Klohn Crippen Berger

Yukon Zinc Corp.

Wolverine Mine

Dam Safety Review

Tailing Storage Facility and Earth Structures

CANADA'S BEST MANAGED COMPANIES Platinum member

ISO 9001
ISO 14001
OHSAS 18001

A05092A01

August 2017

August 10, 2017

Yukon Zinc Corporation
Suite 705 – 1030 West Georgia Street
Vancouver, British Columbia
V6E 2Y3

Peter Mah
Interim Chief Operating Officer

Dear Mr. Mah:

Wolverine Mine - Dam Safety Review
Tailing Storage Facility and Earth Structures

Please find attached the Dam Safety Review (DSR) of the tailings storage facility at the Wolverine Mine. The DSR is a requirement of the Yukon Energy, Mines and Resources, under the Quartz Mining Act per the Quartz Mining License QML-0006 and follows the guidance of the Canadian Dam Association.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Pamela Fines, M.A.Sc., P.Eng.
Associate / Manager

PF:kc

170810R Wolverine DSR.docx
A05092A01

Yukon Zinc Corp.

Wolverine Mine

Dam Safety Review

Tailing Storage Facility and Earth Structures

EXECUTIVE SUMMARY

This report presents the results of a Dam Safety Review (DSR) that was performed by Klohn Crippen Berger Ltd. (KCB) for the Tailing Storage facility (TSF) and Earth Structures. Yukon Zinc Corporation (YZC), the owner of Wolverine Mine, is currently required to submit a DSR on the TSF every 7 years. The DSR included a site visit by the Dam Safety Review Engineer, Mr. Brett Stephens, P.Eng., and Ms. Pamela Fines, M.A.Sc., P.Eng. The Dam Safety Review report has been carried out using the guidelines provided by the Canadian Dam Association (2007).

The Wolverine Mine is a zinc-silver-copper-lead-gold underground mine, located in the southeast Yukon, within Kaska Traditional Territory, approximately 280 km east of Whitehorse and 170 km northwest of Watson lake. The mine had a production capacity of 1,700 tonnes per a day. YZC placed the mine under temporary closure for care and maintenance January 21, 2015 which has continued to the date of tis DSR. As a result, there has been no mining, milling operation, and tailing discharge in the TSF since January 2015.

The TSF is located south of the mill facility and stores tailing discharged as slurry. The TSF embankment was designed using homogenous earth fill material and constructed as a dam in two stages with a current height of 26 m. In 2009, the first construction stage consisted of a 19 m high dam and the second stage was a 7 m downstream raise in 2012. The TSF continues to accumulate water and has a full water cover on top of the tailings. Water is not being discharged from the TSF as the planned water treatment plant has not been constructed.

The 2013 Canadian Dam Association (CDA) Safety guidelines were adopted to determine the classification of the dam. The consequence classification based on CDA guidelines of the dam is currently reported as “High” to “Very High”. We recommend adopting a classification of “Very High” for the Wolverine Tailings Dam.

The conclusion of the DSR assessment is that the dam is “reasonably safe”. The dam safety review identified deficiencies and non-conformances as summarized in the tables below, which should be addressed to ensure ongoing dam safety.

With a change in classification to Very High, Dam Safety Reviews should now be completed at least every 5 years as per the CDA guidelines. The next DSR for Wolverine Mine should be completed in 2022 or earlier if the dam classification is revised upward in the future.

Table X.1 Recommendations for Dam Safety Aspects

Deficiency or Non-Conformance	No. (Report Section)	Recommended Action	Schedule
Deficient Flood Event Values and Assessment	4.6.1	The hydrology assessment appears to be comprehensive: ▪ However, the specific rainfall total used to calculate the IDF should be presented (not just the design event duration). ▪ PMF volume inflow volume should also be provided.	December 2017.
North End Slump Repair	4.5.3	The slumped section under the liner at the north end should be repaired prior to placement of additional 1 m of water (2020) or additional tailings in the TSF.	Repair by Dec 2019 or prior to restart of mining activities (whichever is first).
Out of date inundation study.	4.2.2	The inundation study was conducted based on published tables and does not meet the current state of practice for inundation studies. This should be updated and used to update the Emergency Preparedness Plan.	C&M – Dec. 2018 Active Mining – Dec. 2018 Closure – part of closure plan development

Table X.2 Recommendations for Surveillance and Maintenance Aspects

Deficiency or Non-Conformance	No. (Report Section)	Recommended Action	Schedule
Lack of consolidated site records	2.1	Site records need to be consolidated into a centralized file, including: ▪ site investigation data and laboratory test data (historic and recent); ▪ as-constructed records, including site visit notes and foundation preparation assessments; and ▪ design basis with assumptions to key design parameters and criteria.	Closure – August 2019 Prior to restart of mining activities (whichever is sooner)
OMS document not updated	4.10.2	The OMS manual should be updated as summarized in Table 4.3 of this document	December 2017
EPP update	4.10.3	Emergency preparedness plan should be updated to reflect current operating staff and communications. The plan should be reviewed/revised again once the new inundation study is available. This can also be used for communication with local stakeholders on potential impacts of a dam safety incident.	December 2017

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

List of Tables

TABLE OF CONTENTS

(continued)

List of Figures

List of Appendices

1 INTRODUCTION

This report presents the results of a Dam Safety Review (DSR) that was performed by Klohn Crippen Berger Ltd. (KCB) for the Tailing Storage facility (TSF). The Wolverine Mine is located in the southeast Yukon, within Kaska Traditional Territory, approximately 280 km east of Whitehorse and 170 km northwest of Watson lake, as shown on Figure 1.1.

The DSR included a site visit by the Dam Safety Review Engineer, Mr. Brett Stephens, P.Eng., and Ms. Pamela Fines, M.A.Sc., P.Eng.

The CDA Dam Safety Guidelines (CDA, 2013) define a DSR as "a systematic review and evaluation of all aspects of design, construction, maintenance, operation, processes, and systems affecting a dam's safety, including the dam safety management system." The guidelines provide a suggested frequency of DSRs based on consequence classification. The tailings dam at Wolverine is classified as "High to Very High" consequence structures and the agreed DSR frequency was 7 years during operation, consistent with a "High" consequence dam, prior to decommissioning and following closure. This is the first DSR for this facility. The comprehensive review is to provide verification of:

- safety and environmental performance of the facility;
- adequacy of the surveillance program;
- adequacy of delivery of OMS requirements;
- design basis with respect to current standards and possible failure modes; and
- compliance with engineering standards.

The DSR presented herein is classified as a "comprehensive *dam safety review*", which has been carried out by a "*Qualified Professional".* The Qualified Professional is Mr. Brett Stephens, P.Eng., who is a geotechnical engineer with 25 years of experience with tailings dams design, construction and operation worldwide.

Given that the Wolverine Mine is currently under care and maintenance, our recommendations have been provided considering either continued care and maintenance, re-activation of mining or closure of the structure.

Figure 1.1 General Location Plan

2 BACKGROUND INFORMATION AND SITE VISIT

2.1 Document Review

A review of available documentation was carried out and the available references are summarized in Table 2.1.

Table 2.1 Tailing Storage Facility – Permitting, Design and Construction Records

Date	Prepared By	Title	Permitting (P), Inspection (I) Design (D) or Construction (C)	Key Items of Interest
February 2015	Yukon Energy, Mines and Resources	Inspections Direction- Subsection 146(1) Quart Mining Act and Subsection 35(1) Waters Act	P	Inspection Report (Ministry Order-Yukon Government). Direction from the Yukon Government based on mine inspection.
December 2015	Yukon Energy, Mines and Resources	Response to EMR Wolverine Project Reclamation and Closure Plan Approval	P	Terms and Conditions outlined by the Yukon Government to be met in order to approve the reclamation and closure plan.
December 2006	Yukon Energy, Mines and Resources	Yukon Office of the Minister	P	Quartz Mining License outlines development and production with underground mining. Expires December 2021.
October 2007	Yukon Water Board	Yukon Water board	P	Water License outlines conditions for the use and release of site water. Expires December 31, 2027
August 2015	Klohn Crippen Berger	Annual Physical inspection of TSF and on-site earth structures	I	Dam Safety Inspection Report to inspect tailing storage and earth structures
December 2016	Knight Piesold Consulting	Tailings Storage Facility and On-site Earth Structures 2016 Inspection	I	Dam Safety Inspection Report to inspect tailing storage and earth structures
August 2013	Klohn Crippen Berger	Wolverine Mine Tailing Facility 2013 Annual Tailings Facility Physical Inspection	I	Annual Inspection Report to inspect tailing storage and earth structures
2007	Klohn Crippen Berger	Feasibility Study Update	D	Feasibility level design of the tailings storage facility (TSF) and related infrastructure.
March 2009	Klohn Crippen Berger	Tailings and Infrastructure Design and Construction Plan	D	Detailed design of the tailings storage facility (TSF) and related infrastructure.
March 2012	Klohn Crippen Berger	Design Overview for Stage 2 Dam Construction	D	Outlines the design and construction plan for the stage 2 dam raise for Wolverine Mine.
May 2015	Yukon Zinc Corp	Cross-section drawing of the Tailings Pond	D	Bathymetry cross-section of the tailings pond. Volumes and elevations are on the drawing.
May 2011	Klohn Crippen Berger	Addendum to Starter Tailings Storage Facility - 2009 Civil Works	C	Includes information on outstanding construction items following substantial completion of TSF. This includes construction of starter dam spillway, seepage construction dam, install of reclaim pump barge system, and instrumentation install.
November 2012	Klohn Crippen Berger	Wolverine Stage 2 Expansion Construction Record Report	C	Includes information on: construction observation, QA testing, design changes, photos, technical specifications, earthworks QA, liner QA/QC, instrument plan drawing, and design drawings.
May 2010	Klohn Crippen Berger	Starter Tailings Storage Facility - 2009 Civil Works	C	Includes information on: scope of work, construction schedule, weather, material, design changes, construction observations, QA, photos, technical specifications, earthworks QA, liner QA/QC, Instrument plan drawing, and design drawings.
2007-2015		Temperature and Precipitation Data		Temperature-Year-Precipitation Plot.
2009-2016		Ground Water Quality and Water Level Data		Water quality test result and plots and water level reading and plots.
2009-2015		Surface Water Quality and Hydrogeology		Stream discharge, flow rate, surface water quality, water level, precipitation data, precipitation-year-discharge plot.
August 2016	ALS Environmental	Certificate of Analysis		Results for metal detection in surface water.
2015-2016		Wolverine TSF Elevation and Storage Volume		Pond elevation, dam crest elevation, surveyed tailings volume, and plot.
2010-2016		TSF Water Quality Test Results		Water quality test results.
2006-2013		Underground Mine Water Quality Results		Underground dewatering, production development, and mine water quality test results and plot
2011 to 2015	Yukon Zinc Corp	Tailing Facility Monitoring Monthly Impoundment Reports	I	Mill data, site measurements, sketch, photos
2011-2015	Yukon Zinc Corp	Tailing Facility Monitoring Weekly Visual Inspection Report	I	Tailing facility inspection of the dam, discharge, reclaim infrastructure, spillway, and ditches.
2011-2015		Tailing Volume Information		Tailings volume, ditch flow, under drain flow rate, precipitation and temperature, seepage collection flow, and mill tailing solids volume.
2010-2016		Piezometer Data Spreadsheet		Vibrating wire table and plots
2011-2016		Tailing Inclinometer Data Summary		Digital inclinometer data and plots.
July 2010	Yukon Zinc Corp	Operation, Maintenance, Surveillance Manual	C	Project overview, regulatory requirements, tailing facility operation, facility maintenance, surveillance, and emergency response plan.
December 2014	Yukon Zinc Corp	Emergency Response Plan	C	Facility emergency response, preventative measure for dam breach, training and testing.
July 2015	Klohn Crippen Berger	Wolverine Mine Tailings Storage Facility Preliminary Study of TSF Closure Options -Rev 2	C	Mine observations and closure options.
August 2015	Klohn Crippen Berger	Short Term Remediation for Slump along TSF North Wall	I	North wall slump remedial plan
August 2014	Klohn Crippen Berger	2014 Annual Tailings Facility Physical Inspection	I	Annual inspection for tailing storage, earth structures and instrumentation review.

2.2 Organization and Responsibilities

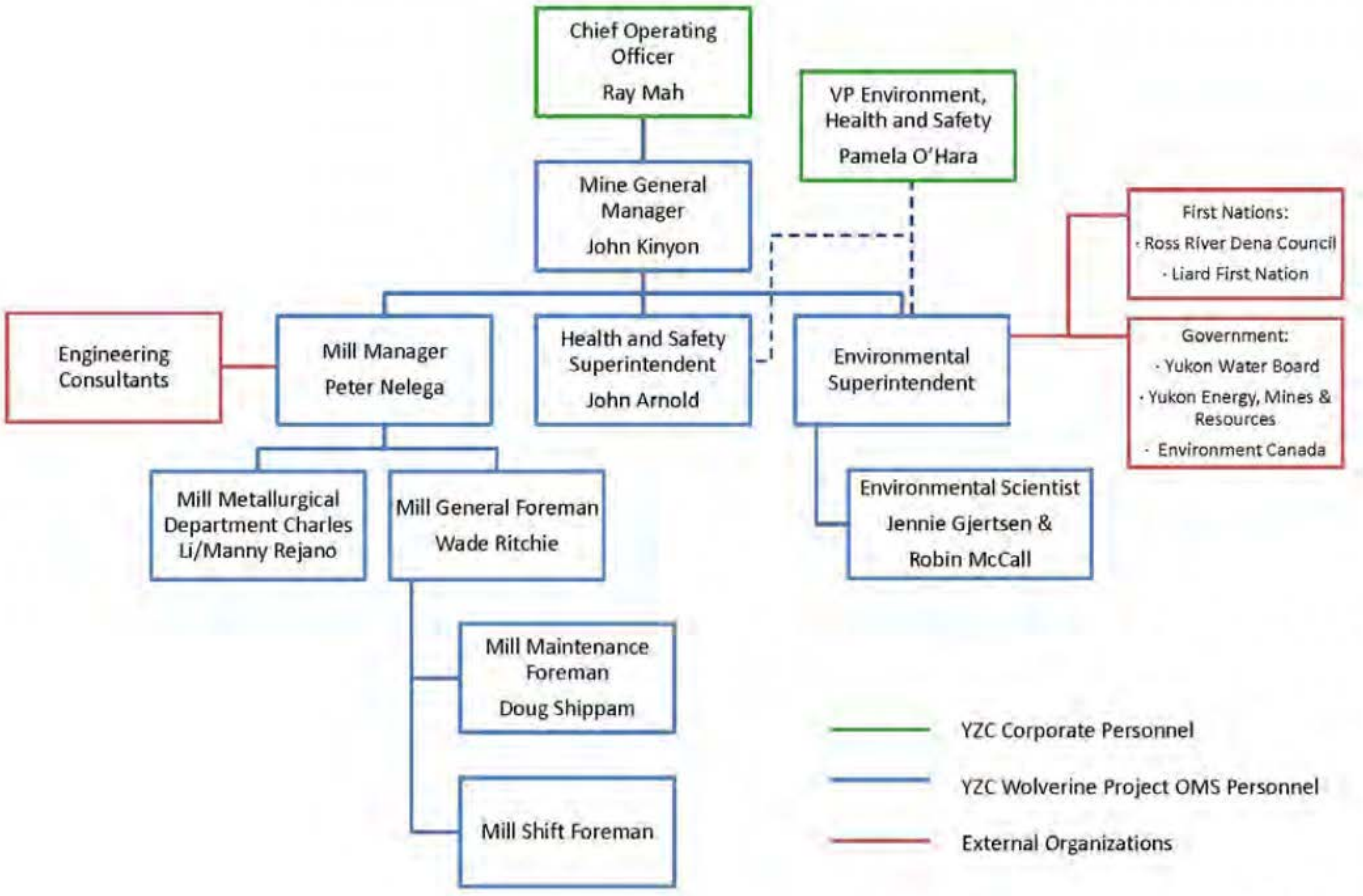
An OMS manual is intended to be a living document that is updated to reflect the changing nature of the life cycle of the facility. The current OMS manual was last updated in 2010 and was not revised when the mine entered care and maintenance. The OMS manual is out of date and needs to be revised to reflect the current roles and responsibilities, surveillance and maintenance activities, and emergency response procedures.

2.2.1 Management

A description of the organization and roles and responsibilities when the mine was in operation is presented in the Operations, Maintenance and Surveillance (OMS) Manual and is summarized in the following sections. The general organization chart shows reporting links are shown on Figure 2.1.

The overall set up and content of the OMS manual is relevant and meets the general requriements of the CDA recommendations. However, the OMS manual is out of date as most of the people referenced in the document no longer work for Yukon Zinc. The mine is currently in care and maintenance and the OMS manual represents how the facility was managed while in operation. The OMS manual needs to be updated to the current status of the facility under care and maintenance. If the mine transitions to to either restart of operations or full closure then the OMS manual should again be revised to represent these new conditions.

Figure 2.1 Wolverine Mine – Operations Organization Chart (outdated) – Main Reporting Links



Currently, the TSF is managed by the care and maintenance crews and they report to Peter Mah who responsible for the site operations. Given the small teams on site and in Vancouver the reporting structure is very lean and should be indicated in the OMS manual.

2.2.2 Management Review and Reporting

Current reporting and review activities are shown below:

- routine surveillance is being conducted by the care and maintenance crew but recording of observations is on paper only in the daily log book;
- engineer inspection report on the condition of the tailing facility; and
- comprehensive dam safety reporting every 7 years.

The OMS manual indicates that more reporting activities should be conducted. Reporting requirements in the OMS were not revised when the mine entered care and maintenance.

Currently there is a small team on site (typically 3 people) and recordings of observations are made and recorded. YZC is also in contact with the Yukon Government regarding their permit requirements.

Formal weekly and monthly observation reports are not being collected at this time. Reporting and management review need to be updated if the mine goes back into production or goes to full closure.

2.2.3 Design

The EoR for the TSF dams is Klohn Crippen Berger Ltd. Mr. Harvey McLeod, P.Eng. has been leading the recent design and associated studies, and construction monitoring works. The EoR is responsible for the design and performance of the mining dam (CDA, 2014). These responsibilities include such items as: 1) dam safety inspections; 2) Construction monitoring; 3) instrumentation planning, design and review; and 4) design modifications.

2.3 Regulatory

The Wolverine Mine falls under The Yukon Territorial Government jurisdiction and the following section present key details of their current permits.

2.3.1 Yukon Energy Mines and Resources

The tailings impoundments at Wolverine are regulated under the Yukon Quartz Mining Act and is to comply with a Quartz Mining License (QML-0006) issued by Yukon Energy Mines and Resources (expires December 31, 2027). The mining license was approved by the territorial minister and stipulates the following:

- process for approval of operations plans and environmental protection plans:
  - the Operation, Maintenance and Surveillance (OMS) manual must be revised regularly during operations; and
  - the Emergency Response Plan (ERP) is required for any dam with a consequence classification of “High” or “Very High”. The ERP will be tested and updated or amendments made as necessary.
- conditions for temporary closure;
- inspection and reporting requirements:
  - annual physical inspection by an engineer to completed before July 1st to review structure, works, and installations to be submitted to Director, Mineral, and Resources (10.1); and
  - annually, on or before March 31st, submit a report that includes information on yearly mining activities (10.5).
- financial security.

There have been communications between the government and YZC regarding the temporary closure plan which was not accepted by the government and the DSR should have been completed in 2016. KCB is not aware of any other contraventions of the conditions of their permits.

2.3.2 Yukon Water Board

The Yukon Water Board issued a water license QZ04-065 to Yukon Zinc Corporation (expires December 31, 2027) per the Waters Act and Regulation to obtain water, divert water, store water, alter the flow of water, deposit a waste, and modify the bed and bank of a Watercourse for quartz mining and milling.

Annual reports are submitted to the Yukon Water Board per the water licence QZ04-065 on or before February 28 of the following year. The annual reports are to include:

- A summary of data generated through the monitoring requirements of this license, including analysis and interpretation by a qualified company and outline variations from baseline conditions; and
- Record of any major maintenance work that may impact water.

Monthly reports were submitted to the Yukon Water Board per the water licence QZ04-065 capturing monthly monitoring results no more than 30 days following the end of the month the data was collected in. It is not clear if the same reporting is being done now that the mine is in care and maintenance.

2.4 Current Operational Status

Operation of the tailing facility commenced in 2009 and increased to an approximate production rate of 1,700 tonnes per day (tpd). The mine entered care and maintenance in January, 2015 but is considering restarting mining activities. The original facility was designed with approximately 8 years of tailings storage with an assumption that 50% of the tailings would be used to produce paste backfill to be placed in the underground workings. The current capacity in the TSF is approximately 1.1 Mt which correlates to approximately 4 years of storage, assuming the original plan of 50% of the tailings being used for paste backfill is achieved at the planned restart tonnage of 1,500 tpd.

The 19 m high starter dam was constructed in 2009 and the 7 m downstream raise was constructed in 2012. The crest elevation is 1,313.5 m and currently stores approximately 853,700 tonnes of tailings and supernant pond volume of 560,000 m^3. Currently no water is being released from the TSF.
A detailed bathymetry should be conducted and reconciled with the original liner survey to calculate the volume of tailings and confirm the settled density of the tailings. The bathymetric survey completed in 2016 is suspect due to the very small reported volume occupied by the tailings. A new survey is recommended to confirm the available space remaining in the TSF and what additional dam raise may be required to meet future storage requirements. If the mine goes back into production an annual reconciliation of the tailings density should be completed to compare the tailings rate of rise to the filling plan.

Site activities are currently limited to instrument monitoring and routine maintenance.

2.5 Incident Reporting

There have been no incidents reported for the TSF involving discharge of either water or tailings from the TSF or erosion of the infrastructure.

