REPORT

2018 Dam Safety Inspection for North Tailings Pond and South Tailings Pond

Teck Coal Limited, Fording River Operations

Submitted to:

Teck Coal Limited
Fording River Operations
PO Box 100
Elkford, BC
V0B 1H0

Attention: Ms. Heather Brickner, P.Eng., Dam Safety Engineer

Submitted by:

Golder Associates Ltd.
Suite 200 - 2920 Virtual Way Vancouver, BC, V5M 0C4 Canada

+1 604 296 4200

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Executive Summary

This report presents the 2018 annual dam safety inspection (DSI) for the North Tailings Pond (NTP) and South Tailings Pond (STP) facilities at the Teck Coal Limited, Fording River Operations (FRO) mine site, located near Elkford, British Columbia (BC). This report was prepared based on a site visit carried out by Golder Associates Ltd. (Golder) from 11 to 12 September 2018, discussions with FRO staff, and a review of data provided by FRO. The reporting period for the data review is from 1 September 2017 to 31 August 2018, unless otherwise noted. The dam inspection reports and photographs from the site visit are presented with this report. The DSI report was prepared in accordance with Part 10 of the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (Ministry of Energy and Mines 2017), which sets out the frequency for inspection of dams and tailings storage facilities.

John Cunning, P.Eng., of Golder is the Engineer of Record for the NTP and STP dams. Kerr Wood Leidal Associates Ltd. (KWL) has historically been the Designer of Record for hydraulics-related works. KWL has prepared design and construction record reports (KWL 2017a,b) for erosion protection along the NTP and STP dam toes following the 2013 flood event, completed a Fording River hydraulics assessment (KWL 2017c), and completed the annual riprap inspections since 2014. The 2018 annual riprap inspection report by KWL is appended (KWL 2019).

Summary of Facility Description

The FRO site is an open pit coal mine located near Elkford, BC. FRO's tailings storage infrastructure includes two tailings pond facilities, the NTP and STP, and two in-pit tailings storage facilities, the 2 Pit and 3 Pit Tailings Storage Area and Turnbull Tailings Storage Facility (TSF). The NTP has been essentially filled to its design capacity and is currently inactive. Tailings discharge from the wash plant is currently directed to the STP.

The NTP is a downstream constructed, zoned, earth fill dam located on the west side of a realigned reach of the Fording River across from the wash plant. The NTP was developed on a segment of the Fording River flood plain and has a surface area of approximately 32 ha and a minimum crest elevation of 1,652.6 m. Construction of the NTP was initiated in 1971 and the dam was raised four times between 1973 and 1979.

The STP facility is located south of the wash plant, on the east side of a realigned reach of the Fording River; it occupies a total area of approximately 67 ha and has a minimum crest elevation of 1,637.85 m. The STP is a downstream constructed, zoned, earth fill dam and was developed on the flood plain of the Fording River. Construction of the STP was initiated in 1977 and the dam was raised in six stages between 1983 to 2013.

Summary of Key Hazards

The key hazards for the NTP and STP facilities are as follows:

- internal erosion (suffusion and piping)
- overtopping

- instability
  - static
  - seismic
  - erosion of toe from the Fording River

Dam Classification

Both the NTP and STP dams meet the definition of a “dam” as defined in the HSRC (Ministry of Energy and Mines 2017).

Both of the dams are classified as Very High consequence, following the dam consequence classification guidelines from HSRC Guidance Document Section 3.4 (Ministry of Energy and Mines 2016), which references the Canadian Dam Association (CDA) *Dam Safety Guidelines* (CDA 2013). The classifications are governed by the consequences of a potential fair-weather failure scenario. An updated geotechnical and hydrological assessments was completed in 2018 based on the updated consequence classification (Golder 2018a).

An incremental inundation assessment was completed in 2017 to assess the consequence of failure of the NTP and STP during a major flood event of the Fording River (Golder 2017d). The assessment concluded that the consequence of a failure occurring coincident with a major river flood event was High. A risk-informed assessment, which would be supported by a design level flood-induced dam break and inundation assessment, is recommended to determine the appropriate criteria for the flood protection requirements along the downstream toes of the NTP and STP dams.

Summary of Significant Changes, and Changes to Instrumentation, Stability, and Surface Water Control

A risk assessment was completed for the STP and NTP facilities (Wood 2018).

Due to the reclassification of the STP and NTP dams from High to Very High consequence structure, in November 2018 Golder finalized the updated liquefaction assessment, seismic stability analysis, and inflow design flood (IDF) and freeboard assessment (Golder 2018a). The assessments indicated the following conclusions:

- The saturated soils below the STP and NTP dams are unlikely to liquefy during the design earthquake event with a return period of ½ between 1-in-2,475-year and 1-in-10,000-year as the Factors of Safety (FoS) against liquefaction are above unity.
- The loose Coarse Rejects (CR) layer identified in the NTP dam at TH15-07 between elev. 1,640.3 m to elev. 1,640.9 m, which is currently unsaturated, may liquefy if saturated during the design earthquake event. Should the NTP be put back into operation, an assessment must be carried out to consider the loose CR layer. The loose CR layer should be considered in any proposed modification of the dam.
- The FoS of the NTP and STP dams meet or exceed the Very High consequence static and pseudo-static slope stability FoS design criteria.
- The conclusions from the IDF and freeboard assessment are provided in the subsection of each facility below.

North Tailings Pond

The Liverpool outlet channel and fish barrier at the north abutment area of the NTP facility were completed in late 2016. They are not considered part of the NTP facility, but as part of the Liverpool Sediment Pond system. A figure outlining the NTP facility boundary has been prepared and included in the FRO Tailings Facility operation, maintenance, and surveillance (OMS) manual (FRO 2018a).

NTP riprap work was completed in September/October 2017. There were no significant changes in visual monitoring records, instrumentation, dam stability, or surface water control for the NTP since the 2017 DSI. Quantitative performance objectives (QPOs) for the inclinometers have been developed and added to the OMS manual.

The FRO Tailings Engineer and FRO Environment inspected the animal burrows at the south end of NTP, near Sta. 1+400, in October 2017. Photos from the inspection were provided to a biologist for preliminary assessment and the biologist visited the area in August 2018. During the site visit, the biologist indicated the animal burrows were likely those of ground squirrels but there was no evidence of animal activity in recent months. An animal burrow removal plan is under development by FRO Environment and is planned for implementation in 2019/2020.

The results of the IDF and freeboard assessment indicated the following:

- The NTP should be closed or an emergency spillway should be constructed to pass the peak outflow from the 24-hour IDF.
- NTP maximum operating water level should be at elev. 1,650.7 m, which is 1.9 m below the NTP dam crest level. Based on historical water level monitoring, this may require active management during wetter periods.

One bathymetric survey was carried out on two separate days, 24 August and 16 October 2018 at the NTP (Golder 2018b).

FRO had ceased the use of prisms on the NTP dam starting in May 2018 due to difficulties with backsight and difficulty of access in winter due to snow cover. The prisms were replaced with GPS units, with three units installed along the crest of the NTP in June 2018.

