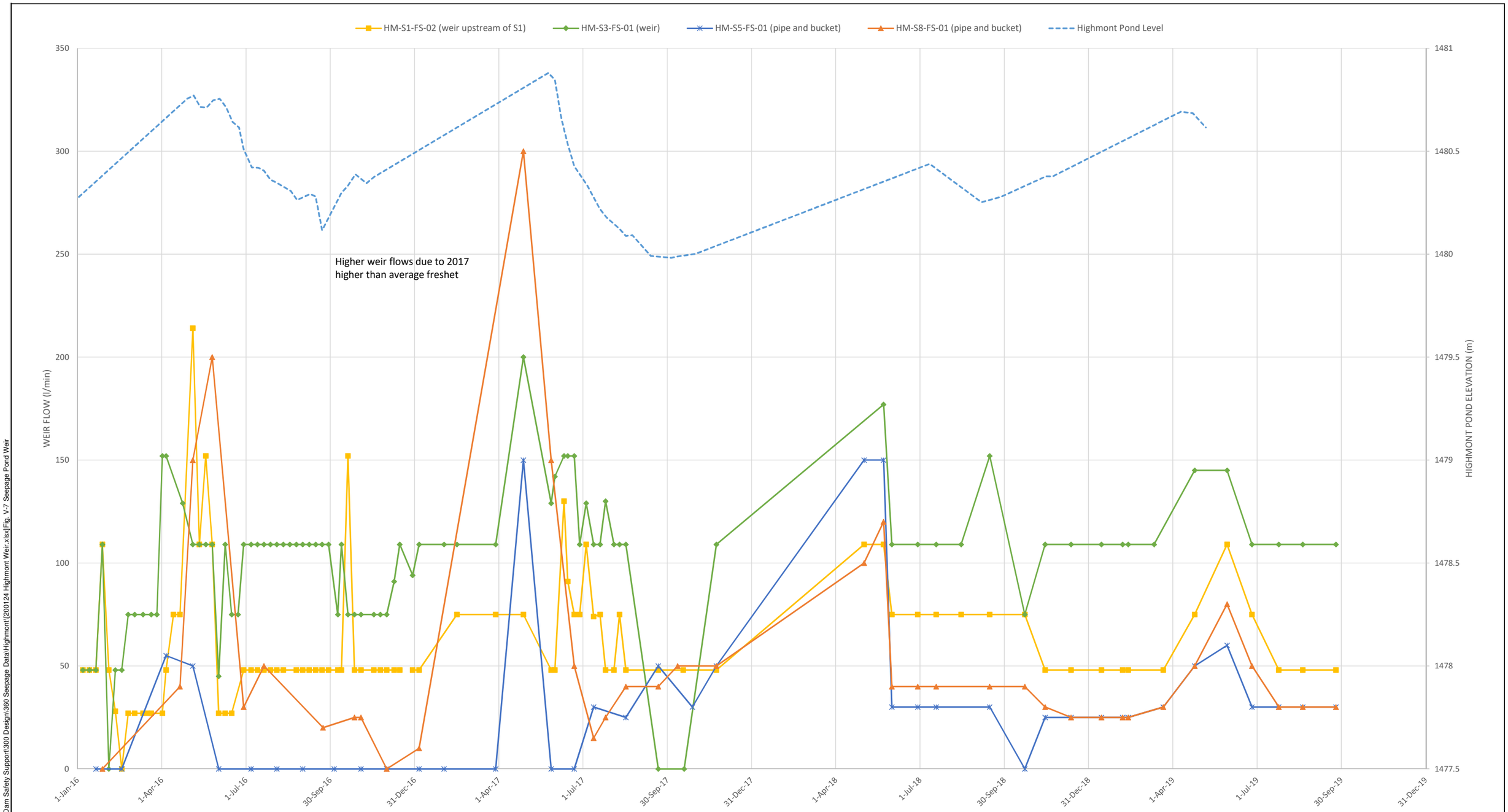
PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE: HIGHMONT DAM
SURVEY MONUMENT READINGS

PROJECT No. M02341B53

FIG No. IV-B-6

January 13, 2020
Z:\MVCR\M02341B53 - HVC 2019 Dam Safety Support\300 Design\370 Survey Monument Hgmont\[200113 HighmontDamMonitoring.xlsm]Figure