The only issue is the current temporary closure plan has not been approved by the Yukon Government. YZC are working with the Water Board and the Ministry and Mines to finalize a closure plan. The delay is understood to be associated with the control of water in the underground workings, and unrelated to the TSF.

2.6 Instrumentation

Instrumentation includes survey prisms on the dam crest and four vibrating wire piezometers. Three of the original 7 piezometers installed are no longer functional. Inclinometers were installed but are no longer readable.

The location of instrumentation is shown in plan on Figure 3.4.

The piezometers are attached to data loggers and collect readings twice daily. Survey data is collected annually now that the facility is in care and maintenance.

2.7 Site Visit Dam Inspection

A site visit dam inspection was made over the period of May 5 to May 7, 2010. The site visit was made by Mr. Brett Stephens, P.Eng. and Ms. Pamela Fines, P.Eng.. Mr. Preston Volk provided a tour and inspection of the site and facilitated meetings and information acquisition. Appendix I provides a photographic record from the site visit.

Some of the key observations made during the site visit dam inspection included:

- The weather was sunny with temperatures ranging from 1°C to 10°C, with some brief periods of rain.
- The dam appears stable with no visual evidence of cracking, piping or instability, with the exception of a previously identified slump at the north end of the TSF which is discussed in Section 4.5.3.
- Seepage was noted near the toe of the dam based on the observance presence of wet ground at the toe of the dam near the seepage pond.
- The downstream slope of the dam has presence of minor erosion gullies. This is not a dam safety concern, but rather a reclamation/surveillance/maintenance issue.
- Site contact water is being pumped to the TSF as there is no water treatment plant. The TSF is currently a temporary holding pond for all site surplus water.

2.8 Interviews

Interviews were held with site staff during the DSR site visit of June 24 to 25, 2017 and a brief summary of the interviews are as follows:

Preston Volk

Preston was the prime contact for the site visit and provided a tour of facilities, helped arrange meetings, and provided supporting documentation. Preston is one of seven staff on rotation that maintain the site during the current Care and Maintenance period.

Peter Mah

Peter Mah is the acting Chief Operating Officer and is tasked with the planning for a potential mining restart in 2018. He is responsible for maintenance and management of the TSF. Some of the main observations of the interview included:

- The current site focus is getting permits and activities in line with mining and environmental permits.
- Health and safety is a focus for site activities due to previous incidents on site.
- We discussed several options for restart of mining activities. Restart will also address maintenance and engineering requirements for the TSF, water treatment and potential tailings storage facility expansion.

2.8.1 Engineer of Record

The DSR team has had conversations with KCB design team (Harvey McLeod, P.Eng. and David Willms, P.Eng.) and discussions included clarification of the groundwater assessment and stability review of the slump area. Flows towards the north end of the TSF appear to be affecting the stability of the embankment and the underdrain system was observed to be flowing full during the DSR site visit.

3 FACILITY DESCRIPTION

3.1 General

The tailings facility is an earthfill structure in an elongated natural depression in the Go Creek watershed. The facility has constructed embankment on two sides and ties into rising natural ground on the north and east side of the impoundment. The facility is completely lined with an LLDPE liner to limit seepage from the tailings reaching the environment. The embankment is constructed of a homogeneous glacial till. The embankment was constructed in 2 stages to its current height.
A spillway has been constructed on the western side of the impoundment. A floating reclaim barge which is currently anchored on the south side of the impoundment.

Figure 3.1 shows an aerial photo of the site overlaid with the GPS tracks from the DSR site inspection. Appendix II contains selected design and construction record drawings for the facility.

3.2 Site Conditions

3.2.1 Hydrology and Floods

3.2.1.1 Hydrology and IDF

Average annual precipitation at the site is 570 mm which includes 175 mm equivalent snowpack (KBC, 2009). Monthly rainfall is highest in July. The catchment area of the TSF is approximately 100 ha and during operation most of the catchment is diverted through the surface water ditches. The catchment is largely forested mountainous slopes.

Based on the permits the facility was required to be designed to manage the PMF. The spillway is designed to pass the 1:10,000-year flood and assumes that the clean water diversions are decommissioned or failed. The analysis was based on a peak inflow from a 30-day storm of 9.5 m^3/s. The IDF recommended for “Very High” consequence structures by CDA (2013) is 2/3 between the 1:1000 and the PMF. The inflow from both a 30 minute and a 30-day storm event was assessed. Also, the rational method was used assuming a runoff factor of 1, which will provide a very conservative estimate of inflow. Consideration of rain on snow events was also assessed.

3.2.2 Surficial Geology

The tailings pond is constructed in the Go Creek catchment. Generally, the site is underlain by up to 20 m of interbedded sands, gravels and cobbles, overlying layered volcanoclastic and carbonaceous sediments. These deposits contain springs which were observed during the site investigation and construction. The assessed inflows from these springs were estimated to be of the order of 15 l/s during design of the TSF.

A thin organic layer was removed from the entire foundation area to expose the underlying granular soils (KCB, 2010).

3.2.3 Tailings Properties

A summary of the typical tailings properties (KCB, 2009) is presented in Table 3.1.

Table 3.1 Summary of Typical Tailings Properties

Parameter	Unit	Range
Density	t/m^3	.8 – 1.1
% solids by weight	%	80
Specific Gravity		3.7 – 3.9
Shear Strength	Friction angle	34
Permeability	m/s	$7x10^{-8}$ m/s
% fines[1]	%	83-92

Note: [1] Non plastic fines

3.2.4 Seismicity

CDA Dam Safety Guidelines (2013) state that the 1 in 5000-year event should be used as the design earthquake for a "Very High" consequence dam. However, regulatory requirements state that the facility must be designed to withstand a 1: 10,000 event. A site specific hazard assessment was conducted for the site coordinates of 61.41°N and 130.09°W, giving a peak ground acceleration of 0.22 g for the 1 in 10,000-year event. The acceleration typically used for pseudo-static stability analysis is 50% of the peak ground acceleration.

3.2.5 Hydrogeology

A detailed assessment of the hydrogeology of the site was not conducted. The surficial soils were tested and found to be very permeable. To control seepage, the facility was designed with a liner and a regional groundwater assessment was not necessary. Observations of artesian groundwater levels and seeps during construction were considered when sizing the underdrain system for the liner.

3.3 Tailings Storage Facility Design

3.3.1 General

The dam was constructed along the south and west sides, while the higher topography on the north and east side contain the pond without the need for a dam. Construction of the dam began in 2009 and was raised in 2012. The dam has a maximum height of 16.5 m and is approximately 800 m long, as shown on Figure 3.2. Tailings have not been placed since 2015 as the facility is in care and maintenance.

Figure 3.1 Facility Overview and Site Visit GPS Tracks

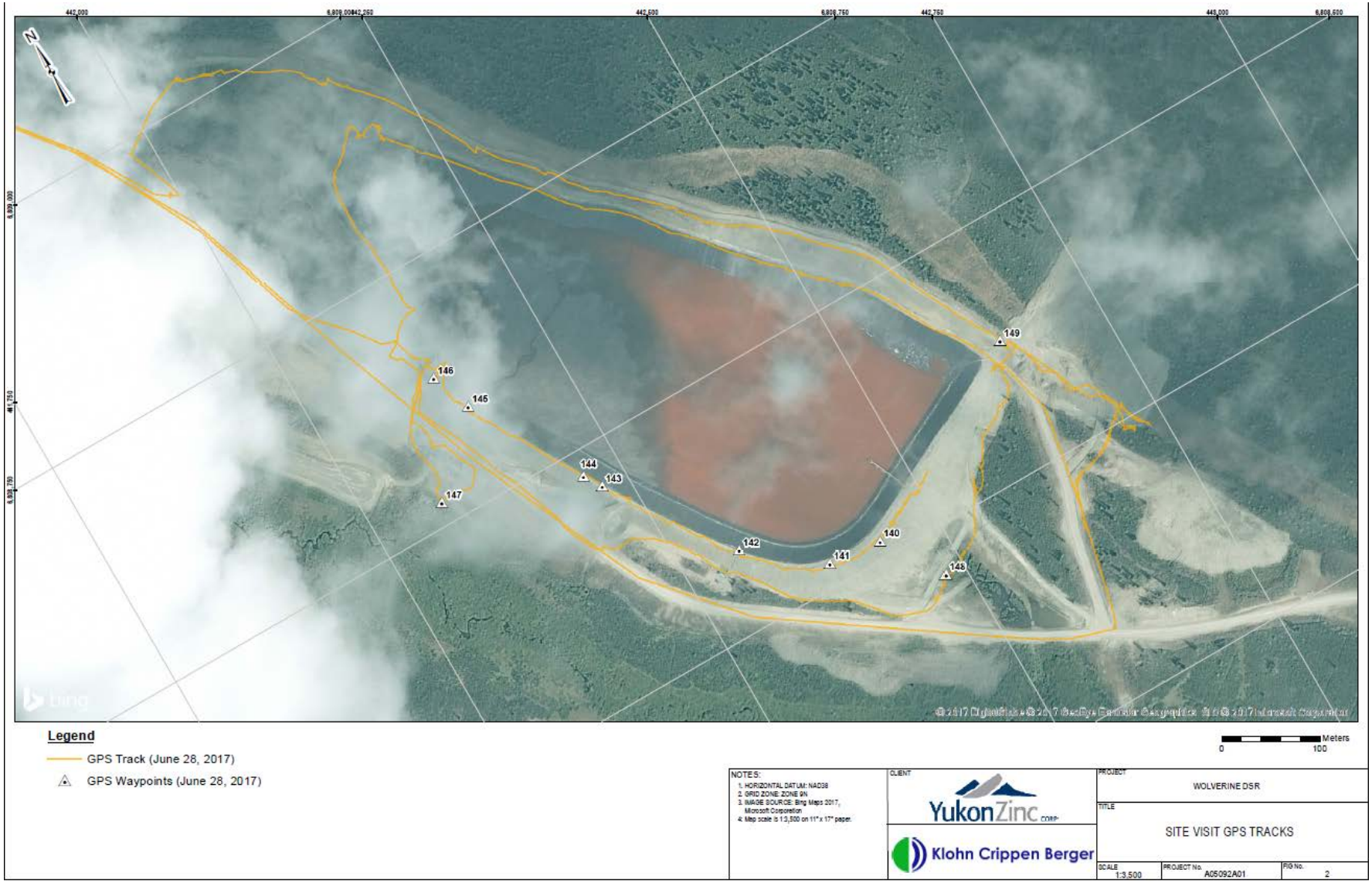
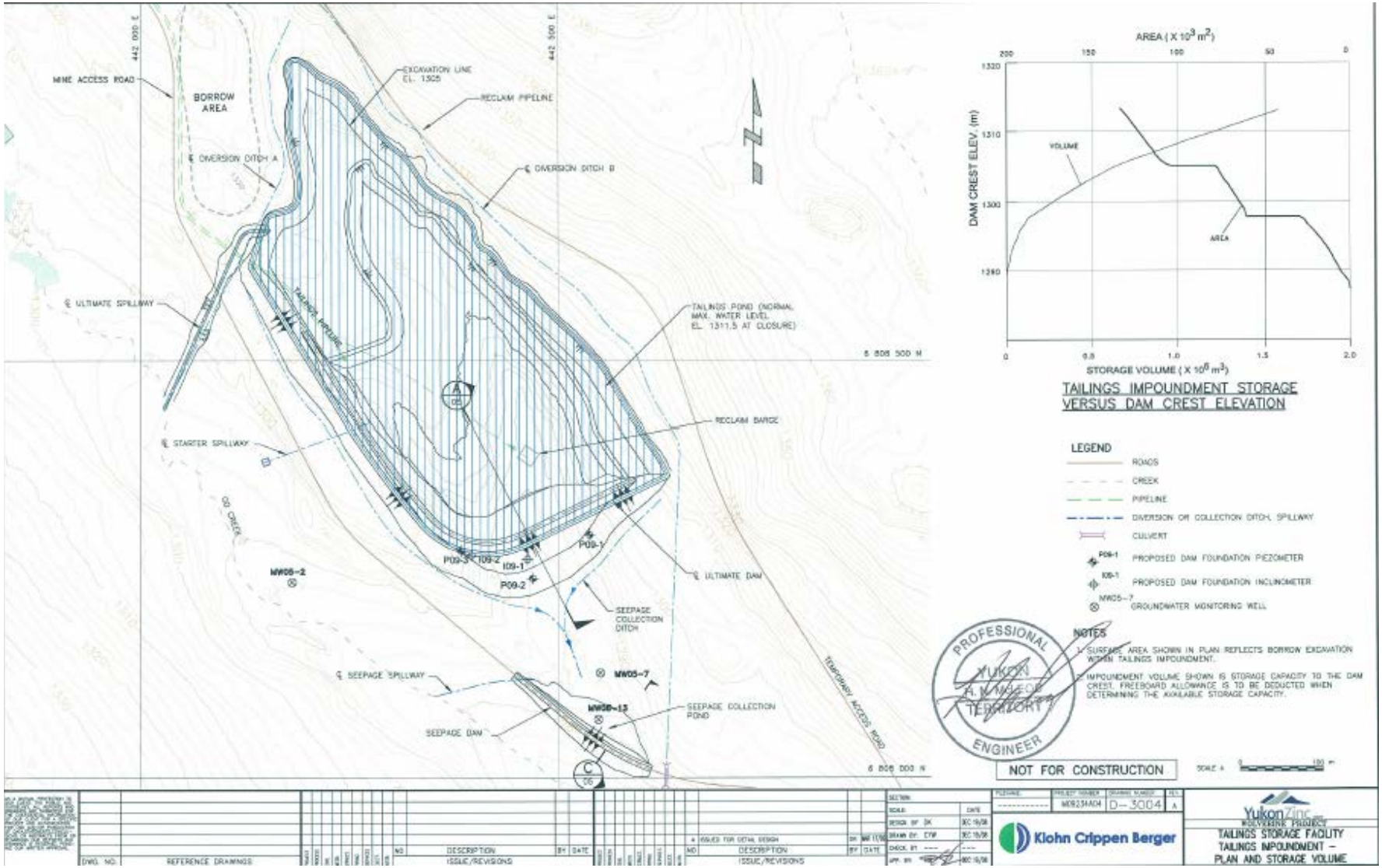


Figure 3.2 Plan View



3.3.2 Dam Design

The dam was constructed as a homogenous earthfill dam using locally borrowed glacial soils for the embankment and screened till for the liner bedding layer. The glacial till was largely borrowed from near the tailings facility or within the footprint. A typical section is shown on Figure 3.3. The dam was raised downstream to allow for the liner to be extended. The upstream and downstream slopes are 2H:1V based on the design slopes and observations on site. The glacial till is a heterogeneous mix of sand, gravel and cobbles. Triaxial tests on the glacial till gave a friction angle of 37° (KCB, 2007). Construction records for the compaction of the glacial till exceeded the specified density of 95% Standard Proctor Density.

The downstream slope of the dam has volunteer grasses that are becoming established but no topsoil or erosion protection has been placed on the slope.

3.3.3 Foundation Conditions

The foundation stratigraphy is up to 20 m of glacial sand, gravel and cobbles over bedrock. The glacial materials were covered with a thin organic layer that was removed prior to construction.

Figure 3.3 Typical Cross Sections

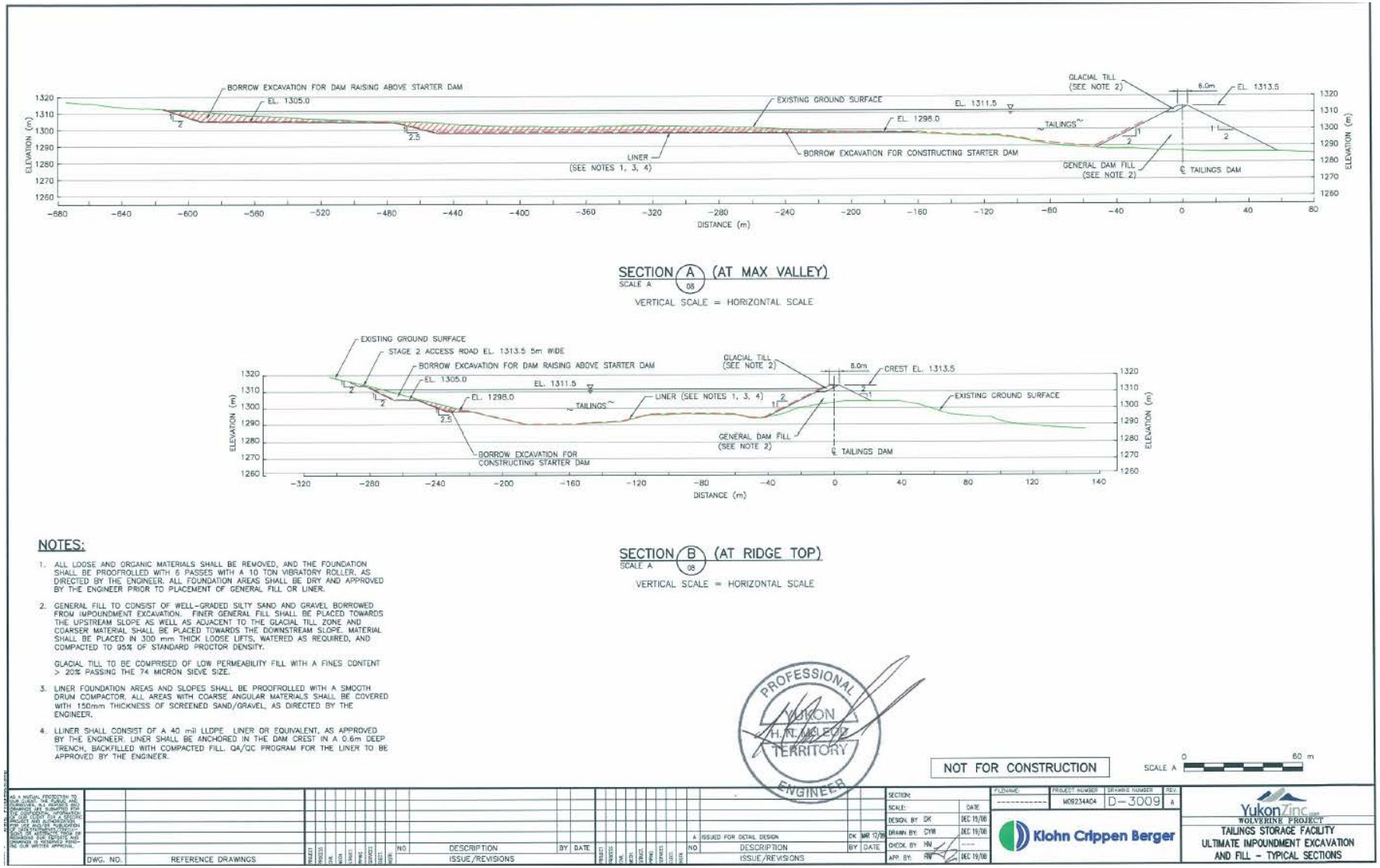
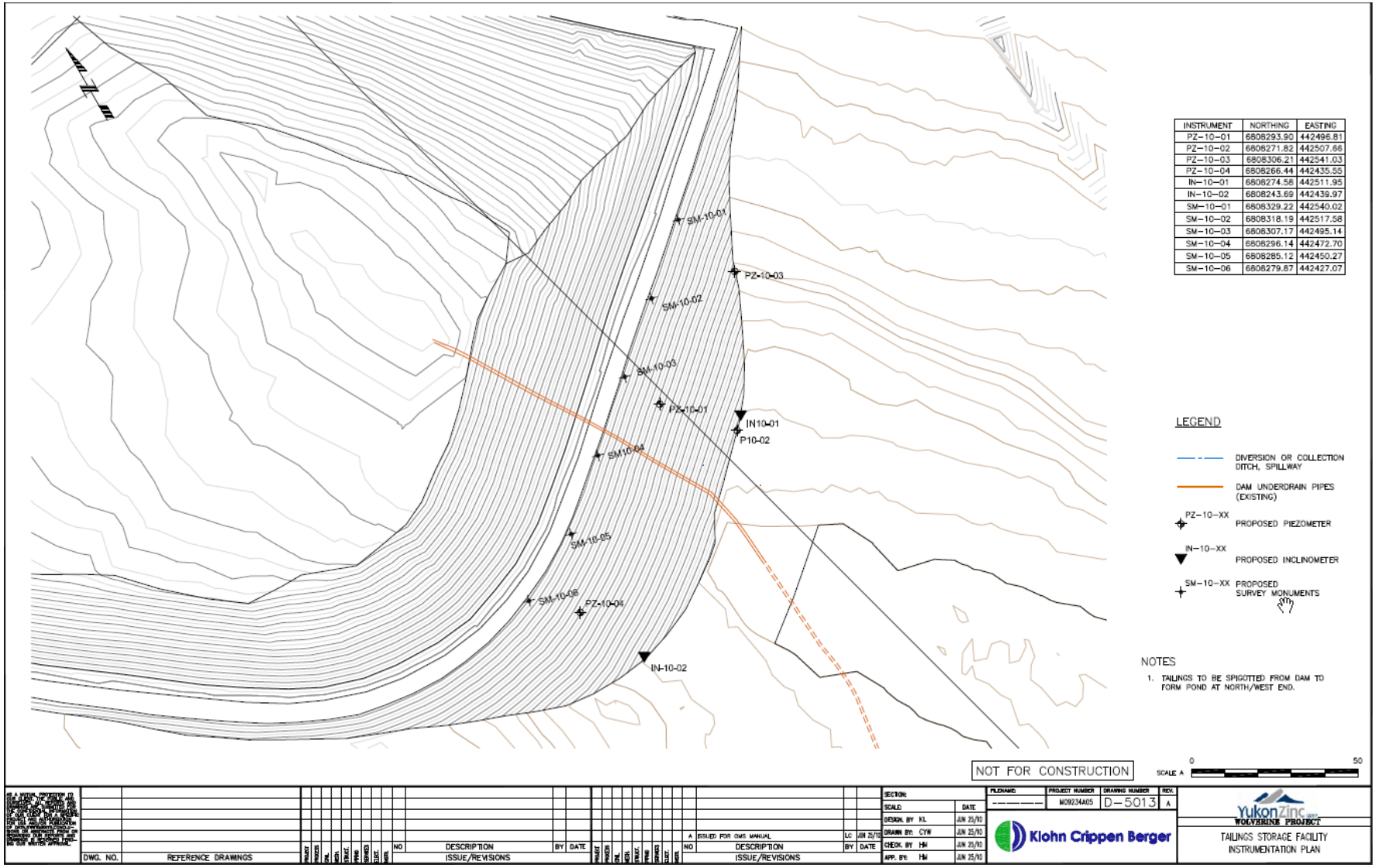


Figure 3.4 Instrumentation Plan



3.4 Water Management and Seepage

3.4.1 Water Management

The tailings pond has two fresh water diversions that direct surface water to the environment before it can flow into the tailings facility. An underdrain has been constructed under the liner to manage groundwater flows under the tailings facility. The underdrains pass under the dam and seepage pond and discharge to the environment.