South Tailings Pond

As a result of the volume of tailings deposited into the STP facility during the 2017/2018 winter, the operating pond size was significantly reduced by early Spring 2018 and pond water levels were operated near the freeboard limit during the spring freshet period. In response, FRO developed an STP Water Levels – Interim Operation at High Levels Trigger Action Response Plan (TARP) and followed this through the 2018 spring period. This TARP is now included in Appendix C of the updated OMS manual (FRO 2018a).

Dredging operations at the STP were started in early April 2018 as part of the plan to manage the high tailings volume in the facility. FRO also increased the annual dredging total plan for the 2018 season, targeting 1.5 million tonnes for 2018, and achieving 1.64 million tonnes.

The updated IDF and freeboard assessment (Golder 2018a) considers diversion of the external catchment which reports to the STP via Blackmore Creek during the IDF event to maintain the 1.2 m freeboard. FRO has Golder working on a conceptual design for the Blackmore Creek diversions at the time of preparation of this report.

The FRO Tailings Engineer and FRO Environment inspected the animal burrows downstream of the southern end of the Main Dam in October 2017. Photos from the inspection were provided to a biologist for preliminary assessment and the biologist indicated there was evidence of badgers in the vicinity but not in the embankment. No animal burrows have been found in the embankment. During a site visit in August 2018, the biologist did not see any badgers and indicated there was no evidence of recent animal activity in the area.

FRO indicates that a total of 1,635,590 dry metric tonnes of tailings was dredged from the STP to the Turnbull TSF during the 2018 dredging operations (3 April to 24 October 2018). The total estimated tonnage of tailings dredged from the STP to Turnbull to date is 2,701,558 dry metric tonnes.

The tailings pipeline from the plant was extended and raised at the north single point discharge in July 2018 during the plant shut down.

Bathymetric surveys were conducted by FRO in June, September, and October 2018 as part of monitoring the remaining capacity in the facility.

Site drainage was directed to the North Loop Settling Pond except during September and October 2017, and February 2018 to reduce the runoff solids reporting to the STP.

There were no significant changes in visual monitoring records or surface water control for the STP since the 2017 DSI. QPOs for the inclinometers have been developed.

Review of Operation, Maintenance, and Surveillance Manual

The OMS manual was updated by FRO in October 2018 (FRO 2018a) as required by HSRC Section 10.5.2 (Ministry of Energy and Mines 2017).

Review of Emergency Preparedness Plan and Emergency Response Plan Manuals

An emergency response plan (ERP) was developed in draft for all TSFs on site at FRO in 2018 (SP&P EP.009; FRO 2018b). This document is currently under final review by senior staff at FRO. The ERP was developed to meet the guidelines provided by the HSRC (Ministry of Energy and Mines 2016, 2017), the CDA (2013), the Mining Association of Canada (MAC 2011), and Teck Resources Limited (Teck 2014).

FRO has also developed a *Tailings Impoundment Flood Response Protocol for the Fording River*. This document was issued on 26 September 2017 (FRO 2017) and will be updated prior to the 2019 freshet.

The emergency preparedness plan (EP.008.R1) was last updated on 15 December 2015 (FRO 2015a). FRO plans to update the emergency preparedness plan once the ERP is finalized as the document will outline the warnings FRO will issue and the expected actions of local authorities and other responders for dam breach flood emergencies.

The emergency planning documents should continue to be reviewed at least annually, with updates incorporated when required. The ERP should be tested annually. FRO carried out an internal tabletop exercise to test the ERP on 18 December 2018. The ERP was considered useful by Teck for the purposes of the test (FRO 2018d).

Dam Safety Review

The most recent dam safety review of the NTP and STP was completed in 2014 (KCB 2014). A dam safety review is required every five years for all water and tailings storage facilities regardless of dam consequence classification according to HSRC Section 10.5.4 (Ministry of Energy and Mines 2017). The next dam safety review is required in 2019 and is already under development with FRO.

Annual Dam Inspection

The NTP and STP facilities were observed to be in good condition at the time of the 2018 annual inspection.

Status of 2017 Dam Safety Inspection Recommended Actions

A number of recommended actions were prepared as part of the 2017 annual DSI (Golder 2018c). A summary of the status of the 2017 annual DSI recommended actions is presented in Table E-1. Recommendations that are noted as complete can be closed out. Items from the 2017 DSI that are incomplete have been brought forward into the 2018 DSI recommendations and shown in Table E-2.

A number of recommendations are in progress and some are incomplete, but Golder considers the work to be appropriately prioritized based on good communication between the Engineer of Record team and the FRO Tailings Engineer.

Table E-1: Current Status of 2017 Dam Safety Inspection Recommend Actions for the North Tailings Pond and South Tailings Pond Facilities

Structure	ID Number	Deficiency or Non-conformance	Recommended Action	Current Status as of March 2019
NTP	2015-05a,b	No passive emergency system against overtopping; emergency system requires active response	Assess the need for spillway after finalizing the NTP closure plan.	**Incomplete** – see Table E-2 for updated recommendation and timeline
			If required, determine a construction schedule.	**Incomplete** – see Table E-2 for updated recommendation and timeline
	2015-06a,b,c	Risk-informed criteria for flood erosion protection along toe of dams not defined	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along the Fording River and the timeline to implement.	**Incomplete** – see Table E-2 for updated recommendation and timeline
			Implement required protection measures for the operational phase according to the as-defined schedule.	**Incomplete** – see Table E-2 for updated recommendation and timeline
			Execute the flood risk mitigation plan until the flood protection requirements defined by the risk-informed assessment are in place.	**Ongoing**
	2015-07a,b	Buried pipes passing through crest locations	Inspect steel pipes as part of regular dam inspections until NTP closure plans are finalized. Include inspections in OMS manual update.	**Ongoing**
			Execute abandonment plan for PVC pipes.	**Incomplete** – see Table E-2 for updated recommendation and timeline
	2016-05a	North abutment excavated without input or approvals from Engineer of Record or Qualified Person	Assess and revise required internal and external communication for work and construction activities carried out near the site TSFs.	**Complete**
	2016-06	No closure plan for NTP	Develop closure plan for NTP based on results of feasibility investigation into NTP decommissioning.	**Incomplete** – see Table E-2 for updated recommendation and timeline
STP	2013-16	No passive emergency system against overtopping; emergency system requires active response	Assess the best combination of active and passive emergency systems during various stages of the pond life cycle. If the assessment determines that passive systems are warranted, then develop a construction schedule for the selected system(s).	**Complete** – Assessment of best combination of active and passive emergency systems were reviewed at the 1 June 2019 workshop. See Table E-2 for Recommended action related to a passive emergency spillway system.
	2015-12a,b,c	Riprap erosion protection along downstream toe north of STP Stn. 0+680, no riprap south of STP Stn. 0+680; risk-informed protection requirements not yet defined	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along Fording River and timeline to implement.	**Incomplete** – see Table E-2 for updated recommendation and timeline
			Implement required protection measures for the operational phase according to the as-defined schedule.	**Incomplete** – see Table E-2 for updated recommendation and timeline
			Execute flood risk mitigation plan until flood protection requirements defined by the risk-informed assessment are in place.	**Ongoing**
	2017-01	North abutment construction deficiencies	Address construction deficiency, finish dam construction.	**Incomplete** – gas line relocation planned for 2019. See Table E-2 for updated recommendation and timeline
	2017-02	Tailings that were excavated along upstream slope to place the riprap zone impede water flow towards main pond	The tailings should be regraded with an excavator so that water will preferentially flow into the pond.	**Complete**
	2017-03	Inspection frequency inadequate for active, Very High consequence facility	Increase geotechnical inspections to weekly from May to October and twice per month from November to April for STP	**Complete** – included in OMS manual (FRO 2018a)

