Klohn Crippen Berger

Teck Highland Valley Copper Partnership

2017 Dam Safety Inspection Report

Highmont Tailings Storage Facility

CANADA'S BEST MANAGED COMPANIES Platinum member

ISO 9001
ISO 14001
OHSAS 18001

M02341B26.730

March 2018

March 29, 2017

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

Mr. Chris Anderson
Superintendent, Tailings and Water Management

Dear Mr. Anderson:

2017 Dam Safety Inspection Report
Highmont Tailings Storage Facility

We are pleased to submit the 2017 Dam Safety Inspection 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), Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the Code Guidance Document.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

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

RF/DB: cd

180329R-Highmont DSI 2017.docx
M02341B26.730

Teck Highland Valley Copper Partnership

2017 Dam Safety Inspection Report

Highmont Tailings Storage Facility

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) were engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2017 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., as a representative of KCB on September 20, 2017. Mr. Chris Anderson, P. Eng., THVCP Tailings and Water Superintendent, is the TSF Qualified Person (as defined by the Code) for Highmont TSF.

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 and are no longer capable of retaining water.

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. 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 continue ongoing surveillance of the site including environmental sampling, visual inspections and maintenance activities. Under this level of site presence, Dam No. 1 and Bose Lake Dam 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 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 cutoff, and with a sand and gravel erosion blanket on the upstream and downstream faces.

The Highmont dams are assigned a “High” consequence category as defined by CDA (2013) 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”. There were no significant changes to the key geotechnical or hydrotechnical hazards during 2017. The most recent dam safety review (DSR) was completed by AMEC in 2013 (AMEC 2014a). The Code requires a DSR be undertaken every five years for tailings dams; therefore, the next DSR is scheduled for 2018.

The tailings pond is located in the center of the impoundment. The water level varied seasonally by 0.9 m in 2017, with a peak in April/May and low in September, which is consistent with the historic trend which shows no long-term trend of increasing pond volume.

The Highmont TSF spillway, installed near the left abutment of the North Dam, is designed for a storm event with return periods greater than those required by the Code. The S3 spillway is plugged with glacial till to prevent discharge of water that does not meet water quality regulatory requirements. The S5 spillway was partially obstructed with sandbags in 2016 to increase the storage capacity

before discharging to the environment. KCB have recommended further action to reduce the reliance on pumping at pond S5.

The Emergency Preparedness and Response Plan (EPRP) was updated in 2017. The Operation, Maintenance and Surveillance (OMS) manual, was also reviewed and issued as draft in March 2018 (THVCP 2018). The OMS manual and EPRP meets the intent of the Mining Association of Canada (MAC) and CDA guidelines, is current and provides adequate coverage for existing conditions.

Visual inspections and instrument measurements were completed by THVCP at the prescribed frequencies during periods of the year when dams were accessible. Event driven inspections were carried out in response to the May 2017 freshet, details of the inspections are described in Section 5.2.

There were a several threshold exceedances of some instruments in response to freshet, in each case the readings dissipated to normal levels shortly after freshet passed. No follow up activities were required except for a group of 3 piezometers in the northeast corner of the impoundment which showed 0.5 m to 1.0 m rise over previous trends. THVCP have discussed with KCB and raised an action to investigate whether these observations are due to something other than rising piezometric levels (e.g. surveyed tip elevation or data entry). The current phreatic levels are not a dam safety concern but thresholds have been revised to notify whether the increase is sustained in 2018.

The incremental horizontal movement at one survey monument from 2016 was greater than typical variance based on historic readings. This monument was not measured in 2017 because vegetation growth has impeded survey line of site, THVCP have actioned for this to be addressed and monument surveyed in spring, 2018. Revised piezometric and movement thresholds have been set for 2018 to monitor deviation from the established trend.

Water quality downstream of the Highmont TSF is monitored by HVC monthly to assess the effectiveness of the tailings facility in protecting the downstream receiving environment (ERM 2018). All permit sampling requirements and frequency were met in 2017, except for two instances when a subset of the required water quality parameters was not measured for specific samples. HVC reported a non-compliance on May 5, 2017 to the BC MOE regarding discharge of the portion of spillway flows in excess of 860 m^3/hour directly into the environment from the Highmont Tailings Pond Spillway during the unusually high freshet. British Columbia Ministry of Environment & Climate Change Strategy (BC MOECCS) reviewed this event and identified that this discharge is within HVC's authorization.

The Highmont TSF appears in good physical condition and the observed performance during the 2017 site inspections is consistent with the expected design conditions and past performance. THVCP made significant progress in 2017 to close outstanding recommendations from past DSIs, refer to Table 1. Closed recommendations are shown in *italics*. Recommendations to address deficiencies and non-conformances identified during the 2017 DSI are summarized in Table 2.

Table1 Previous DSI Recommendations – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority (1)	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2015-02	*Seepage*	-	*During the Q4 dam inspection, seepage and erosion was noted at the toe of the South Dam. The toe should be repaired with filter compatible fill and seepage rates monitored.*	*3*	*December 2017 (CLOSED)*
HD-2015-04	*Seepage*	-	*Stagnant water is pooled at the toe of the South Dam in the toe drain immediately upstream of S4 Pond Drain. Some erosion and rilling was noted on the dam slopes around the drain. The drainage should be improved so that the water can drain away from the toe of the dam and vegetation added on the slopes to reduce erosion risks.*	*4*	*December 2017 (CLOSED)*
HD-2016-01	*OMS*	*Annual Update*	*As part of the 2017 OMS update, incorporate the following:* *- Update the failure mode assessment* *- Explicitly state the minimum reading frequency for each instrument and measuring point* *- Update event-driven inspection criteria (Section 5.2)* *Incorporate 2017 thresholds (Sections 5.4, 5.5 and 5.6)*	*3*	*Q3, 2017 (CLOSED)*
HD-2016-02	Monitoring	OMS	Complete a survey of monument P2, which was not surveyed in October 2016, to confirm whether the incremental horizontal movement is survey related.	3	Q2, 2017 (Open, Actioned for Q2 2018)
HD-2016-03	*Freeboard*	*The Code*	*Calculate the minimum freeboard required for the Highmont TSF under the Code based on the method proposed by CDA (2013) to demonstrate compliance of existing freeboard.*	*3*	*Q3, 2017 (CLOSED)*
HD-2016-04	*Maintenance*	*OMS*	*Clear vegetation that is obstructing the outlet of the spillway culverts that pass flow below crest access road.*	*3*	*Q3, 2017 (CLOSED)*
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)
HD-2016-06	*Safety Grating*	-	*A safety grate should be placed over the opening in the floor around the spillway gate controls.* *NOTE: this is a suggestion not related to dam safety, THVCP have taken under consideration.*	*4*	*Q1, 2018 (CLOSED)*
HD-2016-07	*Maintenance*	*OMS*	*Remove accumulated sediment and vegetation from inlet and outlet of culverts that pass flow through the toe access road just upstream of S2 pond.*	*3*	*Q3, 2017 (CLOSED)*
HD-2016-08	*Spillway Culvert Capacity*	*The Code*	*After the obstruction are cleared from the spillway culverts (HD-2016-04) complete an assessment to confirm the culverts have adequate capacity to pass the IDF as designed.*	*3*	*Q4, 2017 (CLOSED, refer to HD-2017-02)*
HD-2016-09	*EPRP*	*Comm. Plan*	*Complete assessment of warnings for downstream parties potentially impacted by a failure and update the EPRP as appropriate.*	*3*	*Q4, 2017 (CLOSED)*
S1 Pond					
S1-2016-01	*Maintenance*	*OMS*	*Remove vegetation from outlet of S1 riprap outfall apron.*	*3*	*Q3, 2017 (CLOSED)*

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority (1)	Recommended Deadline
S2 Pond					
HD-2015-03	*Seepage*	*-*	*Sloughing of material around the road culverts at the inflow to Highmont S2 from North Dam toe drain channel was noted. The sloughed material should be removed and the blockage cleared to allow passage of seepage to S2 Pond.*	*3*	*December 2016 (CLOSED)*
S2-2016-01	*Maintenance*	*OMS*	*Remove vegetation from inlet of S2 spillway inlet.*	*3*	*Q3, 2017 (CLOSED)*
S3 Pond					
S3-2016-01	*Freeboard*	*The Code*	*Review the freeboard requirement or take alternate action to increase the freeboard during the IDF to meet design criteria.*	*3*	*Q4, 2017 (CLOSED)*
S5 Pond					
S5-2016-01	*Flood Management*	*The Code*	*Complete an updated flood routing assessment for the existing partially obstructed spillway to confirm acceptable performance during an EDF (if applicable) or IDF. If necessary, identify upgrades required to meet compliance.*	*3*	*Q4, 2017 (CLOSED)*

Notes:
1. Recommendation ID numbers from 2016 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.

Table2 2017 DSI Recommendations

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority (1)	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2017-01	Flood Management	Spillway	THVCP should modify the spillway channel in this area 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. Suggested interim milestones: Design: 2019; Permit and Construction: 2020.	3	Q4, 2020
S1 Pond / S2 Pond / S3 Pond / S8 Pond – None					
			No new recommendations from 2017		
S5 Pond					
S5-2017-01	Flood Management	Storage Capacity	THVCP should increase the storage capacity within the S5 Pond system to reduce the reliance on pumping to prevent a spill and includes an emergency outflow that does not require a temporary plug.	3	Q2, 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.

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

List of Tables

List of Figures (In text)

List of Figures

TABLE OF CONTENTS
(continued)

List of Appendices

1 INTRODUCTION

Klohn Crippen Berger Ltd. (KCB) was engaged by Teck Highland Valley Copper Partnership (THVCP) to complete the 2017 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 site has been reclaimed since tailings discharge ceased and THVCP continue ongoing surveillance. 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 reclaimed site is monitored and THVCP staff are onsite to support the ongoing operations at the site and regularly visit the Highmont TSF for environmental sampling, 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 scope of work consisted of:

- a visual inspection of the physical conditions of the various containment facilities;
- a review of updated piezometer, inclinometer and seepage monitoring data provided by THVCP;
- a review of climate and water balance data for the site;
- a review of other relevant dam safety management documents (e.g. Operations, Maintenance & Surveillance (OMS) manual); and
- a review of the past year's construction records, 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), Section 4.2 "Annual Tailings Facility and Dam Safety Inspection Report" of the Code Guidance Document (MEM 2016).

The inspection was completed by the Engineer of Record (EoR), Mr. Rick Friedel, P.Eng., as a representative of KCB on September 20 to 28, 2017. During the inspection, the weather was cloudy with sunny and rainy periods. Mr. Chris Anderson, P. Eng., THVCP Tailings and Water Superintendent, is the TSF Qualified Person (as defined by the Code) for the Highmont TSF.

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.

The Highmont dams are assigned a “High” consequence category as defined by CDA (2013) 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 latest dam safety review (DSR) was completed by AMEC in 2013 (AMEC 2014a). The Code requires a DSR be undertaken every five years for tailings dams; therefore, the next DSR is scheduled for 2018.

2 FACILITY DESCRIPTION

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 Figure 2.1. Refer to Appendix III 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 23 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. When required before a wide tailings beach had been established, 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 left[1] abutment of the North Dam. 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 are diverted by an inlet structure via a HDPE pipe to Seepage Recovery Pond S1. Larger flow continue along the spillway channel which discharges downstream of Seepage Recovery Pond S2 and eventually to Witches Brook.

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

Seepage Recovery Ponds

The layout of perimeter seepage dams is shown in Figures 2 and the typical geometry and dimensions are summarized in Figure 2.1. Refer to Appendix III for relevant design drawings.

- A construction record report for ponds S1 and S2 (KL 1981) and a design report showing details for ponds S1 through S5 (KL 1980) were available. No records were 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, and runoff from the TSF and local catchments. The dams at S4 and S9 have since 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 pond S9 (which was not in the design report). There are no records that indicate ponds S6 or S7 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 Seepage Recovery Pond Dam S4 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 pond S1 (refer to Figure 4.1). Details of pumping operations, pipelines and other water management structures in these ponds are discussed in Section 4.1.

Figure 2.1 Summary of Approximate Dam Geometry

Dam	Crest Elevation (m)	Maximum Height (m)	Crest Length (m)	Minimum Crest Width (m)	Downstream Slope	Upstream Slope
Main Dams						
North Dam	1487	47	1200	30	2.5H:1V	n/a
East Dam	1487	30	1200	15	2.3H:1V	n/a
South Dam	1487	35	1300	9	2.3H:1V	n/a
Seepage Recovery Pond Dams						
S1 Dam	1445	9.1 (2015 DSI)	60	10	2H:1V [3]	3H:1V (1980 design report)
S2 Dam	1459	4	140	4	2.2H:1V [3]	3H:1V (1980 design report)
S3 Dam	1459	3.4	150	4	3H:1V	3H:1V (1980 design report)
S4 Dam	Decommissioned by breaching					
S5 Dam	1452.2	6.3 (2015 DSI)	340	3	1.7H:1V [3]	3H:1V (1980 design report)
S8 Dam	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 HISTORY AND RECENT ACTIVITY

3.1 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 (approximately 1487 m) was reached, 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 and 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 pond S1 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 ponds S3 and S5 to be stored in the Highmont tailings pond instead of to pond S1.
- The pond S3 spillway was plugged to prevent discharge to the environment. 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 pond S5 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.

3.2 2017 Activities

No construction activities were conducted at the Highmont TSF in 2017. Maintenance activities as required by the OMS manual were conducted (e.g., clearing weirs of vegetation, pumping of seepage recovery ponds).

In 2016, sandbags were placed to partially block the intake of the S5 spillway to increase the storage capacity in the pond before discharging into the environment. Sandbags were still in place at the time of the 2017 inspection.

4 WATER MANAGEMENT

4.1 Overview

Water management at each structure in upstream to downstream order and how they interact with each other is summarized below. The process flow diagram for Highmont TSF is shown in Figure 4.1. Decommissioned structures (S4 and S9) 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.
- Inflows include precipitation on the pond, surface runoff from upstream catchments, pumpback from Seepage Recovery Pond S1, and pumpback from seepage recovery ponds S3 and S5 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 under normal operations. Flows exceeding the capacity (1000 m^3/h) of the diversion to S1, report to S2 except during large flood events when the diversion plug in the spillway channel is overtopped and the flow bypasses S2 and discharges downstream to the environment at Fourier Creek.

Seepage Recovery Pond S3 (S3) 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 was plugged with glacial till to prevent release into Fowler Creek.

Seepage Recovery Pond S5 (S5) 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 in that 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.
- Outflows 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 in 2016 with sandbags, 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) downstream of the North Dam and west of S1

- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, and low flows from the Highmont spillway.
- Outflows include pumping to S8, an open channel spillway located at the dam's left abutment that discharges into the Highmont TSF spillway, and ultimately reports to Fourier Creek.

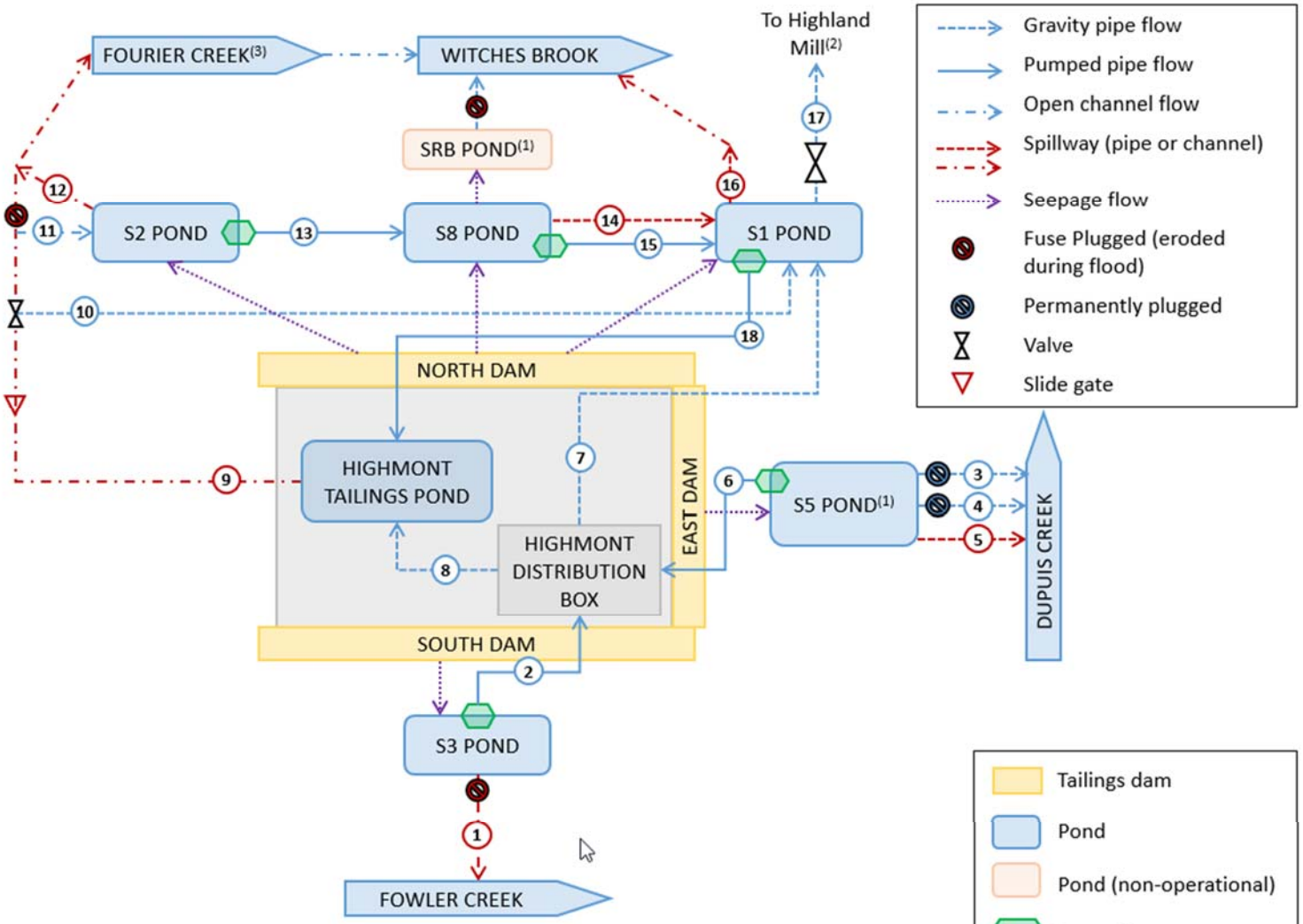
Seepage Recovery Pond S8 (S8) downstream of the North Dam, between S2 and S1

- Inflows include seepage from the North Dam, precipitation on the pond, surface runoff from upstream catchments, and pumping from S2.
- 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 if required. When necessary, there is an emergency spillway pipe which discharges to S1.

Seepage Recovery Pond S1 (S1) 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, and pumping from S3 and S5 via the Highmont Distribution Box. This is the point of seepage collection convergence 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 4.1 Process Flow Diagram 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.

Figure 4.1 Process Flow Diagram for Highmont TSF (cont.)

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	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	2x 8"dia. HDPE pipes with control valves	
5	S5 Overflow	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) Till plug diversion to S2 (decommissioned).	Operational
10	Diversion to S1	18" dia. HDPE pipeline	Operational
11	Diversion to S2	Open channel	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

Climate data was collected throughout the year from the L-L Dam weather station (El. 1122 m) and summarised on Table 4.1and Figure 4.2. Climate normals (1981 to 2010) from the Highland Valley Lornex Station (Environment Canada Station No. 1123469) are shown on the same figure for comparison. This climate station was located near the Highland Mill, and had the longest running record for the mine site from 1971 until being decommissioned in November 2011.

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 to track the changes in snowpack. The measurements are sorted by survey period (the first of January through May) to compare snowpack depths (in snow-water equivalent (SWE) around the same time each year. Historical average and 2017 snowpack depths based on available records are summarized in Table 4.2.

The following observations were noted for 2017:

- May through August appear noticeably drier than average. No data was missing during this time.

- On an annual basis, precipitation at the L-L Dam weather station was 28% lower than normal (at Lornex).
- Snowpack depths were not measured for the January 1st or February 1st survey periods. The March 1st, April 1st, and May 1st snowpack depths (in SWE) were 30%, 50%, and 271% greater than average, respectively.

During freshet, a period of rainfall followed by a sudden increase in temperature (Figure 4.3) triggered greater than normal surface runoff on site and in the region starting May 5, 2017. Available records also show the snowpack depth (in SWE) near the Trojan TSF was 3.7 times greater (relative percent difference = +271%) than average for that time of year. The combination of available snowpack and rapid melt-inducing changes led to a more severe freshet in 2017 than normal. Observations and actions in response are discussed in the relevant sections of this report.

Table 4.1 Monthly Precipitation in 2017

Month	Precipitation (mm)	
	L-L Dam – Unadjusted	Lornex Normals
January	13.5	27.5
February	37.1	21.0
March	21.2	16.7
April	34.6	21.3
May	15.6	41.3
June	5.9	47.9
July	2.8	43.5
August	10.8	31.7
September	28.8	31.2
October	33.5	30.0
November	46.2	40.4
December	34.8	40.8
Annual Total	284.7	393.3

Figure 4.2 Monthly Precipitation in 2017 and Climate Normals

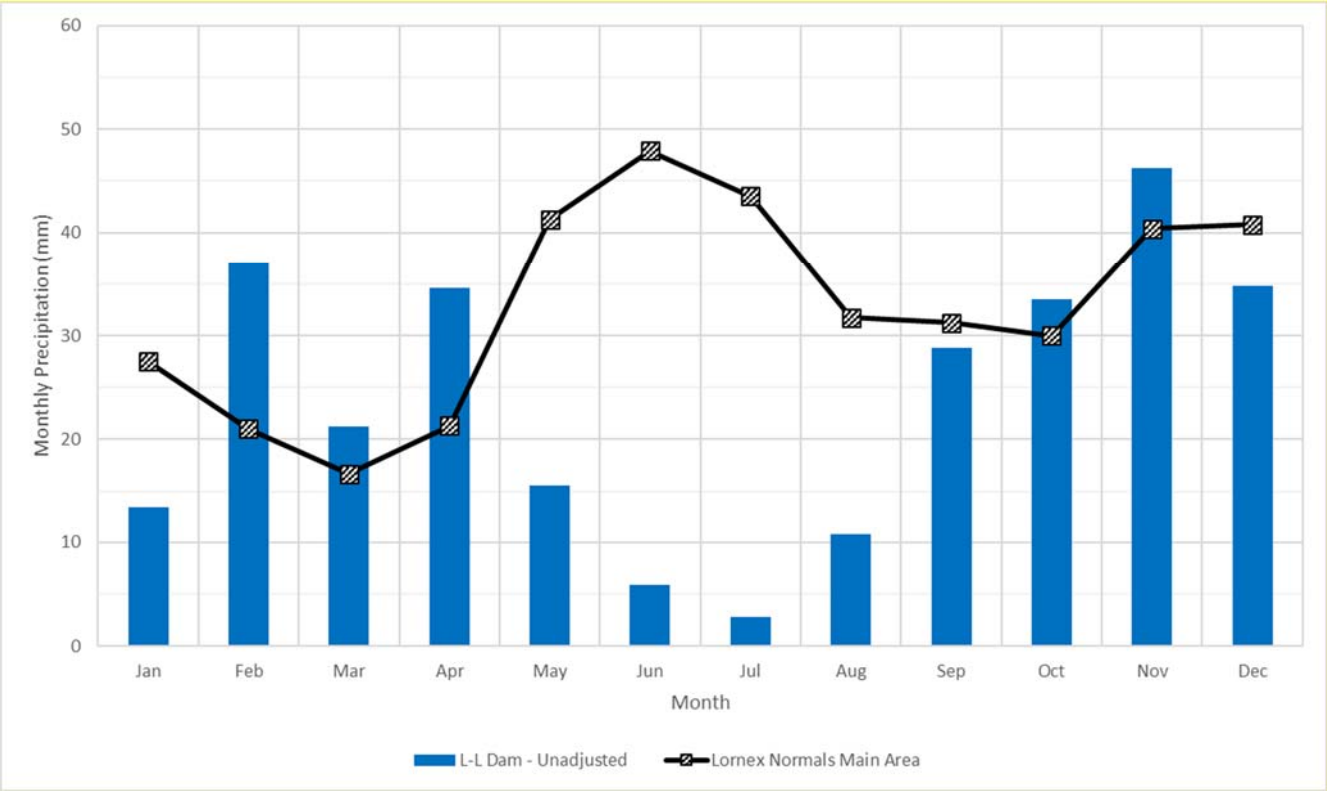
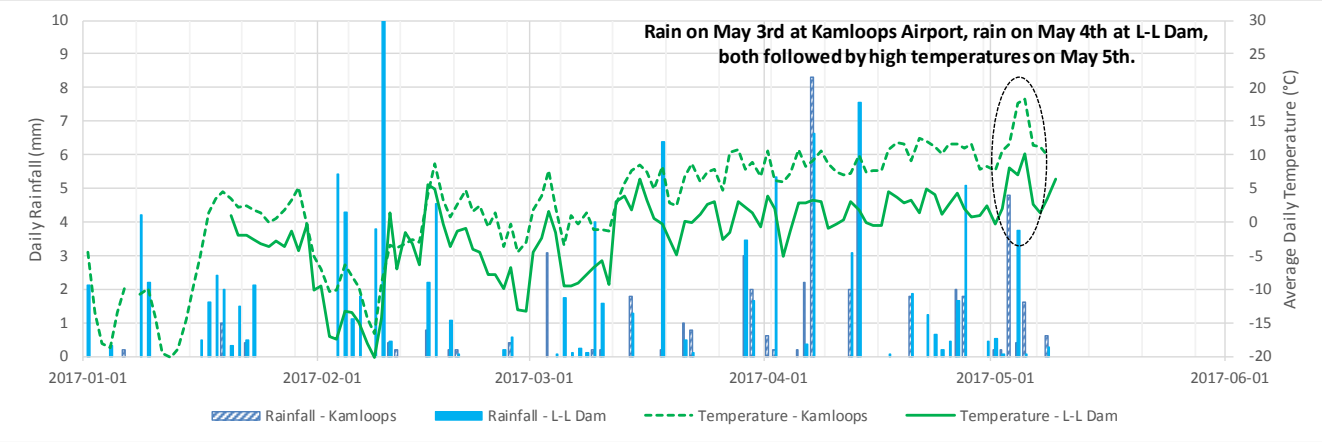


Table 4.2 Historical Average and 2017 Snowpack Depths

Survey Period	Years of Record[1]	Historic Average Snowpack Depth[2] (mm SWE[3])	2017 Snowpack Depth (mm SWE[3])	Percent Difference (%)
January 1st	11	50.2	Not surveyed	N/A
February 1st	25	83.5	Not surveyed	N/A
March 1st	51	89.5	116[4]	+30%
April 1st	51	96.3	144[4]	+50%
May 1st	48	27.3	101[4]	+271%

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.
3. SWE = snow water equivalent.
4. The March 1st survey was conducted on March 4, 2017. The April 1st survey was conducted on April 3, 2017. The May 1st survey was conducted on May 3, 2017.

Figure 4.3 Daily Rainfall and Average Temperature at Kamloops Airport and L-L Dam Climate Stations Leading up to Freshet



4.3 Water Balance

THVCP manages and tracks the annual water balance for the Highmont TSF. Figure 4.4 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. In general, 2017 had relatively low precipitation resulting in a roughly neutral water balance. Surveys are not regular, but don't indicate a significant change in pond volume.

Figure 4.4 Annual Water Balance for Highmont TSF

Item	Volume in 2016 (m^3)
Inflows	
Direct precipitation and runoff	413,100
Groundwater	300
Total inflow:	*413,400*
Outflows	
Seepage	351,200
Evaporation(3)	62,200
Total outflow:	*413,400*
Balance	
Balance (inflow minus outflow)	0

Notes:
1. Values received from THVCP have been rounded to the closest 100 m^3.
2. Precipitation from the Shula Flats weather station adjusted to the Highmont area was used in the water balance.
3. Evaporation was 540 mm/year at Highmont.