Currently all contact water is discharged into the TSF. The eventual plan is to construct a water treatment plant so that water can be discharged to the environment.

3.4.2 Water Balance and Seepage

YZC have a water balance for the Wolverine Tailings facility that is maintained along with water quality readings. This has been updated in 2017 and should be reviewed again as part of start-up operations, if the mine goes back into construction.

The facility is lined so there is very low seepage from the tailings expected. The seepage collection dam appears to collect mostly local runoff and foundation seepage. Seepage observed at the toe of the dam is likely natural groundwater seepage.

Visual observations of seepage during the 2017 DSR along the South leg of the toe were observed were limited to damp soil but not actual flowing water.

4 DAM SAFETY ASSESSMENT

4.1 General

4.1.1 Current Dam Classification and Status of Dam Safety Reviews

The reported CDA dam classification for the facility is in the detailed design report is “High to Very High”. The dam classification registered with the Yukon Government is “High”. We recommend that the TSF be considered a “Very High” consequence structure which could be reduced to “High” if a more detailed environmental assessment is conducted. The change to a Very High consequence structure means that the dam safety reviews should be completed every 5 years, rather than 7 years.

This is the first DSR for the facility however, there have been annual inspections conducted since 2014.

4.1.2 Dam Design and Life of Mine Planning

The dam designs, construction and operations spanned from 2007 through 2017. The facilities the design basis and supporting documentation (e.g. borehole logs, laboratory test data, climate analysis, etc.) is available but has not been compiled either into a single comprehensive document or into a complete design/data base for easy access. As a result, this DSR is based on an assessment of the data and design reports, construction documentation and data that were available. Based on our review we consider that we have reviewed all of the key relevant documents. It is recommended that all records for the TSF be consolidated for the facility.

The potential mine restart may also lead to a desire to increase the tailings storage capacity. If that is the case, consolidated investigation, design and instrumentation details will be valuable.

4.1.3 Credible Failure Modes and Relevant Hazards

The most relevant failure mode is related to geotechnical stability, with respect high phreatic levels in the embankments. The risk of this is considered to be low, but the slump that has occurred at the north end of the impoundment shows that there is some potential for instability in the cut slope under the liner.

The environmental consequence of seepage is low due to the presence of the liner.

The current monitoring program is sufficient for monitoring of the potential for instability due to increased pore pressures however there is no active monitoring for deformations under static loading conditions.

4.2 Consequence Classification Review

4.2.1 Consequence Classification

The Canadian Dam Association Dam Safety Guidelines (2007, revised in 2013) provide a classification of dams based on the consequences of failure, as shown in Table 4.1. The dam consequence classification should be selected based on the criteria shown in each category of incremental losses, and supported by relevant quantitative or qualitative evidence.

The classification was reviewed with respect to these categories as follows, based on review of available information:

- Loss of life: The nearest permanent residents downstream of the dams are more than 40 km away, and are not at risk from a dam breach (KCB 2009). Recreational activities (hunting, fishing, etc.) in the inundation zone are infrequent. The guidelines clarify that the population at risk can be counted as "None" if "There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure" (CDA, 2007). Since people may be present in the inundation zone, it is foreseeable that there is a possibility for loss of life. Therefore, the consequence classification for loss of life should be considered "Significant."
- Environmental and cultural values: Go Creek is a fish-bearing river immediately downstream of the dams, and the flood plain area is inhabited by moose, deer and other wildlife species (KCB 2007). The consequences of a dam breach would most likely include "significant loss or deterioration" of fish habitat, high costs and socioeconomic impacts of a failure suggest a consequence classification of "Very High"
- Infrastructure and economics: The inundation zone includes limited infrastructure and no industry downstream of the dam. The economic costs of a failure could be high, but repair is highly possible which results in a consequence classification of "High".

On the basis of the environmental impacts, the dam consequence classification can be considered either "High" or "Very High" but a detailed environmental assessment would be needed to confirm which classification is appropriate. However, the current design meets criteria for an "Extreme" consequence structure. If the dam is classified as "Very High" then only change required is that Dam Safety Reviews should be conducted every 5 years rather than every 7 which is the current approved DSR interval.

Table 4.1 Dam Classification

Dam class	Population at Risk	Incremental Losses		
		Loss of Life	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short-term No long term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat Restoration or compensation in kind is highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very high	Permanent	100 or fewer	Significant loss or deterioration of critical fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities, for dangerous substances)
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services, (e.g., hospital, major industrial complex, major storage facilities for dangerous substances

See Table 2-1 in the CDA 2007 Guidelines for notes related to population at risk and implications of loss of life.

4.2.2 Review of Inundation Assessment

The potential downstream influence of a dam breach was assessed by KCB as part of the feasibility study (KCB, 2007) using dam break charts.

Additional observations related to the dam break assessment include:

- The dam breach assumed that only 30% of the tailings would be mobilized and would be deposited near to the dam. Due to the high specific gravity of the tailings this may be the case but this is based on previous case studies and not on site specific assessment of the tailings breach.
- The study does not quantify if it was a “rainy day” or “sunny day” failure mode.
  A water/slimes depth of approximately 5 m was assumed and the maximum instantaneous flow estimate was 1,850 m^3/s.

A more detailed dam break assessment should be completed to meet the new state of practice for dam break assessments. The results of the assessment should be used to quantify the dam classification and to support Emergency Preparedness Plans and Emergency Response Procedures.

4.3 Regulatory Compliance

The Wolverine Mine is regulated under the Quartz Mining Lease and Yukon Water Board. YZC reports annually to meet the regulatory requirements outlined in Section 2.3 of this DSR report.

4.4 Instrumentation Review

Survey has been conducted annually since the mine entered care and maintenance. However, no specific survey monuments have been surveyed. The slope inclinometers that were installed after the Stage 1 construction have all failed. From the data it appears that they were damaged due to construction of Stage 2 rather than significant movement. However, with the loss of these instruments and no specific survey monuments on the dam means there is no way to evaluate potential movements in the subsurface.

The four remaining vibrating wire piezometers are installed in the dam fill and in the foundation. They show seasonal fluctuations but have largely stabilized in a range. The piezometers had been slowly increasing but since 2015 have largely stabilized. The phreatic surface remains low within the dam fill and is currently below the Yellow or Red alert levels. If the dam is raised in the future, then number of piezometers should be reviewed. The piezometer plots are presented in Appendix III.

4.5 Geotechnical Assessment

4.5.1 General

The dam has performed satisfactorily to date based on the instrumentation data and the annual inspections. Localized minor erosion gullies on the dam slopes were noted during the site visit. This superficial erosion does not present an immediate concern to stability, and the risk can be mitigated through regular repairs. In the long term, a plan for erosion protection should be developed. This plan may include re-grading to a shallower slope angle in some locations to improve vegetation growth. Additional berms and erosion protection may be required for closure.

4.5.2 Stability Analysis

The stability of the dams was confirmed by a limit equilibrium stability analysis using the computer program Slope/W. The model geometry, material properties and analysis results are presented in Figure 4.1 and the factors of safety are summarized in Table 4.2. The analysis was carried out to check the stability and to review the sensitivity groundwater elevation.

The analyses were performed for the highest dam section. Only failure geometries that include at least half the width of the dam crest were considered in the analysis. The material properties were taken from the most recent design update report (KCB, 2010). The pore pressures assumed are based on the vibrating wire piezometer data collected in 2017.

The pseudo-static analysis considered the typical PGA reduction of 50% (Hynes-Griffin and Franklin, 1984).

Table 4.2 Results of Limit Equilibrium Stability Analysis

Loading Case	Calculated Factor of Safety	Minimum Required FoS from CDA (2013) Guidelines
Static	1.5	1.5
Pseudo static, 0.12g	1.2	1.0

The results indicate that the static factors of safety meet CDA guidelines. The dam fill is still largely undrained, due to the presence of the liner and under drain system. Even pore pressures 2 m above the base of the dam fill met the required Factor of Safety of 1.5. Given the lack of evidence of seepage on the downstream face of the dam the stability assessment is adequate.

4.5.3 North End Slump

The north end of the impoundment has slumped under the liner. This section of the impoundment is excavated into natural ground and there is no constructed embankment at this location. This area is adjacent to the upstream end of the liner under drain system. The slope failure is likely a combination of high groundwater levels from region sources, seepage from Ditch A before it was lined and potentially high water levels from the liner under drain. This instability does not presently pose a dam safety hazard. But as the liner is damaged there is potential for seepage of contaminated tailings water into the environment if it is not repaired in a timely manner. A short term remediation (recommended by the EOR) of the slump area was implemented but the movement continues and a long term solution is required.

At this time, there is no evidence of a significant rupture in the liner. The pond level is continuing to rise slowly from inflows from other sources on site. If there was a tear in the liner the water would be flowing into the under drain system and unlikely to rise at the rate it has shown. If the mine remains in care and maintenance and there is no water treatment plant available, the pond level will continue to rise. If the mine goes back into operations, then tailings will again be deposited in the tailings facility. If the mine goes to full closure, then the pond will be pumped out and the tailings covered. We recommend that the liner area be repaired before the pond level rises another 1 to 2 meters or additional tailings are placed in the area. However, if the pond level will be managed through water treatment or the move to full closure then there is no reason to repair the area.

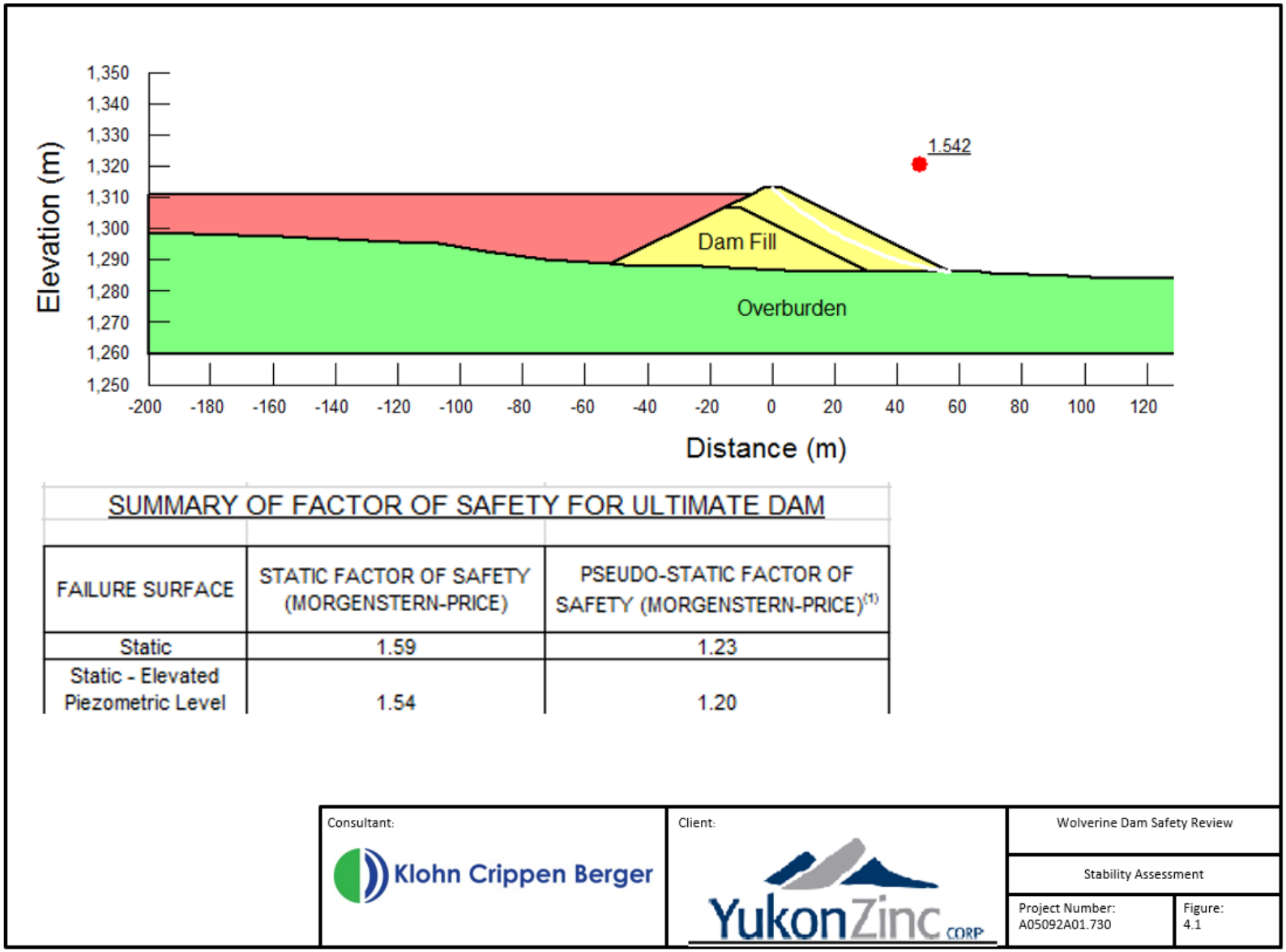
The area can be repaired now fairly easily, as there is less than 1 m of tailings in the area. The area will have to be isolated keep the tailings and water away from the area. An aquadam (inflatable dam) could be used as an isolation structure and water pumped over into the main pond. The liner could then be pulled back and the soft, failed materials removed and replaced with compacted granular fill. A new lined area could be installed and work completed to ensure long term stability of the area.

The repair will also provide an opportunity to inspect the upper section of the underdrains and make sure they are not blocked and adding to ponding at the upstream end of the impoundment.

The repair should be fully documented. This information will be required for future management of the TSF in both operation and closure.

If the tailings facility is expanded this area will be contained within a constructed embankment and consideration will need to be given to foundation conditions and surface water drainage. Ditch A will be constructed over by a tailings dam raise and this will require rerouting of the surface water ditches.

Figure 4.1 Stability Analysis



SUMMARY OF FACTOR OF SAFETY FOR ULTIMATE DAM

FAILURE SURFACE	STATIC FACTOR OF SAFETY (MORGENSTERN-PRICE)	PSEUDO-STATIC FACTOR OF SAFETY (MORGENSTERN-PRICE)[1]
Static	1.59	1.23
Static - Elevated Piezometric Level	1.54	1.20

Consultant: Klohn Crippen Berger
Client: Yukon Zinc Corp
Wolverine Dam Safety Review
Stability Assessment
Project Number: A05092A01.730
Figure: 4.1

4.6 Hydrotechnical Assessment

4.6.1 Inflow Design Flood

The inflow design flood protection is managed by providing storage for the 30 day IDF. This is achieved with a freeboard requirement, which is maintained at all times KCB (2009). The basis for the IDF includes:

- a peak runoff estimate based on a 30-minute storm added to the total runoff volume predicted from a long duration storm event; and
- runoff coefficients of 1.0 for the entire catchment.

The above IDF assessment was used to confirm a minimum freeboard of 1.0 m for the impoundment.

The main KCB observations on the IDF include:

- The specific rainfall event for the design storm is not listed. It would be recommended to have the total rainfall that was the basis for the IDF.
- Wave run-up has not been included in the freeboard assessment and this should be determined.

Based on the above discussion, the IDF documentation should be revised to state a specific rainfall event and wave run-up calculations should be completed to confirm that the freeboard is sufficient to manage waves.

The facility has been designed with a spillway that can safety pass the 1:10,000-year flood event. Currently the spillway not adjacent to the deepest part of the pond but future tailings planning will move the pond closer to the inlet of the spillway.

4.6.2 Water Balance and Seepage

The tailings impoundment is operated on a “no-discharge” basis with water currently being stored in the TSF. Once the water treatment plant is constructed then water will be able to be discharged from the TSF to the environment. If the mine restarts, then water will also be recycled back to the mill via the reclaim barge system. KCB review of the water balance indicates that the loss of water to the tailings voids is included. Routine updates of the water balance are completed by YZC and these should continue and potential updates made as part of the restart plan.

Seepage rates out of the impoundment are very low due to the LLDPE liner. Minor seepage is observed at the toe of the south leg of the dam but this is likely due to regional groundwater and not leakage from the TSF based on the water quality results to date.

4.7 Structural/Hydro-mechanical Assessment

The reclaim system is not operational at this time as the facility is in care and maintenance. Prior to restart of mining operations the reclaim system should be tested and regular maintenance should resume at that time.

From a dam safety perspective, the reclaim system could be shut down for a period of time as long as the dam safety freeboard is maintained. The reclaim system could assist in dewatering the pond during an extreme precipitation event. However, it would not have the capacity, for example, to handle the current IDF volume which flows in at an average rate of approximately 10 m^3/sec.

4.8 Mining Dam Considerations

4.8.1 Closure

The CDA technical bulletin for Mining Dams (2014) introduce requirements for consideration of closure and environmental objectives of the dams. A closure plan for the facility has been developed. The closure plan includes a plan to remove the pond and transition the facility to a dry landform. The CDA technical bulletin for Mining Dams (2014) also recommends higher design criteria for closure-passive care. The design for the facility is suitable for an “Extreme” consequence dam and therefore meets the recommendation for a consequence classification that is higher at passive closure.

4.8.2 Water Quality

The facility is currently operating without direct discharge of surface water to the environment. Seepage from the impoundment is discussed in Section 3.4.2 of this report. Water quality data were available for review up to 2016. The main observations regarding seepage water quality include:

- currently groundwater monitoring outside of the TSF shows minimal change from background readings; and
- surface water sample collection has restarted in 2017 but there have been no reported exceedances of water quality.

We understand that YZC reports water quality data from 4 groundwater wells and a number of surface water sampling points. These reports are issued to the Yukon Government. The only concern at the time of the DSR was that sampling frequency had not been maintained during the care and maintenance period. However, sampling intervals were being re-established in accordance with the permit requirements.

4.9 Public Safety Management

YZC have an Emergency Response Procedure (ERP) in place which is the framework for identifying and responding to emergencies. The ERP is out of date as it references contacts for staff that no longer work of YZC. This document needs to be revised to reflect current site staff and potential

responses to an emergency. A test of the emergency response system tested to evaluate the system using the current operations staff.

If the mine goes back into operation or to full closure the plans should also be revised to reflect these new conditions. Similar to the OMS manual the ERP should be a living document that is tested, reviewed and revised to reflect the current stage of the facilities life cycle.

4.10 Dam Safety Management Program Assessment

4.10.1 Organization and Reporting

4.10.1.1 Management and Reporting

The organization structure for management of the tailings facilities is presented on Figure 2.1, but is out of date. This should be updated to reflect the current status of the operation. The OMS manual needs to be revised to reflect the current status of the mine in care and maintenance. It should also be updated again once decisions are made on whether the mine transitions back to operation or to closure.

The framework that is presented in the OMS manual can be used as a basis for future updates to the OMS.

4.10.1.2 Inspections and Engineer of Record Engagement

Current reporting is managed on by care and maintenance site staff and with an environment consultant as needed. Annual reporting to the government is also completed. The dam freeboard requirement is met as the pond level is well below the crest of the dam. The piezometers are on a datalogger so regular readings are collected but the data is only processed annually at this time. reporting processes should be refreshed as part of the OMS review.

The EoR has been actively involved with the tailings facilities and annual inspection reports, construction reports and design update reports have been produced. The reporting quality and documentation of the work is good. The only exception to this is the 2016 annual inspection was conducted by another firm.

4.10.2 Operations, Maintenance and Surveillance (OMS) Manual

The framework of the OMS document is complete and covers the required components. However, there are improvements that should be made to the document to reflect ongoing changes and the results of this DSR. The main observations for improvement are summarized in Table 4.3

Table 4.3 Summary of Review of the OMS Document

Section No.	Description	DSR Observations
2	Roles and Responsibilities	▪ The organization chart and responsibilities of key staff need to be updated to reflect the change in organization and responsibility. ▪ Primary responsibility should rest with an Engineer registered to practice in the Yukon.
3	Facility Description	▪ Site conditions should include 24 hr precipitation rates for various return periods. ▪ Site conditions should show a plan of all drill holes and reference the supporting data (logs, laboratory tests, etc) and their storage location. ▪ Basis of design should document IDF flood volumes for design return period. ▪ Construction history should include current volumes of stored tailings and water.
7	Reporting Responsibilities and Documentation	▪ Update with the new management structure. ▪ Clearly identify Engineer responsible for the TSF. ▪ Report database should be updated to include all reports, with clear reference location for retrieval. Site investigation and laboratory data, etc. should be included. Specify location of Central File.
8	Emergency Planning & Response	▪ Update Emergency Preparedness Plan (EPP) when results of Inundation Study are available. ▪ All contacts should be reviewed and updated as necessary.

4.10.3 Emergency Preparedness Plan

The Emergency Preparedness Plan (EPP) in included in Section 8 of the OMS manual, and as summarized in Table 4.3.