Structure	ID Number	Deficiency or Non-conformance	Recommended Action	Current Status as of March 2019
	2017-04	Planned dredging of Tailings to Turnbull TSF is behind schedule and the result is a very high level of tailings in STP which is causing operational issues (e.g., disposition line backing up and reclaimed process water with too much sediment)	Dredging to Turnbull TSF should be started as soon as possible with an increased annual dredging target.	**Complete**
NTP/STP	2015-03	Roles of Geotechnical and Hydraulics Engineers of Record undocumented	Golder, FRO, and KWL to document the roles of the Engineer of Record for the geotechnical and hydraulics related works in the OMS manual.	**Complete** – FRO (2018a)
	2016-01	Seismic design criteria for stability out of date due to dam reclassification from High to Very High	Complete updated seismic stability assessment and liquefaction based on revised design criteria. Update QPOs based on revised stability assessment.	**Complete** – Golder (2018a)
	2016-02	IDF and freeboard out of date due to dam reclassification from High to Very High	Update the IDF and freeboard assessment for the NTP and STP.	**Complete** – Golder (2018a)
	2016-03	OMS manual requires updating	Update OMS manual as follows: ■ Update all references to consequence classification of structures—change from High to Very High. ■ Include design criteria. ■ Review the manual using the updated HSRC and Guidance Document (Ministry of Energy and Mines 2017, 2016). ■ Review the manual using most recent Mining Association of Canada guidelines ■ Include QPOs for surveillance. ■ Update the dredging section to identify that dredging is currently operating to the Turnbull TSF. ■ Include safe work plans. ■ Include incident reporting procedures. ■ Include non-compliance reporting procedures. ■ Include animal burrow inspection and procedures ■ Include NTP pipe inspections ■ Include hydroseeding records ■ Include Liverpool and NTP boundaries Complete minor updates identified in the 2015 DSI report (Golder 2016b).	**Complete** – FRO (2018a)
	2016-04	EPP & ERP require updating	Reference to the TARPs needs to be included for actions required based on instrumentation warnings and alarms.	**In progress** – draft ERP is being finalized. EPP will be updated after ERP is finalized
	2016-09	No QPOs set for inclinometers	QPOs and frequency of readings should be set for the inclinometers.	**Complete** – see Golder (2018a) and FRO (2018a)
	2017-05	Potential overtopping hazard due to tailings liquefaction and redistribution during seismic event needs to be assessed	Complete liquefaction and overtopping assessment for tailings within facility.	**Retracted for NTP** – redistribution of tailings as a result of a seismic event was determined to have a close to non-credible likelihood in the risk assessment **In progress for STP**

Structure	ID Number	Deficiency or Non-conformance	Recommended Action	Current Status as of March 2019
	2017-06	Trigger-action-response plans (TARPs) and related QPOs not strongly tied to risk assessment results	TARPs with related monitoring plans and QPOs should be reviewed with consideration of the results from the 2017 TSF risk assessment	**Complete** – TARPs added to OMS manual

IDF = inflow design flood; FRO = Fording River Operations; KWL = Kerr Wood Leidal Associates Ltd.; NTP = North Tailings Pond; STP = South Tailings Pond; HSRC = Health, Safety and Reclamation Code; DSI = dam safety inspection; TSF = tailings storage facility; OMS = operation, maintenance and surveillance; EPP = Emergency Preparedness Plan; ERP = Emergency Response Plan; QPO = quantitative performance objectives; PVC = poly vinyl chloride.

2018 Dam Safety Inspection Findings and Recommended Actions

Table E-2 summarizes the 2018 findings and recommended actions for the NTP and STP, along with incomplete and in-progress items from previous DSIs. Previous recommendations have been reviewed and updated according to the information included in the 2018 DSI.

Table E-2: 2018 Dam Safety Inspection Recommended Actions for the North and South Tailings Pond Facilities

Structure	ID Number	Deficiency or Non-conformance	Applicable Guideline or OMS Reference	Recommended Action	Priority Level	Recommended Timing for the Action
NTP	2015-05a,b	No passive emergency system against overtopping; emergency system requires active response	n/a	Assess the need for spillway after establishing an NTP closure plan.	4	2019
				If required, determine a construction schedule.	4	2020
	2015-06a,b,c	Risk-informed criteria for flood erosion protection along toe of dams not defined	CDA 2013 §6.2	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along the Fording River and the timeline to implement.	2	2019
				Implement required protection measures for the operational phase according to the as-defined schedule.	2	2020
				Execute the flood risk mitigation plan until the flood protection requirements defined by the risk-informed assessment are in place.	1	Ongoing
	2015-07a,b	Buried pipes passing through crest locations	n/a	Inspect identified pipes as part of regular dam inspections until NTP closure plans are finalized.	3	Ongoing
				Execute abandonment plan for identified pipes.	3	2019
	2016-06	No closure plan for NTP	HSRC §10.6.7	Develop a closure plan for NTP.	4	Q4 2019
	2018-01	Real time water level readings are not available, and water level readings are limited during winter months when there is ice cover on the pond.	OMS §6.4.2	Install a real time water level monitoring instrument in the NTP pond and connect this to the site GeoExplorer system	4	Q3 2019
STP	2015-12a,b,c	Riprap erosion protection along downstream toe north of STP Stn. 0+680, no riprap south of STP Stn. 0+680; risk-informed protection requirements not yet defined	HSRC §10.1.8	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along Fording River and timeline to implement.	2	2019
				Implement required protection measures for the operational phase according to the as-defined schedule.	2	2020
				Execute flood risk mitigation plan until flood protection requirements defined by the risk-informed assessment are in place.	1	Ongoing
	2017-01	North abutment construction deficiencies	HSRC §10.5.1(3)	Address construction deficiency, finish dam construction following gas line relocation.	2	2019 or 2020
	2017-05	Potential overtopping hazard due to tailings liquefaction and redistribution during seismic event needs to be assessed	n/a	Complete liquefaction and overtopping assessment for tailings within facility.	2	Q2 2019
	2018-02	Planned dredging of Tailings to Turnbull TSF is behind schedule and the result is a very high level of tailings in STP which is causing operational issues (e.g. high	n/a	Dredging to Turnbull TSF should be started as soon as possible in April 2019 with a minimum annual dredging target of 1.3 million tonnes.	2	Q2 2019