4.4 Flood Management

The summary of flood management structures and the applicable design criteria and details for the four dams are given in below with the following discussion points noted:

- The IDF events for each dam complies with requirements under the Code:

- The design flood for Highmont TSF (PMF) is greater than the minimum IDF required by the Code which further reduces overtopping risks which is supported for this type of facility.
- At S3 the spillway is blocked and therefore the IDF is stored, to comply with the Code, the IDF duration was increased from 24-hours to 72-hours (KCB 2018).
- Downstream of the North Dam toe, the lower toe access road crosses the spillway channel (Figure 4.6). Culverts are buried in road to allow flow to pass. However, these culverts do not have capacity to pass the peak spillway design outflow (9.8 m^3/s). During the IDF or other large flood events, the culverts would restrict flow and a pond would form at the toe of the dam until it reached the low point in the access road (El. 1463 m). Above this elevation, water would flow over the road and into S2 Pond which is not a desirable condition. THVCP should modify the spillway channel in this area 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.
- If a temporary pond were to form at the toe of the North Dam as shown on Figure 4.6, this would saturate the 1 m of the dam toe until water level receded. This temporary condition would not compromise the structural stability of the dam in this area.

- Flood routing at S2 Pond does not include any additional flow from the Highland Spillway channel which may flow into S2 via deflection berm. Flows from the Highmont Spillway diverted into S2 Pond by the deflection berm during return periods equal to or below the IDF would be significantly attenuate through the Highmont impoundment. The S2 Pond spillway has an additional 0.35 m^3/s capacity (below freeboard) to manage flows from the Highmont spillway channel that are diverted. In the event that freeboard is being encroached, the plug in the Highmont spillway channel can be breached to reduce flow reported to S2 Pond.
- Flood routing at S5 Pond which is comprised of multiple ponds (Figure 4.7), was updated (KCB 2018) to address a recommendation from the 2016 DSI. The assessment concluded:
  - Under the current configuration, the storage capacity of S5 is essentially equivalent to the capacity of the pumping system.
  - Flow enters in the bow shaped pond (Sub-pond 8 in Figure 4.7) and then flows into the pumping area (Sub-pond 1 in Figure 4.7) via 2 buried pipes.
  - The retention capacity of the pumping pond before spilling pond level would reach the spillway pipe (~270 m^3). Therefore, ability to prevent spilling is highly dependent on pump capacity and operability.
  - Assuming the pumping system is operating, the pond can safely manage the IDF. However, THVCP should increase the storage capacity within the S5 Pond system to reduce the reliance on pumping to prevent a spill and includes an emergency outflow that does not require a temporary plug.

- Flood routing at S8 Pond indicates that the IDF could be routed through the overflow spillway pipe (24-hour duration) or stored (72-hour duration) if the pipe became plugged.

Table 4.5 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	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]	(KCB 2007)
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)	n/a	
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 (2018)
S8 Pond	None	Low	100-year	100-year 72-hour (86 mm, Note 10)	1451.7 m	

Notes:
1. 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 via deflection berm.
6. As IDF is stored, duration increased from 24-hours to 72-hours to be consistent with the Code (KCB 2018).
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 a store (i.e. spillway blocked) or route (i.e. spillway open) the IDF and both conditions were satisfied.
11. Peak flood level during the IDF at pond S5 requires additional flood routing and assessment of existing pumping capacity to be confirmed.

Figure 4.6 Potential Flood Zone Along North Dam Toe Due to Access Road

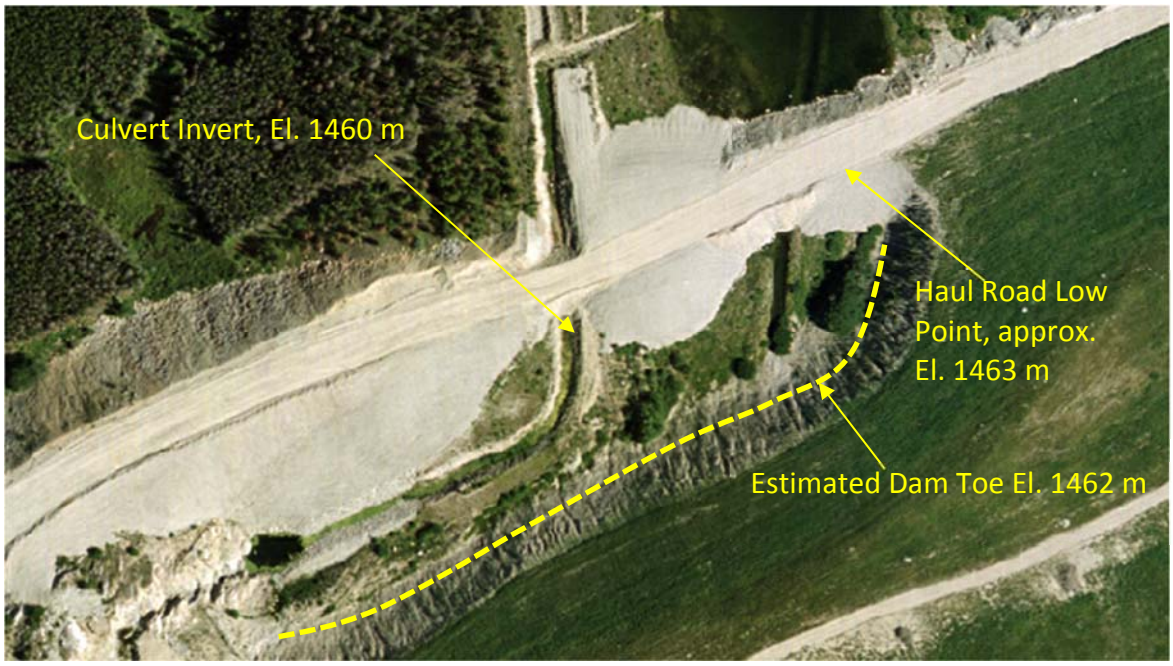
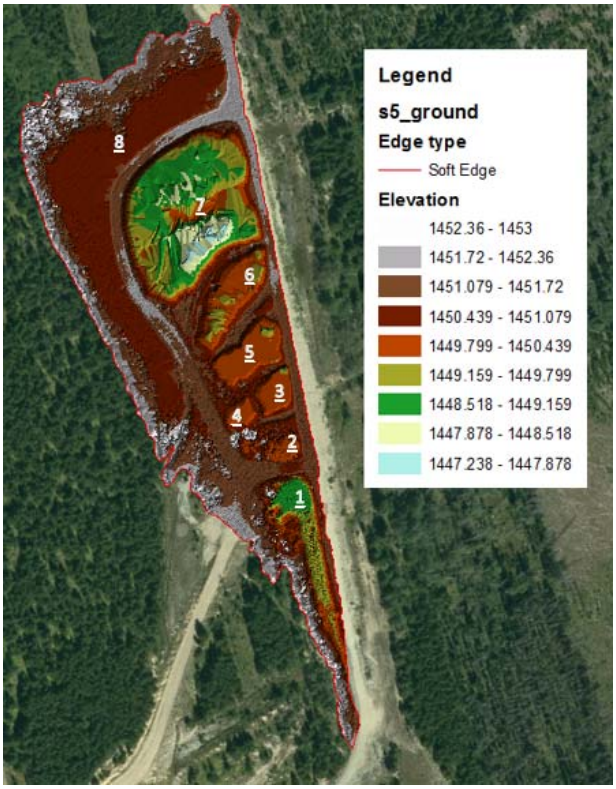


Figure 4.7 S5 Pond Sub-Ponds and Relative Elevations



4.5 Freeboard

Where available, the minimum freeboard[2] measured during 2017 based on either the DSI site visit or regular surveys are estimated in Figure 4.8. THVCP visually estimate 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.
- Freeboard for Highmont TSF is reported relative to the dam crest and the spillway channel at the spillway gate. If flood level were to crest out of the channel near the spillway gate, water can flow downstream, potentially eroding the North Dam.
- 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 stored in the pond.

Figure 4.8 Freeboard at Time of Site Inspection

Dam	Required Freeboard During Inflow Design Flood (1)	Minimum Freeboard During Inflow Design Flood	2017 Freeboard	2017 Freeboard Surveyed/Visually Estimated
Highmont TSF	0.5 m(2, 3)	4.6 m(5) – dam crest 0.6 m(5) – spillway channel	6.1 m(5) – dam crest 2.1 m(5) – spillway channel	Annual minimum from surveys, refer to App IV
S1 Pond	0.5 m(4)	1.0 m(4)	2.75 m	THVCP Inspection Sept 21, 2017
S2 Pond	0.5 m(4)	0.7 m(4)	3.2 m	
S3 Pond	0.3 m(2)	1.1 m(2, 6)	2.25 m	
S5 Pond	0.5 m	To be confirmed (Note 7)	1.1 m	
S8 Pond	0.5 m(4)	0.5 m(2, 8)	2.1 m	

Notes:
1. As per the Code.
2. Based on KCB (2018).
3. Minimum required freeboard to accommodate wave run-up as per CDA (2013) 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.
6. Freeboard reported for 72-hour duration IDF. Freeboard during operations storage condition (100-year 30-day + IDF 24-hour) is 0.4 m which still meets criteria.
7. Minimum freeboard during the IDF at pond S5 requires additional flood routing and assessment of existing pumping capacity to be confirmed.
8. Freeboard reported for the scenario where the IDF is stored in the pond.

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

5 REVIEW OF MONITORING RECORDS AND DOCUMENTS

5.1 Monitoring Plan

An updated Operation, Maintenance and Surveillance (OMS) manual, including the Emergency Preparedness and Response Plan (EPRP) were issued in March 2018 (THVCP 2018). The 2018 update supersedes the versions submitted to MEM in December 2016 and included the recommended items from the 2016 DSI (KCB 2017).

- Update monitoring frequency based on 2016 recommendations or as mutually agreed between THVCP and KCB;
- Review and update the failure mode assessment based on AMEC (2015) failure modes and effects analysis (FMEA);
- Update the event-driven inspection criteria (Section 5.2);
- Annually update threshold levels based on the recommendations in the DSI (Sections 5.4 and 5.5);
- Include a list of named individuals for each of the main roles of responsibility as an appendix to the OMS instead of in the main body of the text, to make it easier to update on a yearly basis;
- Include a plan(s) showing the location of all the facilities associated with the TSF (seepage ponds, slimes ponds, inflows, outflows etc.); and
- Review the structure of the report and transferred data which is updated on an annual basis to an appendix which can easily be updated, rather than the body of the report (e.g., tailings production schedule, threshold levels, groundwater chemistry).

The 2018 OMS manual meets the intent of the Mining Association of Canada (MAC 2011) and CDA (2014) guidelines, is current and provides adequate coverage for existing conditions.

5.2 Inspections

The Highmont TSF monitoring program includes the following inspections:

- Annual DSI (this report) – completed by the EoR to comply with Section 10.5.3 of the Code and submitted to MEM.
- Routine – monthly inspections of the Highmont dams (North, South and East), and monthly inspections of Seepage Recovery Pond S1, S2, S3, S5, and S8 are completed by THVCP staff. The decommissioned Seepage Recovery Ponds S4 and S9 are not formally inspected. Inspections by THVCP staff have been completed at the prescribed frequencies as described in the 2018 OMS update.
- Event-driven – these inspections are of more value to confirm that the changed condition (i.e. flood, earthquake) did not have a significant impact on the structures. THVCP are to complete

an inspection in response to the following threshold exceedances (included in the 2018 OMS manual update):

- Piezometric and dam movement instrumentation thresholds as discussed in Sections 5.4 to Section 5.5.
- Earthquake greater than magnitude 5, within 100 km of the site.
- Rainfall event greater than the 10-year, 24-hour duration storm.

During 2017 the following event-driven inspections were triggered:

- May 2017 (during freshet flooding, refer to Section 0):
  - On May 4, in response to the May 2017 flooding, at Pond S1 significant inflow caused a change in normal operations, and options where considered to divert water to Witches Brook and 24 Mile Lake. At Pond S5 a discharge pump failed, and repairs had to be made in order to stabilize the rising pond levels. HVC also informed KCB that Highmont TSF would likely be discharging water over its spillway in order to stabilize its pond level which was rising due to significant freshet conditions
  - On May 6, Mr. Rick Friedel (EoR) of KCB accompanied THVCP to inspect the Highmont TSF, amongst other structures, via helicopter fly-over. No immediate dam safety concerns were noted throughout the facility during this fly-over.

5.3 Reservoir Level

The pond level is typically measured monthly, at minimum, during non-winter months which is more frequent than prescribed in the 2018 OMS update (monthly). During winter, the pond is not accessible but also the annual period with the sustained lowest levels. Reservoir levels are shown in conjunction with piezometric levels and seepage rates in Appendix IV:

- Figure IV-1 to Figure IV-5 plots measured pond level and piezometric levels at the North Dam, South Dam, East Dam, Spillway, and Seepage Ponds.
- Figure IV-7 plots pond levels with measured weir flows from Seepage Pond S1, S3, S5, and S8.

The pond level has remained relatively constant with the expected seasonal rise and fall associated with freshet. Pond levels have been recorded more frequently in 2016 and 2017. The relatively higher peak pond levels measured during these years relative to previous could be associated with reading frequency rather than actual increased pond levels. The annual fluctuation in pond level measured since 2007 is less than 1 m.

5.4 Piezometers

There are 29 piezometers at the Highmont TSF, 25 of which are active and 4 inoperative as shown on Figure 3 to Figure 5. Inoperative piezometers may be buried, plugged or otherwise damaged.

Piezometers are typically read monthly between March and November (when accessible) which meets the frequency prescribed in the 2018 OMS update. 2017 and historic piezometric readings are shown in Figure IV-1 to Figure IV-5. 2017 piezometer measurements typically show similar seasonal pattern as previous years and reflect fluctuations in the Highmont Pond level.

The following observations are noted:

- A groundwater mound between Highmont Pond and the North and East Dams 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 2017.
- The one set of nested piezometers (HM-PS-02 and HM-PS-03) indicate a modest upward gradient from the foundation glacial till into the tailings in the northeast corner of the facility.
- There were a several threshold exceedances of some instruments in response to freshet, in each case the readings dissipated to normal levels shortly after freshet passed. In some cases, threshold values have been revised based on 2017 readings.
- Instruments in the northeast corner of the impoundment (PW-A, HM-PS-01, HM-PS-02 and HM-PS-03) showed 0.5 m to 1.0 m rise over 2016 and prior readings. The reason for this rise is unknown, THVCP have discussed with KCB and raised an action to investigate whether these observations are due to something other than rising piezometric levels (e.g. surveyed tip elevation or data entry). The current phreatic levels are not a dam safety concern but thresholds have been revised to notify whether the increase is sustained in 2018.

Piezometric level thresholds for Highmont Dam are set to monitor deviation from the established trend. Piezometer readings have been fairly consistent over the past three years or more, showing a similar pattern of seasonal variability in the impoundment and relatively constant in the dam. Therefore, the threshold for each piezometer was set between 0.5 m and 1 m above the maximum elevation head; refer to Figure 5.1. Questionable readings (e.g., where the piezometer was noted as plugged or there was a spike that has not been repeated) were not used when defining thresholds. Thresholds revised for 2018 are identified in Figure 5.1.

Figure 5.1 Proposed Piezometric Level Thresholds

Instrument ID	2017 Piezometric Levels (m)		Level 1 Threshold
	Maximum	Minimum	
S1	1432.3	1431.3	1432.4
S2	1451.7	1450.7	1452.5
S2-1	1480.9	1480.0	*1481.4*
S2-2	1480.9	1480.7	*1482.0*
S2-3	1482.9	1481.5	*1483.4*
S2-4	1481.9	1479.3	*1482.9*
S3-1	1481.5	1481.1	*1482.0*
S3-2	1482.5	1480.9	1483.0
PW-A	1480.0	1479.5	*1480.5*

Instrument ID	2017 Piezometric Levels (m)		Level 1 Threshold
	Maximum	Minimum	
PW-C (TALL)	1482.1	1476.5	1482.6
P-D	1482.0	1479.2	1482.2
P-E	1481.5	1480.5	*1482.6*
P-G	1481.9	1479.8	1482.4
PW-H	1480.7	1480.2	1481.1
P-I	1482.2	1480.6	*1482.7*
PW-J	1481.6	1479.5	1481.9
P-K	1481.6	1479.0	1482.2
PW-L	1481.1	1480.7	1481.5
P-M	1483.2	1480.9	*1483.5*
P-N	1480.7	1478.7	1481.9
P-O	1481.8	1479.4	*1482.4*
PW-P	1481.0	1478.2	*1481.5*
HM-PS-01 (13-SRK-14)	1478.8	1478.2	*1479.3*
HM-PS-02 (13-SRK-13)	1478.0	1477.6	*1478.5*
HM-PS-03 (13-SRK-13)	1478.6	1478.1	*1479.0*

Notes:
1. *Italics* indicates revised threshold for 2018.

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

5.5 Survey Monuments

Survey monuments at the Highmont TSF are shown on Figure 3 to Figure 5. Monuments were surveyed twice in 2017: June and October. This exceeds the required frequency prescribed in the2018 OMS update (annual), except for Monument P2 which has not been surveyed since 2016 because line of site has become obstructed by vegetation growth in the area. THVCP have actioned this issue be resolved and resume monitoring of P2 in spring 2018.

THVCP surveys since 2014 use 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.

Figure 5.2 2017 Survey Monument Incremental Displacement Summary

Monument	Incremental		Cumulative	
	Vector Horizontal Displacement[1] (mm)	Vertical Displacement[1] (mm)	Vector Horizontal Displacement[3] (mm)	Vertical Displacement[3] (mm)
P2	Not measured[(2)]			
P3	6.2, upstream	-0.2	11.0, downstream	-2.1
P4	41.7, parallel to dam crest and downstream	+3.6	27.7, parallel to dam orientation	-3.1
P5	12.0, upstream	-5.8	26.8, downstream	+3.5
P6	13.8, parallel to dam crest	+1.6	27.5, downstream	-30.4
P7	Not measured[(4)]	+1.1	Not measured[(4)]	-34.3

Notes:
1. June 2017 survey compared to June 2016 survey.
2. P2 was not surveyed in October 2016, or June 2017 because of vegetation growth has impeded line of site for surveyor. THVCP have actioned this issue be resolved and resume monitoring of P2 in spring 2018. Comparison of the most recent surveys indicates 138.7 cumulative movement in the downstream direction but reliability of measurement is uncertain.
3. All monuments earliest historic readings are in 2007. Cumulative displacements are calculated as difference from the June 2017 survey and earliest historical reading.
4. P7 is surveyed for elevation only and no horizontal vector displacements can be estimated.

From a review of the historic and 2017 data, the following observations are noted:

- No threshold exceedance recorded and 2017 locations are consistent with previous surveys.
- No significant crest settlements are observed in 2016, uplift is more likely a result of survey accuracy than dam movement.
- At P2 on the North Dam, there was a larger horizontal displacement recorded in June 2016 relative to previous years. No alert threshold levels were in place at the time. The displacement was mostly in a northwest direction perpendicular to the dam orientation but slightly in the downstream direction. After reviewing the data, the June 2016 survey is considered potentially survey error based on comparison with data back to 2004 (refer Figure V-6). With a large horizontal displacement, there should also be an accompanying change in vertical settlement which is not the case. No cracking or slumping was observed in the area during site visit. THVCP have actioned that survey issues be resolved at this location and monitoring resumed in spring of 2018.

Movement thresholds (horizontal and settlement) were established during the 2016 DSI for the survey monuments; refer to Figure 5.3. No changes are proposed for 2018. The thresholds were set based on the following criteria:

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

- Total settlement was set at approximately 50 mm below the most recent reading, based on the observed settlement trends.

Figure 5.3 Proposed 2018 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 2017 to 2018 threshold values for horizontal displacement from original position, incremental vertical displacement between readings, or total vertical displacement between readings.

5.6 Seepage

Seepage flows are monitored at the instruments (weirs) and frequencies summarized in Figure 5.4. Monitoring frequency for all seepage flow instruments are consistent with frequency described in the 2018 OMS update. Instrument locations are shown in Figures 3 to 5 and 2017 flow measurements are plotted on Figure IV-7. In general, flow rates peak in April/May during freshet.

A large flow increase was observed in all the seepage flow measurement instrumentation, specifically HM-S8-FS-01. This increase took place in late April and is likely an early response to the freshet. 2017 seepage measurements during freshet were generally greater than 2016 measurements during the same time period, which is consistent with the fact that the freshet of 2017 was more severe than 2016.

Figure 5.4 Summary of Seepage Flow Measurement Instruments

Instrument ID	Location	Instrument Type	2017 Monitoring Frequency
HM-S1-FS-02	Upstream of S1 Pond	Weir – Datalogger and Manual Reading	Hourly (Datalogger) / Weekly (Manual)
HM-S3-FS-01	Upstream of S3 Pond	Weir – Datalogger and Manual Reading	Hourly (Datalogger) / Weekly (Manual)
HM-S4-FS-02	Downstream of S4 Pond	Weir - Datalogger	Hourly
HM-S5-FS-01	Upstream of S5 Pond	Pipe and Bucket – Manual Reading	Monthly
HM-S8-FS-01	Upstream of S8 Pond	Pipe and Bucket – Manual Reading	Monthly
HM-S9-FS-1	Downstream of S9 Pond	Weir - Datalogger	Hourly

5.7 Water Quality

Water quality downstream of the Highmont TSF is monitored by HVC monthly to assess the effectiveness of the tailings facility in protecting the downstream receiving environment. A copy of the HVC 2017 Annual Water Quality Monitoring Report (ERM 2018) was provided to KCB for review as

part of the DSI. Select observations and findings from the monitoring report 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 _.
- There are two permitted performance targets in PE-376 for this site: Sites #264 (Pond S5 Outlet) and #279 (S8 Outlet). There was no discharge from either pond S5 and S8 during 2017, therefore, no water samples were required to be collected and both sites are in compliance.
- All permit sampling requirements and frequency were met in 2017, except for two instances when a subset of the required water quality parameters was not measured.
- HVC reported a non-compliance on May 5, 2017 to the BC MOE regarding discharge of the portion of spillway flows in excess of 860 m^3/hour directly into the environment from the Highmont Tailings Pond Spillway during the unusually high freshet. British Columbia Ministry of Environment & Climate Change Strategy (BC MOECCS) reviewed this event and identified that this discharge is within HVC's authorization.

The 2017 monitoring results were screened against applicable BC Water Quality Guidelines (WQG). Further discussion on specific WQG exceedances and water quality trends observed during 2017 can be found in the 2017 Annual Water Quality Monitoring Report (ERM 2018).

part of the DSI. Select observations and findings from the monitoring report 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: Sites #264 (Pond S5 Outlet) and #279 (S8 Outlet). There was no discharge from either pond S5 and S8 during 2017, therefore, no water samples were required to be collected and both sites are in compliance.
- All permit sampling requirements and frequency were met in 2017, except for two instances when a subset of the required water quality parameters was not measured.
- HVC reported a non-compliance on May 5, 2017 to the BC MOE regarding discharge of the portion of spillway flows in excess of 860 m^3/hour directly into the environment from the Highmont Tailings Pond Spillway during the unusually high freshet. British Columbia Ministry of Environment & Climate Change Strategy (BC MOECCS) reviewed this event and identified that this discharge is within HVC's authorization.

The 2017 monitoring results were screened against applicable BC Water Quality Guidelines (WQG). Further discussion on specific WQG exceedances and water quality trends observed during 2017 can be found in the 2017 Annual Water Quality Monitoring Report (ERM 2018).

6 VISUAL OBSERVATIONS AND PHOTOGRAPHS

The visual observations made during the DSI site visit are summarized below. Copies of the filed inspection forms are included in Appendix I and photos of all the sites are in Appendix II.

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 (>200 m) based on reservoir level, typical for this time of year.
- **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.
- **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.
  - 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 except for the increased erosion gullies in the shallow vegetated section of the dam slope.
  - There is local ponding in low points in the natural topography along the toe of the South Dam. Seepage ponds are downstream of the main depressions. The main areas of ponding are related to local depressions formed by vehicle tires (from tree clearing activities). An area of undercutting at the toe near the ponding areas was noted during the 2015 DSI, and repaired after the 2017 DSI site visit. Some animal burrows were noted within the downstream slope but no related adverse effects were noted.
- **Seepage**:
  - Observed seepage from western underdrains of the North Dam was clear and flowed to pond S2. Observed seepage from eastern underdrains was clear and flowed to pond S1. The lower access road crosses the drainage channel for the underdrain which discharges to pond S2. No culvert is visible but seepage flows have not been observed to form a significant pond (i.e. to reach the dam toe) upstream of the road fill slope, indicating seepage through the road fill is sufficient to drain seepage rates. There are no signs of recent ponding or issues related to seepage flow through the road fill. Based on these

observations, the previous recommendation (HD-2015-03) related to this area can be closed with no further action.

- Some seepage is likely retained in local ponds along downstream toe of East Dam. Seepage flows from southern underdrains report to pond S5. Seepage and ponded waters were observed to be clear.
- Seepage from the main underdrains flow at the South Dam reports to seepage ponds downstream (S3 and the breached S4).

Spillway

- **Approach Channel**: Pooled water in local depressions of the channel but this was not connected to the main pond. No erosion noted and vegetation is established. Outlet of the spillway culverts that pass through the dam crest is obstructed by vegetation which should be cleared.
- **Gate**: Water is ponded in local low points along the spillway channel (i.e. no current flow). First identified in the 2016 DSI, signage should be added to the 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. A safety grate should also be placed over the opening in the floor of the catwalk that provides access to the gate control.
- Spillway Channel:
  - The upstream segment of the spillway channel is in a vertical walled bedrock excavation. No failures were observed along the channel walls. Water was ponded along the length of the channel upstream of a cascade drop chute in the channel.
  - Downstream of the chute, the channel coverts to a trapezoidal ditch that is excavated in glacial till with exposed bedrock along the majority of the spillway invert and portions of the slopes. No evidence of significant scour was observed although there is vegetation growth, which will be cleared as part of routine maintenance in accordance with the OMS.
  - The culverts that allow flow to pass through the toe access road at the toe of the North Dam are partially obstructed and damaged. The obstruction should be removed as part of routine maintenance.
- **S2 Diversion Berm**: A diversion berm is constructed across the spillway channel to divert base flows into S2 because the water quality is not suitable for discharge to the environment. During large flood events, the plug will be overtopped and eroded, directing the majority of flow along the spillway channel. During the site inspection the berm was confirmed to be lowered to original design height. No signs of significant erosion, deterioration, or displacement.

Seepage Recovery Pond S1

- **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. Slope covered in gravel and moderately vegetated. This combination provides adequate erosion protection based on performance over the service life.
- **Pond**: At the time of inspection was more than 1 m below the spillway invert.
- **Spillway**: Good physical condition. Minor vegetation present immediately 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.
- **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.
- **Seepage**: None observed.

Seepage Recovery Pond S2

- **Crest**: Good physical condition. No signs of significant erosion, deterioration, displacement, or cracking (Photo II-D-2).
- **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.
- **Pond**: At the time of inspection the pond appeared to be visually lower than when inspected in 2016. Observed to be approximately 2.5 m below the invert of the spillway.
- **Spillway**: Good physical condition. The inlet is partially obstructed by a small tree. This does not pose an immediate dam safety concern but should be removed as part of maintenance in 2018.
- **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 and 2016 DSI, and is likely to consist of surface runoff and seepage.

Seepage Recovery Pond S3

- Not visited during 2017 site visit but routine inspection reports and photographs have been reviewed. The facility was visited by the EoR during May freshet inspections.

Seepage Recovery Pond S5

- **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. Minor vegetation present throughout slope. No signs of erosion, deterioration, or animal activity.
- **Pond**: During inspection pond observed to be approximately 1.5 m below crest of dam, which was a similar level compared to the 2016 inspection.
- **Low-level Outlet and Spillway**: As observed during the 2016 DSI, the Low-level Outlet valves were closed and the inlet of the spillway pipes were obstructed by sand bags.
- **Seepage**: None observed.

Seepage Recovery Pond S8

- **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. Moderate vegetation throughout slope and large wood debris present. No observed signs of erosion, deterioration, or adverse displacement.
- **Pond**: At the time of inspection the pond appeared slightly higher in elevation when compared to the 2016 inspection. Approximately 1.3 m below the crest of the dam.
- **Spillway**: The outlet pipe was clear of debris.
- **Seepage**: None observed.

7 ASSESSMENT OF DAM SAFETY

7.1 Dam Classification Review

The dam consequence classifications are summarized in Figure 7.1. Based on the latest dam consequence review hosted by THVCP on January 16, 2018, no change in consequence classification was recommended for any of the Highmont TSF dams.

The consequence categories of the main tailings dams meet or exceed that recommended in the latest DSR (AMEC 2014a), the determination of which was based on the results of dam break and inundation studies (AMEC 2014b).