The EPP will need to be updated to reflect the current mine status. This should also include the revised Inundation Study.

The Emergency Response Procedure provides the framework for response to emergencies, with reference to specific emergency response procedures, of with the OMS manual for the tailings facility is referenced.

A specific procedure for evacuation should be developed in the case of a dam breach. The evacuation procedures would require notification of potentially affected communities downstream of Wolverine.

4.11 CDA Principles Assessment

There are 19 CDA Dam Safety Principles presented in the CDA Guidelines (CDA, 2007) and are divided into five categories:

- Principle 1: Dam Safety Management System;
- Principle 2: Operations, Maintenance, and Surveillance;
- Principle 3: Emergency Preparedness;
- Principle 4: Dam Safety Review; and
- Principle 5: Analysis and Assessment.

The results of the CDA Principles Assessment are presented in Appendix IV. A summary of the findings of this assessment are presented as follows:

- 9 Conformance;
- 4 Non-Conformances in Information;
- 2 Non-Conformances in Surveillance; and
- 4 Non-Conformances in Other Procedures.

The majority of the non-conformances relate to the outdated nature of the OMS manual and can be remedied by updating the OMS manual and formalized documentation of existing information. Other non-conformances can be addressed by revising schedules for maintenance and surveillance, commencing these activities, and by documenting the findings.

A full list of recommendations arising from this report is summarized in Section 5.

5 RECOMMENDATIONS

This 2017 Dam Safety Review report has been carried out using the guidelines provided by the Canadian Dam Association (2013).

The conclusion of the assessment is that the dam is reasonably safe but the dam safety review did reveal deficiencies and non-conformances as summarized in Table 5.1 and Table 5.2.

Table 5.1 Recommendations for Dam Safety Aspects

Deficiency or Non-Conformance	No. (Report Section)	Recommended Action	Schedule
Deficient Flood Event Values and Assessment	4.6.1	The hydrology assessment appears to be comprehensive: ▪ However, the specific rainfall total used to calculate the IDF should be presented (not just the design event duration). ▪ PMF volume inflow volume should also be provided.	December 2017.
North End Slump Repair	4.5.3	The slumped section under the liner at the north end should be repaired prior to placement of additional 1 m of water or additional tailings in the TSF.	Repair by Dec 2019 or prior to restart of mining activities (whichever is first).
Out of date inundation study.	4.2.2	The inundation study was conducted based on published tables and does not meet the current state of practice for inundation studies. This should be updated and used to update the Emergency Preparedness Plan.	C&M – Dec. 2018 Active Mining – Dec. 2018 Closure – part of closure plan development

Table 5.2 Recommendations for Surveillance and Maintenance Aspects

Deficiency or Non-Conformance	No. (Report Section)	Recommended Action	Schedule
Lack of consolidated site records	2.1	Site records need to be consolidated into a centralized file, including: ▪ site investigation data and laboratory test data (historic and recent); ▪ as-constructed records, including site visit notes and foundation preparation assessments; and ▪ design basis with assumptions to key design parameters and criteria.	Closure – August 2019 Prior to restart of mining activities (whichever is sooner)
OMS document not updated	4.10.2	The OMS manual should be updated as summarized in Table 4.3 of this document	December 2017
EPP update	4.10.3	Emergency preparedness plan should be updated to reflect current operating staff and communications. The plan should be reviewed/revised again once the new inundation study is available. This can also be used for communication with local stakeholders on potential impacts of a dam safety incident.	December 2017

6 CLOSING

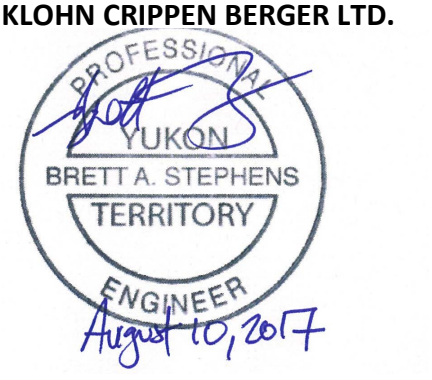
This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Yukon Zinc Corporation. (Client) for the specific application to the Wolverine DSR.

In the preparation of this DSR Report, KCB has endeavored to observe the degree of care and skill generally exercised by other consultants undertaking similar DSRs at the same time, under similar circumstances and conditions, and in the same geographical area. KCB makes no other warranty, expressed or implied.

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

- The report is intended for the sole and exclusive use of the Client and it may not be used or relied upon in any manner or for any purpose whatsoever by any other party, without the express written permission of KCB.
- The report is based on information provided to KCB by the Client or by others on behalf of the Client. KCB has not verified the accuracy or validity of this information and further, makes no representation regarding its accuracy and validity. KCB shall not be liable for any loss, cost, expense, or damage arising from or as a result of the incorrectness or inaccuracy of such information.
- The report is read as a whole, with sections or parts of the report read or relied upon in the context of and subject to the terms of the Contract Agreement between KCB and the Client.
- The executive summary is a selection of key elements of our instrument of service. It does not include crucial details needed for the proper application of our findings and recommendations, which are best evaluated with the active participation of the professionals who developed them.
- The observations, findings, and conclusions in this report are based on conditions that existed at the time of the work described herein and should not be relied upon to precisely represent conditions at any other time.

KLOHN CRIPPEN BERGER LTD.



Brett Stephens, P.Eng.
Dam Safety Review Engineer

Pamela Fines, P.Eng.
Project Engineer

REFERENCES

Refer to Table 2.1 for a list of references reviewed for this report. The tables also provide a brief summary description of main subjects covered by the reports. Additional references used are as follows:

Canadian Dam Association, 2013. “Dam Safety Guidelines”, January. (with Revised Section 6, issued in 2013)

Canadian Dam Association, 2014. “Technical Bulletin: Application of Dam Safety Guidelines to mining Dams”, not yet issued to public.

Hynes-Griffin, M.E. and Franklin, A.G. 1984. “Rationalizing the Seismic Coefficient Method”. Misc Paper GL-84-13, US Army Corps of Engineers, Washington, DC. Natural Resources Canada (2010). 2010 National Building Code of Canada seismic hazard calculator, http://www.earthquakescanada.nrcan.gc.ca/hazard -alea/interpolat/index_2010-eng.php (accessed on June 23, 2014).

APPENDIX I

Site Visit Photographs

Appendix I
Site Visit Photographs

Photo 1 Overview of Pond Looking South

Photo 2 Overview of Pond looking north

Photo 3 Minor rutting on dam crest near left abutment

Photo 4 Left abutment looking north

Photo 5 Debris and dead animals in pond

Photo 6 Reclaim barge

Photo 7 Overview of seepage pond looking back toward tailings dam

Photo 8 Seepage Pond Embankment Crest – Road

Photo 9 D/S slope, seepage at toe leading into seepage pond

Photo 10 Discharge from under drain pipes downstream of seepage pond

Photo 11 Discharge pipes running near full from recent rains

Photo 12 Upstream end of under drains

Photo 13 D/S Slope looking towards left abutment

Photo 14 Downstream slope looking west

Photo 15 Downstream toe near seepage pond

Photo 16 West Leg of Embankment Looking South

Photo 17 Erosion gully near d/s toe of dam

Photo 18 Minor erosion gullies on downstream slope

Photo 19 Dam crest, anchor post, minor veg on d/s slope

Photo 20 D/s slope looking towards spillway

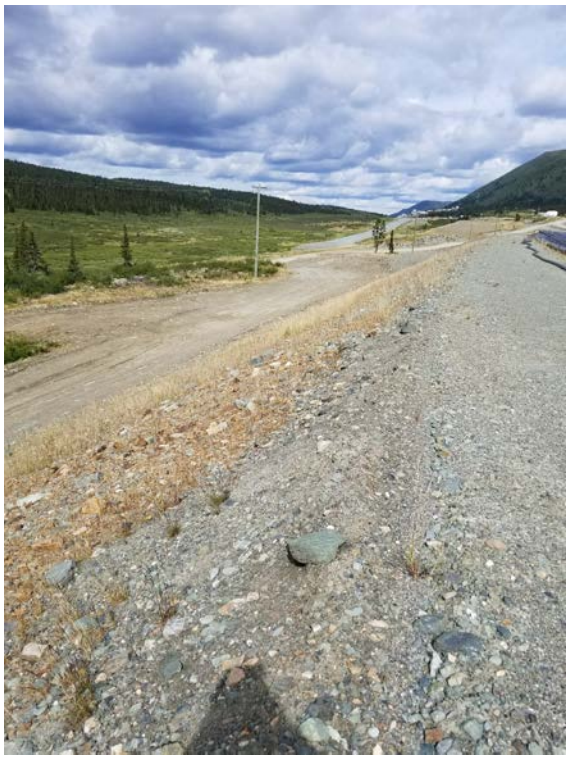


Photo 21 Decommissioned starter spillway]

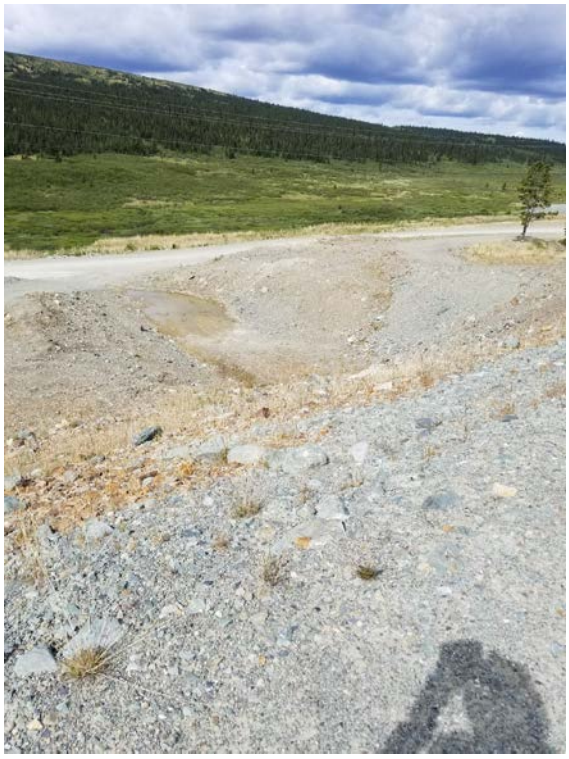


Photo 22 Minor ponded water from recent rainfall

Photo 23 Pipe discharging water from other on site facilities

Photo 24 Cracking in dam crest near north end slump

Photo 25 Temporary cover over slump area

Photo 26 Debris from monitoring set up

Photo 27 Slump at north end

Photo 28 Animal burrow into liner

Photo 29 Ditch B

Photo 30 Ditch B Some Ponding Water

Photo 31 Ditch B Inlet to culvert section pipe to discharge pad

Photo 32 Outlet of Ditch B

Photo 33 Discharge Pad at Bottom of Ditch B

Photo 34 Ditch B Discharge Pad

Photo 35 Reclaim barge anchor – minor damage in tailings pipeline

Photo 36 Spillway channel looking upstream towards pond

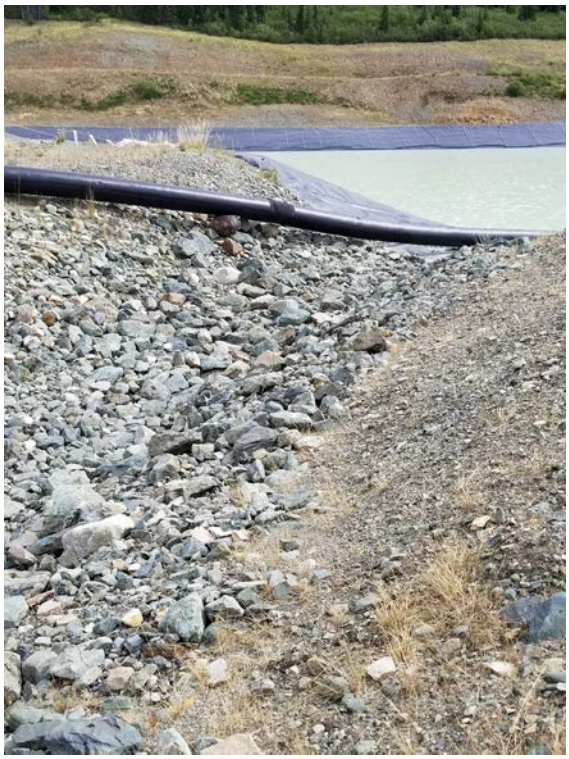


Photo 37 Pipe bridge over spillway channel

Photo 38 Spillway channel looking downstream

Photo 39 Pipe bridge over spillway channel looking downstream

Photo 40 Discharge pad for vacuum trucks

Photo 41 Upstream face and lined section of Ditch A

Photo 42 Ditch A Culvert leading to discharge point

Photo 43 Discharge pad from Ditch A

Photo 44 Lined section of Ditch A

Photo 45 Debris collecting in ditch from surface erosion

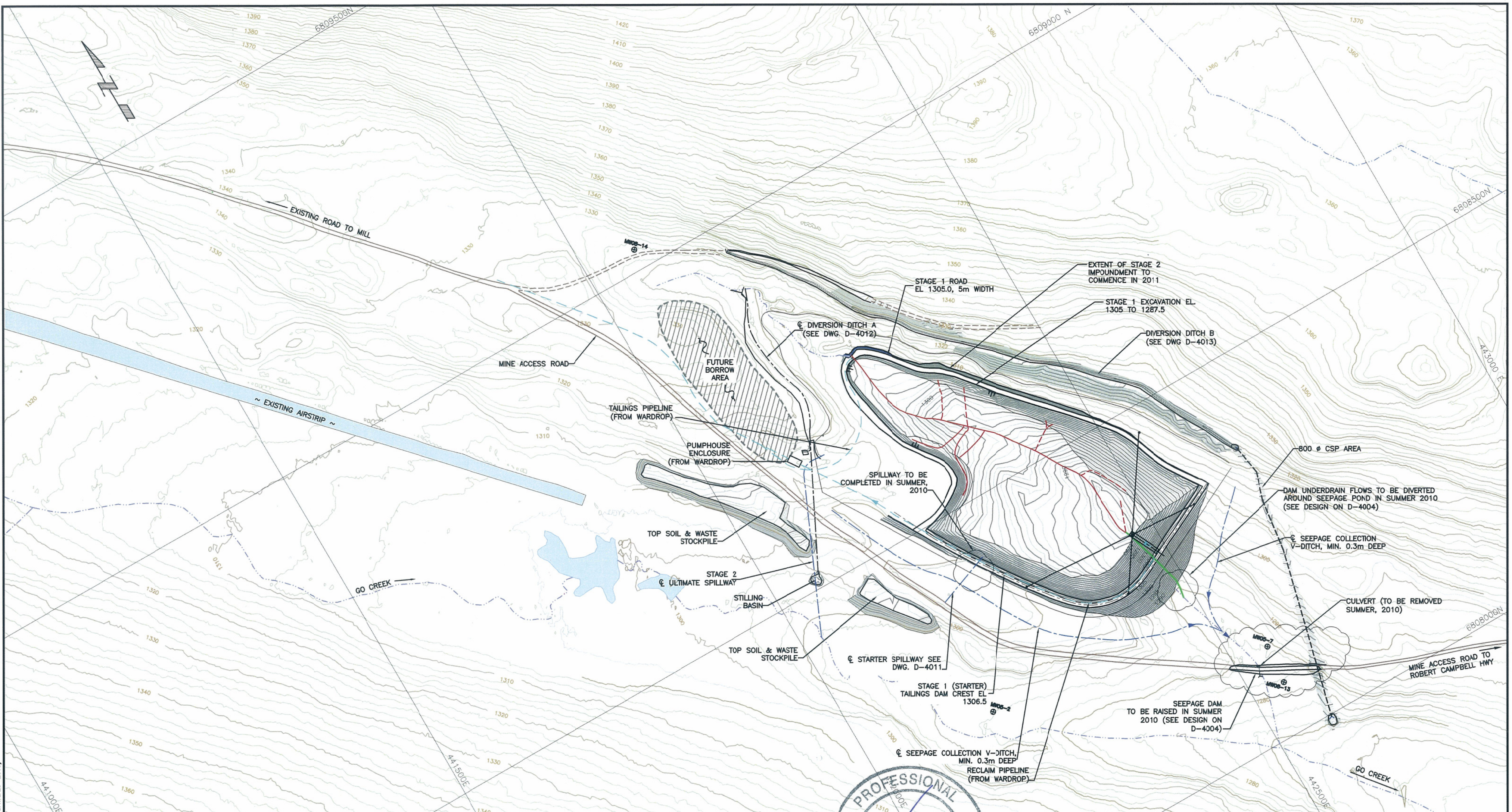
Photo 46 North End of Ditch A

Photo 47 Ditch A Adjacent to Biopass

APPENDIX II

Selected Design and Construction Drawings

Time: 11:30:25
Date: 4/19/2010
Scale: 1=25(PS)
Drawing File: M:\M09234A05 - Wolverine 2009 Construction\400 Drawings\as-built-2009-PersyE\DraftAsbuilt-Mar25-10\D-4001r3.dwg (kiln)
Xrefs: CONT_2M_MINE_4Mgrid(Mod7mar25-2010)



EXISTING ROAD TO MILL
~ EXISTING AIRSTRIP ~
MINE ACCESS ROAD
FUTURE BORROW AREA
TAILINGS PIPELINE (FROM WARDROP)
PUMPHOUSE ENCLOSURE (FROM WARDROP)
TOP SOIL & WASTE STOCKPILE
STAGE 2 ℄ ULTIMATE SPILLWAY
STILLING BASIN
GO CREEK
℄ DIVERSION DITCH A (SEE DWG. D-4012)
STAGE 1 ROAD EL 1305.0, 5m WIDTH
EXTENT OF STAGE 2 IMPOUNDMENT TO COMMENCE IN 2011
STAGE 1 EXCAVATION EL. 1305 TO 1287.5
DIVERSION DITCH B (SEE DWG D-4013)
800 ø CSP AREA
DAM UNDERDRAIN FLOWS TO BE DIVERTED AROUND SEEPAGE POND IN SUMMER 2010 (SEE DESIGN ON D-4004)
℄ SEEPAGE COLLECTION V-DITCH, MIN. 0.3m DEEP
CULVERT (TO BE REMOVED SUMMER, 2010)
MINE ACCESS ROAD TO ROBERT CAMPBELL HWY
SEEPAGE DAM TO BE RAISED IN SUMMER 2010 (SEE DESIGN ON D-4004)
SPILLWAY TO BE COMPLETED IN SUMMER, 2010
℄ STARTER SPILLWAY SEE DWG. D-4011
STAGE 1 (STARTER) TAILINGS DAM CREST EL 1306.5
℄ SEEPAGE COLLECTION V-DITCH, MIN. 0.3m DEEP
RECLAIM PIPELINE (FROM WARDROP)
MW06-14
MW06-7
MW06-13
MW06-2
6809500N
6809000 N
6808500N
6808000N
441000E
441500E
442500E
443000E

NOTES

1. NOT ALL CULVERTS HAVE BEEN SHOWN.
2. ALL ELEVATIONS IN METRES.
3. DRAFT CONSTRUCTION RECORD DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.