Structure	ID Number	Deficiency or Non-conformance	Applicable Guideline or OMS Reference	Recommended Action	Priority Level	Recommended Timing for the Action
		levels of solids in STP causing operational difficulties)				
	2018-03	The current spillway design does not meet the Very High dam consequence classification IDF	HSRC §10.6.10	Update design of permanent spillway as per the new inflow design flood and requirements from HSRC Guidance Document (Ministry of Energy and Mines 2016). Develop a construction schedule accordingly.	2	Q3 2019
	2018-04 a, b, c	Current operation of the facility for water management do not meet the Very High dam consequence classification IDF	HSRC §10.1.8 CDA 2013	Design upstream diversion to divert runoff from upstream catchment (Blackmore Creek). The diversion should be sized to allow the STP to manage the IDF, if possible.	2	2019
				Construct the upstream diversion.	3	2019 to 2020
				Design a permanent emergency spillway to pass the peak outflow from the 24-hour IDF.	3	2019 to 2020
	2018-05	No closure plan for STP	HSRC §10.6.7	Develop a closure plan for STP.	4	Q4 2019
	2018-06	Construction of the active water treatment facility is underway downstream of the STP main dam, potentially increasing the number of workers in the dam breach inundation zone.	HSRC §10.1.7 CDA 2013	Review potential inundation for failure of the Main Dam relative to the downstream facility and develop an emergency response plan for the downstream workers if required	2	Q3 2019
NTP/STP	2016-04	EPP & ERP require updating	HSRC §10.4.2(1)	Reference to the QPOs needs to be included for actions required based on instrumentation warnings and alarms.	4	Q2 2019
	2018-07	GPS, inclinometer, and NTP freeboard QPOs in the OMS manual do not reflect the most recent recommendations in Golder (2018a)	HSRC §10.5.2	Update OMS manual with recommended GPS, inclinometer, and NTP freeboard QPOs from Golder (2018a).	4	Q3 2019

STP = South Tailings Pond; NTP = North Tailings Pond; FRO = Fording River Operations; KWL = Kerr Wood Leidal Associates Ltd.; OMS = operation, maintenance and surveillance; CDA = Canadian Dam Association; HSRC = Health, Safety and Reclamation Code; QPO = quantitative performance objectives; EPP = Emergency Preparedness Plan; ERP = Emergency Response Plan; Stn. = Station; n/a = not applicable; DSI = dam safety inspection; TSF = tailings storage facility.

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

Source: HSRC Guidance Document, Section 4.2 (Ministry of Energy and Mines 2016).

As presented in Golder (2018a), a loose CR layer was identified in the NTP dam at TH15-07, which is currently unsaturated. The conditional recommendation listed in Table E-3 must be completed prior to the NTP facility being put back into operation or for any proposed dam modification.

Table E-3: Conditional Recommendation to be Completed Prior to Restarting Tailings Deposition into the North Tailings Pond Facility

ID Number	Deficiency or Non-conformance	Applicable Regulation or Guideline	Recommended Action
NTP-01	A loose CR layer was identified in the NTP dam investigation, which is currently unsaturated. This loose CR layer may liquefy if it becomes saturated during the design earthquake event.	HSRC §10.1.8	Carry out liquefaction and stability assessments considering the loose CR layer if NTP is put back into operation or for any proposed modification to the dam.

CR = coarse rejects; HSRC = Health, Safety and Reclamation Code; NTP = North Tailings Pond.

Study Limitations

Golder Associates Ltd. (Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

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1.0 INTRODUCTION

1.1 Purpose, Scope of Work, Method

Golder Associates Ltd. (Golder) has completed this annual dam safety inspection (DSI) for the North Tailings Pond (NTP) and South Tailings Pond (STP) at the Teck Coal Limited, Fording River Operations (FRO) site, located near Elkford, BC. The reporting period for the data review is from 1 September 2017 to 31 August 2018, unless otherwise noted.

The report is based on a site visit carried out by Golder from 11 to 12 September 2018, discussions with FRO staff, and review of data provided by FRO. This report was prepared in accordance with the Teck Resources Limited *Guideline for Tailings and Water Retaining Structures* (Teck 2014) and consists of the following:

- a summary of the site conditions and background information for the facilities
- a summary of the construction, operating, and/or maintenance activities for the reporting period
- dam consequence classification and review of required operational documents
- site photographs and records of dam inspection
- review of climate data
- review of water balance
- review of dredging data
- review of assessment of dam safety relative to potential failure modes
- recommended actions

Photographs of NTP and STP from the site inspection are presented in Appendix A, and a summary of the observations is included in the inspection reports in Appendix B and C for the NTP and STP, respectively.

FRO switched coordinate systems on 25 October 2016 from FRO Mine Grid to Universal Transverse Mercator (UTM) with elevations referenced to the Elk Valley Elevation Datum. All coordinates presented in this report are in UTM with elevations referenced to the Elk Valley Elevation Datum unless otherwise noted.

The previous annual DSI for this facility was carried out in October 2017 and is reported in the 2017 DSI report (Golder 2018c).

This report is to be read in conjunction with the Study Limitations provided at the beginning of the report.

1.2 Regulatory Requirements

1.2.1 BC Health, Safety and Reclamation Code

The DSI report was prepared in accordance with Part 10 of the Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia (Ministry of Energy and Mines 2017), which sets out the frequency for inspection of dams and tailings storage facilities. It is understood that this report will be submitted by FRO to the Chief Inspector of Mines.

The guidelines for annual DSI reports provided in the HSRC Guidance Document (Ministry of Energy and Mines 2016, Section 4.2) were followed where applicable during the preparation of this report.

1.2.2 Permits and Licences

Specific amendments to the permits concerning NTP and STP are as follows:

- Permit C-3 Amendment to permit approving work system – South Tailings Pond tailings dredging project. Issued by the Ministry of Energy, Mines and Petroleum Resources. 27 April 1995.
- Permit C-3 Amendment to permit approving work system and reclamation program – Raising the South Tails Pond Dyke. Issued by the Ministry of Energy, Mines and Petroleum Resources. 30 June 2008.
- Permit C-3 Amendment to permit approving work system and reclamation program – Turnbull South Pit Tailings Storage Facility. Issued by the Ministry of Energy and Mines. 14 November 2013.
- Permit C-3 Amendment to permit approving work system and reclamation program – Turnbull South Pit Tailings Storage Facility East Pipeline Route. Issued by the Ministry of Energy and Mines. 6 May 2015.
- Permit C-3 Amendment to permit approving work system and reclamation program – Fording River Swift Mine Plan and Reclamation Program. Issued by the Ministry of Energy and Mines. 15 December 2015.
- Permit 424 Amendment to authorize discharges. Issued by the Ministry of Environment. 6 December 2016.

2.0 BACKGROUND

2.1 Site History

The FRO site is an active, open pit coal mine located near Elkford, BC, which currently has two tailings pond facilities, the NTP and STP, and two permitted destinations for in-pit tailings disposal, the 2 Pit and 3 Pit Tailings Storage Area, and Turnbull Tailings Storage Facility (TSF). This DSI report is for the NTP and the STP.

The NTP has been essentially filled to its design capacity and is currently inactive. Tailings discharge from the wash plant is currently directed to the STP.

The NTP is located on the west side of the Fording River across from the wash plant. The STP facility is located south of the processing plant, on the east side of the Fording River. The STP is composed of two dams, the Main and West dams. A location and plan view of the NTP and STP facilities is shown in Figure 1.

2.2 System Description

At the NTP, the earth fill dam provides storage for settled tailings and only retains a small pond which receives runoff from the local tailings surface area and small surrounding catchment area. This facility is not in active use.