Figure 7.1 Summary of Highmont Dam Consequence Classifications

Name of Dam	Consequence Classification (CDA 2013)
Highmont TSF Dams	High
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)

7.2 Failure Mode Review

Based on the DSI and review of available documents regarding Bethlehem No. 1 TSF, the potential failure modes included in the Canadian Dam Safety Guidelines (CDA 2013) were reviewed:

7.2.1 Highmont Dams

Overtopping

The Highmont TSF has an open channel spillway designed (AMEC 2014a) to safely pass a flood (PMF due to24-hour duration PMP) that is greater than the minimum IDF recommended under the Code. Given the presence of the spillway and wide tailings beach that would be present between the pond and crest while discharging through the spillway (minimum 290 m from the East Dam during the PMF which is larger than the IDF), the likelihood of overtopping is considered very low.

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 Instability - Foundation Irregularities / Dam Fill

Previous slope stability analyses (KC 1996) indicate the minimum static Factor of Safety (FOS) for failure surfaces through the foundation is 2.5. A 2015 stability assessment (KCB 2015c) to assess potential failure surfaces through a lacustrine unit in the South Dam foundation indicated a FOS of 1.8. The FOS for both 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. Therefore, the likelihood of a slope instability failure through the foundation developing is considered very low.

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.

Earthquakes

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). Based on these design analyses the likelihood of seismic related failure during the EDGM is considered low.

7.2.2 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. The likelihood of overtopping during the IDF is considered low.
    - Some flow is diverted into S2 Pond from the Highmont spillway while the fuse plug is in place. There is additional capacity in the pond S2 spillway (before exceeding freeboard) to manage these. If pond levels in pond S2 encroach on freeboard, the spillway fuse plug could be removed as per the OMS.
- The spillway at pond S3 has been plugged and the impoundment can store the 72-hour duration flood event with adequate freeboard. The likelihood of overtopping during the IDF is considered low but is more reliant on monitoring and potential active intervention due to the absence of a functional spillway than other ponds.
- Assessment of pond S5 overtopping risks to be reviewed based on pumping system capacity and potential upgrades to reduce reliance on pumping to manage the IDF.
- The IDF can either be stored within pond S8 or routed through the existing overflow spillway pipe. The likelihood of overtopping during the IDF is considered low.

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.

Dam Instability - Foundation Irregularities / Dam Fill

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.

Surface Erosion

In general, the downstream slope 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.

Earthquakes

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. Therefore, the likelihood of a slope instability failure developing through the foundation is considered very low.

7.3 Emergency Preparedness and Response

The emergency preparedness and response plan (EPRP) for the Highland TSF forms a part of the OMS manual. KCB understands the 2018 update is in progress and as such, the following discussion will be in reference to the 2016 EPRP.

Training of THVCP staff and contractors who work near the dams is provided by a video presentation which outlines dam safety warning signs that all staff should be aware of and report if any 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 table top exercise to review and update the EPRP for the HVC site was hosted by THVCP and attended by a representative of the EoR on November 20, 2017.

8 SUMMARY

The Highmont TSF appears in good physical condition and the observed performance during the 2017 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 2017 DSI are summarized in Table 8.2.

Table 8.1 Previous DSI Recommendations – Status Update

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority (1)	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2015-02	*Seepage*	-	*During the Q4 dam inspection, seepage and erosion was noted at the toe of the South Dam. The toe should be repaired with filter compatible fill and seepage rates monitored.*	*3*	*December 2017 (CLOSED)*
HD-2015-04	*Seepage*	-	*Stagnant water is pooled at the toe of the South Dam in the toe drain immediately upstream of S4 Pond Drain. Some erosion and rilling was noted on the dam slopes around the drain. The drainage should be improved so that the water can drain away from the toe of the dam and vegetation added on the slopes to reduce erosion risks.*	*4*	*December 2017 (CLOSED)*
HD-2016-01	*OMS*	*Annual Update*	*As part of the 2017 OMS update, incorporate the following:* *- Update the failure mode assessment* *- Explicitly state the minimum reading frequency for each instrument and measuring point* *- Update event-driven inspection criteria (Section 5.2)* *Incorporate 2017 thresholds (Sections 5.4, 5.5 and 5.6)*	*3*	*Q3, 2017 (CLOSED)*
HD-2016-02	Monitoring	OMS	Complete a survey of monument P2, which was not surveyed in October 2016, to confirm whether the incremental horizontal movement is survey related.	3	Q2, 2017 (Open, Actioned for Q2 2018)
HD-2016-03	*Freeboard*	*The Code*	*Calculate the minimum freeboard required for the Highmont TSF under the Code based on the method proposed by CDA (2013) to demonstrate compliance of existing freeboard.*	*3*	*Q3, 2017 (CLOSED)*
HD-2016-04	*Maintenance*	*OMS*	*Clear vegetation that is obstructing the outlet of the spillway culverts that pass flow below crest access road.*	*3*	*Q3, 2017 (CLOSED)*
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)
HD-2016-06	*Safety Grating*	-	*A safety grate should be placed over the opening in the floor around the spillway gate controls.* *NOTE: this is a suggestion not related to dam safety, THVCP have taken under consideration.*	*4*	*Q1, 2018 (CLOSED)*
HD-2016-07	*Maintenance*	*OMS*	*Remove accumulated sediment and vegetation from inlet and outlet of culverts that pass flow through the toe access road just upstream of S2 pond.*	*3*	*Q3, 2017 (CLOSED)*

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority (1)	Recommended Deadline
HD-2016-08	*Spillway Culvert Capacity*	*The Code*	*After the obstruction are cleared from the spillway culverts (HD-2016-04) complete an assessment to confirm the culverts have adequate capacity to pass the IDF as designed.*	*3*	*Q4, 2017 (CLOSED, refer to HD-2017-02)*
HD-2016-09	*EPRP*	*Comm. Plan*	*Complete assessment of warnings for downstream parties potentially impacted by a failure and update the EPRP as appropriate.*	*3*	*Q4, 2017 (CLOSED)*
S1 Pond					
S1-2016-01	*Maintenance*	*OMS*	*Remove vegetation from outlet of S1 riprap outfall apron.*	*3*	*Q3, 2017 (CLOSED)*
S2 Pond					
HD-2015-03	*Seepage*	-	*Sloughing of material around the road culverts at the inflow to Highmont S2 from North Dam toe drain channel was noted. The sloughed material should be removed and the blockage cleared to allow passage of seepage to S2 Pond.*	*3*	*December 2016 (CLOSED)*
S2-2016-01	*Maintenance*	*OMS*	*Remove vegetation from inlet of S2 spillway inlet.*	*3*	*Q3, 2017 (CLOSED)*
S3 Pond					
S3-2016-01	*Freeboard*	*The Code*	*Review the freeboard requirement or take alternate action to increase the freeboard during the IDF to meet design criteria.*	*3*	*Q4, 2017 (CLOSED)*
S5 Pond					
S5-2016-01	*Flood Management*	*The Code*	*Complete an updated flood routing assessment for the existing partially obstructed spillway to confirm acceptable performance during an EDF (if applicable) or IDF. If necessary, identify upgrades required to meet compliance.*	*3*	*Q4, 2017 (CLOSED)*

Notes:

3. Recommendation ID numbers from 2016 DSI have been revised as shown.
4. 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 2017 DSI Recommendations

ID No.	Deficiency or Non-Conformance	Applicable Reg. or OMS Reference	Recommended Action	Priority (1)	Recommended Deadline
Highmont Tailings Storage Facility					
HD-2017-01	Flood Management	Spillway	THVCP should modify the spillway channel in this area 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. Suggested interim milestones: Design: 2019; Permit and Construction: 2020.	3	Q4, 2020
S1 Pond / S2 Pond / S3 Pond / S8 Pond – None					
			No new recommendations from 2017		
S5 Pond					
S5-2017-01	Flood Management	Storage Capacity	THVCP should increase the storage capacity within the S5 Pond system to reduce the reliance on pumping to prevent a spill and includes an emergency outflow that does not require a temporary plug.	3	Q2, 2019

Notes:

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.

9 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Teck Highland Valley Copper Partnership (Client). The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

KLOHN CRIPPEN BERGER LTD.

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

REFERENCES

AMEC. 2014a. “Highmont Dams – Highmont Tailings Storage Facility 2013 Dam Safety Review”, February.

AMEC. 2014b. “Dam Break Study – Highmont Tailings Storage Facility”, September 23.

Canadian Dam Association (CDA). 2013. “Dam Safety Guidelines 2007 (Revised 2013).

Canadian Dam Association (CDA). 2014. “Technical Bulletin: Applications of Dam Safety Guidelines to Mining Dams.”

ERM Consultants Canada Ltd (ERM). 2018. “Highland Valley Copper 2017 Annual Water Quality Monitoring Report: Part I and Part II”. March.

Highmont Operating Corporation. (HOC). 1982. “1981 Dam Construction Report – Draft”, March 15.

Highmont Operating Corporation. (HOC). 1984a. “1982 Tailings Dam Construction Report”, January 27.

Highmont Operating Corporation. (HOC). 1984b. “1983 Tailings Construction Report”, July 18.

Highmont Operating Corporation. (HOC). 1984c. “1984 Tailings Construction Report”, October 1.

Klohn Crippen Consultants Ltd. (KC). 2005. “Highmont Dam Spillway Completion Report – 2003 and 2004 Construction”, July 27.

Klohn Leonoff. (KL). 1980. File:VA 1526. “Highmont Tailings Disposal System – Report No. 5 Seepage Recovery”, April 3.

Klohn Leonoff. (KL). 1981. File: VA 1526. “Highmont Tailings Disposal System – 1980 Starter Dam Construction”, March 27.

Klohn Leonoff Ltd. (KL). 1981. File: VA 1526. “Highmont Tailings Disposal System - 1980 Starter Dam Construction”, March 27.

Klohn Crippen Berger Ltd. (KCB). 2007. “Highmont Seepage Recovery Pond S1 Replacement of Outlet Pipe, May 23.

Klohn Crippen Berger Ltd. (KCB). 2015a. “HVC Tailings Dams – Highmont Tailings Storage Facility Response to MEM Memorandum – February 3, 2015”, June 25.

Klohn Crippen Berger Ltd. (KCB). 2015b. “Highland Valley Copper – 2014 DSI Recommendations DSI-HD-01 and DSI-SD-03 - Highmont Seepage Dams Flood Management”, August 4.

Klohn Crippen Berger Ltd. (KCB). 2015c. “Highland Valley Copper – 2014 DSI recommendations – Highmont Dams Stability Updates (DSI-HD-06)”, December 22.

Klohn Crippen Berger Ltd. (KCB). 2015d. “Highland Valley Copper – 2014 DSI recommendations – Highmont Seepage Dams Stability Update (DSI-SD-01)”, December 2.

Klohn Crippen Berger Ltd. (KCB). 2017. “2016 Dam Safety Inspection Report – Highmont Tailings Storage Facility”, March 29.

Klohn Crippen Berger Ltd. (KCB). 2018. “DSI Recommendations Highmont TSF Summary - DRAFT”, January 19.

Mining Association of Canada (MAC). 2011. “Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities.”

Ministry of Energy and Mines. (MEM). 2016. “Guidance Document – Health, Safety and Reclamation Code for Mines in British Columbia – Version 1.0”, July 20.

US Army Corps of Engineers (USACE). 2004. "General Design and Construction Considerations for Earth and Rock-Fill Dams", July 30.

Teck Highland Valley Copper Partnership. 2015. “Highland Tailings Storage Facility – Operation, Maintenance and Surveillance Manual (Revision 2)”, July 2015.

Teck Highland Valley Copper Partnership. 2018. “Highmont Tailings Storage Facility – Operation, Maintenance and Surveillance Manual - DRAFT”, March 2018.

FIGURES

Legend

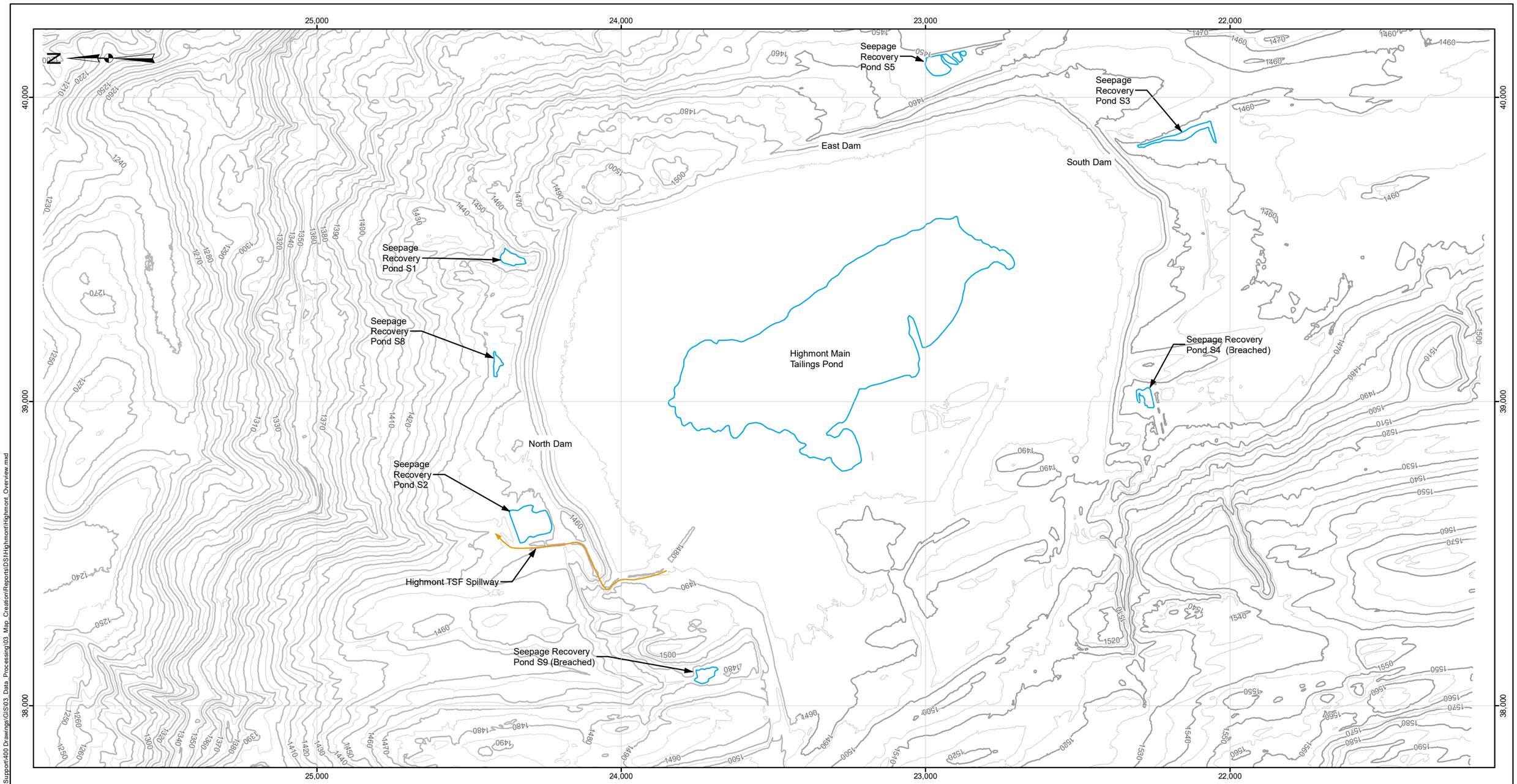
- Creek / River
- Highway
- Ditch

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: TECK HIGHLAND VALLEY COPPER PARTNERSHIP	PROJECT: HIGHMONT TAILINGS STORAGE FACILITY 2017 DAM SAFETY INSPECTION
Klohn Crippen Berger	TITLE: MINE SITE PLAN
	SCALE: 1:100,000 | PROJECT No.: M02341B26 | FIG No.: 1

Date: 2017-12-05
Document Path: Z:\MVCR\M02341B26 - HVC-2017 Dam Safety Support\400 Drawings\GIS\03_Data_Processing\03_Map_Creation\Reports\DSI\Highmont\Highmont_MineSitePlan.mxd



Legend

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

0 500m

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

CLIENT	TECK HIGHLAND VALLEY COPPER PARTNERSHIP
	Klohn Crippen Berger
PROJECT	HIGHMONT TAILINGS STORAGE FACILITY 2017 DAM SAFETY INSPECTION
TITLE	HIGHMONT TAILINGS STORAGE FACILITY OVERVIEW
SCALE	1:12,000
PROJECT No.	M02341B26
FIG No.	2

Date: 2017-12-05
Document Path: Z:\MVCR\M02341B26 - HVC-2017 Dam Safety Support\400 Drawings\GIS\03_Data_Processing\03_Map_Creation\Reports\DSI\Highmont\Highmont_Overview.mxd

Legend

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

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (HGH-2017-xx)
- Spillway
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained July 1st, 2017
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

TITLE
NORTH DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:5,000	M02341B26	3

Date: 2018-02-22
Document Path: Z:\M\VCR\M02341B26 - HVC-2017 Dam Safety Support\400 Drawings\GIS\03_Data_Processing\03_Map_Creation\Reports\DS\Highmont\Highmont_NorthDamPlan.mxd

Legend

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

Instrument Type (Defunct)
- Standpipe Piezometer

- Waypoint (HGH-2017-xx)
- Spillway
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained July 1st, 2017
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

TITLE
EAST DAM
PLAN

SCALE	PROJECT No.	FIG No.
1:5,000	M02341B26	4

Date: 2018-02-22
Document Path: Z:\MV\CRM\02341B26 - HVC-2017 Dam Safety Support\400 Drawings\GIS\03_Data_Processing\03_Map_Creation\Reports\DS\Highmont\Highmont_EastDamPlan.mxd

Legend

Instrument Type (Active)

- Standpipe Piezometer
- Survey Monument
- Weir
- Waypoint
- Spillway
- Spillway (Plugged)
- Index Contour (5 m)
- Intermediate Contour (1 m)

0 250m

Notes:
1. Projection: HVC Mine Grid.
2. Imagery obtained July 1st, 2017
3. Topography from HVC, LiDAR flown on August 23rd, 2014.

CLIENT	TECK HIGHLAND VALLEY COPPER PARTNERSHIP
	Klohn Crippen Berger
PROJECT	HIGHMONT TAILINGS STORAGE FACILITY 2017 DAM SAFETY INSPECTION
TITLE	SOUTH DAM PLAN
SCALE	1:5,000
PROJECT No.	M02341B26
FIG No.	5

Date: 2018-05-28
Document Path: Z:\MV\CRM\02341B26 - HVC-2017 Dam Safety Support\400 Drawings\GIS\03_Data_Processing\03_Map_Creation\Reports\DSI\Highmont\Highmont_SouthDamPlan.mxd

APPENDIX I

Dam Safety Inspection Checklist

APPENDIX I-A

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

2016 ANNUAL DAM SAFETY INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont North, East, and South Dam	**Inspection Date:**	20-Sep-17 (RF/CW)
Weather:	Cloudy with sunny periods, no precipitation	**Inspector(s):**	Rick Friedel, Cindy Wang

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	7.01 m (based on HVC pond survey done on 13-Sep-17)

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

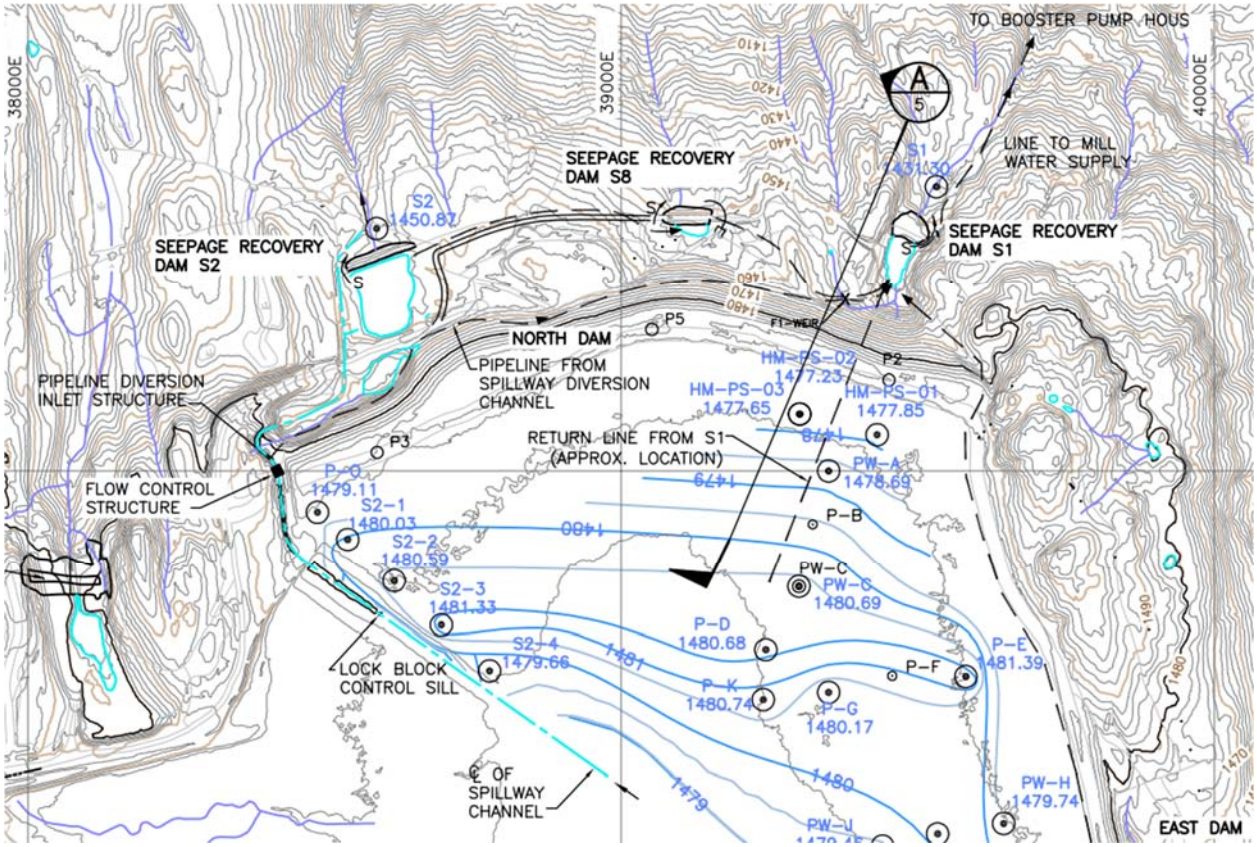
List and describe any deficiencies:

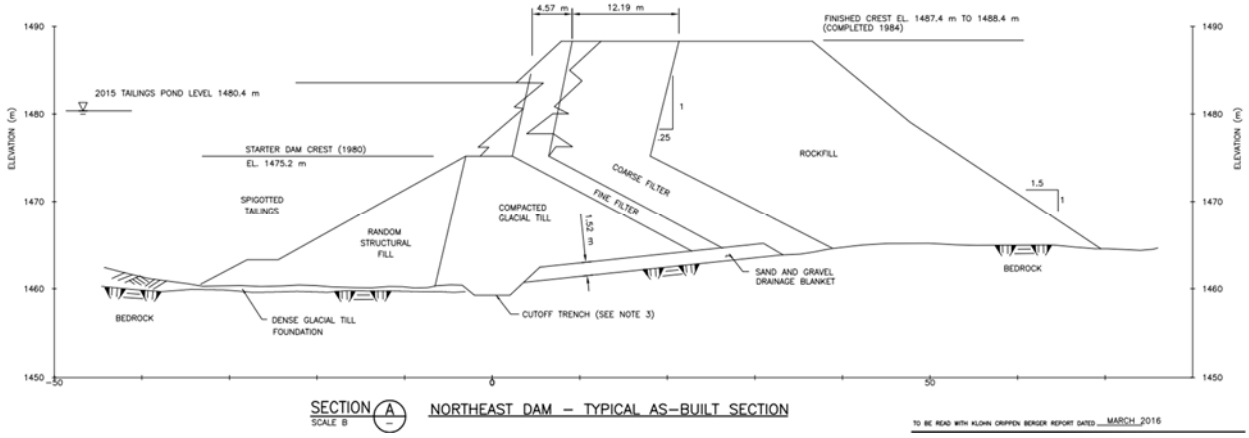
1) The spillway culverts are half-filled with sediment at the inlet of spillway culverts through the toe road. This should be removed as requested to restore the intended flow capacity.
2) Tall vegetation is present in the spillway channel invert as part of routine maintenance. This should be removed to not impede flow and future inspections.

Comments:

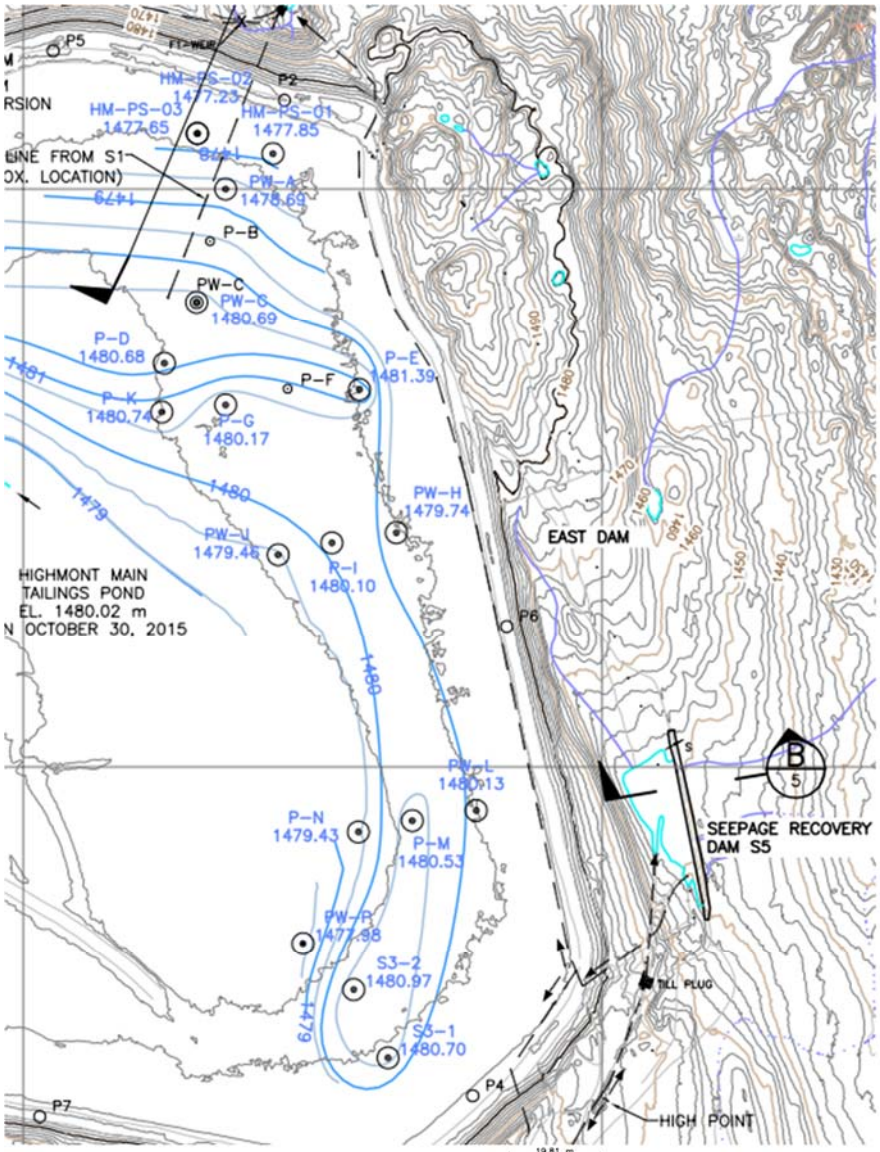
1) Toe of East and South Dams were not walked as part of the inspection. Points of interest were visited subsequent to the DSI site visit.