CONSTRUCTION RECORD

SCALE: 0 — 200 m

PROFESSIONAL ENGINEER — YUKON TERRITORY — McLEOD

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

DWG. NO.	REFERENCE DRAWINGS

NO	DESCRIPTION	BY	DATE
3	CONSTRUCTION RECORD	LC	MAY 12/10
2	DRAFT CONSTRUCTION RECORD	JL	MAR 5/10
1	ISSUED FOR CONSTRUCTION	MD	MAR 13/09
0	ISSUED FOR TENDER	DK	FEB 04/09

		DATE
SECTION		
SCALE:		
DESIGN. BY	LC	MAY 12/10
DRAWN BY:	KL	MAY 12/10
CHECK. BY	HM	
APP. BY:	HM	MAY 12/10

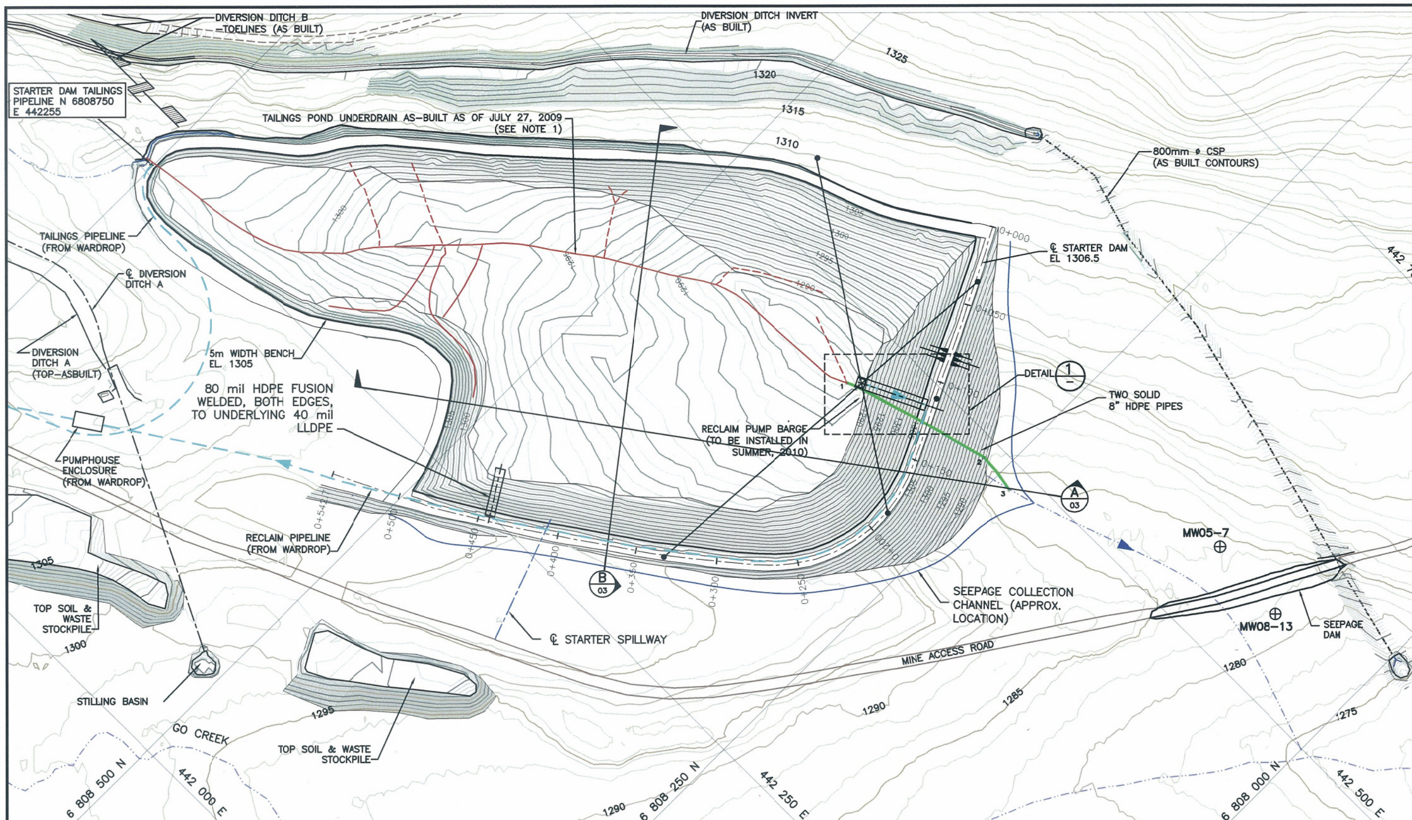
FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A05	D-4001	3

Klohn Crippen Berger

YukonZinc CORP
WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
GENERAL SITE ARRANGEMENT

315476STD.DWG

Time: 15:14:57
Date: 4/20/2010
Scale: 1=3(PS)
Drawing File: M:\M09234A05 - Wolverine 2009 Construction\400 Drawings\as-built-2009-PersyE\DraftAsbuilt-Mar25-10\D-4002_SHT1OF2_r6.dwg (kiln)
Xrefs: CONT_2M_MINE_4Mgrid(Mod7MAR25-2010)
31547STD.DWG


DIVERSION DITCH B
TOELINES (AS BUILT)
DIVERSION DITCH INVERT (AS BUILT)
STARTER DAM TAILINGS PIPELINE N 6808750 E 442255
TAILINGS POND UNDERDRAIN AS-BUILT AS OF JULY 27, 2009 (SEE NOTE 1)
800mm ø CSP (AS BUILT CONTOURS)
TAILINGS PIPELINE (FROM WARDROP)
℄ DIVERSION DITCH A
DIVERSION DITCH A (TOP-ASBUILT)
5m WIDTH BENCH EL. 1305
80 mil HDPE FUSION WELDED, BOTH EDGES, TO UNDERLYING 40 mil LLDPE
PUMPHOUSE ENCLOSURE (FROM WARDROP)
RECLAIM PUMP BARGE (TO BE INSTALLED IN SUMMER, 2010)
℄ STARTER DAM EL 1306.5
DETAIL 1
TWO SOLID 8" HDPE PIPES
RECLAIM PIPELINE (FROM WARDROP)
TOP SOIL & WASTE STOCKPILE
STILLING BASIN
GO CREEK
℄ STARTER SPILLWAY
SEEPAGE COLLECTION CHANNEL (APPROX. LOCATION)
MINE ACCESS ROAD
MW05-7
MW08-13
SEEPAGE DAM
6 808 500 N
442 000 E
6 808 250 N
442 250 E
6 808 000 N
442 500 E
442 750 E

PLAN
SCALE A

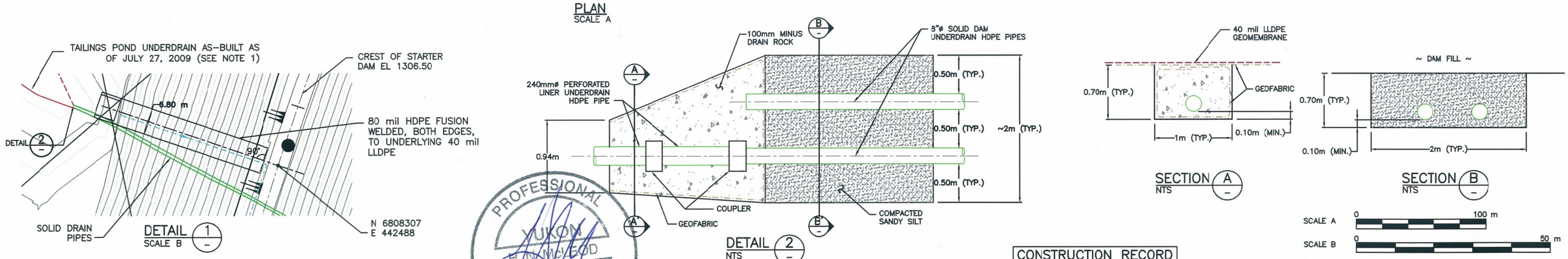
DAM — TWO SOLID UNDERDRAIN PIPES							
WEST PIPE				EAST PIPE			
SURVEY POINTS	NORTHING (m)	EASTING (m)	ELEVATION (m)	SURVEY POINTS	NORTHING (m)	EASTING (m)	ELEVATION (m)
1	6808355.00	442461.90	0.00	1	6808356.00	442462.20	0.00
2	6808264.06	442488.27	1284.45	2	6808263.98	442489.13	1284.44
3	6808238.83	442485.41	1284.02	3	6808239.14	442486.04	1284.08

LEGEND

- ROADS
- CREEK
- DIVERSION OR COLLECTION DITCH, SPILLWAY
- LINER UNDERDRAIN (240 mm ø PERFORATED PIPE INSTALLED)
- LINER UNDERDRAIN (NO PIPE INSTALLED)
- LINER AREA
- MW05-7 GROUNDWATER MONITORING WELL
- SOLID DAM UNDERDRAIN PIPE
- ANCHOR BLOCKS (FROM WARDROP)

NOTES

1. LOCATION AND EXTENT OF LINER UNDERDRAIN WAS DETERMINED IN THE FIELD BY SITE ENGINEER, FOLLOWING THE LOWEST EXISTING DRAINAGE COURSE. THE UNDERDRAIN REPORTS TO AN OPEN DITCH D/S OF THE DAM VIA 2-SOLID PIPES.
2. LINER FOUNDATION CONTOURS SURVEYED JULY 26, 2009. BY ACL
3. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.
4. BASIN VOLUME BELOW EL. 1304.5 = 665,127 m^3
5. ELEVATIONS ARE GIVEN IN METRES UNLESS OTHERWISE STATED.


TAILINGS POND UNDERDRAIN AS-BUILT AS OF JULY 27, 2009 (SEE NOTE 1)
CREST OF STARTER DAM EL 1306.50
6.80 m
80 mil HDPE FUSION WELDED, BOTH EDGES, TO UNDERLYING 40 mil LLDPE
DETAIL 2
SOLID DRAIN PIPES
N 6808307
E 442488
DETAIL 1
SCALE B
100mm MINUS DRAIN ROCK
8"ø SOLID DAM UNDERDRAIN HDPE PIPES
240mmø PERFORATED LINER UNDERDRAIN HDPE PIPE
0.94m
0.50m (TYP.)
~2m (TYP.)
COUPLER
GEOFABRIC
COMPACTED SANDY SILT
DETAIL 2
NTS
40 mil LLDPE GEOMEMBRANE
GEOFABRIC
0.70m (TYP.)
1m (TYP.)
0.10m (MIN.)
SECTION A
NTS
~ DAM FILL ~
2m (TYP.)
SECTION B
NTS
SCALE A 0 100 m
SCALE B 0 50 m

CONSTRUCTION RECORD

DWG. NO.	REFERENCE DRAWINGS

NO	DESCRIPTION	BY	DATE
6	CONSTRUCTION RECORD	LC	MAY 12/10
5	DRAFT CONSTRUCTION RECORD	JL	MAR 5/10

ISSUE/REVISIONS

NO	DESCRIPTION	BY	DATE
4	GENERAL UPDATE	HM	JUL 29/09
3	MODIFY EXCAVATION PLAN, RECLAIM PAD	HM	JUL 17/09
2	ADDED CURVE TABLE	JL	MAY 26/09
1	ISSUED FOR CONSTRUCTION	DK	MAR 13/09
0	ISSUED FOR TENDER	DK	FEB 04/09

ISSUE/REVISIONS

PROFESSIONAL ENGINEER — YUKON TERRITORY — H. N. McLEOD

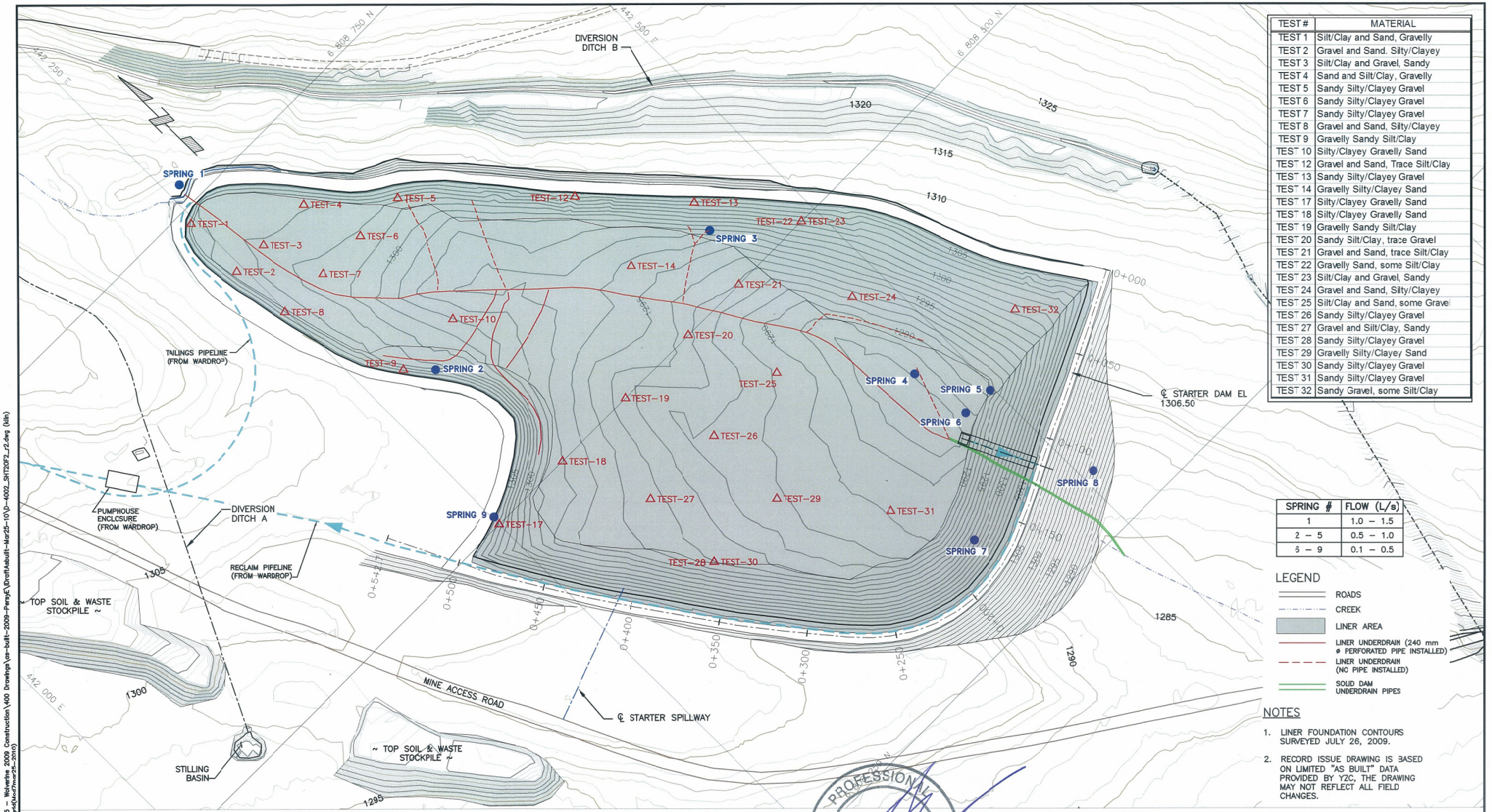
SECTION:	
SCALE:	DATE
DESIGN. BY LC	MAY 12/10
DRAWN BY: KL	MAY 12/10
CHECK. BY HM	
APP. BY HM	MAY 12/10

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A05	D-4002	6

Klohn Crippen Berger

Yukon Zinc CORP
WOLVERINE PROJECT

TAILINGS STORAGE FACILITY
STARTER IMPOUNDMENT
SHEET 1 OF 2



TEST #	MATERIAL
TEST 1	Silt/Clay and Sand, Gravelly
TEST 2	Gravel and Sand. Silty/Clayey
TEST 3	Silt/Clay and Gravel, Sandy
TEST 4	Sand and Silt/Clay, Gravelly
TEST 5	Sandy Silty/Clayey Gravel
TEST 6	Sandy Silty/Clayey Gravel
TEST 7	Sandy Silty/Clayey Gravel
TEST 8	Gravel and Sand, Silty/Clayey
TEST 9	Gravelly Sandy Silt/Clay
TEST 10	Silty/Clayey Gravelly Sand
TEST 12	Gravel and Sand, Trace Silt/Clay
TEST 13	Sandy Silty/Clayey Gravel
TEST 14	Gravelly Silty/Clayey Sand
TEST 17	Silty/Clayey Gravelly Sand
TEST 18	Silty/Clayey Gravelly Sand
TEST 19	Gravelly Sandy Silt/Clay
TEST 20	Sandy Silt/Clay, trace Gravel
TEST 21	Gravel and Sand, trace Silt/Clay
TEST 22	Gravelly Sand, some Silt/Clay
TEST 23	Silt/Clay and Gravel, Sandy
TEST 24	Gravel and Sand, Silty/Clayey
TEST 25	Silt/Clay and Sand, some Gravel
TEST 26	Sandy Silty/Clayey Gravel
TEST 27	Gravel and Silt/Clay, Sandy
TEST 28	Sandy Silty/Clayey Gravel
TEST 29	Gravelly Silty/Clayey Sand
TEST 30	Sandy Silty/Clayey Gravel
TEST 31	Sandy Silty/Clayey Gravel
TEST 32	Sandy Gravel, some Silt/Clay

SPRING #	FLOW (L/s)
1	1.0 – 1.5
2 – 5	0.5 – 1.0
5 – 9	0.1 – 0.5

LEGEND

- ROADS
- CREEK
- LINER AREA
- LINER UNDERDRAIN (240 mm ø PERFORATED PIPE INSTALLED)
- LINER UNDERDRAIN (NO PIPE INSTALLED)
- SOLID DAM UNDERDRAIN PIPES

NOTES

1. LINER FOUNDATION CONTOURS SURVEYED JULY 26, 2009.
2. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.

SCALE: 0 100 m

CONSTRUCTION RECORD

PROFESSIONAL ENGINEER YUKON TERRITORY H. N. McLEOD

DWG. NO. | REFERENCE DRAWINGS

NO	DESCRIPTION	BY	DATE
2	CONSTRUCTION RECORD	LC	MAY 12/10
1	DRAFT CONSTRUCTION RECORD	JL	MAR 5/10

ISSUE/REVISIONS

SECTION:
SCALE: DATE
DESIGN. BY: LC MAY 12/10
DRAWN BY: KL MAY 12/10
CHECK. BY: HM
APP. BY: HM MAY 12/10

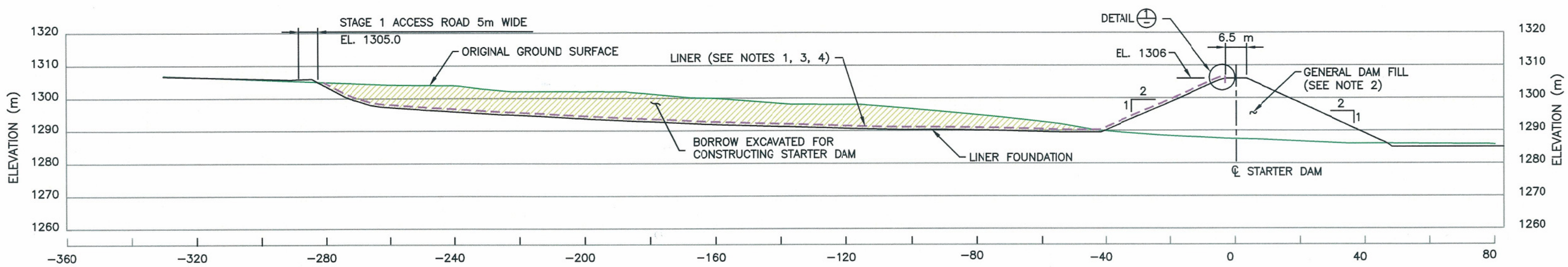
FILENAME:
PROJECT NUMBER: M09234A05
DRAWING NUMBER: D-4002
REV.: 2

Klohn Crippen Berger

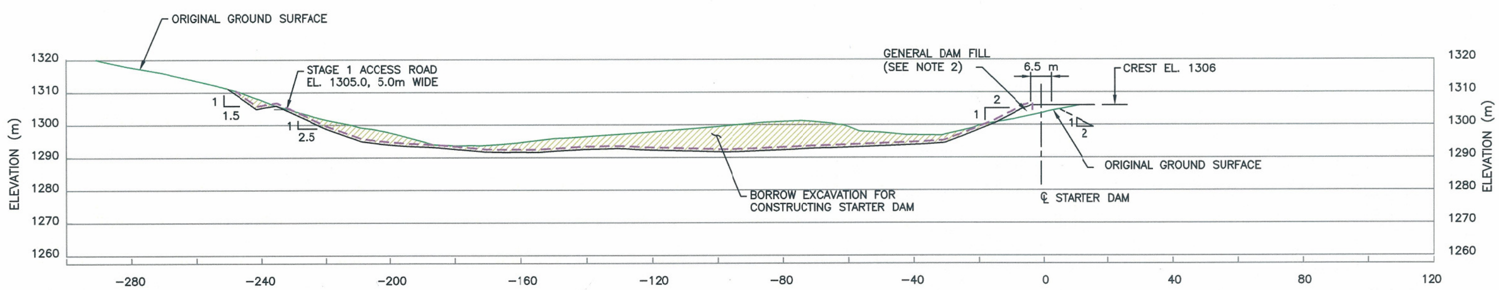
YukonZinc corp
WOLVERINE PROJECT

TAILINGS STORAGE FACILITY
STARTER IMPOUNDMENT
FOUNDATION GEOLOGY
SHEET 2 OF 2

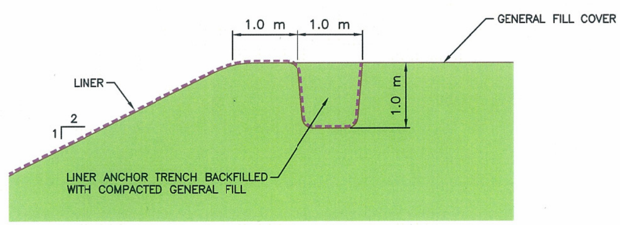
Time: 9:46:05
Date: 5/12/2010
Scale: 1=3(PS)
Drawing File: M:\M09234A05 - Wolverine 2009 Construction\400 Drawings\as-built-2009-Penyk\Drafi\Asbuilt-Mar25-10\D-4002_SHT2OF2_r2.dwg (klm)
Last Modified: klm on Mar 25, 2010



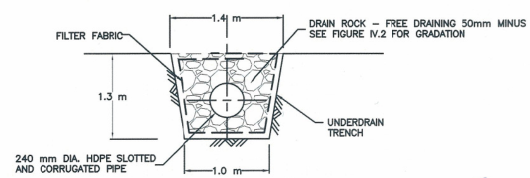
SECTION (A) 02
SCALE A



SECTION (B) 02
SCALE A



DETAIL (1) – LINER ANCHOR TRENCH
NTS



DETAIL (2) 02 LINER UNDERDRAIN
NTS

NOTES

1. LOOSE AND ORGANIC MATERIALS WERE REMOVED, AND THE FOUNDATION PROOFROLLED WITH 6 PASSES WITH A 10 TON VIBRATORY ROLLER, AS DIRECTED BY THE ENGINEER. FOUNDATION AREAS WERE DRY AND APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF GENERAL FILL OR LINER.
2. GENERAL FILL CONSISTED OF WELL-GRADED SILTY SAND AND GRAVEL BORROWED FROM IMPOUNDMENT EXCAVATION. FINER GENERAL FILL PLACED TOWARDS THE UPSTREAM SLOPE AS WELL AS ADJACENT TO THE GLACIAL TILL ZONE (STAGE 2 CONSTRUCTION) AND COARSER MATERIAL PLACED TOWARDS THE DOWNSTREAM SLOPE. MATERIAL PLACED IN 300 mm THICK LOOSE LIFTS, WATERED AS REQUIRED, AND COMPACTED TO 95% OF STANDARD PROCTOR DENSITY.
3. LINER FOUNDATION AREAS AND SLOPES WERE PROOFROLLED WITH A SMOOTH DRUM COMPACTOR. AREAS WITH COARSE ANGULAR MATERIALS WERE COVERED WITH LINER BEDDING AS DIRECTED BY THE ENGINEER.
4. A 40 mil LLDPE LINER WAS USED. THE LINER WAS ANCHORED IN THE DAM CREST AND ACCESS ROAD IN A 1.0 m DEEP TRENCH, AND BACKFILLED WITH COMPACTED FILL.
5. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.