At the STP, the earth fill dam provides the following:

- impoundment of the tailings slurry
- storage of settled tailings
- temporary storage of runoff, excess slurry water, and water from pit dewatering or sediment ponds (when viable based on freeboard)
- reservoir of water as the reclaim source of the coal processing plant

2.2.1 Tailings Description

The raw coal delivered to the breaker at FRO contains high-ash material in the form of carbonaceous mineral rock. To meet product specifications, this high-ash rock is separated from the raw coal at the wash plant. The high-ash waste consists of a coarse fraction and a fine fraction. The coarse fraction, referred to as coarse rejects (CR), consists of sand and gravel-sized fragments of washed, crushed rock ranging in size from approximately 1 to 100 mm. The fine fraction of the waste, comprising rock fragments smaller than approximately 1.0 mm, includes “coarse-fine” rejects (0.75 to 1.0 mm) and the flotation tailings (less than 0.75 mm). Since 2005, the coarse-fine rejects and the majority of the flotation tailings have been separated at the wash plant. The coarse-fine rejects are mixed with the CR to produce combined coarse and fine rejects (CCFR), which are hauled by trucks to a designated CCFR spoil. The flotation tailings from the wash plant are a slurry and are sent via pipeline to the STP where they are hydraulically deposited from the North Single Point discharge.

2.2.2 Tailings Impoundments

In the past, tailings were discharged to the two ponds alternately. The tailings stream has never discharged to the two ponds concurrently. The NTP is essentially full, and tailings have not been deposited there since 2006.

Tailings are seasonally dredged from the STP to increase available tailings storage capacity. Previously, the dredged tailings were pumped to the NTP, 2 Pit, or 3 Pit South (Golder 2016c). Dredging operations to the NTP and 2 Pit was discontinued in 2008 due to capacity constraints. No dredged tailings have been sent to 3 Pit South since 6 October 2015.

Seasonal dredging from the STP to the Turnbull TSF started in 2016 and is planned to continue for approximately the next 15 years until 2034, which is the estimated life of the facility when Turnbull TSF reaches capacity.

2.3 Overview of Design, Construction, and Previous Operation

A summary of the NTP and STP design, dam construction, and operations is presented in the following subsections. Additional details of construction history are presented in the operation, maintenance, and surveillance (OMS) manual (FRO 2018a).

2.3.1 North Tailings Pond

A plan view of the NTP facility is shown in Figures 2 and 3. The NTP was developed on a segment of the Fording River flood plain and has a surface area of approximately 32 ha. In the 1970s, the Fording River was diverted into a new constructed channel (McElhanney 1969) to allow for construction of the NTP on the west side of the Fording River flood plain (Golder Brawner 1969). Along the eastern and southeastern sides of the NTP facility, confinement for water and the stored tailings is provided by a zoned earth fill dam that has a maximum height of approximately 24 m. The NTP dam was designed and constructed using a downstream construction method. A confining dam is not required along the west side of the facility because the natural ground to the west of the NTP is higher than the stored tailings or pond level.

A typical section through the zoned earth fill NTP dam is presented in Figure 4. The crest of the dam was raised in stages, as the tailings storage requirements increased progressively during the early years of operation at FRO. Stage 1 of the dam was constructed entirely of compacted glacial till soil, complete with a compacted glacial till cut-off that extends through the Fording River flood plain gravels and is joined to in situ glacial till soils that underlie the flood plain gravels.

During subsequent stages of construction, the compacted glacial till was extended upward in the form of an inclined zone on the upstream side of the NTP dam. Structural support for this inclined till zone is provided by compacted CR. As shown in Figure 4, the in situ fluvial sands and gravels of the Fording River flood plain extend beneath the cross-section of the dam. These fluvial sediments have a high hydraulic conductivity and serve as an underdrain that promotes downward seepage from the facility.

The original design for the NTP was completed by Golder (Golder Brawner 1969, 1970). Construction of the NTP was initiated in 1971 (Golder Brawner 1971), and the facility was put into service in March 1972. The NTP dam was raised four times between 1973 and 1979 (Golder Brawner 1973, 1974a,b, 1975a,b; Golder 1979) using a downstream construction method and reached its current elevation in 1979. The NTP facility was at its tailings storage capacity by 1980 (Golder 1981). Between 1980 and 1991, the NTP was inactive and the facility was dewatered and excavated using scrapers to recover additional tailings storage capacity (Golder 1981; FCL 1981). The NTP was put back into active use and refilled with tailings between 1993 and 1997, after which the facility was again inactive. From 2001 to 2002, the NTP was dredged and the tailings were sent to 2 Pit and 3 Pit. Dredged tailings from the STP were used to fill the excavated areas of the NTP seasonally between 2004 and 2006. No tailings have been sent to the NTP since 2006 and the tailings pipeline has been partially removed.

The current crest of the NTP dam is elev. 1,653 m (confirmed by 2018 LiDAR). The minimum elevation of the NTP dam is at elev. 1,652.6 m (2017 survey completed by FRO and confirmed by 2018 LiDAR).

Following the flood of June 1995, riprap was placed along the downstream/eastern toe of the dam, as well as along the opposite (left) side of the Fording River channel. The condition of the riprap placed in 1995 had degraded by the time of the 2006 dam safety review (DSR), and review of the riprap sizing and placement was recommended by Golder. Assessment of the riprap was performed by Kerr Wood Leidal Associates Ltd. (KWL 2007, 2009).

Between 19 and 20 June 2013, a significant 48-hour rainfall event occurred which resulted in flooding of the Fording River. High flows along the toes of the NTP dam triggered major erosion of the CR shell. Golder was retained by FRO to provide geotechnical input for flood repairs of the NTP dam. KWL was retained to provide recommendations for sizing and placement of the river bank protection along the downstream dam toe (KWL 2014). The dam shell was rebuilt using compacted CCFR material. A total CCFR fill of approximately 22,350 m^3 was placed and compacted between 3 July and 8 August 2014 (Golder 2014b). Riprap revetment construction was carried out along the toe of NTP dam under the direction of KWL in 2013 and 2014.

In 2016, FRO constructed a sediment pond north of the NTP facility (the Liverpool Sediment Pond); the outlet channel from this pond is routed through the north end of the NTP tailings deposit and includes a fish barrier weir constructed through the north abutment of NTP dam (AMEC-FW 2017).

Additional riprap upgrade works were designed, and construction carried out under the direction of KWL as designer of record in 2016 and 2017 (KWL 2017a). The 2016 work included placing riprap of approximately 2.5 m thickness along the existing NTP riprap alignment for scour protection and to accommodate the revised 200-year return period (Q200) design flow. During 2017, riprap construction was completed under the direction of KWL which included the excavation and placement of approximately 150 m of riprap at the upstream end of the NTP, and the placement of approximately 745 m of riprap over the existing bank protection. During construction, KWL provided oversight to the gradation and quality of the riprap, which was sourced on site. A construction completion report and Record Drawings for these riprap upgrades are included in KWL (2017b).

Golder completed a screening-level flowability assessment of the tailings within NTP in 2016 (Golder 2017c) to asses the possibility of revising the NTP from a tailings dam to a mine waste facility or “landform” per Section 10.6.12 of the HSRC (Ministry of Energy and Mines 2017). The results of the assessment would be used in subsequent stages of design to further assess whether NTP can advance towards a landform status.