CLIENT
Highland Valley Copper / Teck

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2019 DAM SAFETY INSPECTION

TITLE
SEEPAGE PONDS
WEIR FLOWS

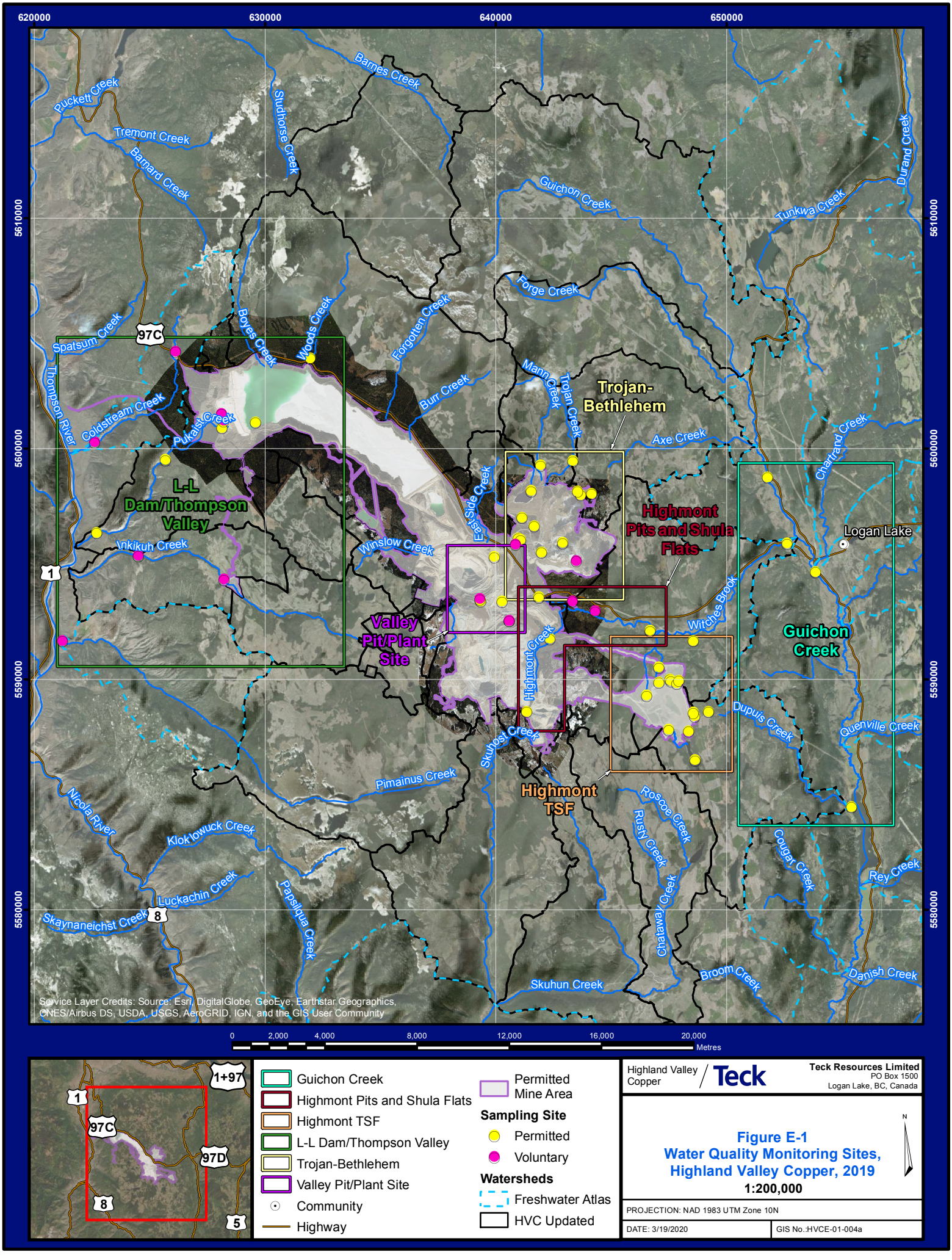
PROJECT No. M02341B53