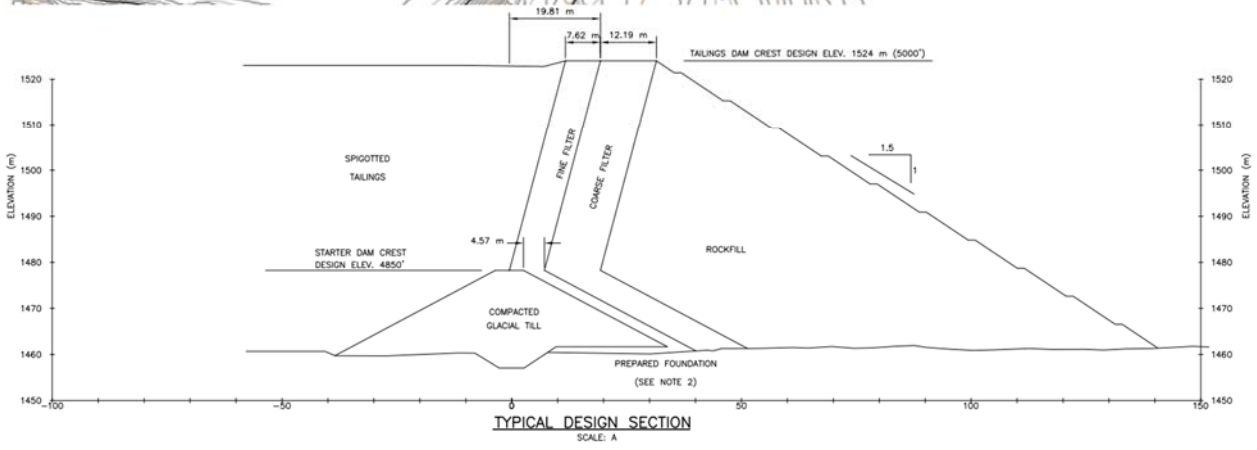
SITE PLAN (North Dam)



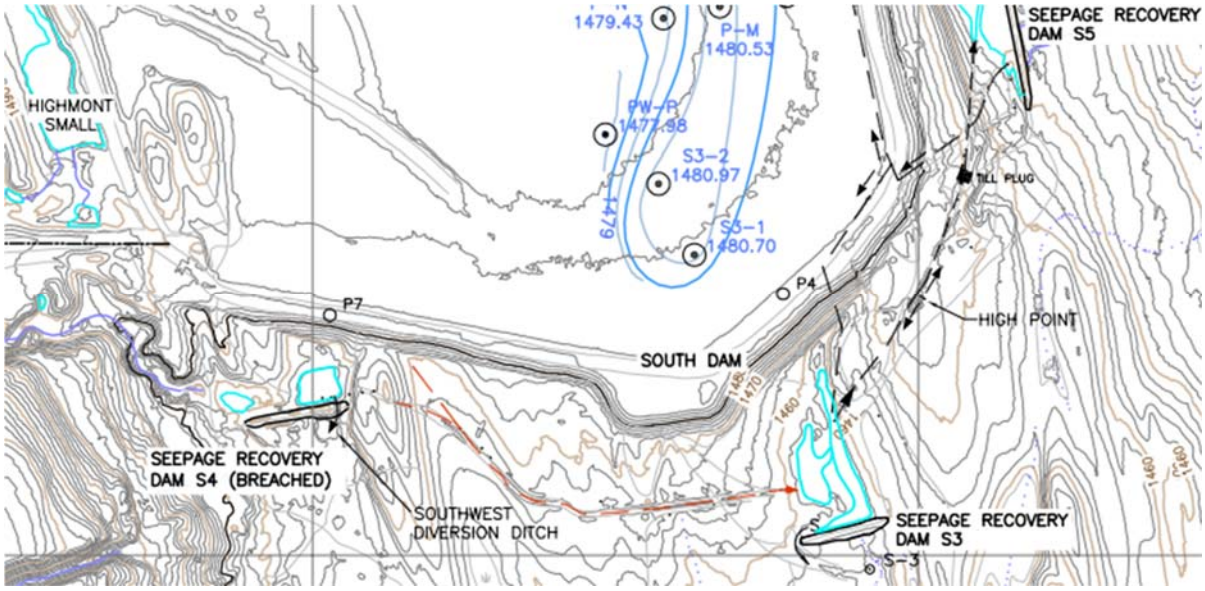


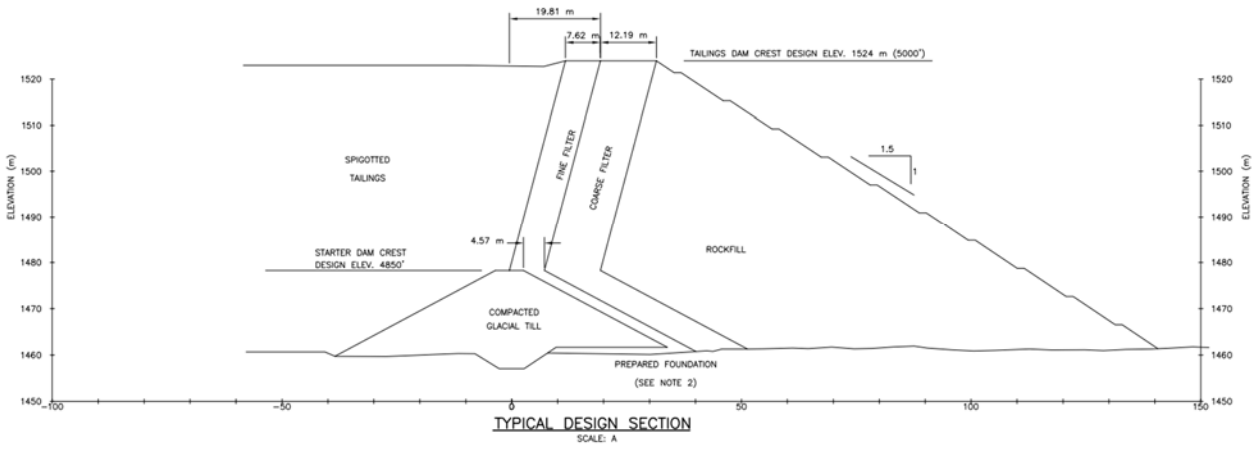
SITE PLAN (East Dam)





SITE PLAN (South Dam)





TYPICAL DESIGN SECTION
SCALE: A

APPENDIX I-B

Dam Safety Inspection Checklist – Seepage Recovery Dams

2016 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S1	**Inspection Date:**	20-Sep-17 (RF/CW)
Weather:	Cloudy with sunny periods, no precipitation	**Inspector(s):**	Rick Friedel, Cindy Wang

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard (from dam crest to current pond level):	2.75 m

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

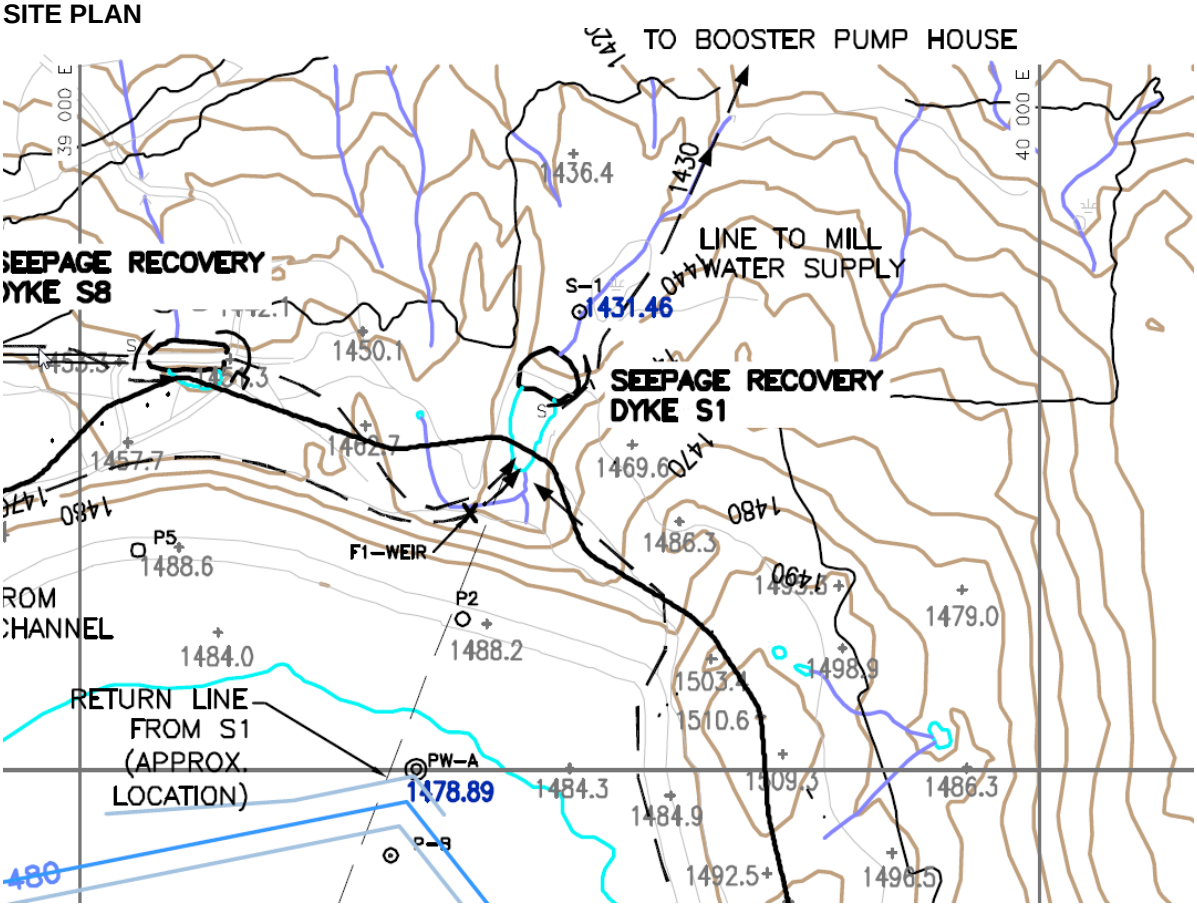
List and describe any deficiencies:

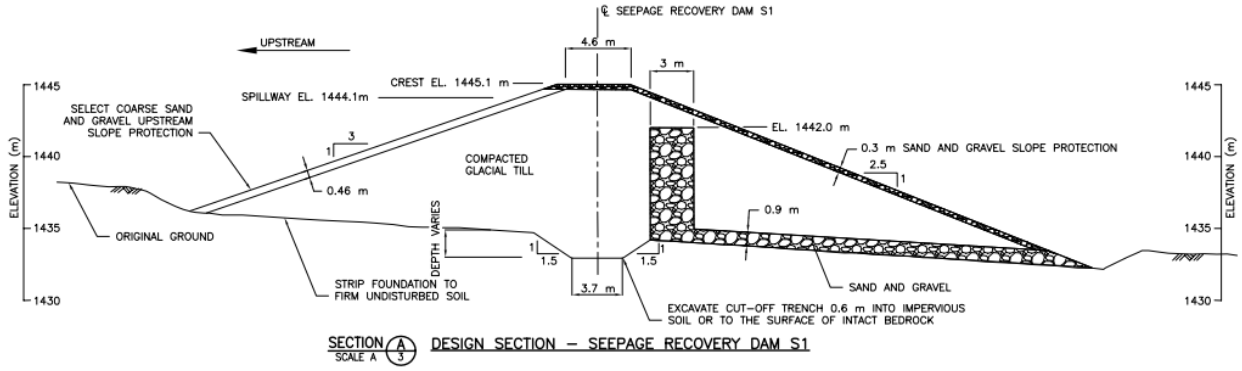
1) None.

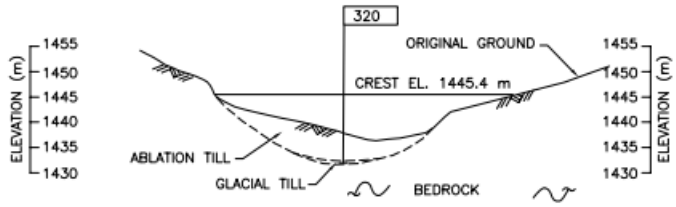
Comments:

1) The outlet of the spillway pipe is partially obstructed by vegetation which has started to grow in the riprap outfall apron. This does not pose an immediate dam safety concern but should be removed as part of regular maintenance by THVCP to facilitate future inspections.

SITE PLAN


TO BOOSTER PUMP HOUSE
LINE TO MILL WATER SUPPLY
SEEPAGE RECOVERY DYKE S1
SEEPAGE RECOVERY DYKE S8
S-1
1431.46
P5
1488.6
P2
1488.2
F1-WEIR
PW-A
1478.89
RETURN LINE FROM S1 (APPROX. LOCATION)
1436.4
1450.1
1469.6
1486.3
1479.0
1498.9
1503.2
1510.6
1484.0
1484.3
1484.9
1492.5+
1509.3
1486.3
1498.5
39 000 E
40 000 E


℄ SEEPAGE RECOVERY DAM S1
UPSTREAM
4.6 m
3 m
CREST EL. 1445.1 m
SPILLWAY EL. 1444.1m
SELECT COARSE SAND AND GRAVEL UPSTREAM SLOPE PROTECTION
COMPACTED GLACIAL TILL
EL. 1442.0 m
0.3 m SAND AND GRAVEL SLOPE PROTECTION
0.46 m
0.9 m
ORIGINAL GROUND
DEPTH VARIES
STRIP FOUNDATION TO FIRM UNDISTURBED SOIL
3.7 m
SAND AND GRAVEL
EXCAVATE CUT-OFF TRENCH 0.6 m INTO IMPERVIOUS SOIL OR TO THE SURFACE OF INTACT BEDROCK
ELEVATION (m)
1445
1440
1435
1430
SECTION A/3 SCALE A
DESIGN SECTION – SEEPAGE RECOVERY DAM S1


320
ORIGINAL GROUND
CREST EL. 1445.4 m
ABLATION TILL
GLACIAL TILL
BEDROCK
ELEVATION (m)
1455
1450
1445
1440
1435
1430
PROFILE OF SEEPAGE RECOVERY DAM S1
SCALE B

2016 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S2	**Inspection Date:**	20-Sep-17 (RF/CW)
Weather:	Cloudy with sunny periods, no precipitation	**Inspector(s):**	Rick Friedel, Cindy Wang

Condition	Spillway
Was it flowing?	☐ Yes ☒ No ☐ N/A
Flow rate:	N/A
Freeboard:	3.2 m (based on HVC pond inspection done on 21-Sept-17)

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

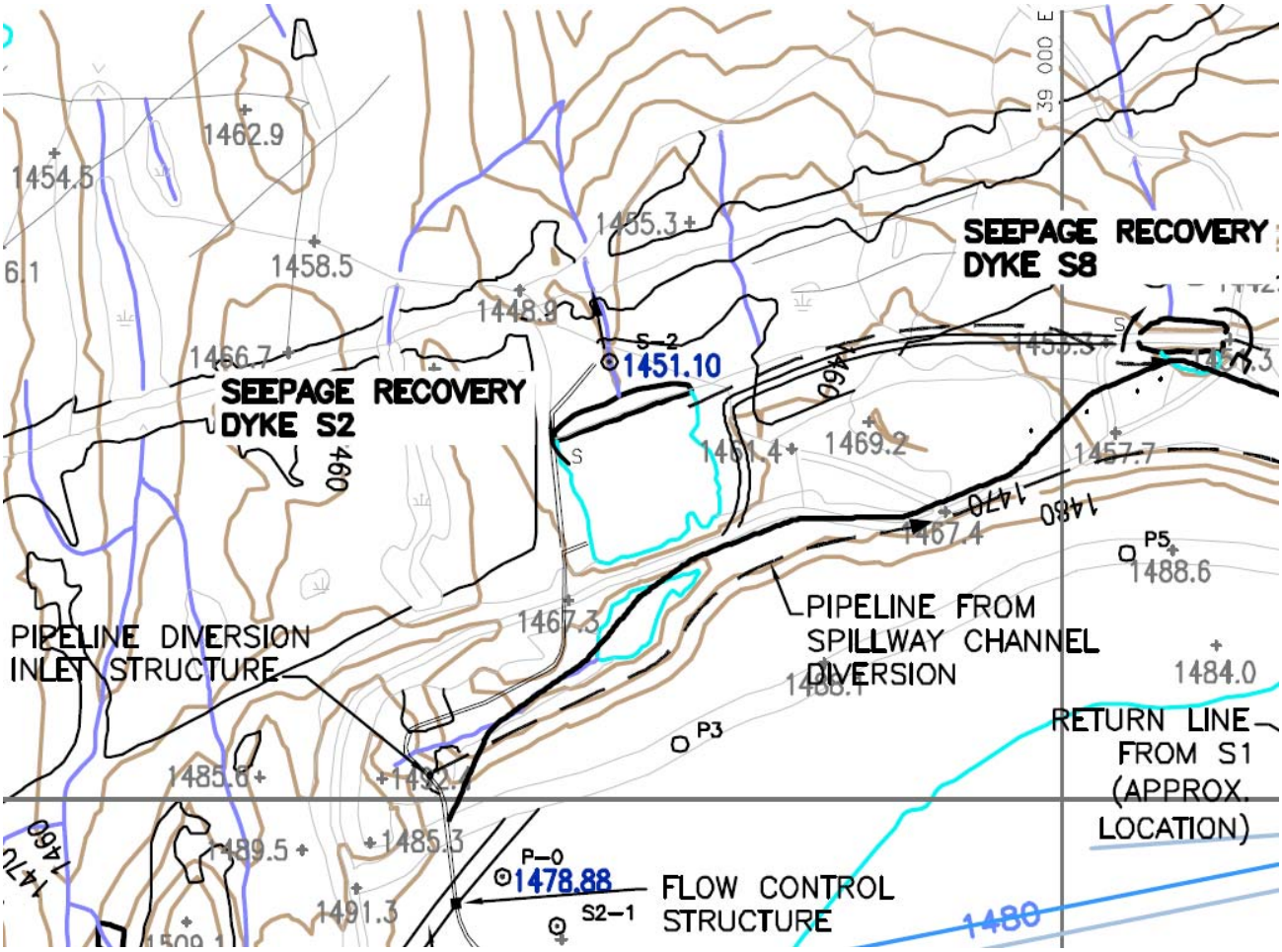
List and describe any deficiencies:

1) None.

Comments:

1) None.

SITE PLAN



PROFILE OF SEEPAGE RECOVERY DAM S2
SCALE B

2016 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S5	**Inspection Date:**	20-Sep-17 (RF/CW)
Weather:	Cloudy with sunny periods, no precipitation	**Inspector(s):**	Rick Friedel, Cindy Wang
Freeboard:	1.12 m (based on THVCP inspection done on 21-Sep-17)		

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

EMBANKMENT	Yes/No	OUTLET - north	Yes/No	OUTLET - south	Yes/No
U/S slope	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No	Outlet Pipe	☒ Yes ☐ No
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

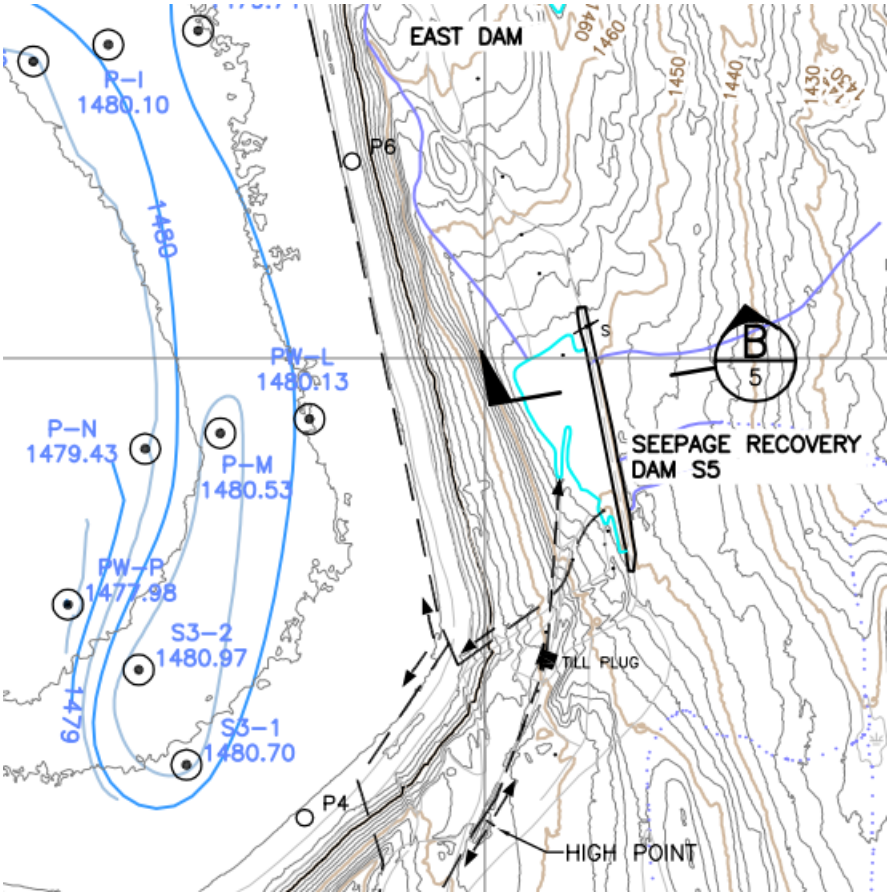
List and describe any deficiencies:

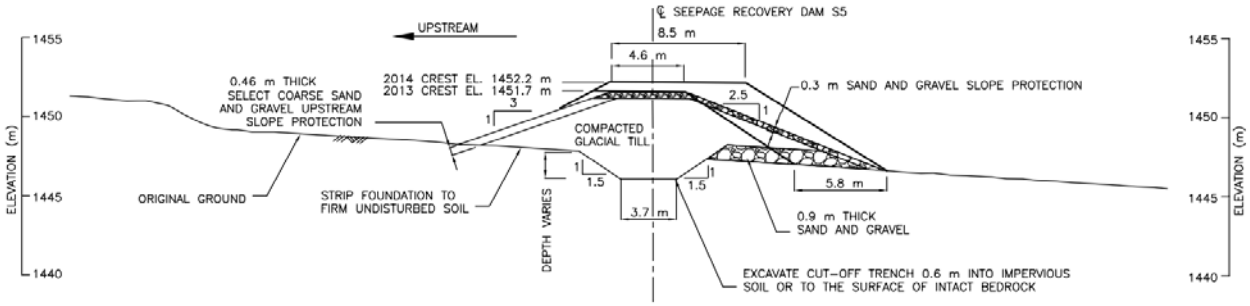
None.

Notes:

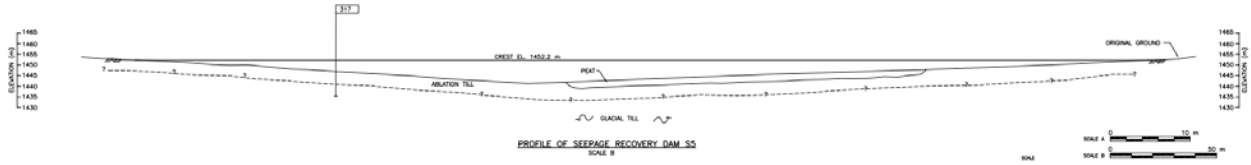
1) Spillway partially plugged with sandbags at time of inspection.

SITE PLAN





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



2016 ANNUAL DAM INSPECTION CHECKLIST

Klohn Crippen Berger

Facility:	Highmont Seepage Recovery Dam S8	**Inspection Date:**	20-Sep-17 (RF/CW)
Weather:	Cloudy with sunny periods, no precipitation	**Inspector(s):**	Rick Friedel, Cindy Wang
Freeboard:	2.1 m (based on THVCP inspection done on 21-Sep-17)		

Condition	Outlet
Was it flowing?	☐ Yes ☒ No
Flow rate:	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

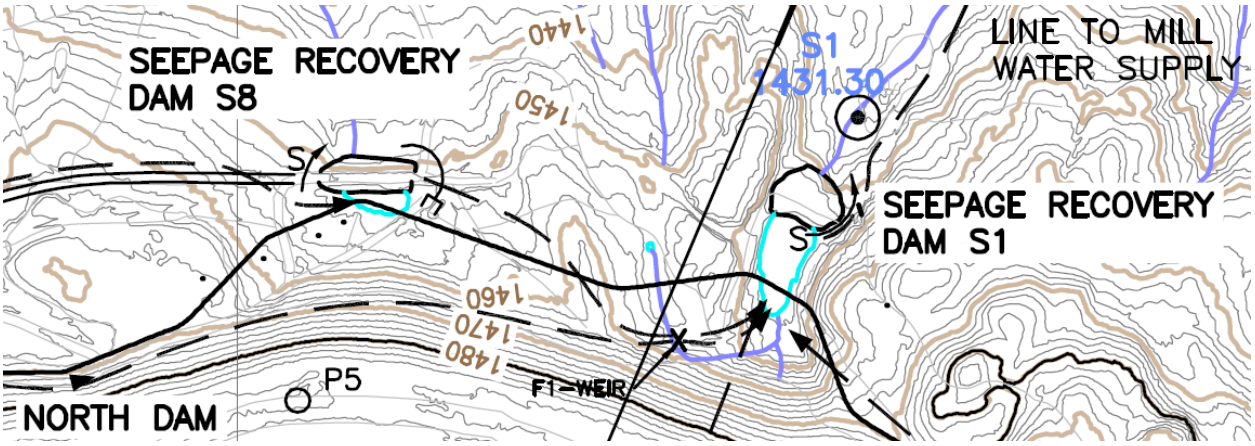
List and describe any deficiencies:

1) None.

Notes:

1) None.

SITE PLAN


SEEPAGE RECOVERY
DAM S8
1440
1450
S1
1431.30
LINE TO MILL
WATER SUPPLY
SEEPAGE RECOVERY
DAM S1
1460
1470
1480
P5
F1-WEIR
NORTH DAM

APPENDIX II

Inspection Photographs

APPENDIX II-A

Inspection Photographs – North, East, and South Dams

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

LEGEND:

- HGH= Highmont Tailings Facility.
- HGH-2017-## refers to 2017 DSI waypoint shown on Figure 3.
- Photographs taken during inspection between September 19 and September 20, 2017. Along with some photos taken during a subsequent visit on August 29, 2017.

Photo II-A-1 Downstream slope from right abutment looking West (HGH-2017-30)

Photo II-A-2 Crest from right abutment looking West (HGH-2017-31)

Photo II-A-3 Beach from right abutment looking South (HGH-2017-31)

Photo II-A-4 Spillway upstream of crest, concrete lock-block control sill (HGH-2017-01)

Photo II-A-5 Spillway culverts, upstream side of crest, submerged (HGH-2017-01)

Photo II-A-6 Spillway culverts, downstream side of crest, vegetated (HGH-2017-02)

Photo II-A- 7 Spillway flow control gate (HGH-2017-03)

Photo II-A-8 Spillway channel looking downstream from the flow control gate (HGH-2017-03)

Photo II-A-9 Spillway channel looking downstream at inlet to Seepage Recovery Pond S1 pipeline division, showing trashrack on invert (HGH-2017-04)

Photo II-A-10 Spillway channel looking downstream, vegetated showing standing water (HGH-2017-06)

Photo II-A-11 Upstream side of 33" ID spillway road culverts, showing vegetation (HGH-2017-07)

Photo II-A-12 Downstream side of 33" ID spillway road culverts, showing vegetation (HGH-2017-09)

Photo II-A-13 Spillway channel looking downstream from road (HGH-2017-09)

Photo II-A-14 Spillway channel till plug (HGH-2017-12)

Photo II-A-15 Steepened section of downstream slope (HGH-2017-08)

Photo II-A-16 Underdrain flow channel (HGH-2017-10)

Photo II-A- 17 Downstream toe and slope area looking east (HGH-2017-40)

APPENDIX II-B

Inspection Photographs – Seepage Recovery Dams

Appendix II-B
Inspection Photographs - Seepage Recovery Dams

LEGEND:

- HGH= Highmont Tailings Facility.
- HGH-2017-## refers to 2017 DSI waypoint shown on Figure 3.
- All photographs taken during inspection between September 19 and September 20, 2017.