SCALE A 0 100 m

CONSTRUCTION RECORD

NO	DESCRIPTION	BY	DATE
3	CONSTRUCTION RECORD	LC	MAY 12/10
2	DRAFT CONSTRUCTION RECORD	JK	MAR 5/10
1	ISSUED FOR CONSTRUCTION	DK	MAR 13/09
0	ISSUED FOR TENDER	DK	FEB 04/09
	ISSUE/REVISIONS		

DWG. NO. | REFERENCE DRAWINGS

PROJECT / PROCESS / CIVIL / MECH. / STRUCT. / PIPING / SERVICES / ELECT. / INSTR.

SECTION:	
SCALE:	DATE
DESIGN. BY LC	MAY 12/10
DRAWN BY: KL	MAY 12/10
CHECK. BY HM	
APP. BY: HM	MAY 12/10

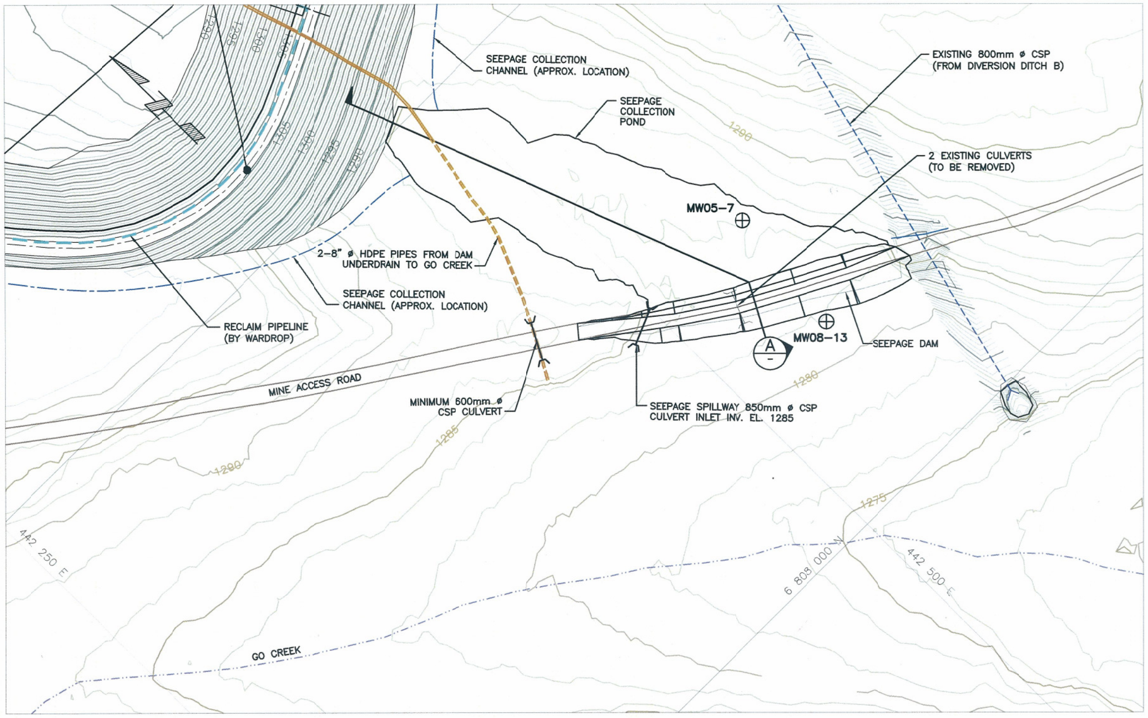
FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A05	D-4003	3

Klohn Crippen Berger

YukonZinc CORP
WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
STARTER IMPOUNDMENT
EXCAVATION AND FILL TYPICAL SECTIONS

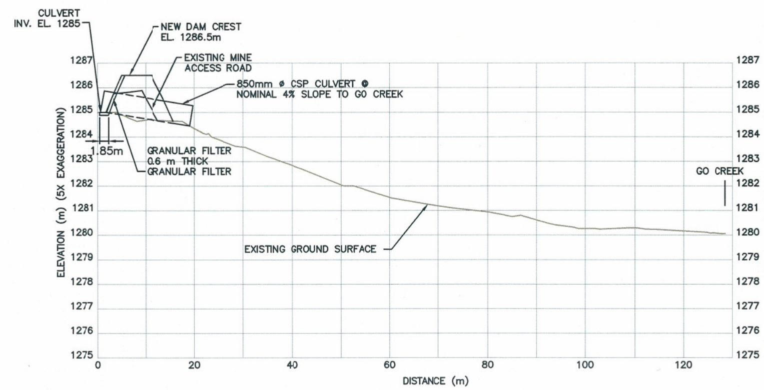
PROFESSIONAL ENGINEER
H. N. McLEOD
YUKON TERRITORY

315476STD.DWG BORREV-0
Time: 9:55:17
Date: 5/12/2010
Scale: 1=6(PS)
Drawing File: M:\M09234A05 – Wolverine 2009 Construction\400 Drawings\as-built-2009-PerayE\DraftAsbuilt-Mar25-10\D-4003r3.dwg (kiln)



SEEPAGE COLLECTION CHANNEL (APPROX. LOCATION)
SEEPAGE COLLECTION POND
EXISTING 800mm ø CSP (FROM DIVERSION DITCH B)
2 EXISTING CULVERTS (TO BE REMOVED)
MW05–7
2–8" ø HDPE PIPES FROM DAM UNDERDRAIN TO GO CREEK
SEEPAGE COLLECTION CHANNEL (APPROX. LOCATION)
RECLAIM PIPELINE (BY WARDROP)
MW08–13
SEEPAGE DAM
MINE ACCESS ROAD
MINIMUM 600mm ø CSP CULVERT
SEEPAGE SPILLWAY 850mm ø CSP CULVERT INLET INV. EL. 1285
442 250 E
6 809 000 N
442 500 E
GO CREEK

PLAN
SCALE A



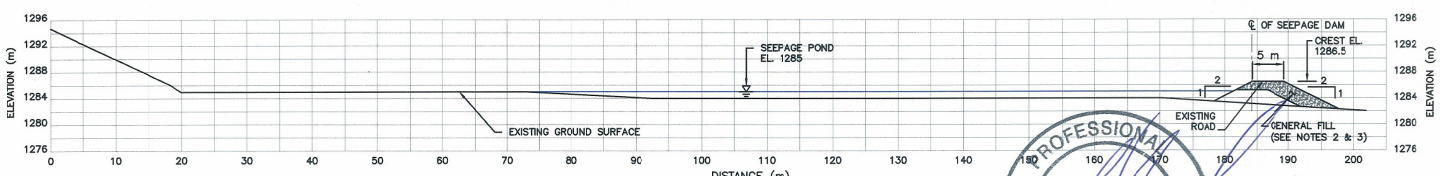
PROFILE OF SEEPAGE SPILLWAY
SCALE: C

LEGEND

- ROADS
- CREEK
- DIVERSION OR COLLECTION DITCH, SPILLWAY
- DAM UNDERDRAIN PIPES (EXISTING)
- MW05–7 ⊕ GROUNDWATER MONITORING WELL (MW08–13) TO BE RELOCATED DOWNSTREAM

NOTES

1. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.
2. ALL LOOSE AND ORGANIC MATERIALS SHALL BE REMOVED, AND THE FOUNDATION SHALL BE PROOFROLLED WITH 6 PASSES WITH A 10 TON VIBRATORY ROLLER, AS DIRECTED BY THE ENGINEER. ALL FOUNDATION AREAS SHALL BE DRY AND APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF GENERAL FILL OR LINER.
3. GENERAL FILL TO CONSIST OF WELL–GRADED SILTY SAND AND GRAVEL BORROWED FROM IMPOUNDMENT EXCAVATION. FINER GENERAL FILL SHALL BE PLACED TOWARDS THE UPSTREAM SLOPE AS WELL AS ADJACENT TO THE GLACIAL TILL ZONE (STAGE 2 CONSTRUCTION) AND COARSER MATERIAL SHALL BE PLACED TOWARDS THE DOWNSTREAM SLOPE. MATERIAL SHALL BE PLACED IN 300 mm THICK LOOSE LIFTS, WATERED AS REQUIRED, AND COMPACTED TO 95% OF STANDARD PROCTOR DENSITY.



SECTION A
SCALE B

PROFESSIONAL ENGINEER YUKON TERRITORY H.N. McLEOD

ISSUED FOR CONSTRUCTION

SCALE A 0 100 m
SCALE B 0 50 m
SCALE C 0 50 m

Time: 14:42:43
Date: 3/25/2010
Scale: 1=3(PS)
Drawing File: M:\M09234A05 – Wolverine 2009 Construction\400 Drawings\as-built-2009-PersyE\DraftAsbuilt-Mar25-10\D-4004r3.dwg (kiln)
Xrefs: CONT_2M_MINE_4Mgrid(Mod6feb25-2010)
315476STD.DWG

DWG. NO.	REFERENCE DRAWINGS

NO	DESCRIPTION	BY	DATE
3	ISSUED FOR CONSTRUCTION	LC	APR 06/10
2	DRAFT CONSTRUCTION RECORD	JL	FEB /10
1	ISSUED FOR CONSTRUCTION	DK	MAR 13/09
0	ISSUED FOR TENDER	DK	FEB 04/09

ISSUE/REVISIONS

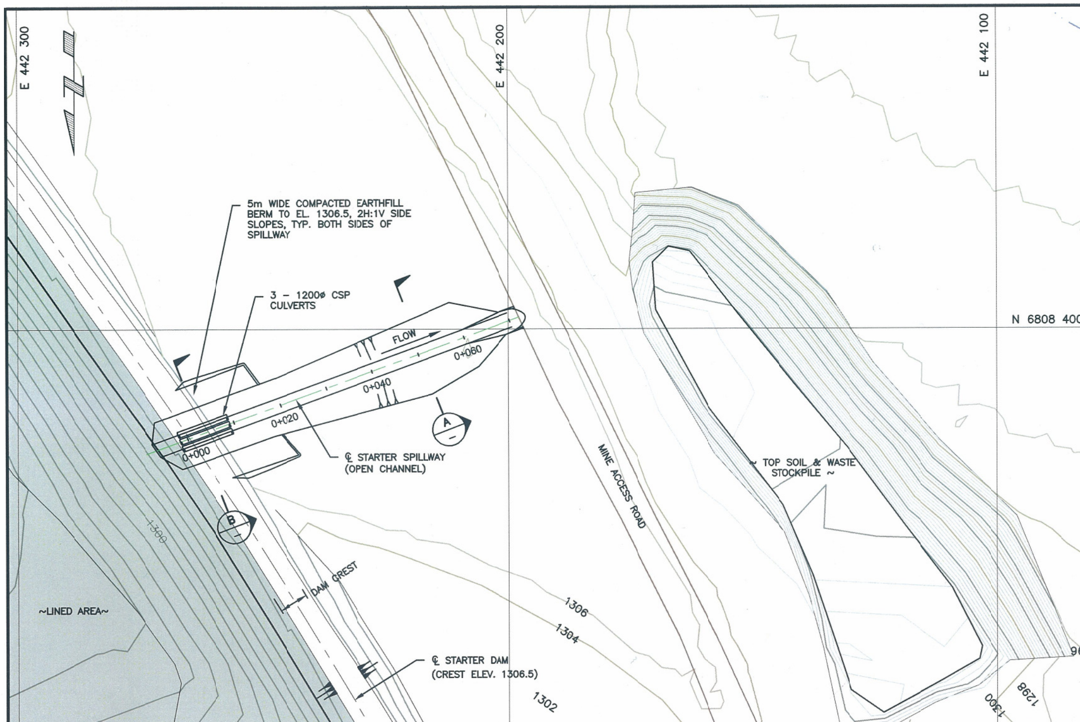
SECTION:	
SCALE:	DATE
DESIGN. BY LC	MAY 12/10
DRAWN BY: KL	MAY 12/10
CHECK. BY HM	
APP. BY: HM	MAY 12/10

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A04	D–4004	3

Klohn Crippen Berger

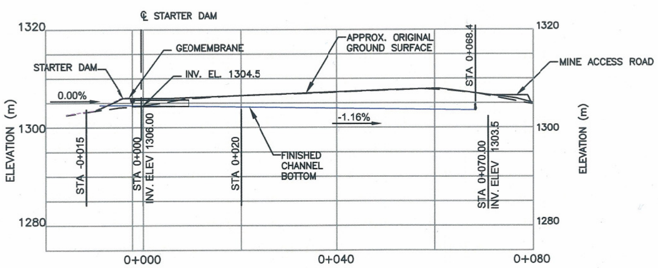
YukonZinc CORP
WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
SEEPAGE DAM
PLAN AND SECTION

Time: 13:31:37
Date: 6/1/2010
Scale: 1=7(PS)
Drawing File: M\M09234A05 – Wolverine 2009 Construction\400 Drawings\as-built-2009-PersyE\DraftAsbuilt-June01-10\D-4011r4.dwg (kiln)
Xrefs: by-others-May11-2010, CONT_2M_MINE_4Mgrid(Mod7mar25-2010).dwg



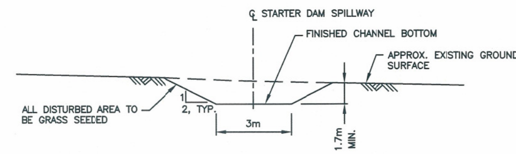
E 442 300
E 442 200
E 442 100
N 6808 400
5m WIDE COMPACTED EARTHFILL BERM TO EL. 1306.5, 2H:1V SIDE SLOPES, TYP. BOTH SIDES OF SPILLWAY
3 – 1200ø CSP CULVERTS
FLOW
0+000
0+020
0+040
0+060
℄ STARTER SPILLWAY (OPEN CHANNEL)
MINE ACCESS ROAD
TOP SOIL & WASTE STOCKPILE
~LINED AREA~
DAM CREST
℄ STARTER DAM (CREST ELEV. 1306.5)
1306
1304
1302
1300
1298

PLAN
SCALE A

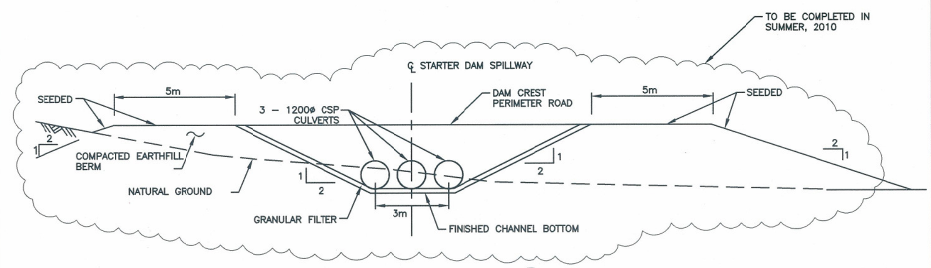


℄ STARTER DAM
GEOMEMBRANE
STARTER DAM
INV. EL. 1304.5
APPROX. ORIGINAL GROUND SURFACE
MINE ACCESS ROAD
0.00%
-1.16%
STA -0+015
STA 0+000
INV. ELEV 1306.00
STA 0+020
FINISHED CHANNEL BOTTOM
STA 0+068.4
STA 0+070.00
INV. ELEV 1303.5
ELEVATION (m)
1320
1300
1280
0+000
0+040
0+080

PROFILE – STARTER SPILLWAY
SCALE A



TYPICAL GRASS LINED SECTION (A)
NOT TO SCALE



TYPICAL CULVERT SECTION (B)
NOT TO SCALE

NOTES

1. FOR GENERAL SITE ARRANGEMENT, SEE DWG. D-4001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
4. SPACING BETWEEN CULVERTS WIDTH OF COMPACTOR.
5. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.

PROFESSIONAL ENGINEER – YUKON TERRITORY – H.N. McLEOD

CONSTRUCTION RECORD

SCALE A 0 – 50 m

DWG. NO.	REFERENCE DRAWINGS

NO	DESCRIPTION	BY	DATE
4	CONSTRUCTION RECORD UPDATE	LC	JUN 01/10
3	CONSTRUCTION RECORD	LC	MAY 12/10
2	DRAFT CONSTRUCTION RECORD	JL	MAR 5/10
1	ISSUED FOR CONSTRUCTON	MD	MAR 13/09
0	ISSUED FOR TENDER	MD	FEB 04/09

ISSUE/REVISIONS

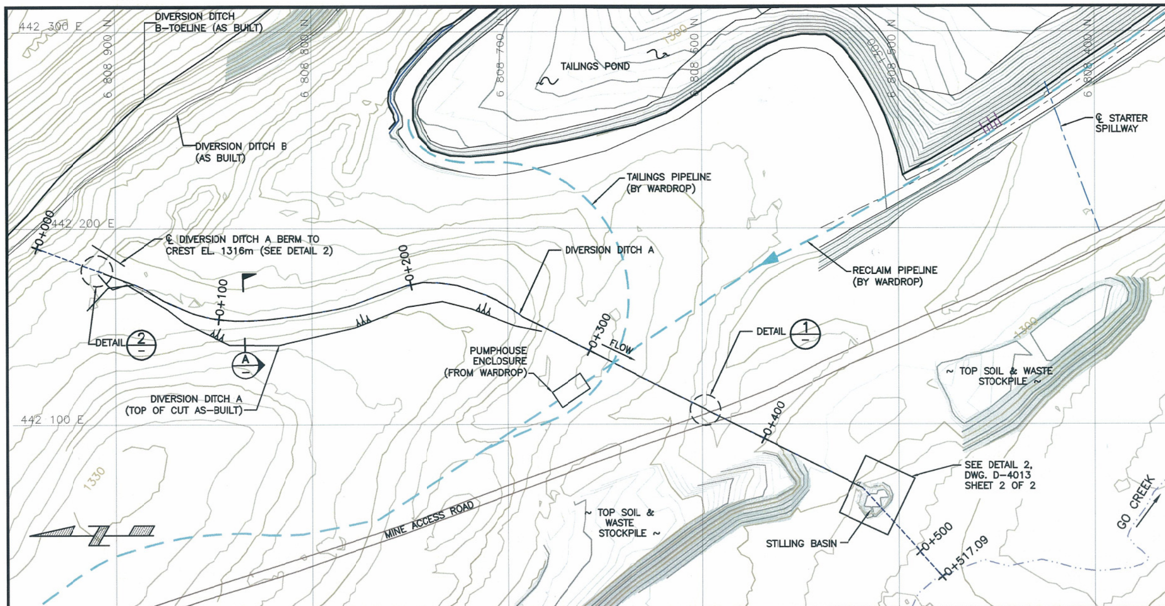
		DATE
SECTION:		
SCALE:		
DESIGN. BY	LC	MAY 12/10
DRAWN BY:	KL	MAY 12/10
CHECK. BY	HM	---
APP. BY:	HM	MAY 12/10

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
------------	M09234A05	D-4011	4

Klohn Crippen Berger

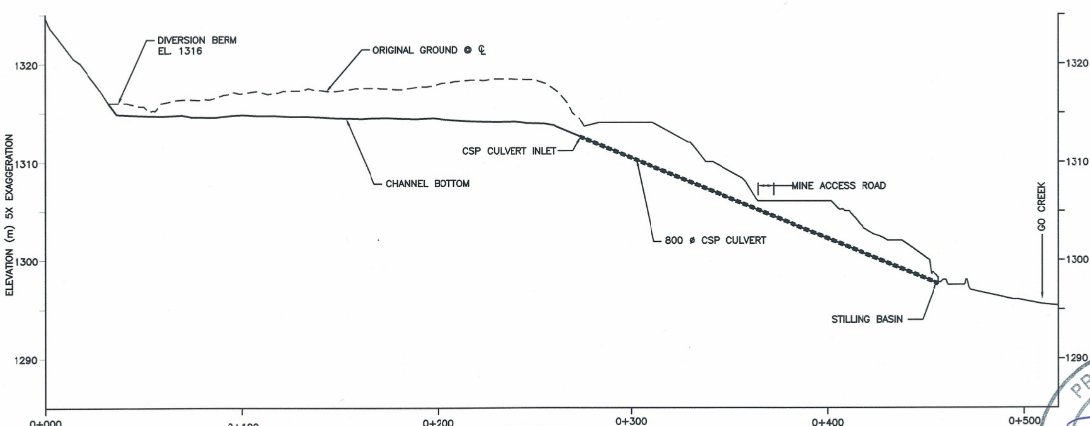
YukonZinc CORP
WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
STARTER SPILLWAY
PLAN, PROFILE AND SECTIONS

Time: 10:15:2
Date: 5/12/2010
Scale: 1=4(PS)
Drawing File: M:\M09234A05 - Wolverine 2009 Construction\400 Drawings\as-built-2009-PersyE\DraftAsbuilt-Mar25-10\D-4012r3.dwg (kiln)
Xrefs: by-others-May11-2010, CONT_2M_MINE_4Mgrid(Mod7MAR25-2010).dwg
315476STD.DWG

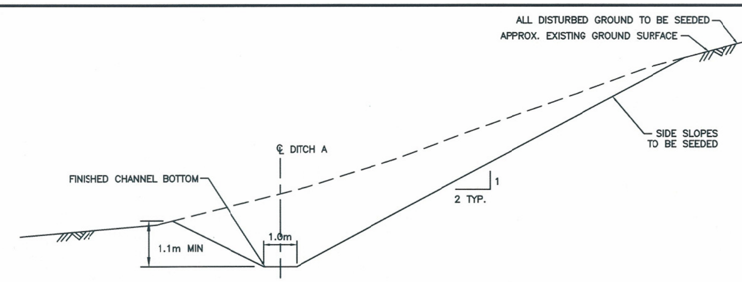


DIVERSION DITCH B-TOELINE (AS BUILT)
DIVERSION DITCH B (AS BUILT)
TAILINGS POND
℄ STARTER SPILLWAY
TAILINGS PIPELINE (BY WARDROP)
℄ DIVERSION DITCH A BERM TO CREST EL. 1316m (SEE DETAIL 2)
DIVERSION DITCH A
RECLAIM PIPELINE (BY WARDROP)
DETAIL 2
DETAIL 1
PUMPHOUSE ENCLOSURE (FROM WARDROP)
FLOW
DIVERSION DITCH A (TOP OF CUT AS-BUILT)
~ TOP SOIL & WASTE STOCKPILE ~
SEE DETAIL 2, DWG. D-4013 SHEET 2 OF 2
MINE ACCESS ROAD
~ TOP SOIL & WASTE STOCKPILE ~
STILLING BASIN
GO CREEK
0+000
0+100
0+200
0+300
0+400
0+500
0+517.09
442 300 E
442 200 E
442 100 E
6 808 900 N
6 808 800 N
6 808 700 N
6 808 600 N
6 808 500 N
6 808 400 N
1330

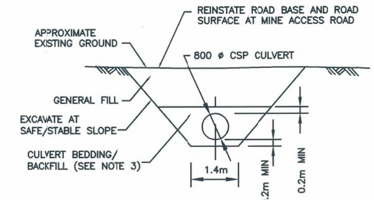
PLAN
SCALE A



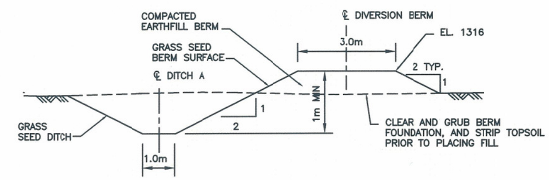
PROFILE DIVERSION DITCH A — VERTICAL SCALE = 5X HORIZONTAL SCALE
SCALE A



SECTION (A) TYPICAL OPEN CHANNEL SECTION
SCALE B
(NO SURVEY DATA)



DETAIL (1) TYPICAL CULVERT SECTION
NTS
(NO SURVEY DATA)



DETAIL (2) DIVERSION DITCH A BERM
NTS
(NO SURVEY DATA)

NOTES

1. FOR GENERAL SITE ARRANGEMENT SEE DWG. D-4001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. CULVERT BEDDING/BACKFILL WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
4. FOR RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS, SEE DWG. D-4013 SHEET 2 OF 2.
5. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.