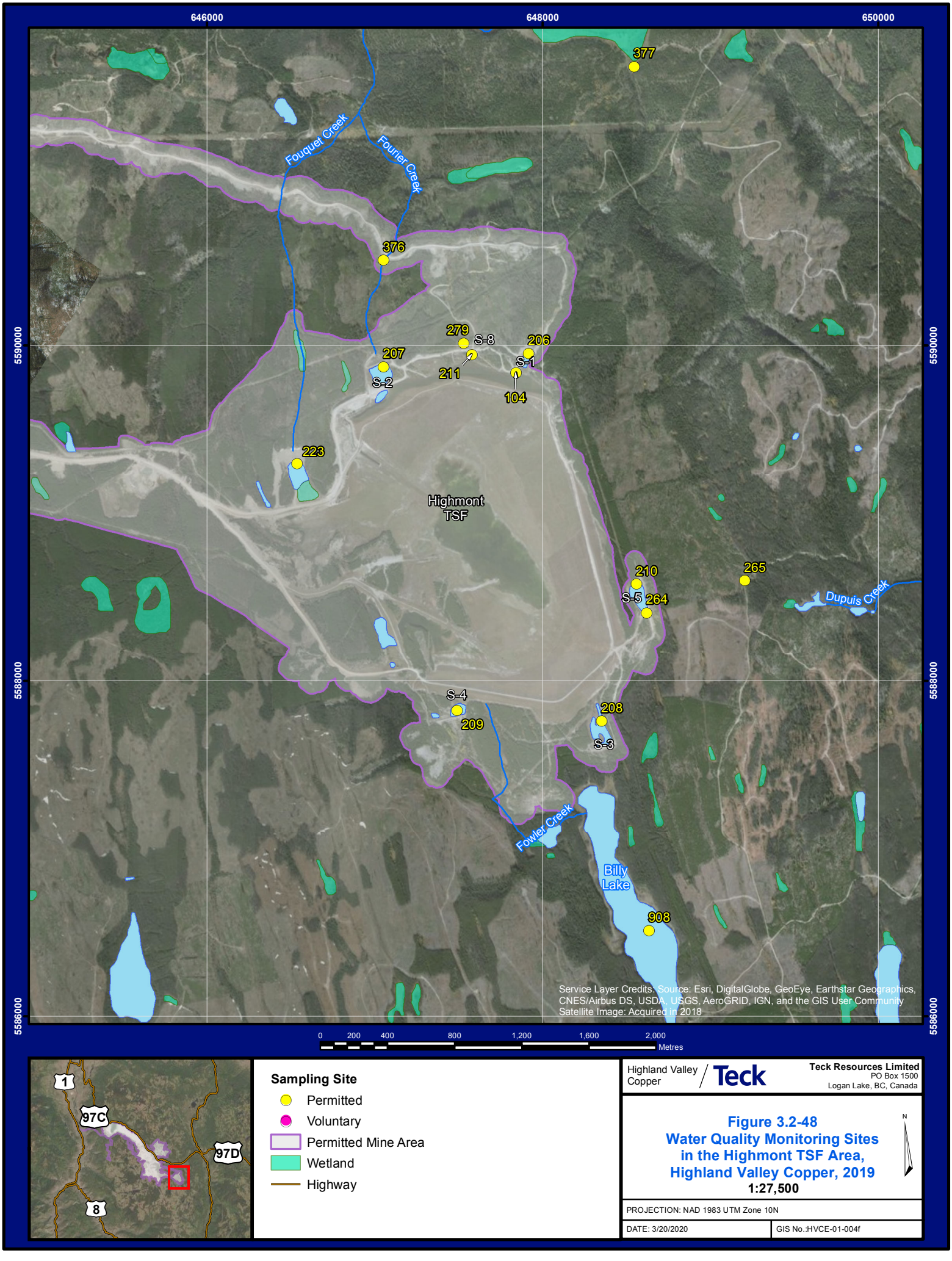
FIG No. IV-B-7

January 24, 2020
Z:\M\VCR\M02341B53 - HVC-2019 Dam Safety Support\300 Design\360 Seepage Data\Highmont\[200124 Highmont Weir.xlsx]Fig. V-7 Seepage Pond Weir