II-B-1 Seepage Recovery Pond S2

Photo II-B-1 S2: pond overview, looking from toe of North Dam. (HGH-2017-11)

Photo II-B-2 S2: dam crest, looking from left abutment. (HGH-2017-13)

Photo II-B-3 S2: downstream slope looking from left abutment. (HGH-2017-13)

Photo II-B-4 S2: ponded water at downstream toe, similar in size to the pond noted during the 2015 and 2016 DSI. (HGH-2017-14)

Photo II-B-5 S2: downstream slope looking from right abutment. (HGH-2017-15)

Photo II-B-6 S2: outlet pump to Seepage Recovery Pond S8. North Dam downstream slope in background. (HGH-2017-16)

Photo II-B-7 S2: spillway looking upstream towards pond. (HGH-2017-13)

Photo II-B-8 S2: spillway looking downstream to tie-in with Highmont spillway. (HGH-2017-13)

II-B-3 Seepage Recovery Pond S8

Photo II-B-9 S8: pond overview with pumphouse to S1 pond (right of photo) and North Dam downstream slope in background. (HGH-2017-18)

Photo II-B-10 S8: upstream slope, right abutment and spillway intake to S1 pond. (HGH-2017-17)

Photo II-B-11 S8: downstream slope looking West from right abutment. (HGH-2017-18)

II-B-3 Seepage Recovery Pond S1

Photo II-B-12 S1: Highmont spillway diversion pipe to S1 pond. (HGH-2017-19)

Photo II-B-13 S1: flow measurement weir HM-S1-FS-01 for S1 inflow diverted from Highmont spillway. (HGH-2017-19)

Photo II-B-14 S1: overview of pond and upstream slope of dam. System components from left to right: outlet pump to Highmont tailings pond, inflow channel from Highmont spillway diversion, inflow channel from toe drain, inflow pipe from S5 pond. (HGH-2017-23)

Photo II-B-15 S1: dam crest looking East towards right abutment. (HGH-2017-24)

Photo II-B-16 S1: downstream slope looking East toward spillway. (HGH-2017-29)

Photo II-B-17 S1: spillway channel and pipe intake looking downstream. (HGH-2017-28)

Photo II-B-18 S1: spillway outlet. (HGH-2017-27)

II-B-3 Seepage Recovery Pond S5

Photo II-B-19 S5: upstream slope of central pond looking south towards right abutment. (HGH-2017-32)

Photo II-B-20 S5: northern end of central pond looking north towards perimeter pond. (HGH-2017-32)

Photo II-B-21 S5: pumping cell with outlet pump to S1 pond. (HGH-2017-36)

Photo II-B-22 S5: access road between central pond (right of photo) and pumping cell (left of photo). (HGH-2017-36)

Photo II-B-23 S5: pumping cell looking South towards outlet channel and spillway. (HGH-2017-36)

Photo II-B-24 S5: intake of pipe connecting perimeter pond to pumping cell. (HGH-2017-34)

Photo II-B-25 S5: seepage inflow to perimeter pond, flow rates measured using bucket. (HGH-2017-35)

Photo II-B-26 S5: spillway pipes (2x), inlet currently blocked with sand bags. (HGH-2017-37)

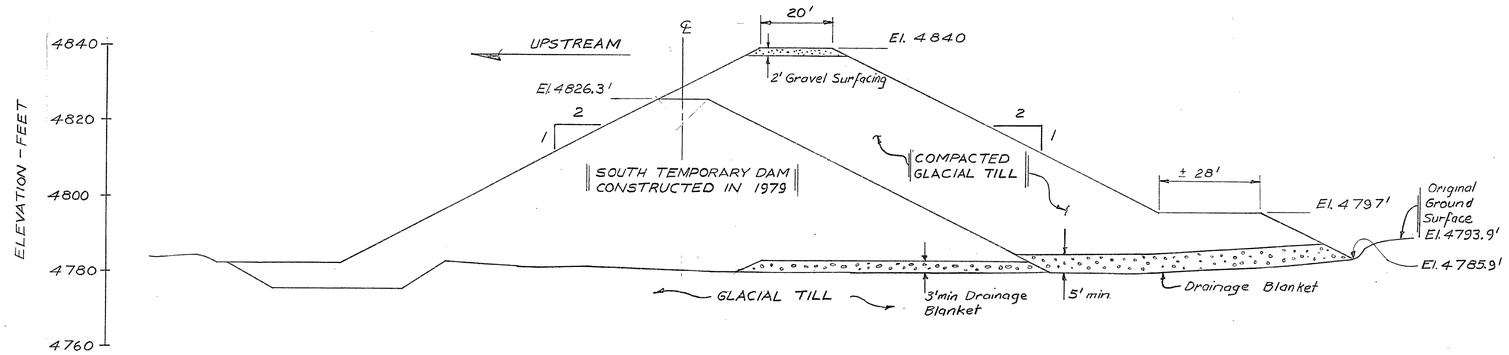
Photo II-B-27 S5: downstream slope and spillway pipes outlet at toe of dam. (HGH-2017-39)

APPENDIX III

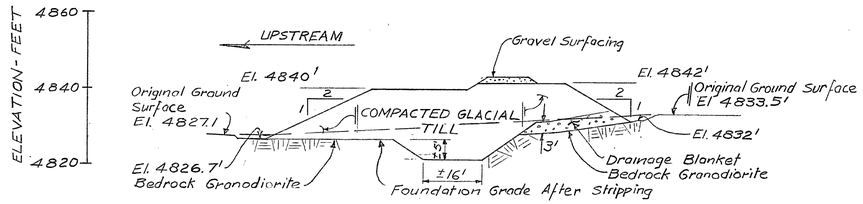
Reference Dam Design Drawings

APPENDIX III-A

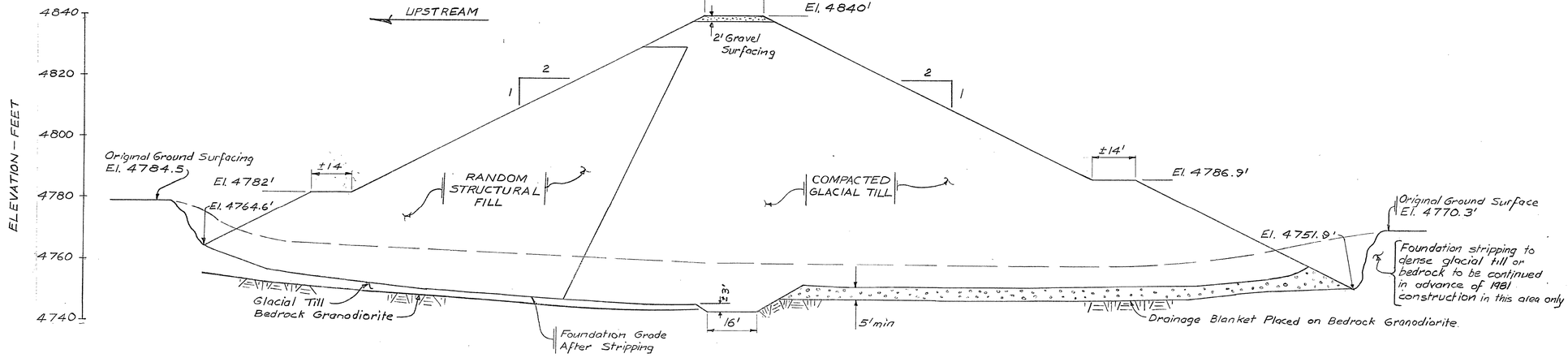
Reference Dam Design Drawings – Highmont TSF



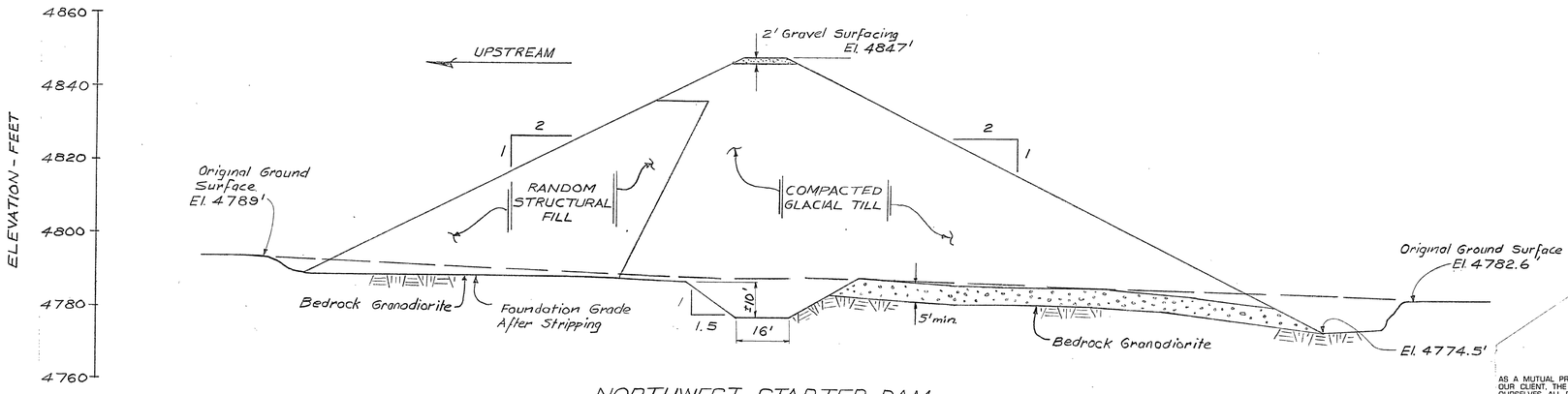
SOUTH STARTER DAM
STATION 104+00



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

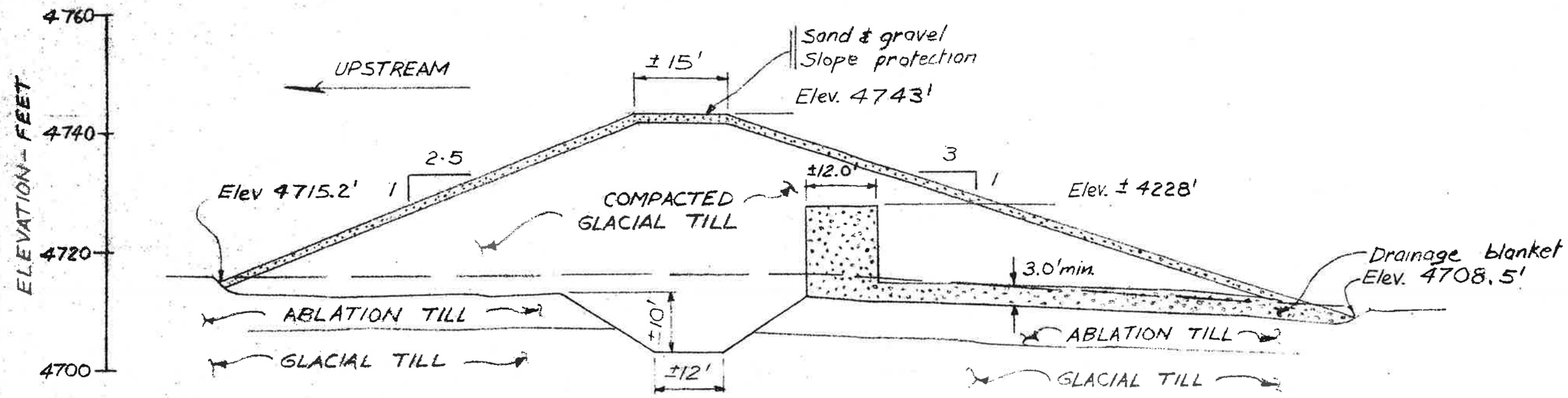
PROJECT: TAILINGS DISPOSAL DAMS

TITLE: STARTER DAM AS-BUILT SECTIONS

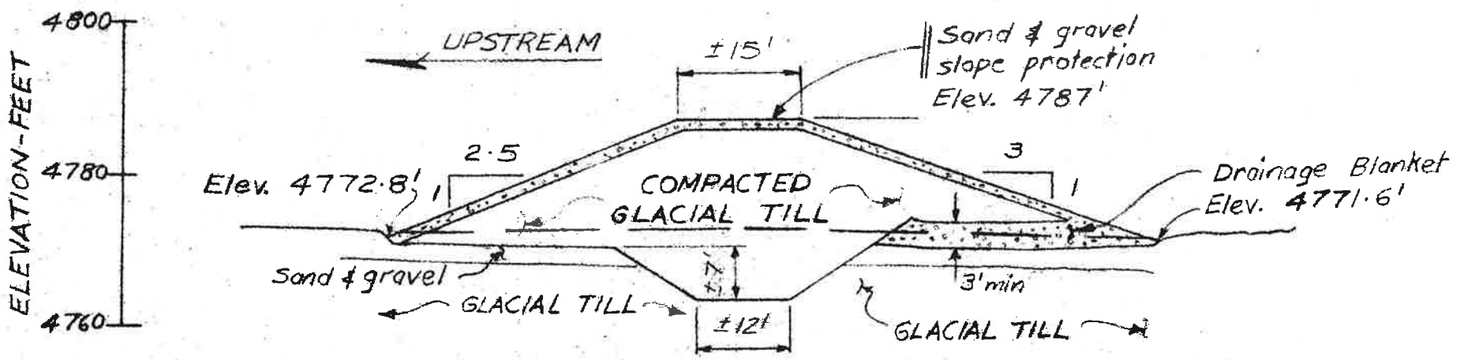
CLIENT: HIGHMONT OPERATING CORP.

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

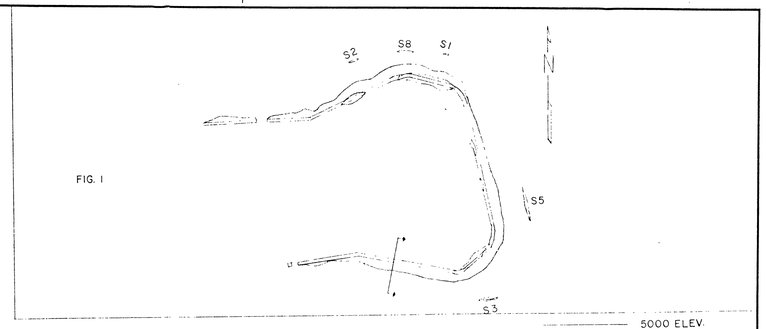
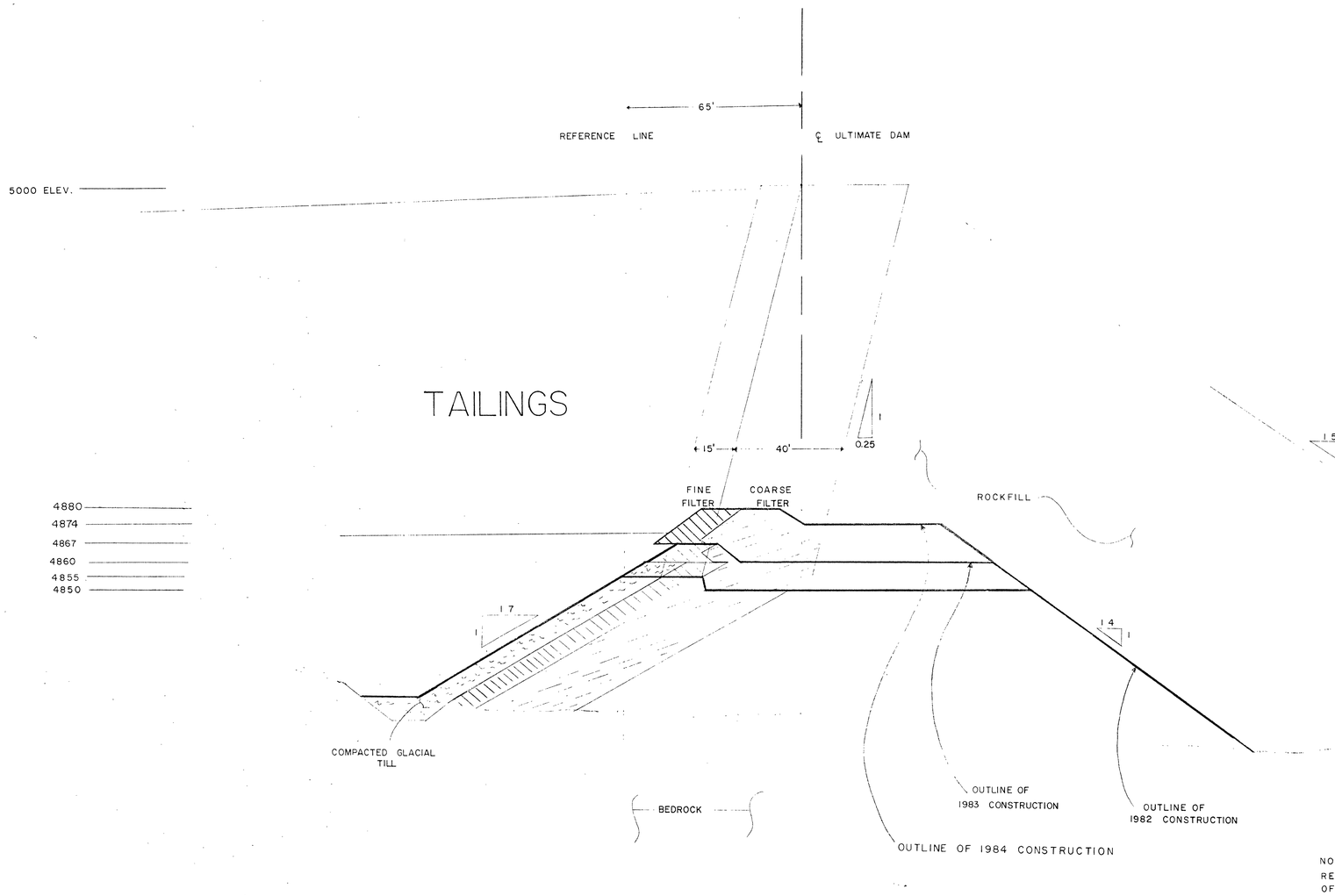


FIG. 1



NOTE,
REFER TO FIG 1 FOR LOCATION OF SECTION

LEGEND
FINE FILTER
COARSE FILTER
COMPACTED GLACIAL TILL

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

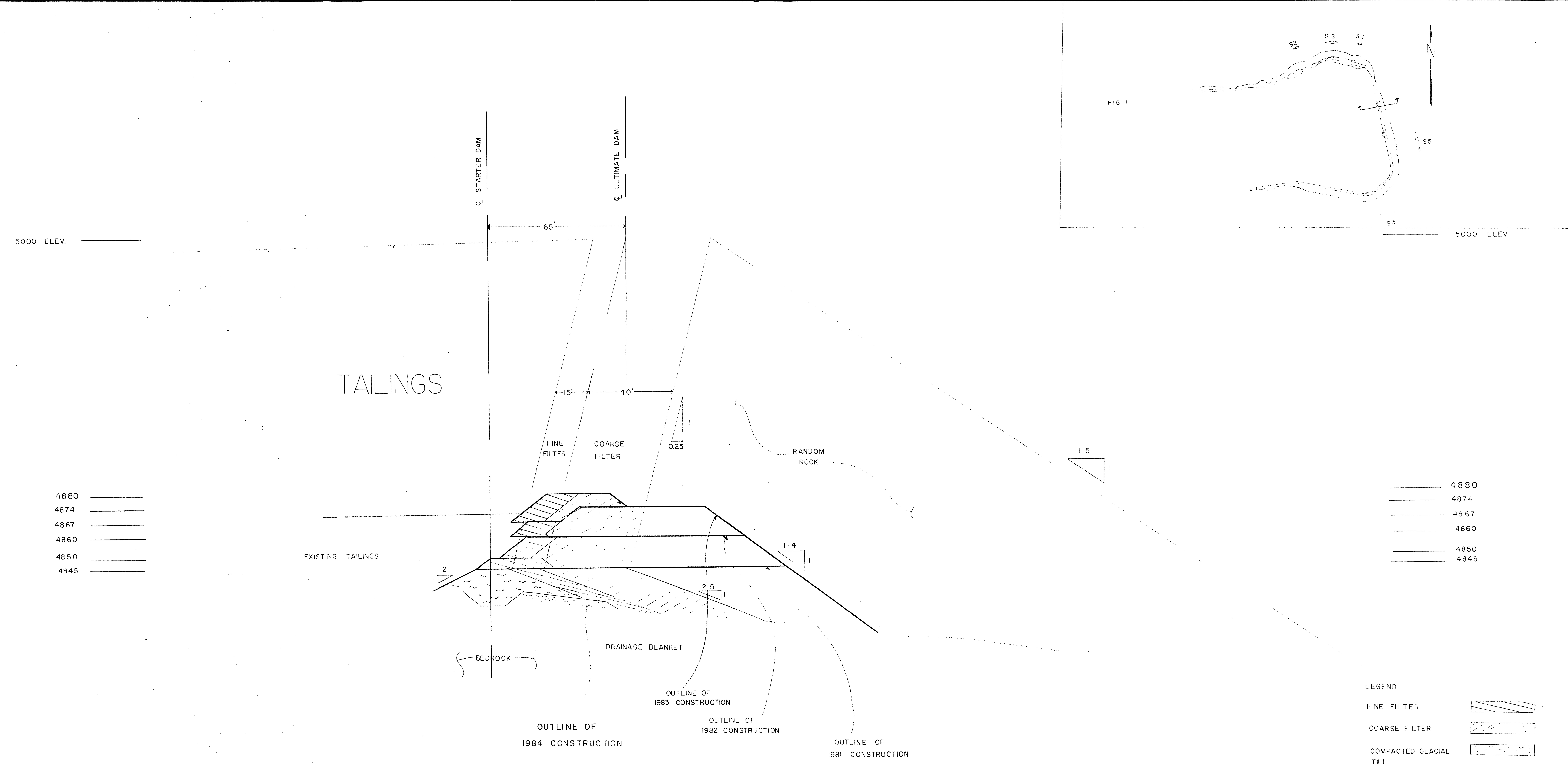
A ISSUED FOR CONSTRUCTION

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'

A | 1984 CONSTRUCTION | REVISION

HIGHMONT OPERATING CORP.
LOGAN LAKE, B.C.

TYPICAL SECTION
OF EAST DAM

SCALE: AS SHOWN
DRAWN: RW 06 09 84
DRAWING NO: TD-23-4
ISSUE: A

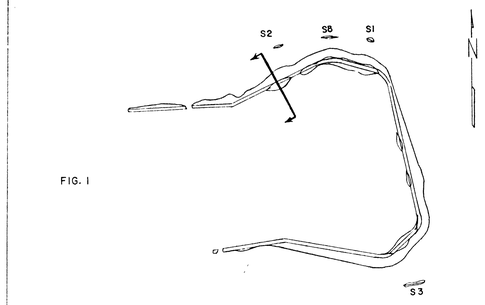


FIG. 1

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			

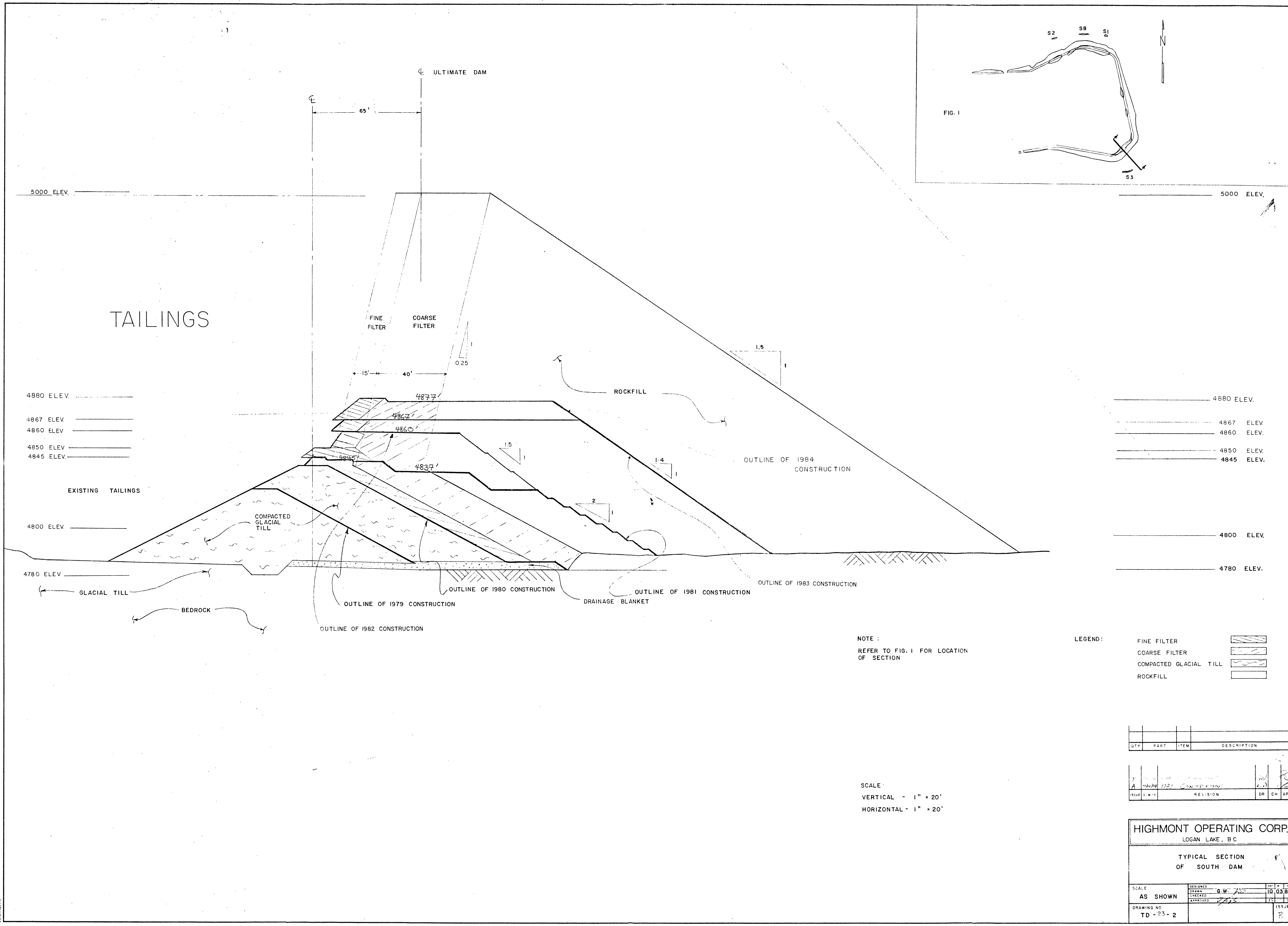
HIGHMONT OPERATING CORP.