SCALE A 0 — 100 m
SCALE B 0 — 6 m

PROFESSIONAL ENGINEER — YUKON TERRITORY — H. N. McLEOD

CONSTRUCTION RECORD

DWG. NO.	REFERENCE DRAWINGS

NO	DESCRIPTION	BY	DATE
3	CONSTRUCTION RECORD	LC	MAY 12/10
2	DRAFT CONSTRUCTION RECORD	JL	MAY 5/10
1	ISSUED FOR CONSTRUCTION	MD	MAR 13/09
0	ISSUED FOR TENDER	MD	FEB 04/09

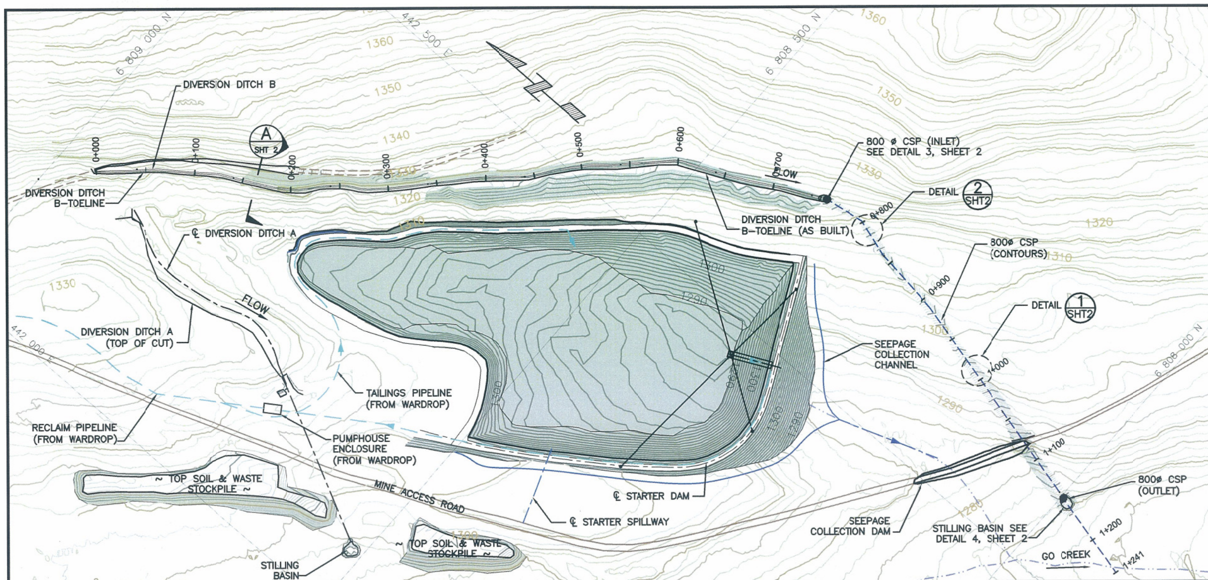
ISSUE/REVISIONS

SECTION:	
SCALE:	DATE
DESIGN. BY LC	MAY 12/10
DRAWN BY: KL	MAY 12/10
CHECK. BY HM	
APP. BY: HM	MAY 12/10

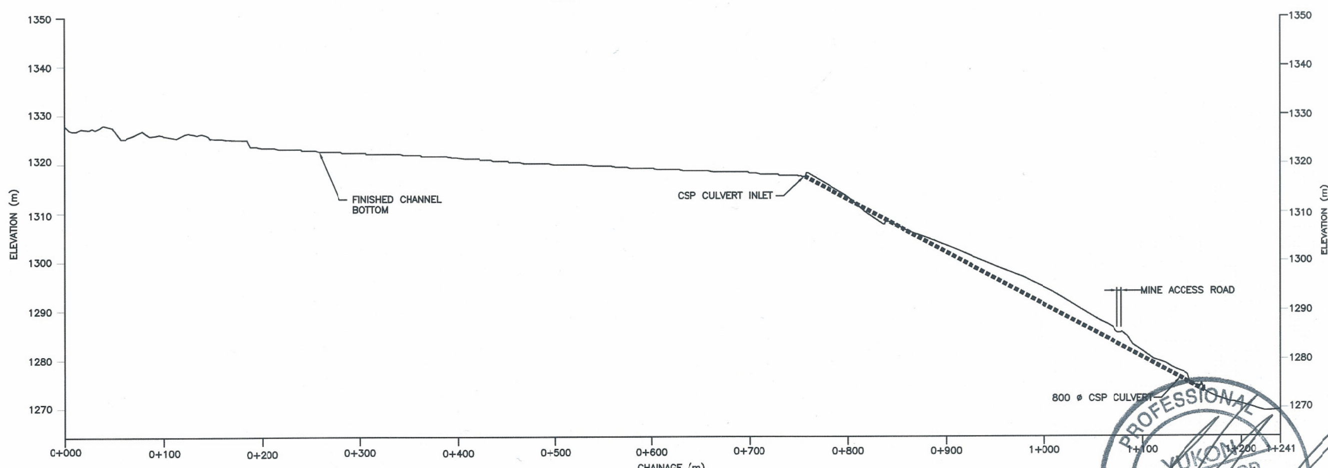
FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A05	D-4012	3

Klohn Crippen Berger

YukonZinc CORP
WOLVERINE PROJECT
TAILINGS STORAGE FACILITY
DIVERSION DITCH A
PLAN AND PROFILE AND SECTIONS


DIVERSION DITCH B
DIVERSION DITCH B-TOELINE
℄ DIVERSION DITCH A
FLOW
DIVERSION DITCH A (TOP OF CUT)
TAILINGS PIPELINE (FROM WARDROP)
RECLAIM PIPELINE (FROM WARDROP)
PUMPHOUSE ENCLOSURE (FROM WARDROP)
~ TOP SOIL & WASTE STOCKPILE ~
MINE ACCESS ROAD
STILLING BASIN
℄ STARTER DAM
℄ STARTER SPILLWAY
SEEPAGE COLLECTION CHANNEL
SEEPAGE COLLECTION DAM
STILLING BASIN SEE DETAIL 4, SHEET 2
GO CREEK
800 ø CSP (INLET) SEE DETAIL 3, SHEET 2
DETAIL 2 SHT2
DIVERSION DITCH B-TOELINE (AS BUILT)
800ø CSP (CONTOURS)
DETAIL 1 SHT2
800ø CSP (OUTLET)
A SHT 2
0+000
0+100
0+200
0+300
0+400
0+500
0+600
0+700
0+800
0+900
1+000
1+100
1+200
1+241
6 809 000 N
6 808 500 N
6 808 000 N
442 500 E
442 000 E

PLAN



PROFILE DIVERSION DITCH B

VERTICAL SCALE = 5X HORIZONTAL SCALE

LEGEND

– – – – APPROX. LOCATION OF 800 ø CSP.

NOTES:

1. FOR GENERAL SITE ARRANGEMENT SEE DWG. D-4001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. CULVERT BEDDING/BACKFILL WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
4. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC, THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.

SCALE 0 — 250 m

PROFESSIONAL ENGINEER H. N. McLEOD YUKON TERRITORY

CONSTRUCTION RECORD

NO	DESCRIPTION	BY	DATE
4	CONSTRUCTION RECORD UPDATE	LC	JUN 01/10
3	CONSTRUCTION RECORD	LC	MAY 12/10
2	DRAFT CONSTRUCTION RECORD	JL	MAR 5/10
1	ISSUED FOR CONSTRUCTION	MD	MAR 13/09
0	ISSUED FOR TENDER	MD	FEB 04/09

ISSUE/REVISIONS

		DATE
SECTION:		
SCALE:		
DESIGN. BY	LC	MAY 12/10
DRAWN BY:	KL	MAY 12/10
CHECK. BY	HM	
APP. BY:	HM	MAY 12/10

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A05	D-4013	4

Klohn Crippen Berger

YukonZinc CORP

WOLVERINE PROJECT

TAILINGS STORAGE FACILITY
DIVERSION DITCH B
PLAN AND PROFILE – SHEET 1 OF 2

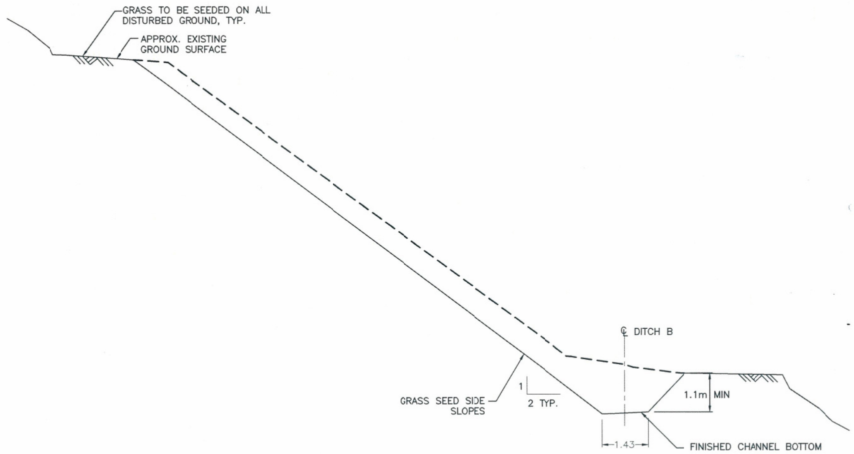
DWG. NO. | REFERENCE DRAWINGS

PROJECT / PROCESS / CIVIL / MECH. / STRUCT. / PIPING / SERVICES / ELECT. / INSTR.

Time: 13:36:41
Date: 6/1/2010
Scale: 1=4(PS)
Drawing File: M:\M09234A05 – Wolverine 2009 Construction\400 Drawings\as-built-2009-PersyE\DraftAsbuilt-June01-10\D-4013-Sht1r4.dwg (kln)
Xrefs: by-others-May11-2010, CONT_2M_MINE_4Mgrid(Mod7MAR25-2010).dwg

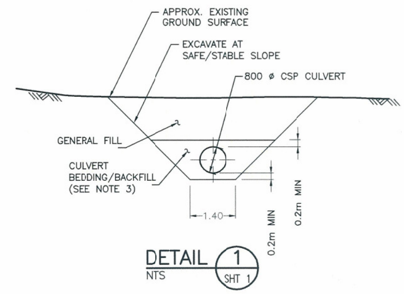
315476STD.DWG

Time: 10:25:16
Date: 5/12/2010
Scale: 1=4(PS)
Drawing File: M:\M09234A05 – Wolverine 2009 Construction\400 Drawings\as-built-2009-PersyE\DraftAsbuilt-Mar25-10\D-4013-Sht2r3.dwg (klin)
Xrefs: CONT_2M_MINE_4Mgrid(Mod6FEB25-2010)
315476STD.DWG



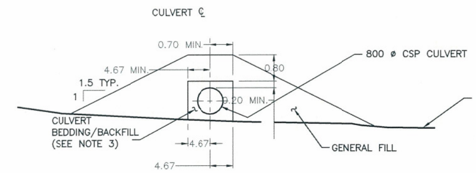
SECTION (A) SCALE A SHT 1

TYPICAL OPEN CHANNEL SECTION



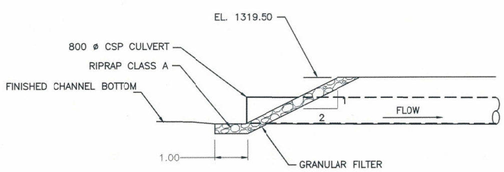
DETAIL (1) NTS SHT 1

TYPICAL CSP CULVERT SECTION IN CUT



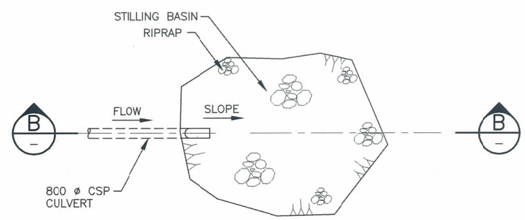
DETAIL (2) NTS SHT 1

CSP CULVERT SECTION IN FILL



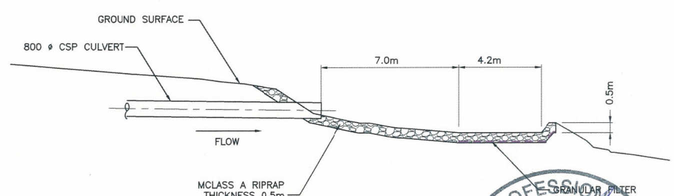
DETAIL (3) NTS SHT 1

CSP CULVERT INLET



DETAIL (4) NTS SHT 1

STILLING BASIN PLAN



SECTION (B) SCALE B

RIPRAP AND GRANULAR FILTER GRADATION AND LAYER THICKNESS

(SEE NOTE 4)

Gradation and Layer Thickness

Material	Particle Size (mm)				Layer Thickness (mm)	
	D_{100}	D_{85}	D_{50}	D_{15}	Riprap	Filter
Riprap A	300	260	200	120	400	200 Filter 1
Riprap B	450	390	300	180	600	200 Filter 1
Riprap C	525	455	350	210	700	300 Filter 1
Riprap D	675	585	450	270	900	300 Filter 1
Riprap E	1200	1040	800	480	1600	300 Filter 1 + 400 Filter 2
Riprap F	1500	1300	1,000	600	2000	400 Filter 1 + 400 Filter 2
Filter 1	75	60 to 70	35 to 50	23 to 28	–	–
Filter 2	300	260	200	120	–	–

- Riprap gradation shall be within –5% to +10% of the specified D_{15}, D_{50}, AND D_{85} sizes
- Filter 1 shall be well graded between the 75 mm and 19 mm screen sizes.
- Filter 2 shall be the same gradation as Riprap A.
- Filter 1 grading is based on the subsoil being a silty sand and gravel

NOTES:

1. FOR GENERAL SITE ARRANGEMENT SEE DWG. D–4001.
2. INVERT ELEVATIONS SHOWN ARE TO FINISHED CHANNEL BOTTOM.
3. CULVERT BEDDING/BACKFILL SHALL BE WELL GRADED 100 mm MINUS MATERIAL WITH LESS THAN 20% PASSING THE #200 SIEVE.
4. UNLESS OTHERWISE DIRECTED BY THE ENGINEER, GRANULAR FILTER IS TO BE PLACED UNDER ALL RIPRAP.
5. RECORD ISSUE DRAWING IS BASED ON LIMITED "AS BUILT" DATA PROVIDED BY YZC. THE DRAWING MAY NOT REFLECT ALL FIELD CHANGES.

SCALE A 0 — 6 m

SCALE B 0 — 10 m

PROFESSIONAL ENGINEER — YUKON — H. N. McLEOD — TERRITORY

CONSTRUCTION RECORD

DWG. NO.	REFERENCE DRAWINGS

PROJECT / PROCESS / CIVIL / MECH. / STRUCT. / PIPING / SERVICES / ELECT. / INSTR.

NO	DESCRIPTION ISSUE/REVISIONS	BY	DATE
3	CONSTRUCTION RECORD	LC	MAY 12/10
2	DRAFT CONSTRUCTION RECORD	JL	MAR 5/10
1	ISSUED FOR CONSTRUCTION	MD	MAR 13/09
0	ISSUED FOR TENDER	MD	FEB 04/09