APPENDIX V

Map of Water Quality Monitoring Points


620000
630000
640000
650000
5610000
5600000
5590000
5580000
Puckett Creek
Tremont Creek
Barnard Creek
Studhorse Creek
Barnes Creek
Durand Creek
Guichon Creek
Tunkwa Creek
Forge Creek
Spatsum Creek
97C
Boyes Creek
Woods Creek
Forgotten Creek
Thompson River
Coldstream Creek
Pukaist Creek
Burr Creek
Mann Creek
Trojan Creek
Trojan-Bethlehem
Axe Creek
Chartrand Creek
L-L Dam/Thompson Valley
Inkikuh Creek
1
East Side Creek
Winslow Creek
Highmont Pits and Shula Flats
Logan Lake
Witches Brook
Valley Pit/Plant Site
Highmont Creek
Guichon Creek
Dupuis Creek
Quenville Creek
Skuhost Creek
Pimainus Creek
Highmont TSF
Roscoe Creek
Rusty Creek
Nicola River
Klokowuck Creek
Cougar Creek
Rey Creek
Luckachin Creek
Skaynaneichst Creek
8
Papsilqua Creek
Chatawa Creek
Broom Creek
Danish Creek
Skuhun Creek
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0
2,000
4,000
8,000
12,000
16,000
20,000
Metres
1+97
1
97C
97D
8
5
Guichon Creek
Highmont Pits and Shula Flats
Highmont TSF
L-L Dam/Thompson Valley
Trojan-Bethlehem
Valley Pit/Plant Site
Community
Highway
Permitted Mine Area
Sampling Site
Permitted
Voluntary
Watersheds
Freshwater Atlas
HVC Updated
Highland Valley Copper
Teck
Teck Resources Limited
PO Box 1500
Logan Lake, BC, Canada
N
Figure E-1
Water Quality Monitoring Sites, Highland Valley Copper, 2019
1:200,000
PROJECTION: NAD 1983 UTM Zone 10N
DATE: 3/19/2020
GIS No.:HVCE-01-004a


646000
648000
650000
5590000
5588000
5586000
377
Fouquet Creek
Fourier Creek
376
279
S-8
206
207
S-1
211
S-2
104
223
Highmont
TSF
210
265
S-5
264
Dupuis Creek
S-4
208
209
S-3
Fowler Creek
Billy
Lake
908
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Satellite Image: Acquired in 2018
0
200
400
800
1,200
1,600
2,000
Metres
1
97C
97D
8
Sampling Site
Permitted
Voluntary
Permitted Mine Area
Wetland
Highway
Highland Valley Copper
Teck
Teck Resources Limited
PO Box 1500
Logan Lake, BC, Canada
Figure 3.2-48
Water Quality Monitoring Sites
in the Highmont TSF Area,
Highland Valley Copper, 2019
1:27,500
N
PROJECTION: NAD 1983 UTM Zone 10N
DATE: 3/20/2020
GIS No.:HVCE-01-004f

APPENDIX VI

Failure Mode Review

Appendix VI
Failure Mode Review

VI-1 OVERVIEW

Based on the DSI and review of available documents regarding Highmont Tailings Storage Facility, the key failure modes included in the Canadian Dam Safety Guidelines (CDA 2014) were reviewed:

VI-2 HIGHMONT DAMS

Overtopping

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 away from the dam crest (minimum 290 m) by the tailings beach. Both are effective controls to manage overtopping risks.

Piping and Internal Erosion

Based on a 2015 review of filter adequacy (KCB 2015a), the likelihood of failure due to filter inadequacy issues (piping) is considered low. Seepage at the five remaining seepage ponds has been regularly measured and visually checked during regular site visits since the end of TSF operations. No sediment in seepage water has been noted in recent inspection reports reviewed for this DSI.

Slope Stability – Static Loading

Previous slope stability analyses (KCB 2015c) indicate the minimum static Factor of Safety (FOS) for failure surfaces through the foundation ranges from 2.0 to 2.2 (under static conditions) at the design sections. The 2015 stability assessment (KCB 2015c) included a sensitivity case to assess potential failure surfaces through a lacustrine unit in the South Dam foundation, assuming the unit is continuous, indicated a FOS of 1.8. The FOS for all analyses are greater than the minimum (1.5) required by the Code. The FOS of failures through the dam fill are greater than the critical slip surfaces through the foundation.

Slope Stability – Earthquakes Loading

Previous stability analyses (KC 1996, KCB 2015c) indicate the FOS under pseudo-static loading conditions are greater than the minimum values recommended by CDA (2013). Pseudo-static analyses are not intended to simulate limit equilibrium conditions but, rather, are considered to provide a preliminary seismic deformation screening analysis. A pseudo-static FOS below criterion does not indicate that the dam will fail, but that the seismic deformations could exceed those implied by the particular method used. In that case, a more rigorous seismic deformation analyses should be conducted. Based on this and given that the pseudo-static FOS for the Highmont Dams are greater than 1.0 assuming 50% of EDGM value (KC 1996), more rigorous deformation analyses are not deemed necessary.