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'
5000 ELEV.
TAILINGS
FINE FILTER
COARSE FILTER
1
0.25
15'
40'
4877'
4867'
4860'
4845'
4837'
4880 ELEV.
4867 ELEV.
4860 ELEV.
4850 ELEV.
4845 ELEV.
EXISTING TAILINGS
4800 ELEV.
4780 ELEV.
COMPACTED GLACIAL TILL
ROCKFILL
1.5
1
1.4
2
OUTLINE OF 1984 CONSTRUCTION
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
S2
S8
S1
N
FIG. 1
S3
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

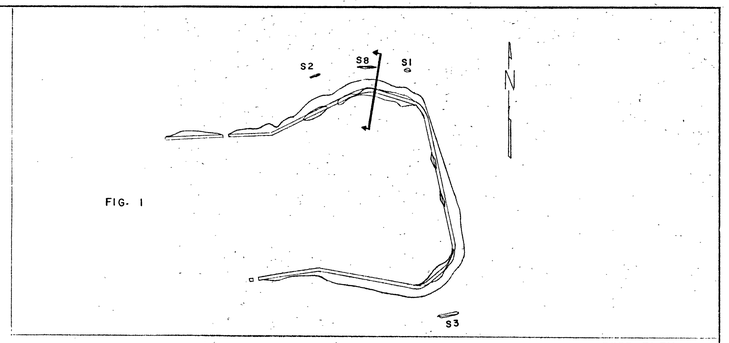


FIG. 1

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

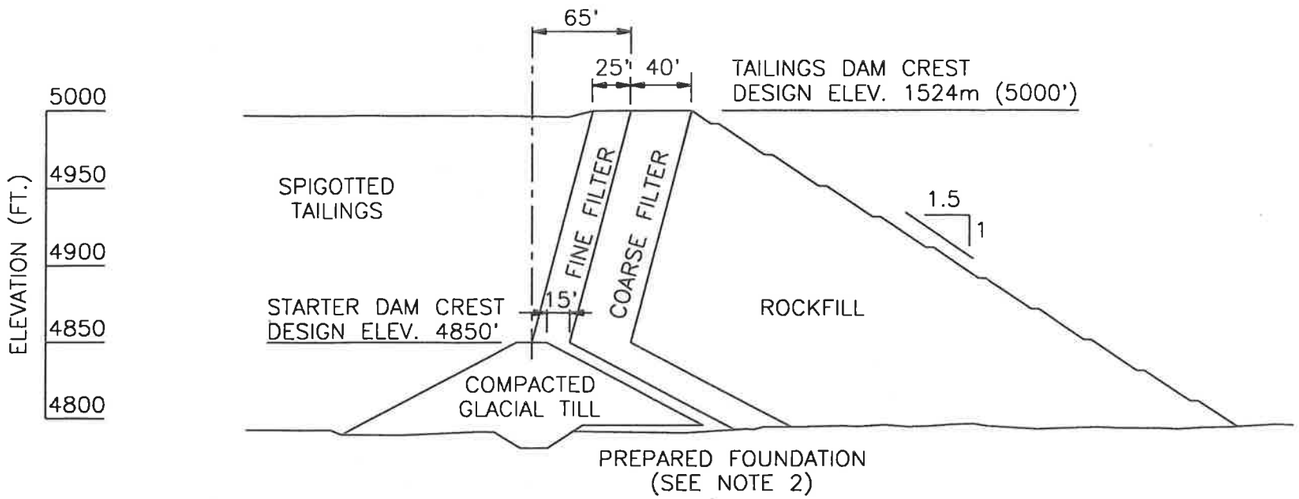
KLOHN-CRIPPEN

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	



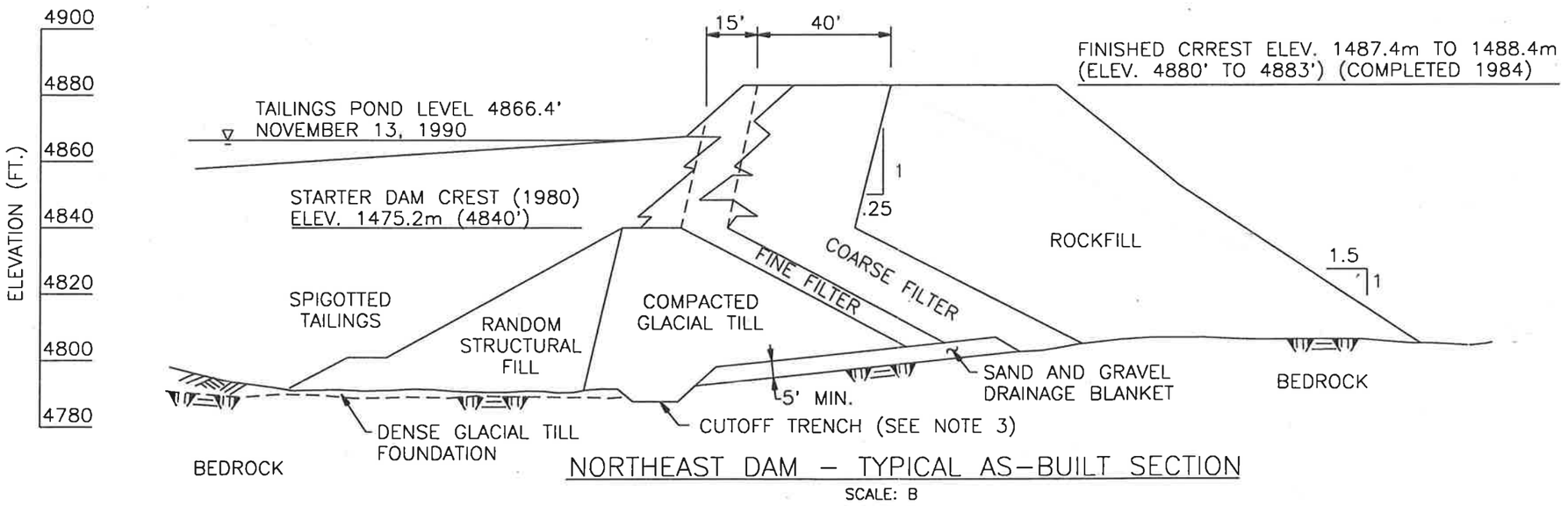
TYPICAL DESIGN SECTION

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

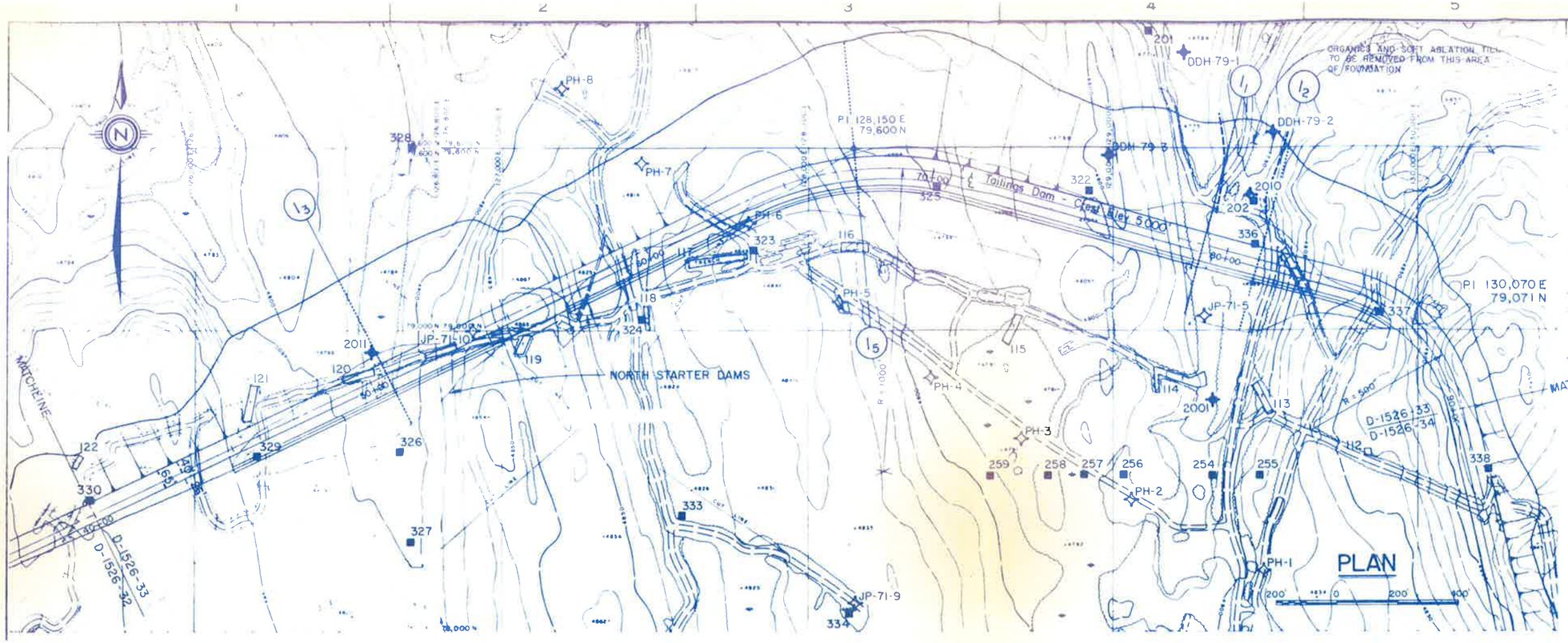
CLIENT
HIGHLAND VALLEY COPPER

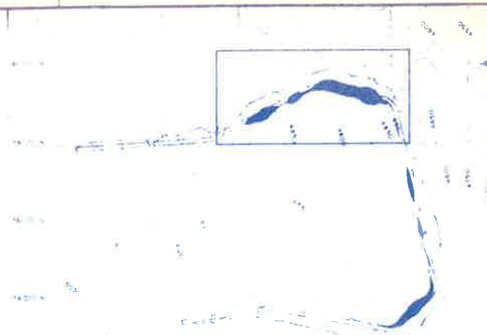
PROJECT
LONG-TERM STABILITY ASSESSMENT

TITLE
TYPICAL SECTION
HIGHMONT DAM

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

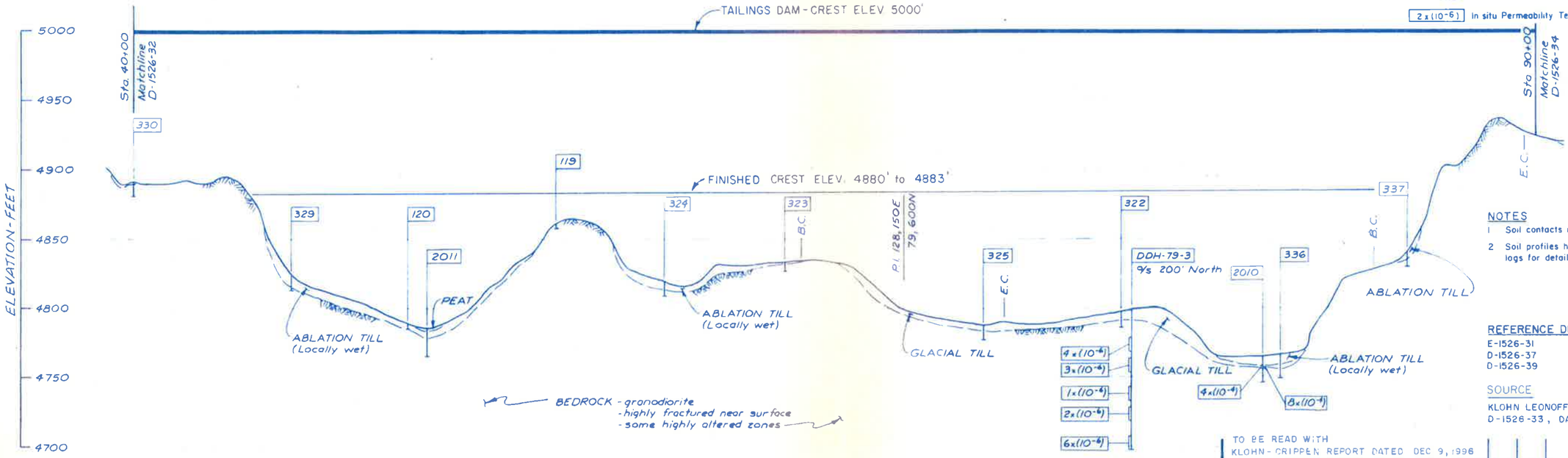
N:\M\M2916\CADD\23
B-23023.DWG





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

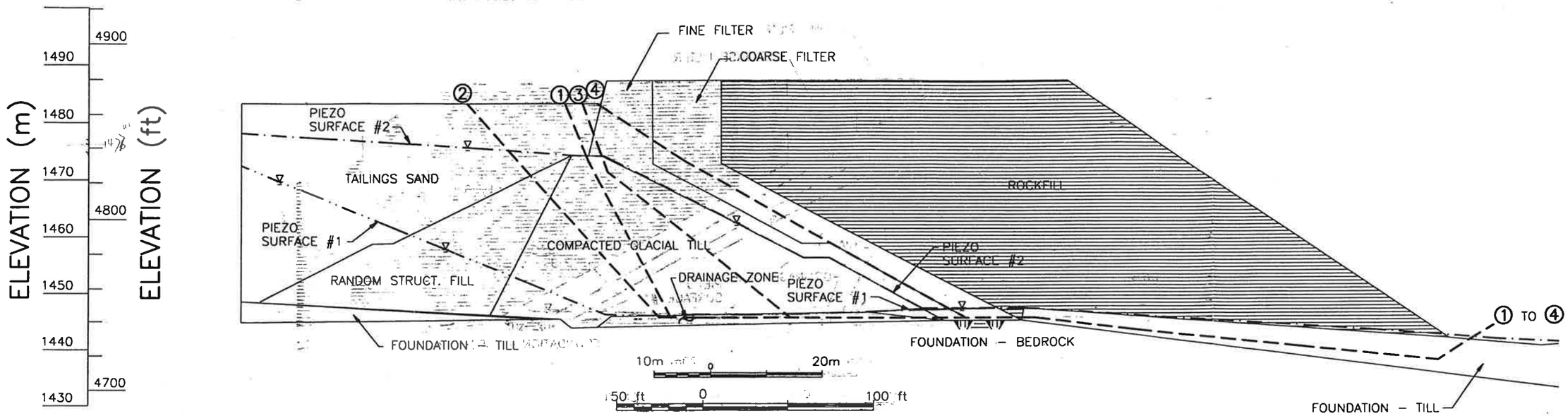
PROJECT: LONG-TERM STABILITY ASSESSMENT

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

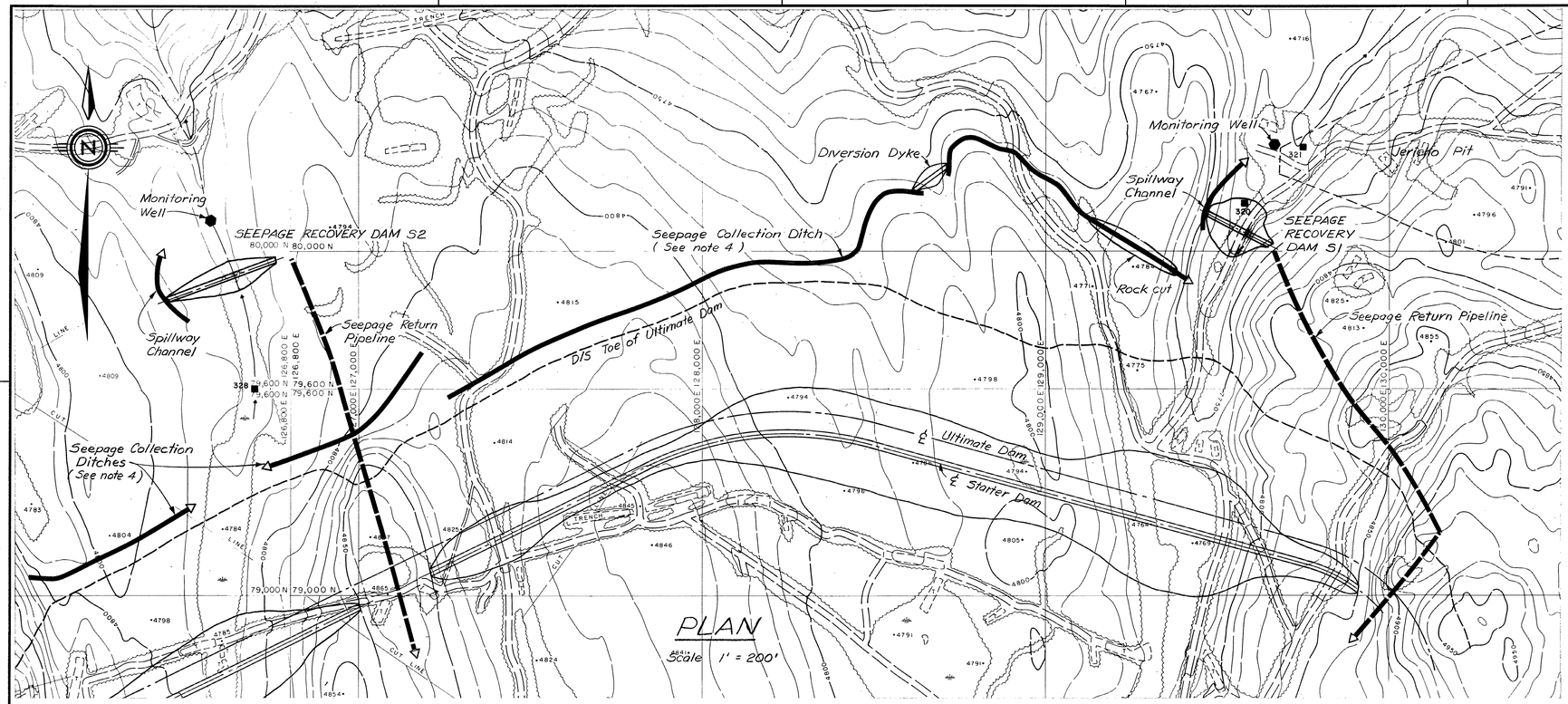
TITLE: STABILITY ANALYSES – HIGHMONT DAM

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

N:\M\M2916\CDD\23\B-23025.DWG
08/23/96 TIME: 4:35

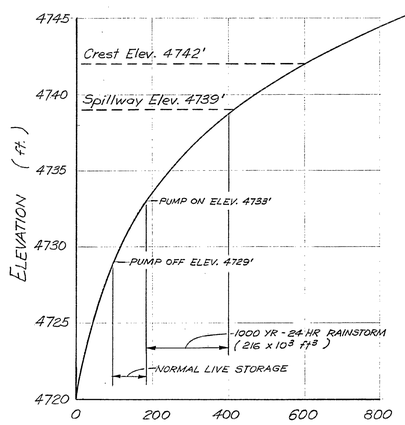
APPENDIX III-B

Reference Dam Design Drawings – Seepage Dams

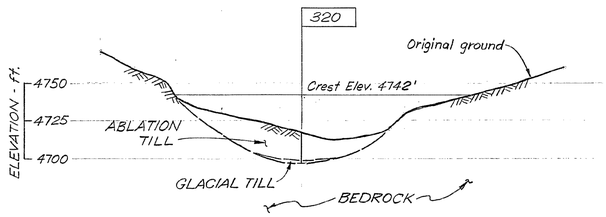


PLAN

Scale 1" = 200'

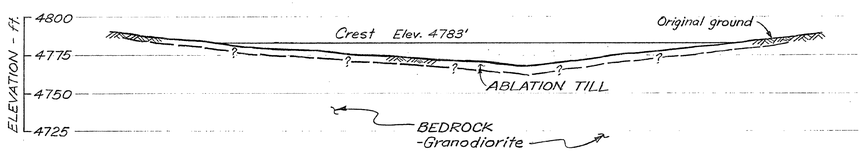


VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S1



PROFILE OF SEEPAGE RECOVERY DAM S1

Scale 1" = 50'

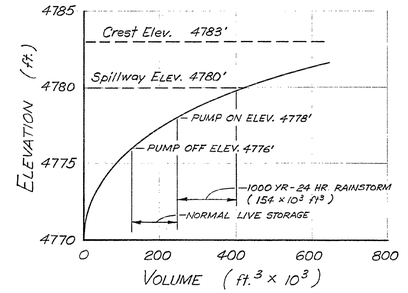


PROFILE OF SEEPAGE RECOVERY DAM S2

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

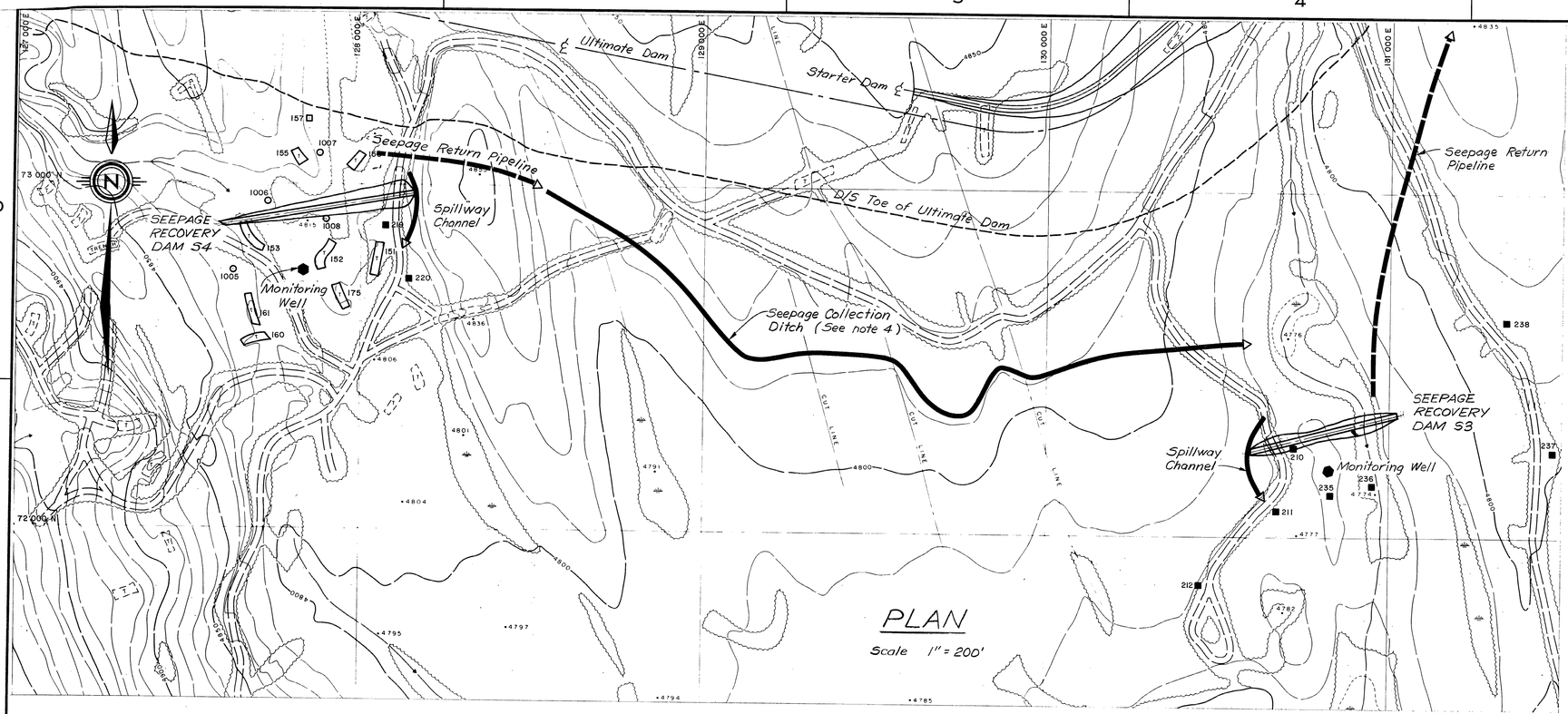
TITLE: SEEPAGE RECOVERY DAMS S1 & S2 PLAN, PROFILES & STORAGE CURVES

CLIENT: HIGHMONT OPERATING CORP.

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

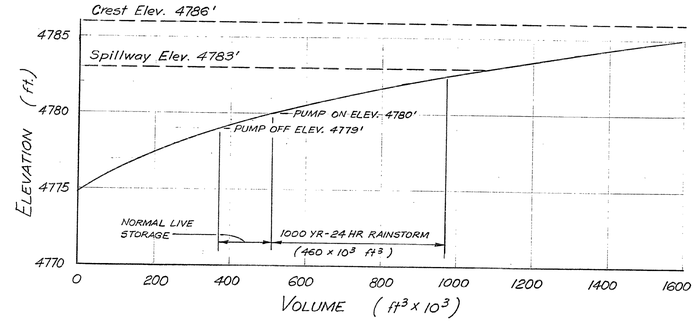
APPROVED

NCI 317 — K.L.C.L.

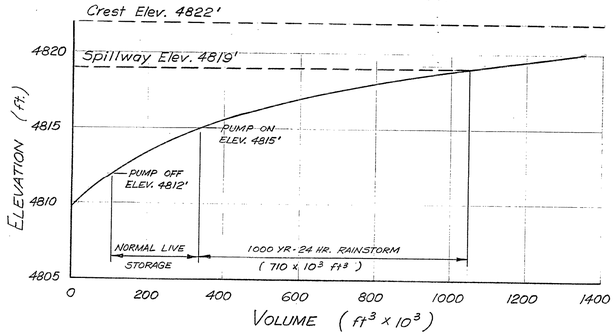


PLAN

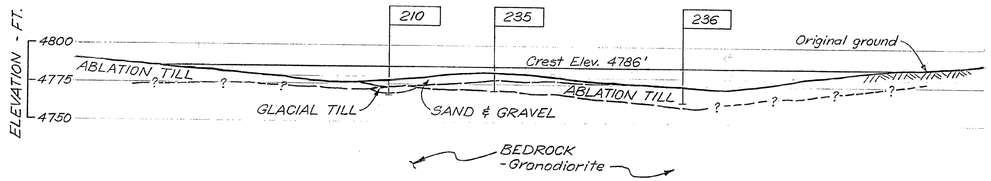
Scale 1" = 200'



VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S3

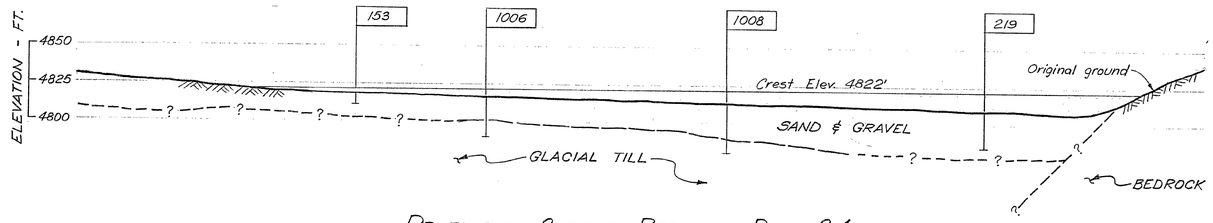


VOLUME ELEVATION CURVE
SEEPAGE RESERVOIR S4



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

Klohn Leonoff Consultants Ltd.

CIVIL • GEOTECHNICAL • HYDRAULIC

VANCOUVER - CALGARY - WINNIPEG - DENVER

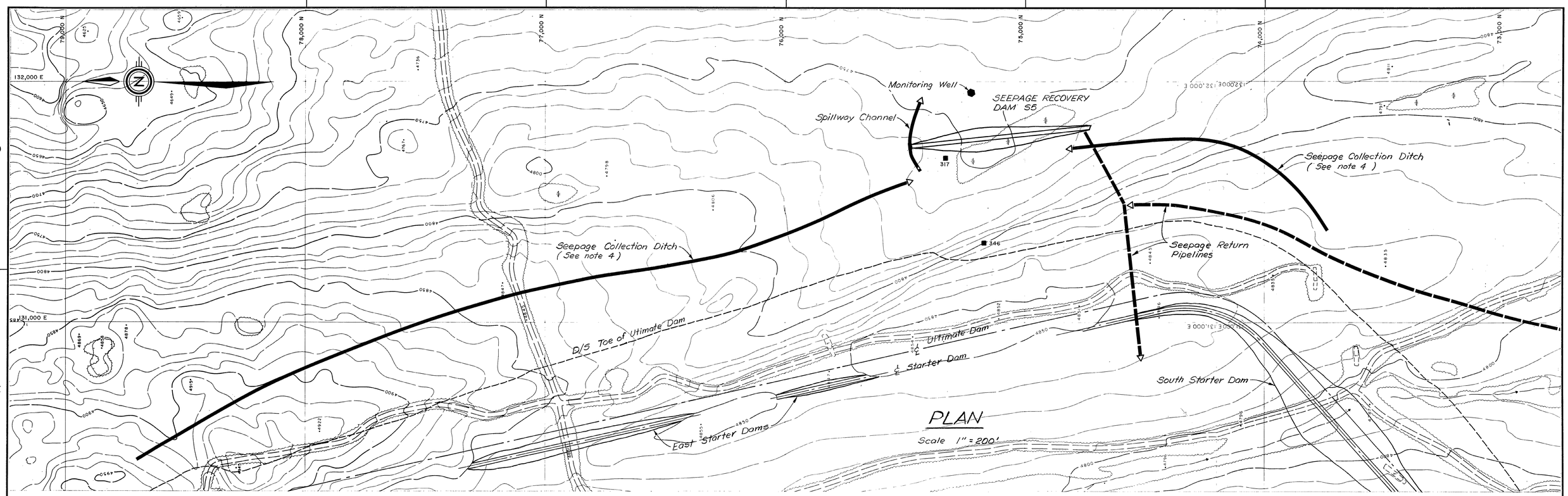
PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

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

CLIENT: HIGHMONT OPERATING CORP.

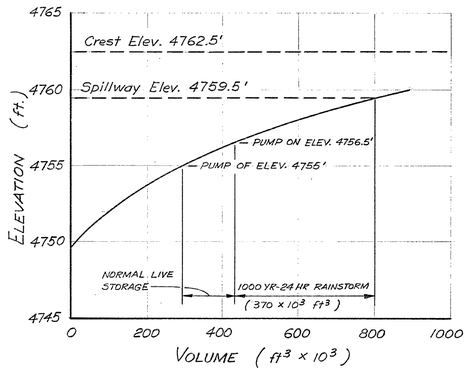
DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-27	

APPROVED

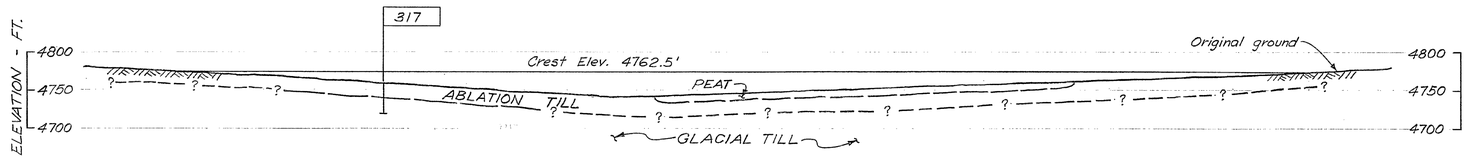


PLAN

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

Klohn Leonoff Consultants Ltd.