2.3.2 South Tailings Pond

A plan view of the STP facility is shown in Figures 5 and 6. The STP occupies a total area of approximately 67 ha, and is located to the south of the wash plant, on the east side of a realigned reach of the Fording River. The STP was developed on the flood plain of the Fording River. The Fording River was diverted to a new alignment outside the footprint of the STP by excavating a new channel through a topographic bench on the west side of the Fording River flood plain. This topographic bench consists of native glacial till soils overlying Fernie Shale. Confinement at the STP is provided by the Main Dam, which extends across the width of the Fording River flood plain, and by the West Dam, which extends parallel to the east side of the Fording River Diversion Channel. The West Dam is primarily founded on the glacial till bench.

Initial construction of the STP dams was performed between 1977 and 1979. From 1983 to 2013, the STP dams have been raised in six stages using the downstream construction method:

1) 1983 to 1984 (FCL 1984)

2) 1985 to 1990 (FCL 1988, 1989, 1990)

3) 1993

4) 2008 (Golder 2009)

5) 2010 (FRO 2010)

6) 2012 to 2013 (Golder 2013, 2014d)

The design crest elevation of 1,637.85 m was specified in the original design report (reported as elev. 1,638.3 m FRO Mine Grid in Golder 1976), and this elevation was reached with construction carried out in 2013. Designs of the north and south abutment sections of the dam are presented in the design update report and design drawings (Golder 2011, 2012a), and the construction summary of the STP raise is reported in the construction record report (Golder 2014d). The design crest elevation of the north end of the West Dam is 1,639.5 m.

The current minimum crest of the STP dam is elev. 1,637.85 m. The 2018 LiDAR survey provided by FRO confirms the crest of the Main Dam ranges between elev. 1,637.5 and 1,638 m.

The dam construction prior to 2008 was wider than design, which created a bench along the length of the facility when the 2008 and later lifts were constructed, as shown in the sections in Figures 7 and 8.

The June 2013 flooding of the Fording River caused high flows along the downstream toe of the STP dam, which eroded the foundation soils and a minor portion of the CR shell. Repairs to the STP downstream toe area were completed in 2013.

Riprap upgrades were completed for the STP in 2016, and construction carried out under the direction of KWL as Designer of Record. KWL oversaw the placement of approximately 2.5 m thickness of riprap by FRO and FRO contractors along the existing STP riprap alignment for scour protection and to accommodate the revised Q200 design flow (KWL 2017b). During construction, KWL provided oversight to the gradation and quality of the riprap, which was sourced on site. A construction completion report and Record Drawings for these riprap upgrades are included in KWL (2017b). Golder provided on-site services to oversee resloping of the till bench, cutting into existing bedrock for key-in of the riprap material, and monitored seepage conditions and signs of instability (Golder 2017a).

One recommendation remains outstanding from the reconstruction and riprap upgrades (Golder 2014c): river flood protection south of STP Stn. 0+680 needs to be completed to improve long-term stability of the STP structure (recommendation 2015-12 in Table 27).

2.3.2.1 Main Dam

The STP Main Dam, which extends across the Fording River flood plain, has a maximum height of approximately 35 m. A typical section of the STP Main Dam is presented in Figure 7. The Main Dam was constructed and raised using a downstream construction method. It consists of a low permeability starter dam of compacted glacial till soil and an inclined low permeability zone of compacted glacial till soil on the upstream side of the dam, supported by a zone of compacted CR or CCFR. The compacted CR or CCFR zone that forms the downstream shell of the Main Dam provides the structural strength of the dam.

As indicated in Figure 7, discontinuous flood plain sands and gravels extend beneath the whole downstream shell of the Main Dam. These flood plain sediments are pervious and serve as an underdrain for the dam.

2.3.2.2 West Dam

The STP West Dam is founded on the till bench that borders the western edge of the Fording River flood plain. It was constructed and raised using downstream construction method. A typical section through the West Dam, presented in Figure 8, consists of a low permeability zone of compacted glacial till soil on the upstream side of the STP West Dam, supported by a zone of compacted CR or CCFR.

2.3.2.3 Railway Embankment

A segment of the railway embankment south of the loading loop traverses an area that impounds tailings in the STP facility. A stability assessment of the embankment was previously carried out by Golder in 1984 (Golder 1984) and updated in 2010 (Golder 2010). The 1984 assessment recommended a buttress on both sides of the embankment to maintain stability of the railway embankment with respect to the increase in the pond elevation. FRO constructed this buttress in stages as the tailings and STP pond level increased between 1985 and 2014.

In 2010, Golder recommended that FRO grout the existing culverts that conveyed surface runoff through the railway embankment, install new culverts at a higher elevation and backfill the area east of the railway embankment to provide further buttressing for the railway embankment to improve stability (Golder 2010). The corrugated steel culverts passing through the railway embankment were filled with concrete during 2009 and 2010 to prevent the flow of tailings from the STP to the east as the tailings level rose above the elevation of the existing culverts. The unused culverts were properly closed and abandoned, and in 2010 the area of the railway embankment was backfilled and graded. Surface runoff from the area upslope of the railway embankment, including Blackmore Creek, is now diverted around the backfilled area into the STP through twin 0.8 m diameter culverts installed in 2010.

A till cut-off was constructed through a section, close to the south abutment, of the rejects buttress (Golder 2012a).

Three additional culverts (two at 0.6 m diameter and one at 0.3 m diameter) were installed under the railway track in 2015 just north of the Blackmore Creek culverts as part of the STP to Turnbull TSF tailings transfer project.

2.3.3 Water Management of North Tailings Pond and South Tailing Pond

2.3.3.1 Freeboard Management

The NTP and STP dams have been reclassified from High to Very High consequence structures following the dam consequence classification guidelines from the HSRC Guidance Document Section 3.4 (Ministry of Energy and Mines 2016), which references the Canadian Dam Association guidelines (CDA 2013). As a result of the reclassification in 2018, Golder updated the inflow design flood (IDF) and freeboard assessment for both facilities (Golder 2018a). The resulting minimum required freeboard during the IDF event and maximum operating water level for the NTP and STP are summarized in Table 1 (Golder 2018a).

For the NTP, the maximum operating water level must be 1.9 m below the minimum dam crest elevation to store the IDF while maintaining the required minimum freeboard. For the STP, a maximum operating water level at 1.2 m below the minimum dam crest elevation would provide the required minimum freeboard only if the external catchment area of STP is diverted during the IDF event.

Table 1: Maximum Pond Elevations and Freeboard Levels

Parameter	STP	NTP
Minimum dam crest elevation	1,637.85 m[(a)]	1,652.60 m[(b)]
Minimum required freeboard (during inflow design flood [IDF])	0.40 m	0.35 m
IDF Water Level (dam crest elevation minus the minimum freeboard)	1,637.45 m	1,652.25 m
Maximum operating water level	1,636.65 m [(c)]	1,650.7 m

Notes:

a) Minimum Main Dam crest elevation following 2013 dam raise construction reported in Golder (2014d), confirmed with 2018 LiDAR survey data provided by FRO.

b) Dam crest elevation from 2018 LiDAR survey data provided by FRO.

c) The maximum operating water level is calculated assuming all the STP external watershed areas are diverted during the IDF event.