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 and event driven monitoring and maintenance. With the current routine and event-driven inspection program in place, the likelihood of surface erosion over the downstream slope resulting in a failure from a single event is negligible.

VI-3 SEEPAGE RECOVERY POND DAMS

Overtopping

Based the recent flood routing reviews:

- The spillways at ponds S1 and S2 are designed for storm events with return periods greater than or equal to the minimum IDF prescribed by the Code and meet minimum freeboard requirements:
  - Refer to discussion in Section 4.4 of the main report and Appendix III-A regarding impacts of diverting flow from Highmont TSF spillway into S2 Pond and KCB's recommendation to permanently relocate till plug.
- The spillway at S3 Pond has been plugged and the impoundment can store the 72-hour duration flood event with adequate freeboard.
- Refer to discussion in Section 4.4 of the main report and Appendix III-A regarding flood routing and storage of S5 Pond:
  - Under the current configuration, the storage capacity of the pond is essentially equivalent to the capacity of the pumping system. Therefore, assuming the pumping system is operating, the pond can safely manage the IDF (KCB 2019a). KCB recommend that THVCP increase the storage capacity or attenuation within the S5 Pond system to reduce the reliance on pumping.
- The IDF can either be stored within S8 Pond or routed through the existing overflow spillway pipe.

Piping and Internal Erosion

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

Previous stability analyses (KCB 2015d) indicate the FOS for slip surfaces through dam fill and foundation are greater than the minimum FOS (1.5) required by the Code. Therefore, the likelihood of a slope instability failure developing through the foundation is considered very low.

Slope Stability – Earthquakes Loading

Previous stability analyses (KCB 2015d) indicate the FOS for slip surfaces under pseudo-static loading are greater than the minimum FOS (1.0) required by the Code. As discussed above for the Highmont Dams, pseudo-static analyses are not intended to simulate limit equilibrium conditions but, rather, are considered to provide a preliminary seismic deformation screening analysis. As a result, and given that the pseudo-static FOS for the Seepage Recovery Pond Dams is greater than unity, more rigorous deformation analyses are not deemed necessary.

Surface Erosion

In general, the downstream slopes of the seepage dams are moderately to well vegetated or faced with coarse rock with light vegetation. With the current routine and event-driven inspection program in place the likelihood of surface erosion over a dam slope resulting in a failure from a single event is considered low.

APPENDIX VII

2018 DSR Recommendations

Appendix VII
Dam Safety Review Recommendations

Table VII-1 2018 Highmont TSF Dam Safety Review Recommendations

ID	Priority[1]	2018 DSR Comment	Topic
GEN-001	3	Inconsistencies between seepage pond crest elevations reported in the OMS Manual, DSI reports and responses to recommendations. Correct inconsistencies in the OMS Manual.	OMS
HD-001	3	Current displacement and piezometer thresholds have been set to highlight deviations from trends and are not linked to stability assessments. No sensitivities were included in the stability assessments to verify how sensitive dam stability is to phreatic levels. Update stability analyses to include sensitivities to the phreatic surface. If phreatic levels are shown to be critical to stability, re-define thresholds based on the results of stability and/or other appropriate engineering analyses.	Geotechnical / Highmont Dams
HD-002	3	Most piezometers are in the upstream tailings beach, and there are none through the dams. SRK has not been provided with details on the latest stability assessments to verify how sensitive dam stability is to phreatic levels through the dam fill materials. Update stability analyses to include sensitivities to the phreatic surface. If phreatic levels in this area are shown to be critical to stability, evaluate the need to install additional piezometers through the dam that intersect the filter zones.	Geotechnical / Highmont Dams
HD-003	3	The PMF is not in accordance with CDA (2013) requirements. Update the PMF for the Highmont TSF and determine which PMF event (summer/autumn PMF or spring PMF) is most critical.	Hydrotechnical / Highmont TSF
HD-004	3	Normal freeboard requirements were not evaluated. Establish a maximum normal operating water level and evaluate the required and available normal freeboard.	Hydrotechnical / Highmont TSF
HD-005	4	Highmont TSF erosion protection in the spillway channel is sized for the 200-year peak flow and not IDF. Provide details on the justification for sizing the erosion protection for the 200-year event and the associated risk and consequence of undersized riprap should be evaluated.	Hydrotechnical / Spillway
HD-006	3	The current (2016) OMS Manual does not include a protocol on how to operate the control gate (i.e. when is it closed and when does it need to be opened). Provide additional details in the OMS manual on the operations of the spillway gate. Signage should be added to the spillway gate controls indicating which turn direction to open and close the gate and identify which seepage pond water is being diverted to in each position.	OMS / Spillway
HD-007	4	The current (2016) OMS Manual does not include the maximum normal operating water level. Include maximum water levels in the OMS manual.	OMS / Spillway
HD-008	3	The culvert crossing in the Highmont TSF spillway channel poses a risk of overtopping into seepage pond S2. Evaluate options to modify the Highmont spillway channel to ensure flows do not overtop into S2.	Hydrotechnical / Spillway
S1-001	4	The current (2016) OMS Manual does not include the maximum normal operating water level for seepage pond S1. Include maximum water levels in OMS manual.	OMS/ S1