CIVIL • GEOTECHNICAL • HYDRAULIC

VANCOUVER - CALGARY - WINNIPEG - DENVER

PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

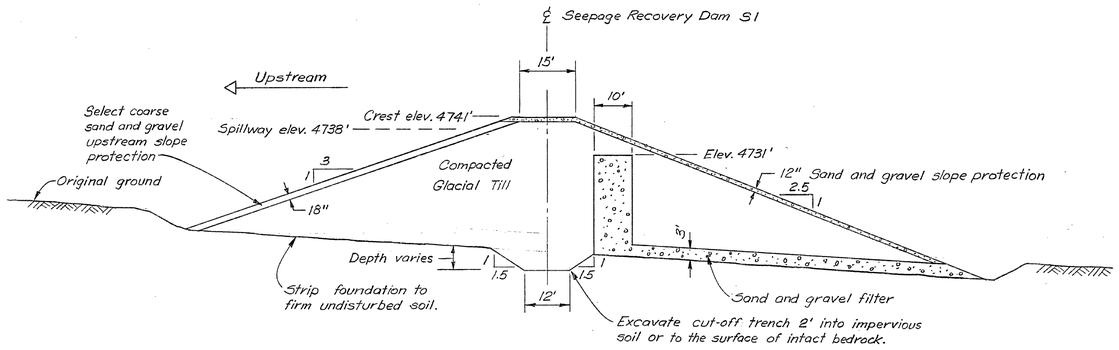
TITLE: SEEPAGE RECOVERY DAM S5
PLAN, PROFILE & STORAGE CURVE

CLIENT: HIGHMONT OPERATING CORP.

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
Apr. 3, 1980	VA 1526	D-1526-28	

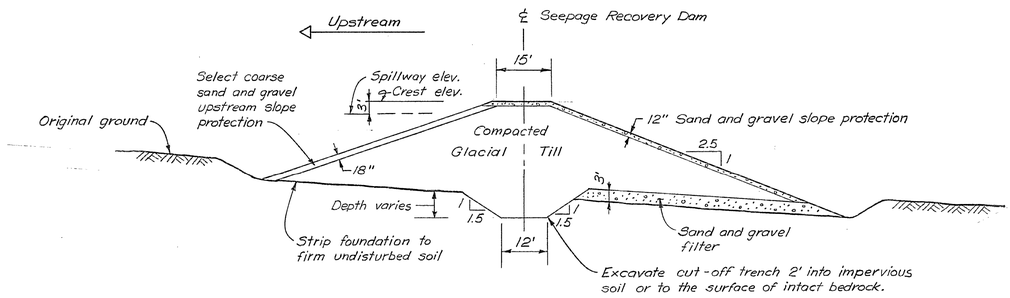
APPROVED

NCI 317 – K.L.C.L.



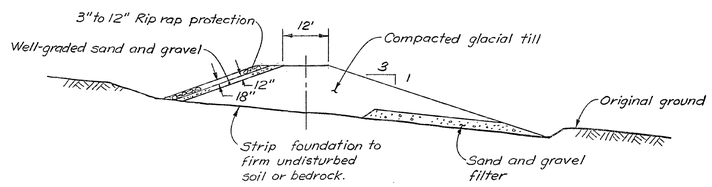
Design Section - Seepage Recovery Dam S1

Scale 1" = 20'



Typical Section - Seepage Recovery Dams S2 to S7

Scale 1" = 20'

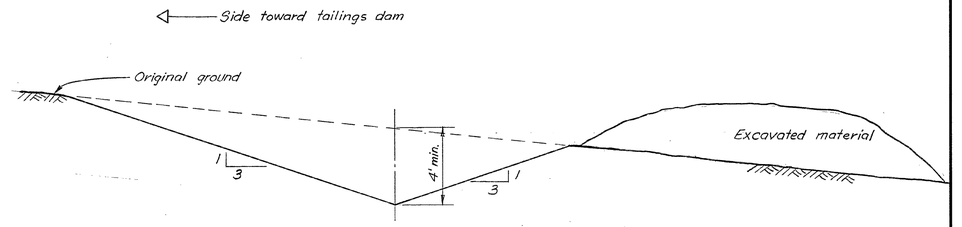


Typical Section - Diversion Dyke

Scale 1" = 20'

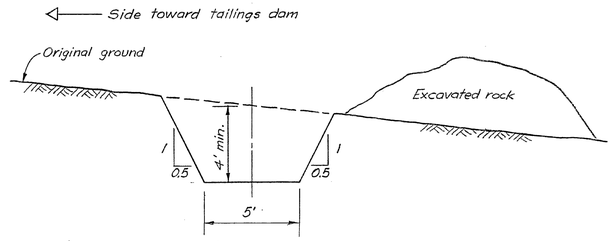
Gradation Requirements For Upstream Slope Protection

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



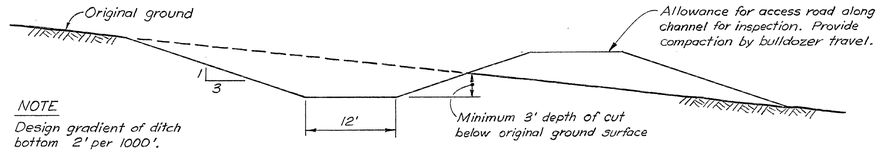
Seepage Collection Ditch Excavated In Soil

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.
CIVIL • GEOTECHNICAL • HYDRAULIC
VANCOUVER - CALGARY - WINNIPEG - DENVER

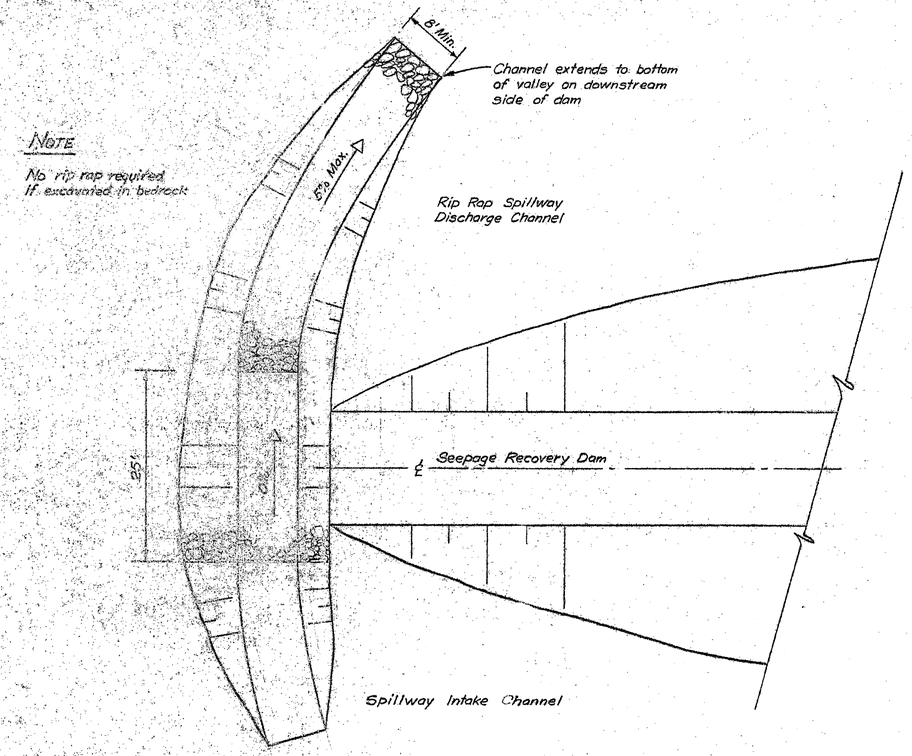
PROJECT: TAILINGS DISPOSAL - SEEPAGE RECOVERY

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

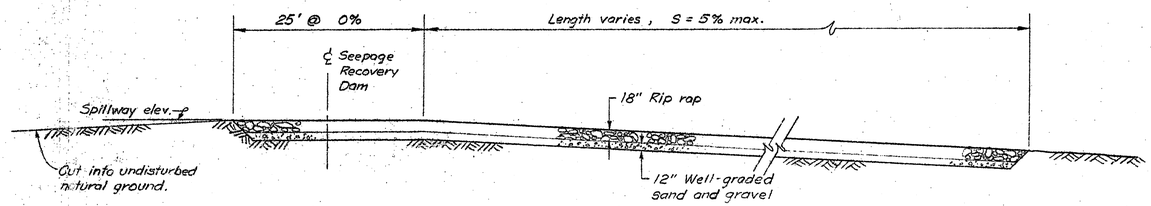


NOTE

No rip rap required if excavated in bedrock.

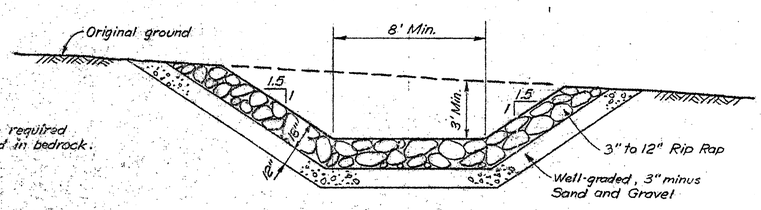
TYPICAL PLAN OF SPILLWAYS FOR SEEPAGE RECOVERY DAMS

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

Klohn Leonoff Consultants Ltd.

CIVIL • GEOTECHNICAL • HYDRAULIC

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

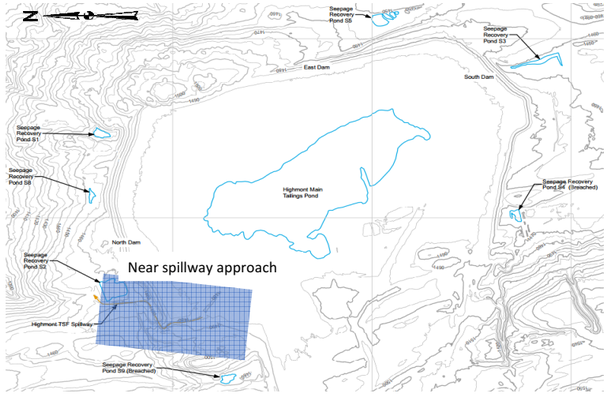
DWG. NO. D-1526-30

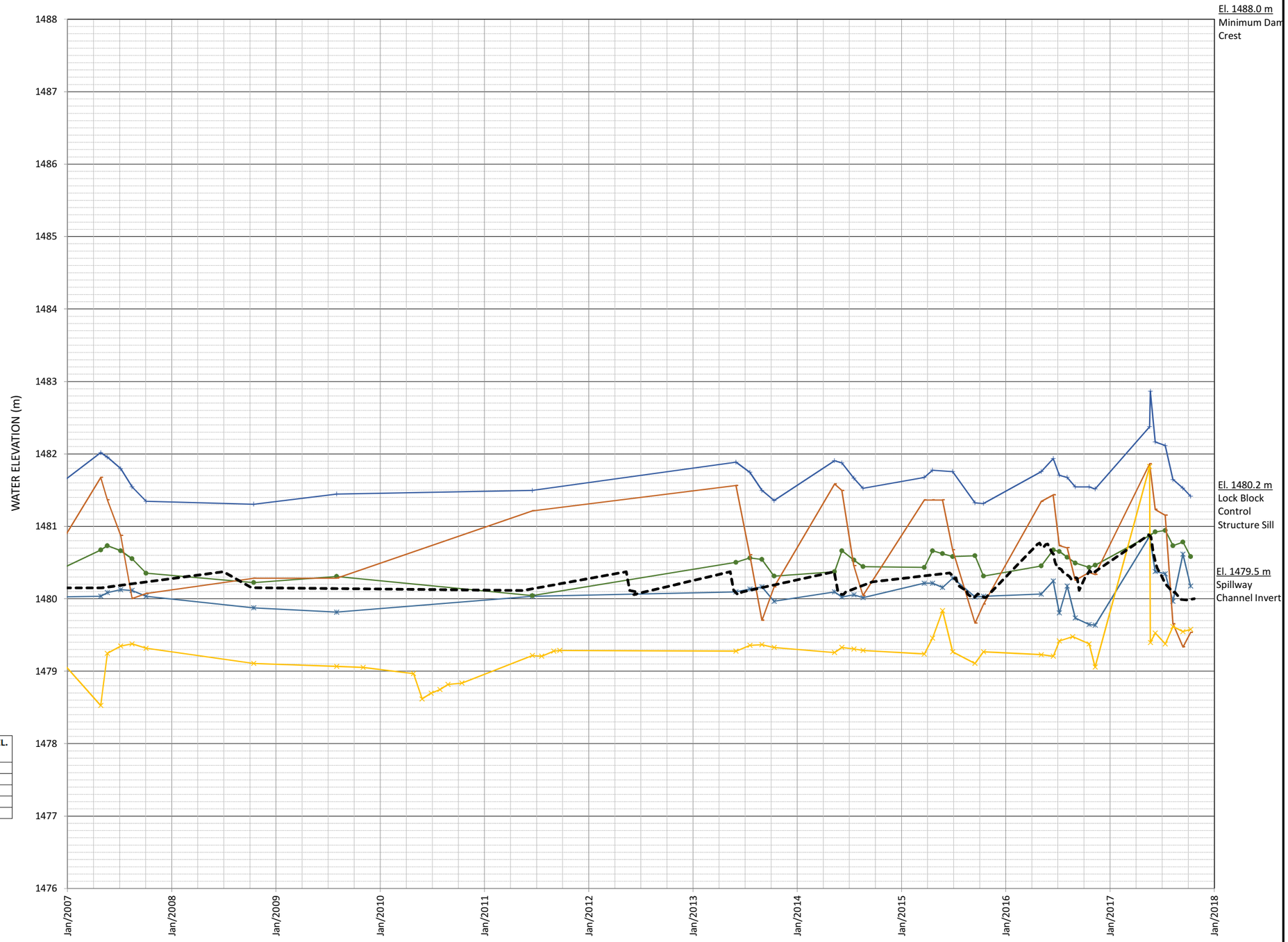
REV.

NCI 317 - K.L.C.L.

APPENDIX IV

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

PIEZOMETER ID	2018 THRESHOLD EL. (m)
P-O	1480.8
S2-1	1482.8
S2-2	1483.1
S2-3	1483.9
S2-4	1483.2

NOTES:

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

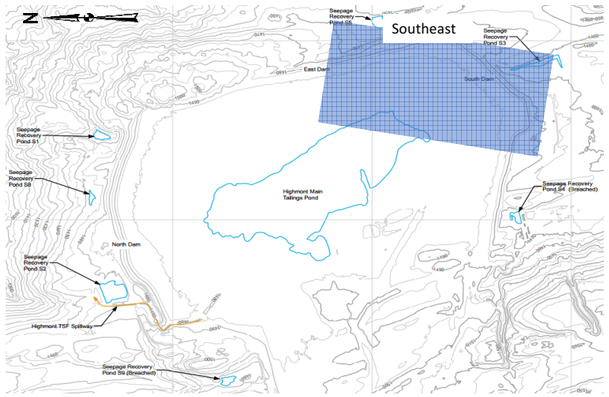
TITLE: HIGHMONT TSF PIEZOMETRIC DATA 2007-2017

NEAR SPILLWAY APPROACH

PROJECT No. M02341B26

FIG No. IV-1

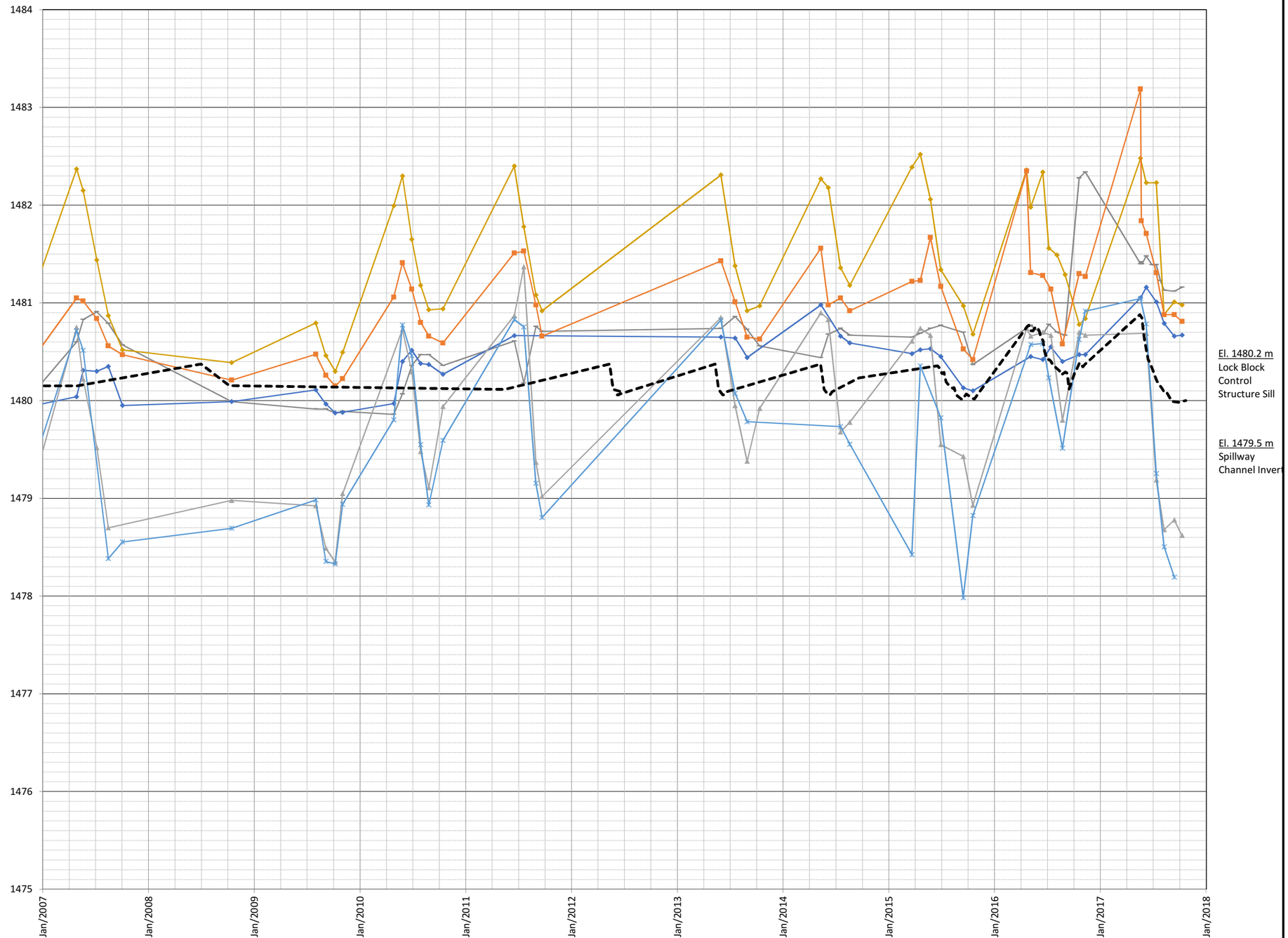
February 20, 2018
Z:\MVCR\M02341B26 - HVC-2017 Dam Safety Support\300 Design\Piezo Data\Highmont\[180220 Highmont Piezo.xlsx]SPILLWAY



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

PIEZOMETER ID	2018 THRESHOLD EL. (m)
PW-L	1481.5
P-M	1482.8
P-N	1481.9
S3-1	1481.2
S3-2	1483.0
PW-P	1482.2



NOTES:

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

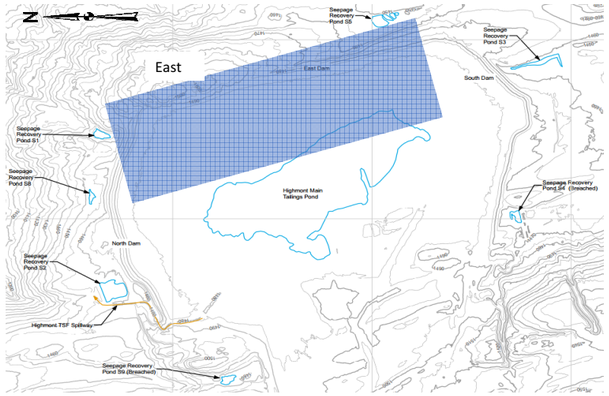
TITLE: HIGHMONT TSFPIEZOMETRIC DATA
2007-2017

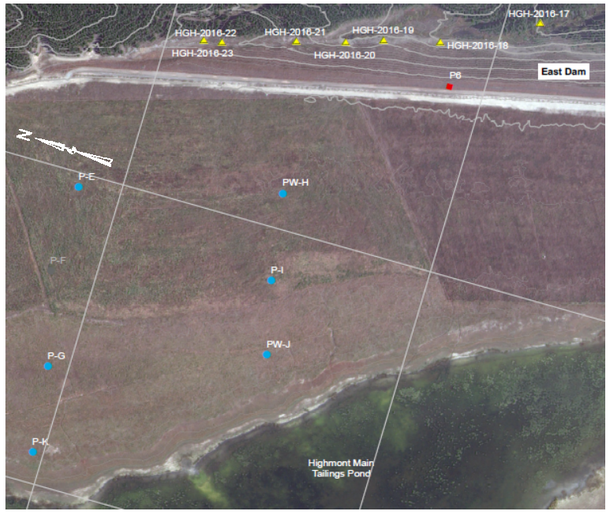
SOUTH EAST

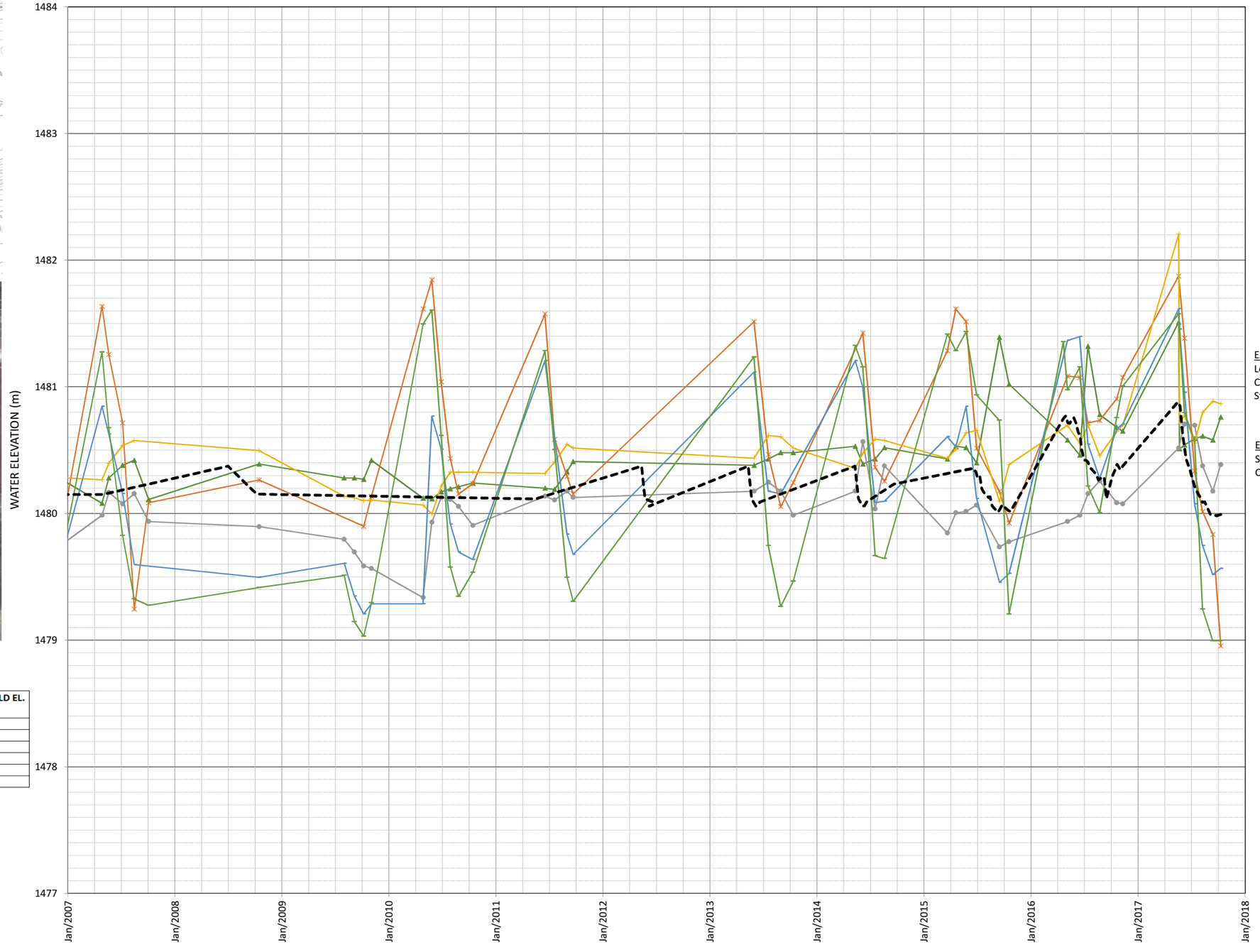
PROJECT No. M02341B26

FIG No. IV-2

February 20, 2018
Z:\MVCR\M02341B26 - HVC-2017 Dam Safety Support\300 Design\Piezo Data\Highmont\180220 Highmont Piezo.xlsx]SOUTHEAST







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

PIEZOMETER ID	2018 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

NOTES:

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY 2017 DAM SAFETY INSPECTION

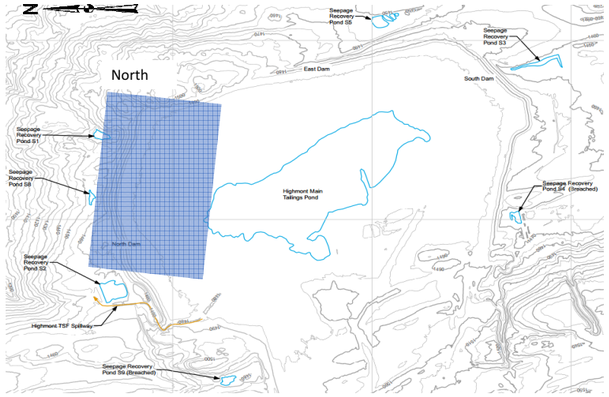
TITLE: HIGHMONT TSF PIEZOMETRIC DATA 2007-2017

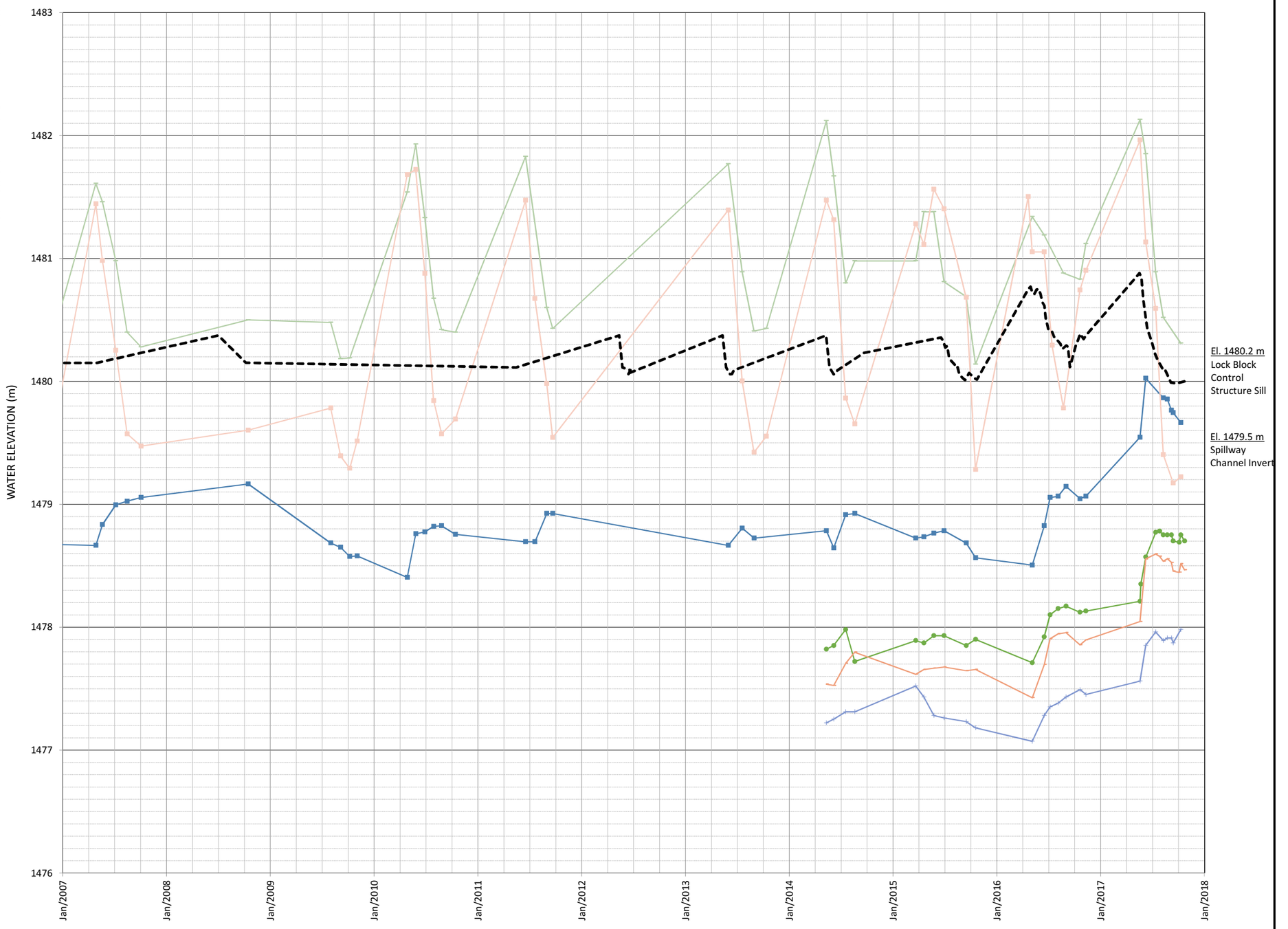
EAST

PROJECT No. M02341B26

FIG No. IV-3

February 20, 2018
Z:\MVCR\M02341B26 - HVC-2017 Dam Safety Support\300 Design\Piezo Data\Highmont\[180220 Highmont Piezo.xlsx]EAST