2.3.3.2 Control of Inflows and Outflows

Floating reclaim pumps are used to recirculate water from the STP to the processing plant. Water demand at the plant is greater than the volume of water that is available from recirculation of tailings slurry transport water alone, creating a water deficit in the STP facility water balance. Makeup water is added to the STP from various locations on site to satisfy the reclaim water demand. In the event of high water levels at the STP, the STP Water Level Trigger Action Response Plan (TARP) from Appendices B or C of the OMS manual would be followed (FRO 2018a).

There are no permanent working pumps at the NTP.

2.3.4 Design Parameters for the North Tailings Pond and South Tailings Pond

The following design parameters apply to the NTP and STP. Typical sections of the dams are shown in Figure 4 for the NTP and in Figures 7 and 8 for the STP.

2.3.4.1 Foundation Materials

The retention dams at the NTP and the STP are founded on Fording River flood plain sands and gravels, dense glacial till soils, or shale bedrock.

A subsurface investigation was completed by FRO to compile in situ density data and subsurface stratigraphy under the NTP and STP dams (FRO 2016).

2.3.4.2 Embankment Fill Materials

The following materials were used in the construction of the dams: till fill, and CR and CCFR.

2.3.4.2.1 Till Fill

A zone of compacted glacial till fill forms the upstream face of the retaining dams. This till fill zone serves as a low permeability zone to minimize seepage through the dam rather than structural support. The glacial till material was sourced locally on site.

2.3.4.2.2 Coarse Rejects and Combined Coarse and Fine Rejects

At both the NTP and the STP, support for the low permeability zone of the dams is provided by compacted CR or CCFR. The CR is a waste product generated at the wash plant and consists of sand and gravel-sized, well-graded, washed crushed rock material.

For the 2010 and 2012 raises of the STP dams, CCFR was used in place of the CR following modifications to the wash plant waste streams. The CCFR is formed by combining the CR with finer material previously sent to the tailings ponds as tailings. The CCFR contains approximately 2% to 10% material finer than 0.075 mm. The engineering properties of the CCFR are similar to those of the CR as presented in Table 2.

Golder personnel were on site throughout the 2012 and 2013 dam raise construction period to provide quality control services following the Quality Control Specifications from Golder (2011). Results of the quality control related to the dam raise, including construction observations and deficiencies noted by the Golder personnel, and recommendations to address the deficiencies, are included in the construction record reports (Golder 2013, 2014d).

Table 2: Engineering Properties of Compacted Coarse Rejects (CR)

Property	Value
Average in situ density	1.75 t/m^3
Friction angle	38 to 40.5 degrees
Compressibility	Low

2.3.4.3 Seismicity

The site is located in an area of relatively low seismicity in BC. Golder developed a site-specific seismic hazard model for the FRO site based on historical seismicity and a review of geological and paleoseismological features (Golder 2016a). Golder's model includes four area sources from the 5th Generation Seismic Hazard Model and nine faults and fault segments mapped in northwest Montana. The 5th Generation Seismic Hazard Model was developed by Natural Resources Canada for use in the 2015 National Building Code of Canada.

Probabilistic analysis results from site-specific hazard model are listed in Table 3. All site-specific peak ground acceleration (PGA) values were evaluated for a soil Site Class C as described in the 2010 National Building Code of Canada (NRCC 2010) as this represents Golder's understanding of the general foundation conditions at the dam locations.

Table 3: Fording River Operations Site Seismic Hazard Values

Exceedance Probability	Return Period (years)	Peak Ground Acceleration (g)
40% in 50 years	100	0.020
10% in 50 years	475	0.063
5% in 50 years	1,000	0.097
2% in 50 years	2,475	0.158
1% in 50 years	5,000	0.222
½% in 50 years	10,000	0.300

Notes: For firm ground site class "C," very dense soil and soft rock foundation, as defined by 2010 National Building Code of Canada (NRCC 2010).

Return periods are not exact representations of annual exceedance probabilities; rounding per Canadian Dam Association (CDA 2013, 2014) is shown.

FRO site coordinates: 50.202°N, -114.876°W.

The HSRC Guidance Document, Section 3.3.1 (Ministry of Energy and Mines 2016) recommends a return period of ½ between the 2,475-year and 10,000-year seismic event or the maximum credible earthquake for tailings dams with Very High consequence classification.

2.4 Key Personnel

The Engineer of Record (EoR) for the NTP and STP dams is John Cunning, P.Eng., of Golder.

KWL has historically been responsible for hydraulics-related works and has completed a Fording River hydraulics assessment (KWL 2017c), prepared design and construction record reports for erosion protection along the NTP and STP dam toes following the 2013 flood event (KWL 2017a,b). Jason Miller of KWL is the Designer of Record for the erosion protection works for both the NTP and STP facilities. Inspection of riprap for both the NTP and STP was completed in October 2018 by KWL and its associated report is included in Appendix D.

The TSF Qualified Person for the NTP and STP is Heather Brickner, P.Eng., an employee of Teck Coal Limited and the Dam Safety Engineer.

2.5 Quantitative Performance Objectives

Quantitative performance objectives (QPOs) have been established for NTP and STP with consideration of the credible failure modes for the facilities. Golder has updated the QPOs for piezometers and Global Positioning System (GPS) units at the NTP and STP based on the stability update completed in 2018 (Golder 2018a). QPOs for the slope inclinometers installed in 2015 were recently established and have been included in the updated OMS Manual.

2.5.1 Piezometers

Updated slope stability analysis of the STP and NTP dams (Golder 2018a) confirmed the warning and alarm QPOs that were established and presented in the 2016 stability re-assessment (Golder 2016d) are still applicable. The warning and alarm QPOs presented in Golder (2016d) were in the FRO Mine Grid coordinate system, and they have been updated to the Elk Valley Elevation Datum and rounded to the nearest 0.1 m.

Seven new piezometers were installed in three locations (CP17-NTP-01, -02, and -04) within the NTP tailings deposit in November and December 2017. These are being monitored to support NTP facility closure studies. No QPOs are required for these instruments.

The piezometer QPOs are presented in Table 4.

Table 4: Piezometer Instrumentation Trigger Levels for the North Tailings Pond and South Tailings Pond

Dam	Monitoring Instrument	Warning Water Elevation (m)
NTP	TH15-05	>1,646.5
	TH15-06	>1,643.5
	TH15-07	>1,640.5
STP – Main Dam	SP-3	>1,604.0
	SP-5	>1,603.5
	TH15-04	>1,603.5
	TH15-01 / VW-5	>1,617.5
	TH15-02 / VW-4	>1,624.0
STP – West Dam	TH15-03 / VW-1 / VW-2	>1,627.5
	SP-W1	>1,623.1
	SP-W3	>1,623.0
	VW-3	>1,627.0

NTP = North Tailings Pond; STP = South Tailings Pond; > = greater than.

2.5.2 Dam Crest Displacement Monitoring

FRO ceased the use of prisms on the NTP dam in May 2018 due to difficulties with surveying in winter (i.e., snow cover on the prisms), and with backsight readings. The prisms were replaced with GPS units, with three units installed at the NTP in June 2018. The STP has only GPS units to monitor displacements.