		DATE
SECTION:		
SCALE:		
DESIGN. BY	LC	MAY 12/10
DRAWN BY:	KL	MAY 12/10
CHECK. BY	HM	
APP. BY:	HM	MAY 12/10

FILENAME:	PROJECT NUMBER	DRAWING NUMBER	REV.
----------	M09234A05	D–4013	3

Klohn Crippen Berger

YukonZinc CORP

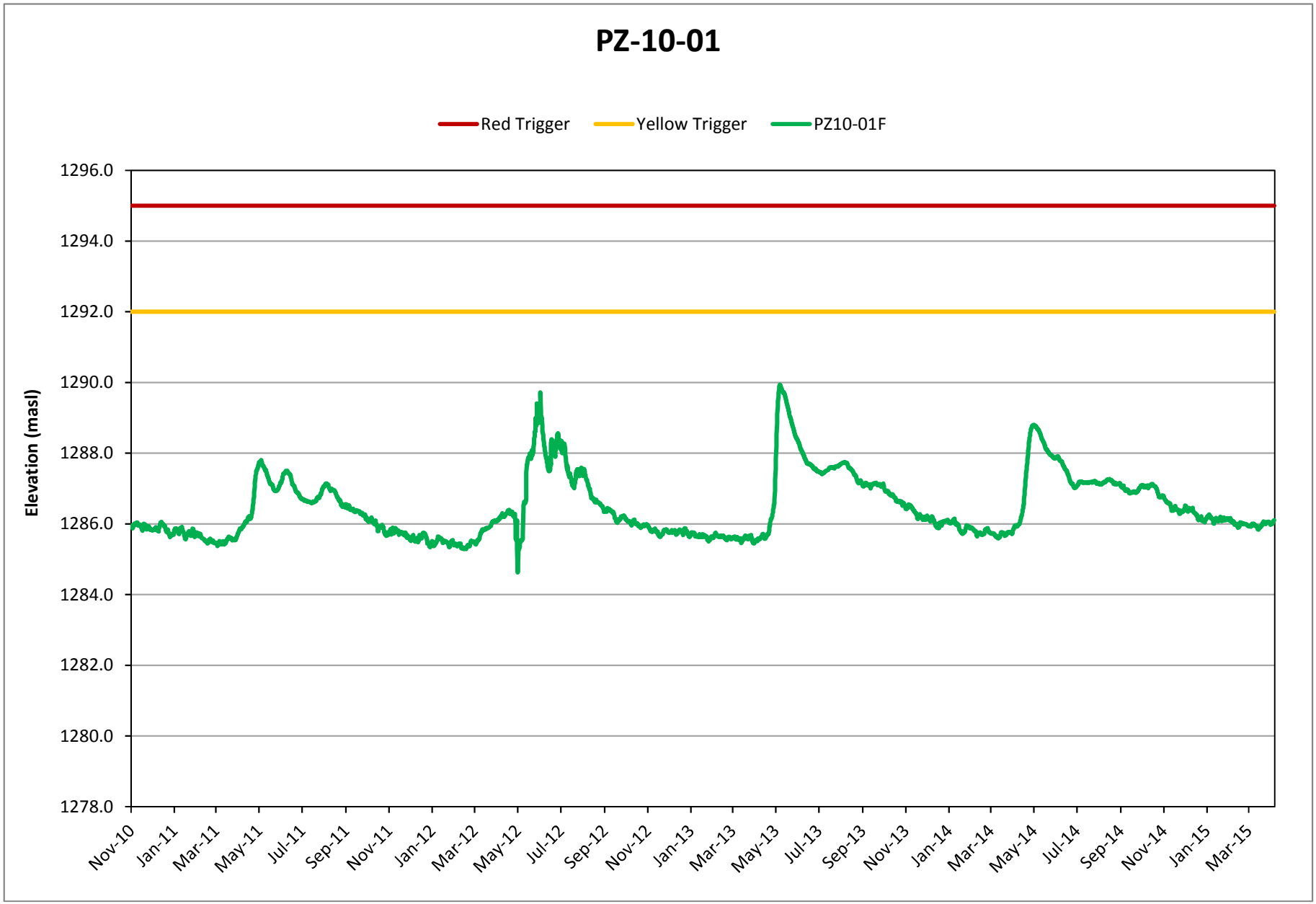
WOLVERINE PROJECT

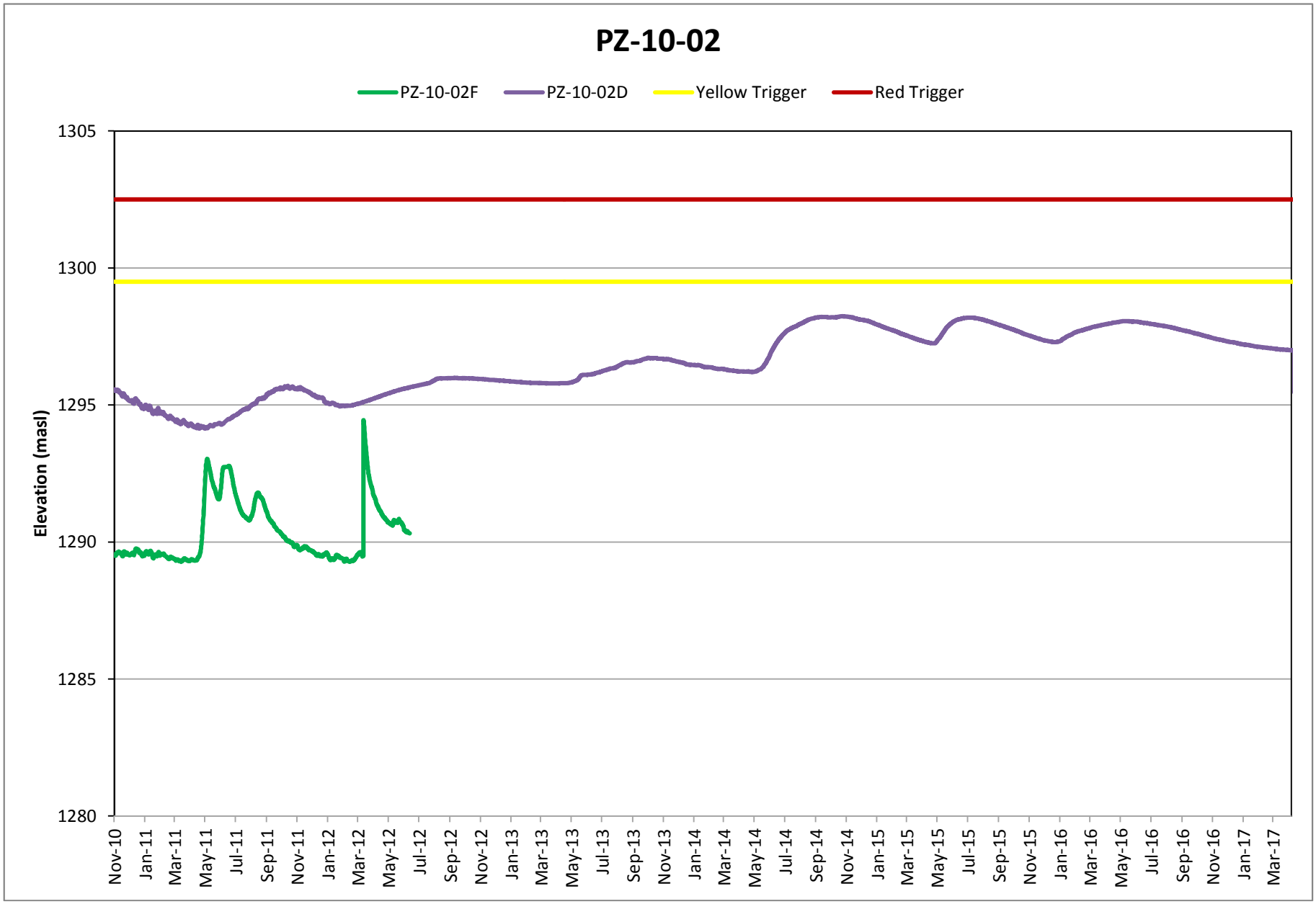
TAILINGS STORAGE FACILITY
DIVERSION DITCH B
SECTIONS AND DETAILS – SHEET 2 OF 2

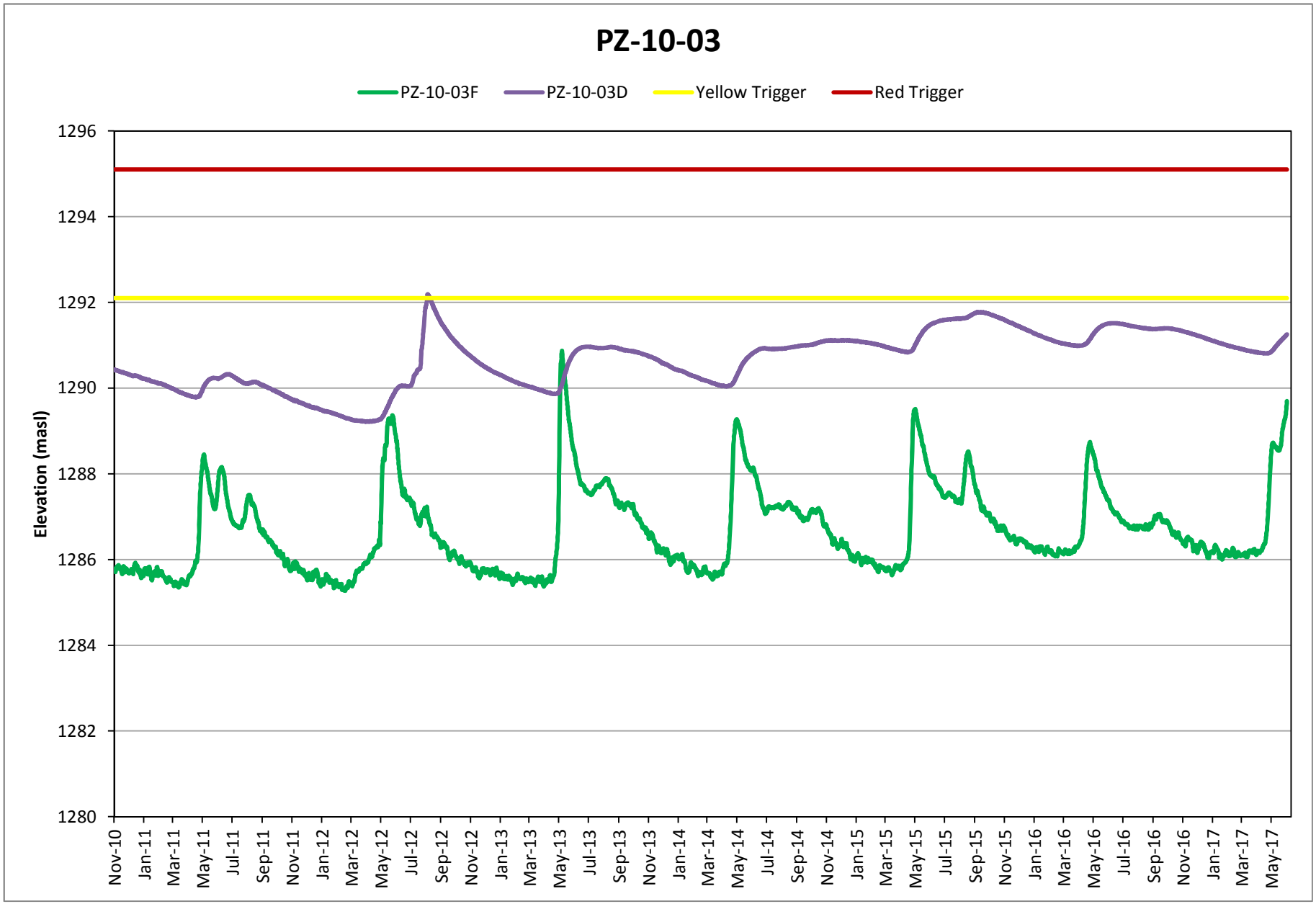
APPENDIX III

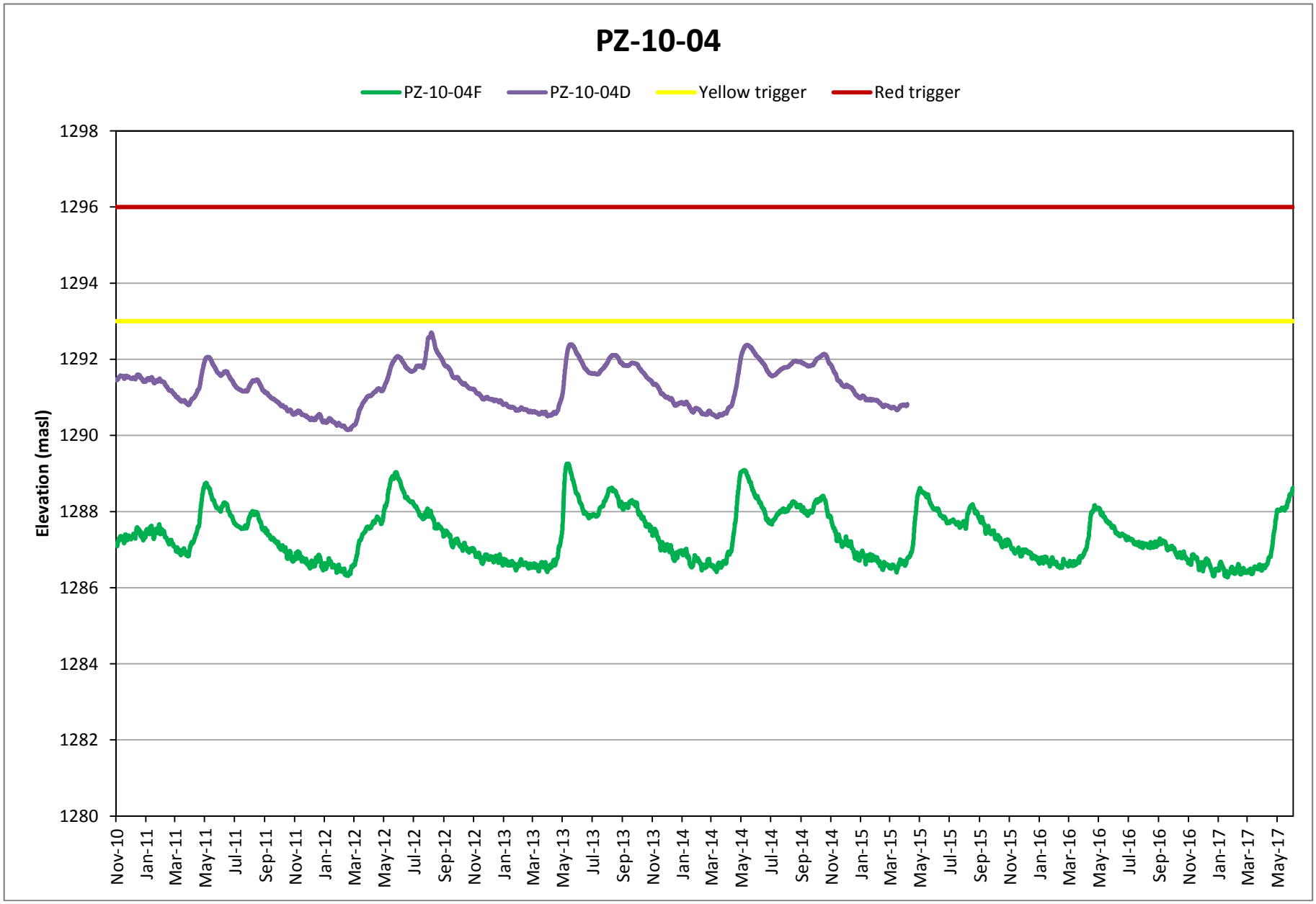
Instrumentation Data

Piezometer Data


PZ-10-01
Red Trigger
Yellow Trigger
PZ10-01F
Elevation (masl)
1296.0
1294.0
1292.0
1290.0
1288.0
1286.0
1284.0
1282.0
1280.0
1278.0
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15


PZ-10-02
PZ-10-02F
PZ-10-02D
Yellow Trigger
Red Trigger
Elevation (masl)
1305
1300
1295
1290
1285
1280
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Mar-17


PZ-10-03
PZ-10-03F
PZ-10-03D
Yellow Trigger
Red Trigger
Elevation (masl)
1296
1294
1292
1290
1288
1286
1284
1282
1280
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Mar-17
May-17


PZ-10-04
PZ-10-04F
PZ-10-04D
Yellow trigger
Red trigger
Elevation (masl)
1298
1296
1294
1292
1290
1288
1286
1284
1282
1280
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Mar-17
May-17

APPENDIX IV

CDA Principles Assessment

Appendix IV
CDA Principles Assessment

There are 19 CDA Dam Safety Principles presented in the CDA Guidelines (CDA, 2007) and are divided into five categories:

- Principle 1: Dam Safety Management System
- Principle 2: Operations, Maintenance, and Surveillance
- Principle 3: Emergency Preparedness
- Principle 4: Dam Safety Review
- Principle 5: Analysis and Assessment

Conformance / Non-Conformance Types

The types of conformance or non-conformance referred to in each of the CDA sub-principles are listed in the table below.

Label	Type	Description
An	Actual Deficiency	Deficient under normal loads
Au	Actual Deficiency	Deficient under unlikely loads
Cnf	Conformance	Conforms
NCi	Non-Conformance	Information
NCm	Non-Conformance	Maintenance
NCo	Non-Conformance	Operations
NCp	Non-Conformance	Other Procedures
NCs	Non-Conformance	Surveillance
Pq	Potential Deficiency	Expected not to be deficient, quickly demonstrated
Pd	Potential Deficiency	Expected not to be deficient, difficult to demonstrate
Pn	Potential Deficiency	Expected to be deficient under normal loads
Pu	Potential Deficiency	Expected to be deficient under unlikely loads

Principle 1 – Dam Safety Management System

Principle 1A: The public and the environment shall be protected from the effects of dam failure, as well as release of any or all of the retained fluids behind a dam, such that the risks are as low as reasonably practicable (ALARP).

Type:	Conforms (Cnf)
Description:	The design meets or exceeds CDA guidelines for a “Very High” consequence strucutre.
Recommendations:	No recommendation

Principle 1B: The standard of care to be exercised in the management of dam safety shall be commensurate with the consequences of dam failure.

Type:	Conformance (Cnf)
Description:	The dam consequence classification is currently ‘Very High’ but key design features are desiged to “Extreme” consequence classification based on permit requirements.
Recommendations:	

Principle 1C: Due diligence shall be exercised at all stages of a dam’s life cycle.

Type:	Non-Conformance: Other Procedures (NCp)
Description:	OMS requirements for routine inspections are not being documented in accordance with the OMS manual. The OMS manual was never revised to reflect the care and maintenance status of the operation. Inspections are being completed but inspection sheets in the OMS are not being used and the surveillence schedule was never reviewed for care and maintenance.
Recommendations:	Revise OMS surveillance schedule and requirements for mining restart or for closure, depding on decision made on restart of operation..

Principle 1D: A dam safety management system, incorporating policies, responsibilities, plans and procedures, documentation, training, and review and correction of deficiencies and non-conformances, shall be in place.

Type:	Non-Conformance: Information/Other Procedures (NCi/NCp)
Description:	YZC has a dam safety management system for the TSF, which includes annual dam safety inspections, an Operation, Maintenance and Surveillance (OMS) Manual and DSR. In addition to the site based team management system also includes input from experienced individuals within Yukon Zinc. With the potential restart of mining activities an update to the OMS manual is required.. An additional area of improvement for the dam management system is in specifying and documenting training requirements and completion records.
Recommendations:	Refer to recommendations for Principle 1A, 1B and 1C. i. Document staff training in all areas related to dam safety management. Training should include an overview of the TSF facilities and how their work fits into the safe operation of the facilities.

Principle 2 – Operation, Maintenance, and Surveillance

Principle 2A: Requirements for the safe operation, maintenance, and surveillance of the dam shall be developed and documented with sufficient information in accordance with the impacts of operation and the consequences of dam failure.

Type:	Non-Conformance: Information (NCi)
Description:	The OMS document is complete and covers the required components. However, there are improvements that should be made to the document to reflect ongoing changes and the results of this DSR. The main observations for improvement are documented in Table 4.4 in the DSR and include the following: ▪ Revising roles and responsibilities based on new site team ▪ Facility description updated to include design rainfall events and consolidation of site records. ▪ Reporting responsibilities and documentation to be revised based on restart plan ▪ Emergency Planning and Response to be updated based on revised inundation study
Recommendations:	Update the OMS document based on the above recommendations.

Principle 2B: Documented operating procedures for the dam and flow control equipment under normal, unusual, and emergency conditions shall be followed.

Type:	Conformance: (Cfn)
Description:	Operating procedures for components of the tailings facilities are specified in the OMS..
Recommendations:	

Principle 2C: Documented maintenance procedures shall be followed to ensure that the dam remains in a safe and operational condition.

Type:	Conforms (Cnf)
Description:	Maintenance procedures for components of the TSF are docuemented in the OMS
Recommendations:	No recommendation

Principle 2D: Documented surveillance procedures shall be followed to provide early identification and to allow for timely mitigation of conditions that might affect dam safety.

Type:	Non-Conformance: Surveillance (NCs)
Description:	Surveillance records are maintained in a book on site, but not formally logged using the inspection sheets in the OMS. Where appropriate, reference is made in the OMS to the location of the surveillance records. Threshold values for monitoring equipment (piezometers,) and the appropriate response is included in the OMS.
Recommendations:	Formal inspection records should be developed and saved in a central location on site if the mine goes back into production. If the mine is going to closure then surveillance activities should be revised to reflect the operating condition.

Principle 2E: Flow control equipment shall be tested and be capable of operating as required.

Type:	Non-Conformance: Other Procedures (NCp)
Description:	The barge needs to be tested prior to restart of mining activities. Current operations do not require the barge to be in operating condition but will need to be evaluated for restart.
Recommendations:	Test reclaim system prior to restart and re-establish maintenance protocols for the reclaim barge.

Principle 3 – Emergency Preparedness

According to the CDA (2007), Emergency Response Plans (ERPs) and Emergency Preparedness Plans (EPPs) "should be in place for all dams where lives are at risk or if implementation of emergency procedures could significantly reduce the consequences of failure." These documents should establish a clear emergency response structure that is issued to and understood by all internal and external emergency responders.

Principle 3A: An effective emergency management process shall be in place for the dam.

Type:	Conformance (Cnf):
Description:	There is an ERP in place for the facility. It can be revised once the updated inundation study is complete.
Recommendations:	Refer to Principle 3B.

Principle 3B: The emergency management process shall include emergency response procedures to guide the dam operator and site staff through the process of responding to an emergency at a dam.

Type:	Non-Conformance (NCi)
Description:	The emergency management process is well documented but various site contacts are out of date and government contacts may also be out of date. This should be updated. The inudation study should be revised to provide more detail on potential impacted areas to communicate with external stakeholders.
Recommendations:	Review and update all relevant reporting structures and contact details. The ERP should also be updated once the revised inundation study is available.

Principle 3C: The emergency management process shall ensure that effective emergency preparedness procedures are in place for use by external response agencies with responsibilities for public safety within the floodplain.

Type:	Non-Conformance: Information (NCi)
Description:	Refer to discussion in Principle 3B regarding innundation maps and off site contacts.
Recommendations:	See Principle 3B

Principle 3D: The emergency management process shall ensure that adequate staff training, plan testing, and plan updating are carried out.

Type:	Non-Conformance: Other Procedures (NCp)
Description:	There is no evidence of training of staff or testing of the ERP. This should be included as part of ongoing training and system improvement and implemented as part of the mining restart process or transition to closure.
Recommendations:	i. Define ERP drills for the tailings facilities in the OMS and confirm that drills include that all members of the dam management team participate.

Principle 4 – Dam Safety Review

Dam Safety Reviews (DSRs) should be conducted regularly to ensure that the dam is safe based on current knowledge and standards, which may have been updated since a previous DSR. A qualified registered professional engineer should conduct the review and should evaluate all aspects that may affect the dam's safety, including design, construction, maintenance, operation, processes, and dam safety management systems.

Principle 4A: A safety review of the dam ("Dam Safety Review") shall be carried out periodically.

Type:	Non-Conformance (NCs)
Description:	The CDA (2007) guidelines call for a Dam Safety Review to be conducted every 7 years for a dam with a "High" consequence rating. The first DSR was conducted in 2017 and should have been conducted in 2016..Dam classification should be revised to "Very High" and DSRs conducted in 5 year intervals
Recommendations:	DSR schedule to be set and observed in future.

Principle 4B: A qualified registered professional engineer shall be responsible for the technical content, findings, and recommendations of the Dam Safety Review and report.

Type:	Conforms (Cnf)
Description:	This review has been conducted by a qualified registered professional engineer.
Recommendations:	No recommendation.

Principle 5 – Analysis and Assessment

According to Principle 5, the purpose of dam safety analysis is to determine the capacity of the dam system to retain the stored volume under all conditions and to pass flows around and through the dam in a safe, controlled manner.

Principle 5A: The dam system and components under analysis shall be defined.

Type:	Conforms (Cnf)
Description:	The Engineer or Record appears to be responsible for all components of the facility. It is important that the OMS manual is revised either for closure or mine restart and that updated roles and responsibilities are identified.
Recommendations:	Update OMS manual

Principle 5B: Hazards external and internal to the dam shall be defined.

Type:	Potential Deficiency: Unlikely to be deficient, difficult to prove (Pd)
Description:	The amount of groundwater that reports to the liner underdrain system has never been comprehensively assessed. The slump at the north end of the TSF may indicate that the liner under drain and French drains constructed to manage water are undersized and more groundwater management is required.
Recommendations:	An assessment of the North Slump area should be conducted to determine what caused the movement and what mitigations are required to prevent further slope movements in the future.

Principle 5C: Failure modes, sequences, and combinations shall be identified for the dam.

Type:	Conforms (Cnf)
Description:	The ERP descirbes various failure modes and consequences of failure and responses that can be implemented to mitigate damage to the facility.
Recommendations:	No recommendation

Principle 5D: The dam shall safely retain the reservoirs and any stored solids, and it shall pass flows as required for all applicable loading conditions.

Type:	Conformance (Cnf)
Description:	The records for the design and construction suggest that the facility was designed and constructed to standards that exceed CDA requirements.
Recommendations:	No recommendation