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

PIEZOMETER ID	2018 THRESHOLD EL. (m)
PW-A	1479.7
PW-C (TALL)	1482.6
P-D	1482.2
HM-PS-01 (13-SRK-14)	1478.7
HM-PS-02 (13-SRK-14)	1478.0
HM-PS-03 (13-SRK-13)	1478.5

NOTES:

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

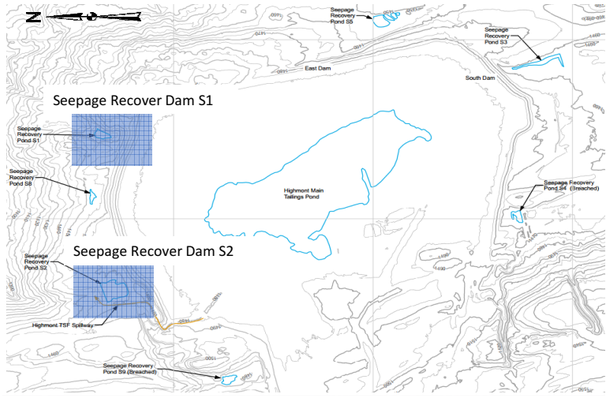
TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2017

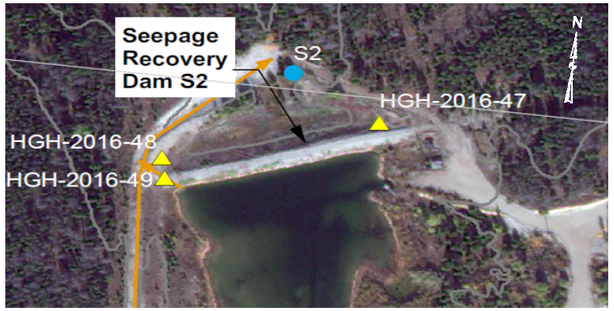
NORTH

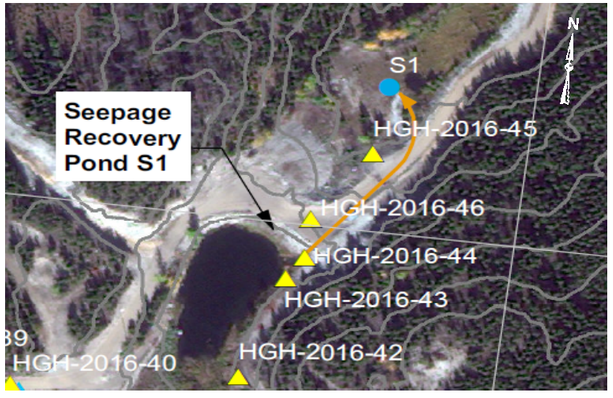
PROJECT No. M02341B26

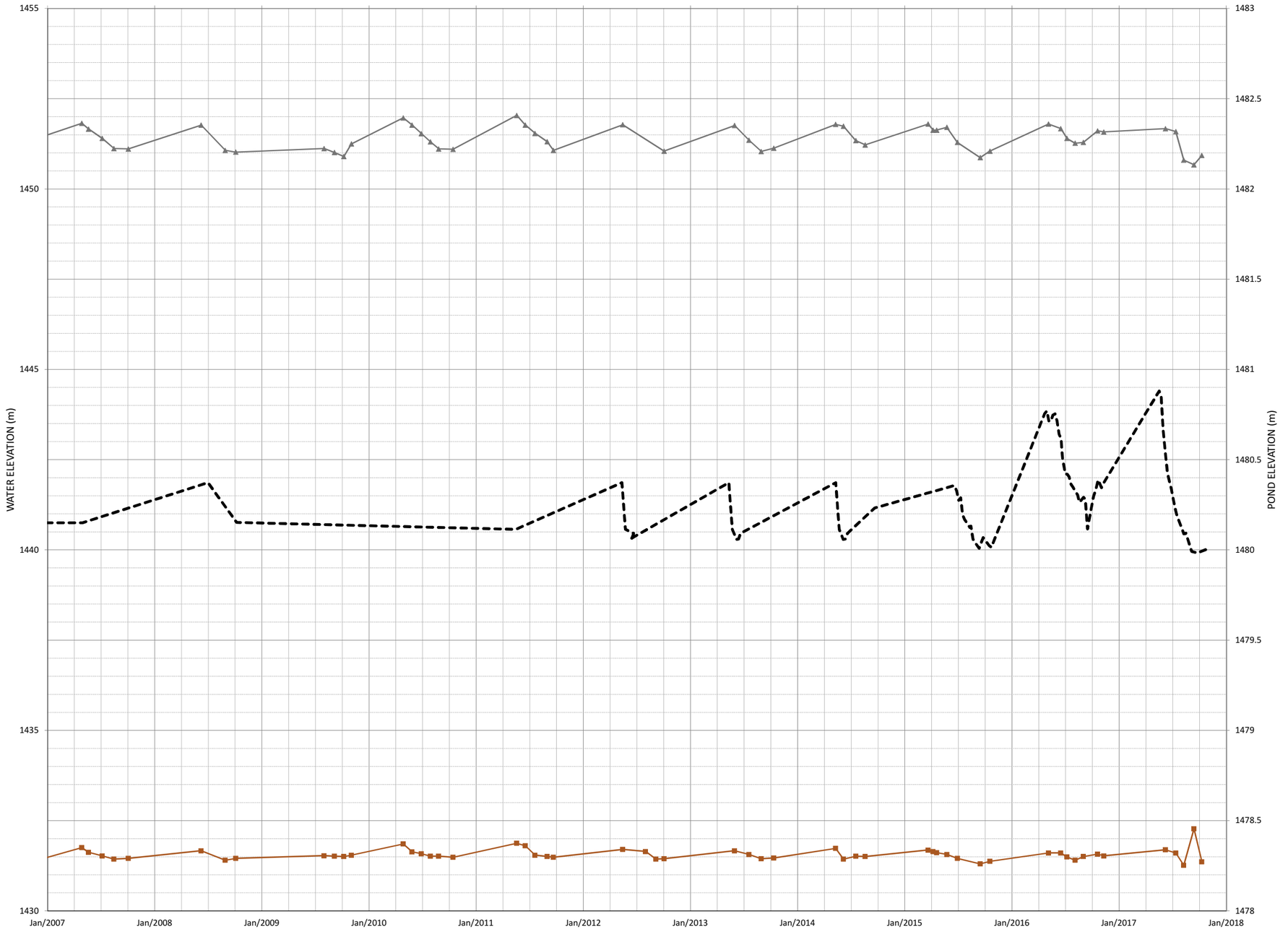
FIG No. IV-4

March 7, 2018
Z:\MV\CR\M02341B26 - HVC-2017 Dam Safety Support\300 Design\Piezo Data\Highmont\[180220 Highmont Piezo.xlsx]Pond El









LEGEND:

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

PIEZOMETER ID	2018 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: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

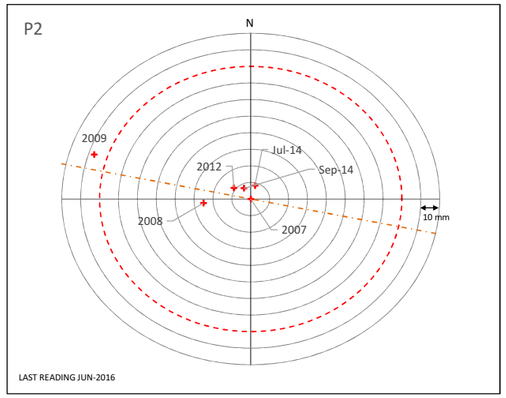
TITLE: HIGHMONT TSF PIEZOMETRIC DATA
2007-2017

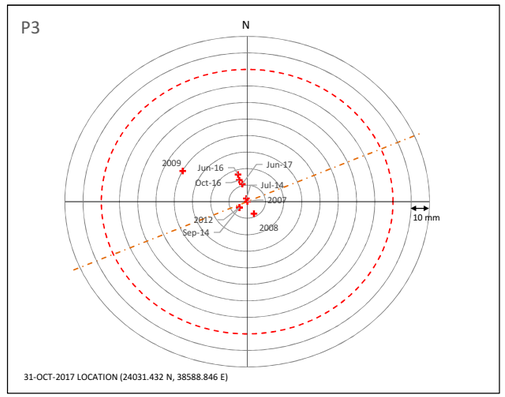
SEEPAGE PONDS

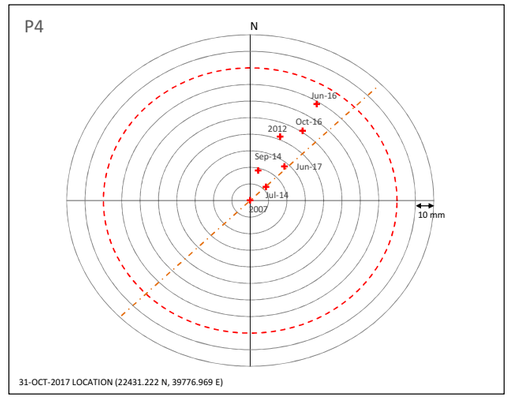
PROJECT No. M02341B26

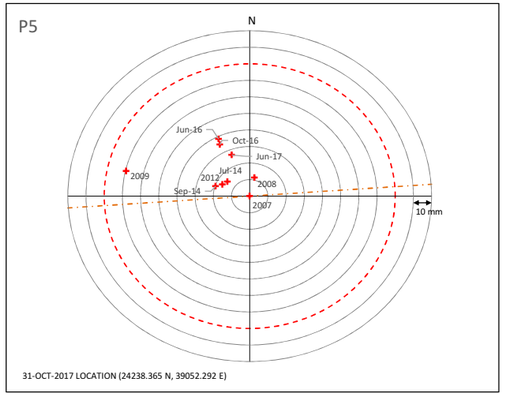
FIG No. IV-5

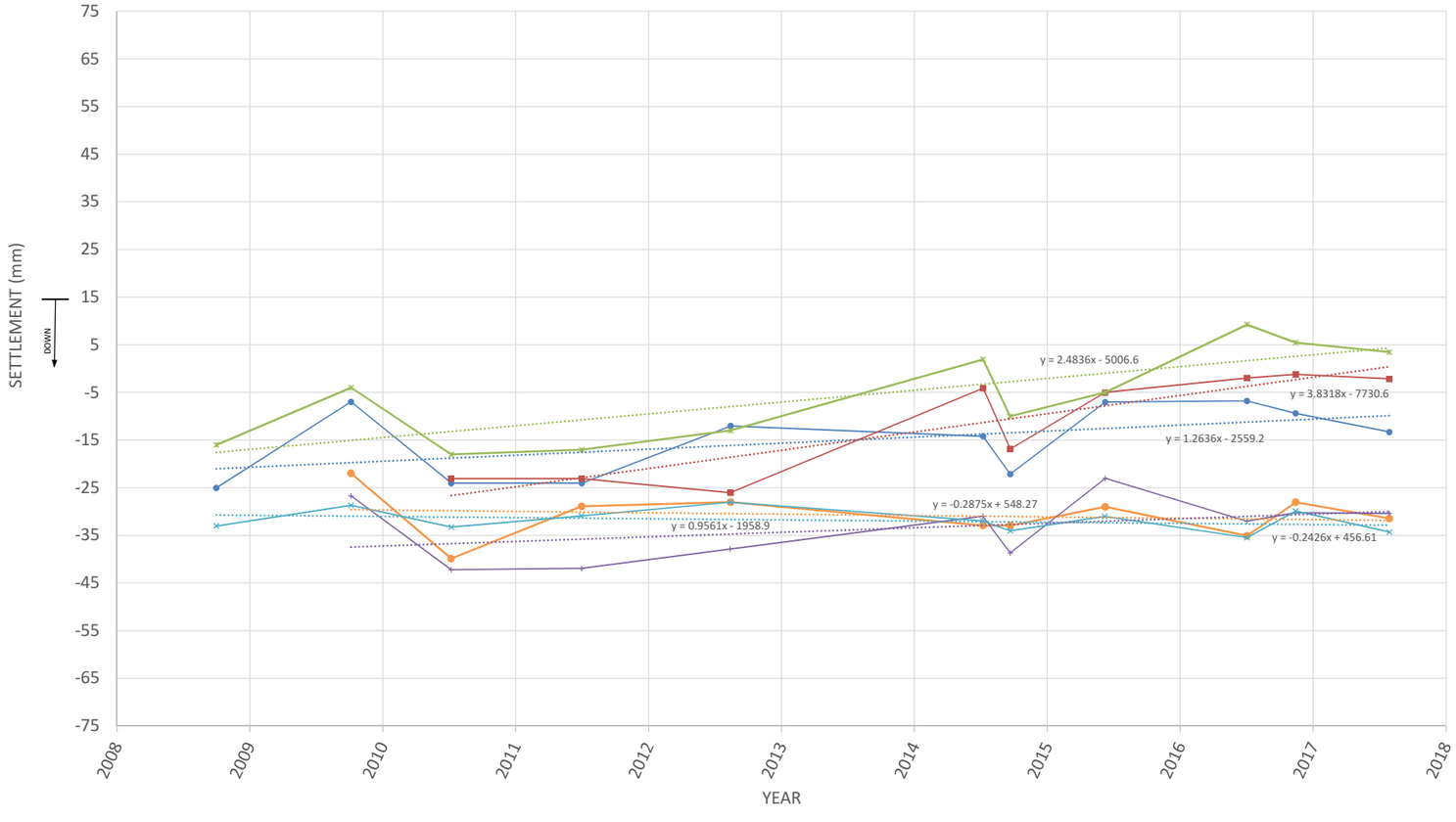
February 20, 2018
Z:\MV\CRM\02341B26 - HVC-2017 Dam Safety Support\300 Design\Piezo Data\Highmont\[180220 Highmont Piezo.xlsx]SEEPAGE PONDS

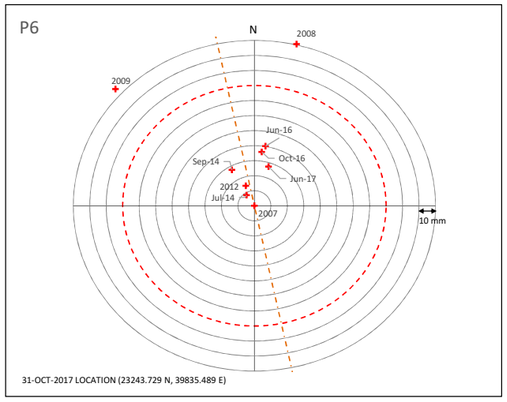












DAM CENTERLINE ORIENTATION

THRESHOLD HORIZONTAL DISPLACEMENT FROM ORIGINAL POSITION

LEGEND:

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

MONUMENT ID	2018 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 1997 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 2009 READING (NOT SHOWN IN PLAN PLOT) LOCATED 167 mm FROM INITIAL 2007 READING. READING WAS REVIEWED AND FOUND MORE LIKELY RELATED TO SURVEY ERROR THAN DISPLACEMENT.

CLIENT: TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

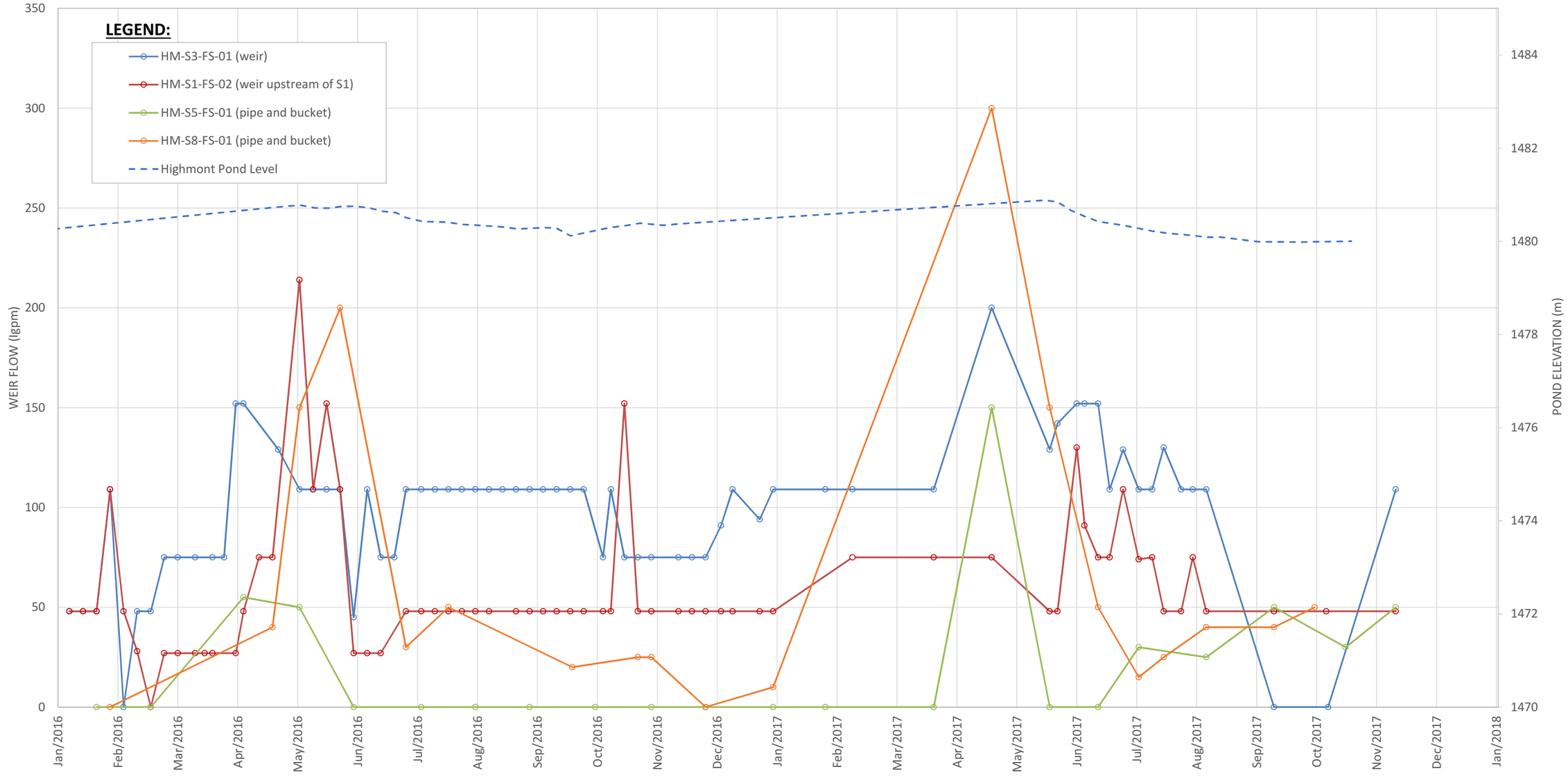
PROJECT: HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

TITLE: HIGHMONT DAM
SURVEY MONUMENT READINGS

PROJECT No. M02341B26

FIG No. IV-6

February 21, 2018
Z:\MV\DPM\02341B26 - HVC-2017 Dam Safety Support\300 Design\Monument Data\Highmont\182221 HighmontDamMonitoring.xlsm]Figure



CLIENT
TECK HIGHLAND VALLEY COPPER PARTNERSHIP

Klohn Crippen Berger

PROJECT
HIGHMONT TAILINGS STORAGE FACILITY
2017 DAM SAFETY INSPECTION

TITLE
SEEPAGE PONDS
WEIR FLOWS

PROJECT No. M02341B26

FIG No. IV-7

March 28, 2018
Z:\MVCR\M02341B26 - HVC-2017 Dam Safety Support\300 Design\Freeboard Summary\[180219 - Freeboard summary.xlsx]2017 Pond Summary

APPENDIX V

Map of Water Quality Monitoring Points

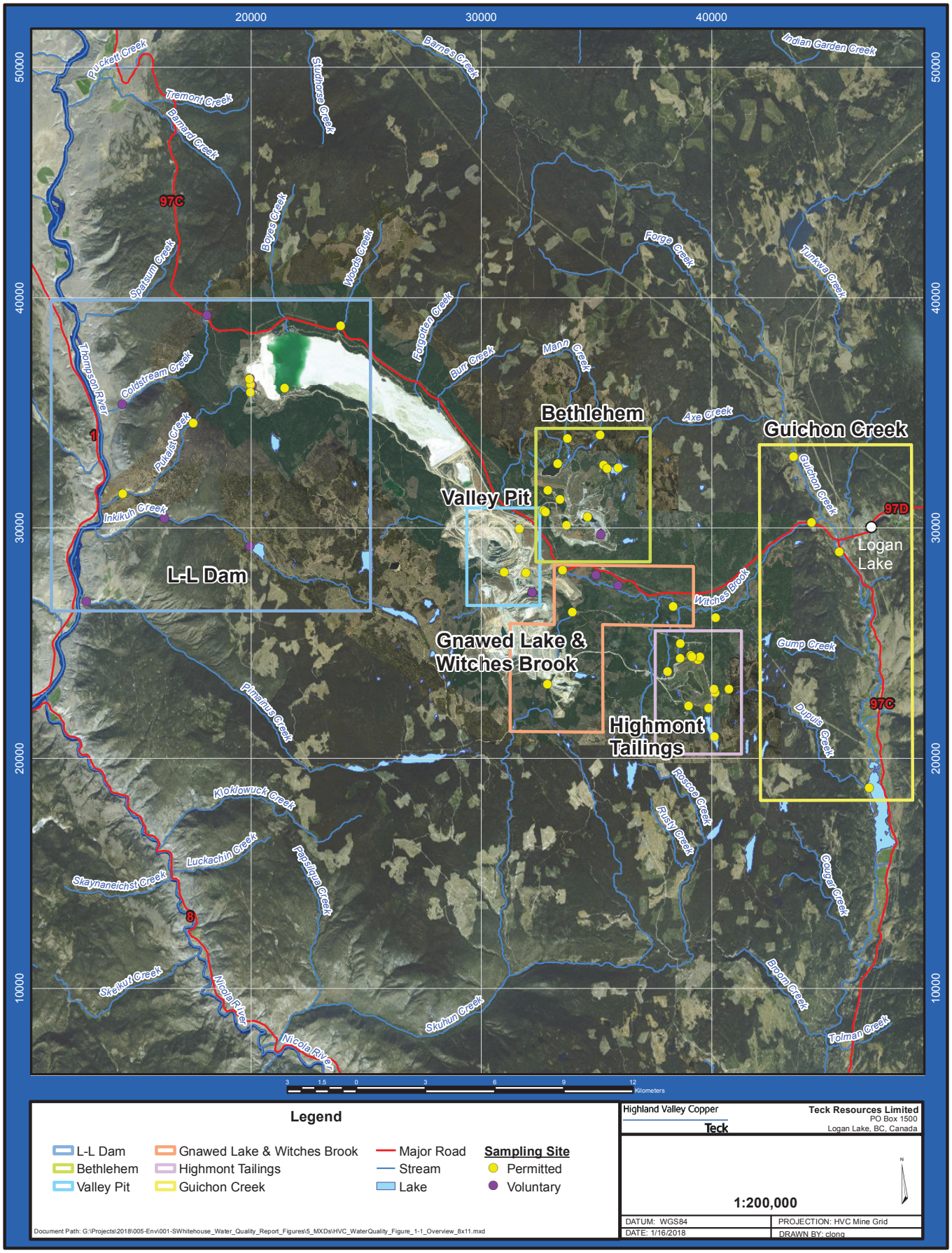


Figure 1-1 Water Quality Monitoring Sites Highland Valley Copper, 2017

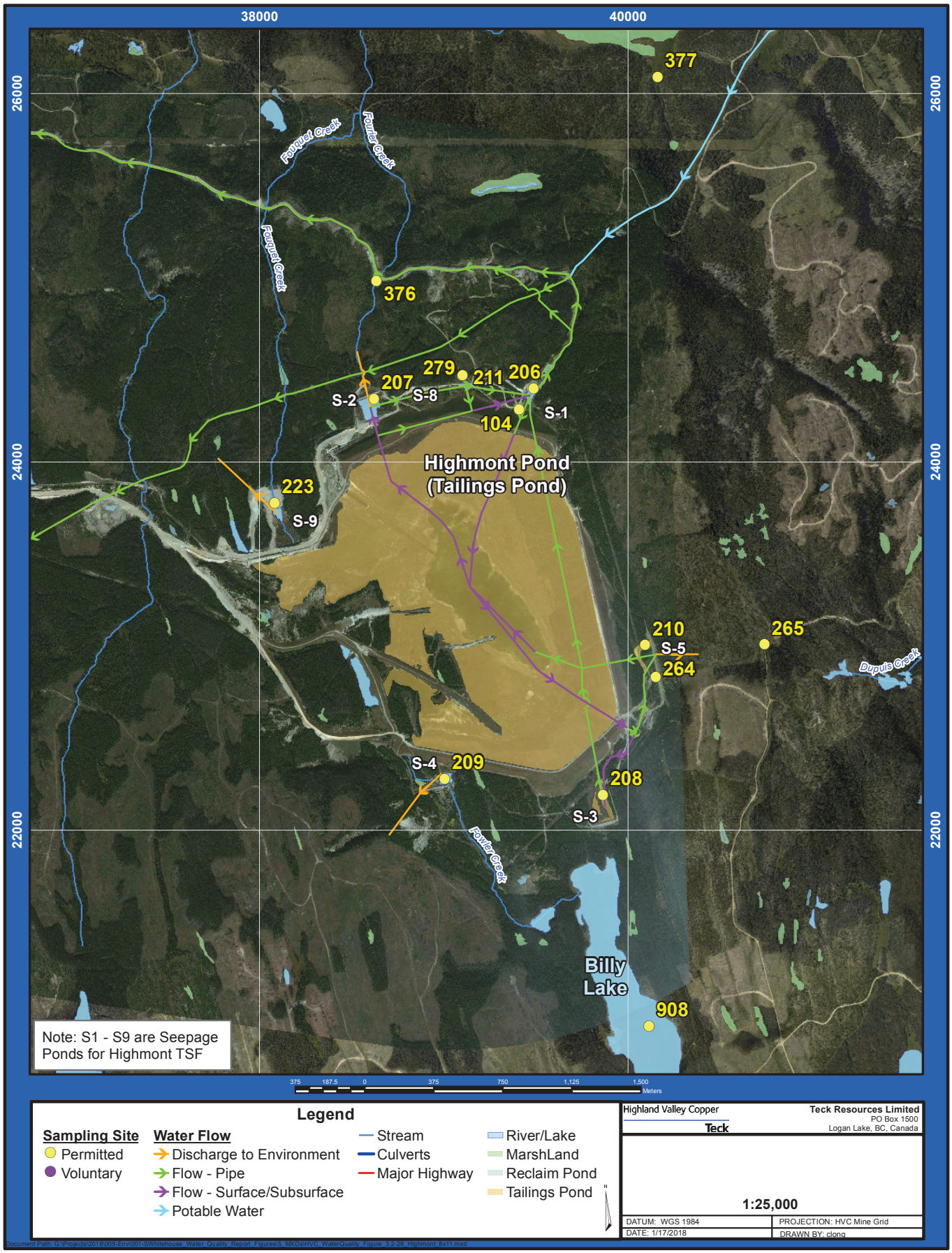


Figure 3.2-36 Water Quality Monitoring Sites in the Highmont Area, Highland Valley Copper, 2017