ID	Priority[1]	2018 DSR Comment	Topic
S1-002	4	Inflow design flood is not based on most recent hydrology analysis Update the inflow design flood and flood routing analysis using the latest hydrology.	Hydrotechnical / S1
S1-003	4	Normal freeboard requirements were not evaluated. Evaluate the required and available normal freeboard.	Hydrotechnical / S1
S2-002	4	Inflow design flood is not based on most recent hydrology analysis Update the inflow design flood and flood routing analysis using the latest hydrology.	Hydrotechnical / S2
S2-003	4	Normal freeboard requirements were not evaluated. Evaluate the required and available normal freeboard.	Hydrotechnical / S2
S2-004	4	Risk of overtopping if the till plug in Highmont TSF spillway channel is not removed. Include a protocol in the OMS manual on the till plug located in the Highmont spillway.	OMS / S2
S3-001	2	No in-situ data is available to estimate material properties, potential for liquefaction, and post-seismic strengths for the foundation materials found at S3. Undertake site investigations and test work to characterize the S3 foundation materials. Re-run stability analyses using revised material properties. Based on the results of the stability analysis, evaluate whether any foundation improvement is needed.	Geotechnical / S3
S3-002	4	Inflow design flood is not based on most recent hydrology analysis Update the inflow design flood and flood routing analysis using the latest hydrology.	Hydrotechnical / S2
S3-003	4	Normal freeboard requirements were not evaluated. Evaluate the required and available normal freeboard.	Hydrotechnical / S3
S3-004	3	Significant vegetation (including trees) observed on crest and downstream slope. Continue to remove trees, however grassy vegetation on slopes can be left in place, provided steady-state conditions continue.	Maintenance / S3
S5-001	4	Under current operation, seepage pond S5 is not able to contain the EDF. Identify pond upgrades necessary to meet EDF compliance.	Hydrotechnical / S5
S5-002	4	Inflow design flood is not based on most recent hydrology analysis Update the inflow design flood and flood routing analysis using the latest hydrology.	Hydrotechnical / S2
S5-003	4	Under current operations, the minimum freeboard requirement is not being met. . Identify pond upgrades necessary for freeboard compliance.	Hydrotechnical / S5
S5-004	4	Normal freeboard requirements were not evaluated Evaluate the required and available normal freeboard.	Hydrotechnical / S5
S5-005	2	Road and crest material have a high fines content and plasticity, making it slippery and a possible safety hazard for vehicles. Address safety hazard by, for example, adding coarse road surfacing material to improve trafficability.	Safety / S5
S8-001	4	Unknown spillway invert elevation and if spillway invert is sufficiently high enough to contain the EDF without discharge to the downstream environment. Provide details of the EDF and spillway invert elevation in the OMS and annual DSI reports.	Hydrotechnical / S8
S8-002	4	Inflow design flood is not based on most recent hydrology analysis. Update the inflow design flood and flood routing analysis using the latest hydrology.	Hydrotechnical / S8

ID	Priority[1]	2018 DSR Comment	Topic
S8-003	4	Available minimum freeboard does not meet the minimum freeboard requirement adopted by THVCP. Provide details of the IDF flood routing analysis and minimum freeboard requirement calculation based on wind setup and wave run-up as required by CDA (2013).	Hydrotechnical / S8
S8-004	4	Normal freeboard requirements were not evaluated. Evaluate the required and available normal freeboard.	Hydrotechnical / S8

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