NTP dam prisms were read during the reporting period of this DSI, and the QPO's from FRO (2018a) for those prisms are shown in Table 5.

Table 5: Prism Monitoring Instrumentation Trigger Levels for the North Tailing Pond

Dam	Monitoring Instrument	Survey Data	Warning	Alarm
NTP	Prism	SD displacement	> 15 mm	> 20 mm
		3D displacement	> 100 mm	> 150 mm

NTP = North Tailings Pond; SD = slope distance; > = greater than; 3D = three dimensional.

Table 6 provides the updated QPOs for GPS units on the NTP and STP dams from Golder (2018a). The QPOs for 3D velocity with 12 point averaging are set above the noise level of the instruments. It is understood that the GPS data is reviewed manually by FRO as part of the tailings dam inspections for the STP and NTP (on a weekly to monthly basis for STP and monthly basis for NTP) to check for movements or trends of concern below the trigger levels. These updated QPOs and this frequency of manual review should be included in the next update of the OMS manual.

Table 6: GPS Monitoring Instrumentation Trigger Levels for both North and South Tailings Ponds

Dam	Monitoring Instrument	Survey Data	Warning	Alarm
STP & NTP	GPS	3D displacement (or Cumulative Relative Displacement)	> 100 mm	> 150 mm
		3D point velocity with 12 point averaging	> 100 mm/day	> 150 mm/day

Notes:

Discuss with Engineer of Record prior to zeroing displacement data.

3D = three dimensional; STP = South Tailings Pond; NTP = North Tailings Pond; > = greater than.

2.5.3 Inclinometers

In total, there are seven inclinometers (Table 7); four inclinometers are installed in the STP dam (TH15-01 to TH15-04) and three are installed in the NTP (TH15-05 to TH15-07). Slope inclinometer data were collected quarterly up until September 2018. During the DSI site visit, the EoR and TSF Qualified Person agreed to revise the frequency for reading the inclinometers to three times per year. Readings from the inclinometers should be timed with the following events:

- shortly before freshet

- latter part of freshet
- late summer

Table 7: Inclinometer Summary

Location	Test Hole	Approximate A-A Axis Azimuth (°)	Hole Depth (m)	Casing Stickup (m)	Start Depth (m)	Reading Intervals (m)
STP	TH15-01	310	41.00	0.8	40.0	1.0
	TH15-02	10	40.00	1.0	40.0	1.0
	TH15-03	30	30.05	1.1	30.0	1.0
	TH15-04	15	6.00	1.0	6.0	1.0
NTP	TH15-05	235	20.90	0.9	21.0	1.0
	TH15-06	290	29.20	1.0	29.0	1.0
	TH15-07	305	40.80	0.9	41.0	1.0

Summary table provided by email (Roseingrave 2017, pers. Comm.).

STP = South Tailings Pond; NTP = North Tailings Pond.

The QPO and trigger levels for slope inclinometers are presented in Table 8.

Table 8: QPO and Trigger Levels for Inclinometers

Monitoring Instrument	Trigger Level	Severity		
		Acceptable	Warning	Alarm
Inclinometer	Downstream displacement (per year)	<5 mm	>5 mm and <15 mm	>15 mm

QPO = quantitative performance objective; > = greater than; < = less than.

2.5.4 Freeboard Triggers

The warning and alarm triggers shown in Table 9 are currently used by FRO for the NTP and STP pond elevations. The warning and alarm triggers shown for NTP in Table 9 should be included in the next update of the OMS manual. STP Water Level TARP's are provided in Appendix B and C of the OMS (FRO 2018a).

Table 9: Freeboard Trigger Levels for the North Tailings Pond and the South Tailings Pond

Dam	Survey Data	High Level Warning	High Level Alarm (i.e., Freeboard Exceedance)
NTP	Water Level	>1,650.6 m	>1,650.7
STP	Water Level	>1,636.55 m	>1,636.65 m

NTP = North Tailings Pond; STP = South Tailings Pond; > = greater than.

2.5.5 Swift Mine Blasting

The Swift mine has open pits located near the NTP and STP dams. A blast monitoring TARP has been prepared to monitor potential effects from this nearby blasting. The response framework for the monitoring data is described in Golder (2018d), and the TARP is included in Appendix D of the OMS manual (FRO 2018a).

3.0 OPERATION, MAINTENANCE, AND CONSTRUCTION DURING 2017/2018 REPORTING PERIOD

A summary of the operations, maintenance and any construction for the 2017/2018 DSI reporting period are discussed in the following sections.

A risk assessment for the NTP and STP facilities was developed in December 2017 and January 2018 with a final report issued in December 2018 (Wood 2018).

3.1 North Tailings Pond

3.1.1 Tailings Boundary Area

A figure outlining the NTP facility boundary has been prepared and is included in the OMS manual (FRO 2018a). The boundary was defined in consultation with the EoR.

3.1.2 Operation and Capacity

The NTP was not operational in 2018 and there was no tailings deposition.

A bathymetric survey of the NTP pond was carried out over 2 days, on 24 August and 16 October 2018 (Golder 2018b), and the data from this survey was used in the NTP water balance. Based on the survey, NTP contains a pond of about 16,340 m^3 at a pond elevation of 1650.1 m (as of 10 September 2018). Above this pond, there is an available storage volume of about 36,100 m^3 to the current maximum allowable pond elevation of 1,650.7 m.

For planning purposes, the NTP should be considered as having no available tailings capacity.

3.1.3 Liverpool Sediment Pond System

The Liverpool Sediment Pond System outlet channel and fish barrier at the north abutment area of the NTP facility were completed in late 2016, and are not considered part of the NTP facility. The Liverpool Sediment Pond outlet channel was constructed over the NTP tailing beach at the north end of the facility and the fish barrier structure was constructed through the NTP dam's north abutment. The outlet works for the Liverpool system should continue to be inspected during both the monthly NTP and Liverpool Sediment Pond inspections.

3.1.4 Site Investigation and New Instrumentations

Three new GPS units, NTP-GPS-02 through -04, were installed by FRO in June 2017 to replace the existing prisms.

A site investigation was carried out from 21 November to 16 December 2017 on the tailings in the NTP facility to support facility closure studies (Norwest 2018). The investigation consisted of conducting eight cone penetration test soundings, 17 electronic vane shear tests, one auger drilling borehole, and installing seven vibrating wire (VW) piezometers in three cone penetration test borings, all using a track-mounted rig.

Trenching was carried out to bury the VW piezometer cables across the tailings surface and to connect them to data loggers installed on the NTP dam crest.

3.1.5 Inspections

The NTP dam is inspected monthly by FRO geotechnical personnel. A summary of the dam inspection action items are included in Appendix E and the NTP dam inspection reports have been reviewed by the EoR.

Water quality testing is completed quarterly by environmental personnel. Water quality testing results are provided in Appendix F.

3.2 South Tailings Pond

3.2.1 Tailings Boundary Area

A figure outlining the STP facility boundary has been prepared and is included in the OMS manual (FRO 2018a). The boundary was defined in consultation with the EoR.

3.2.2 Operation and Capacity

The STP was active and tailings were deposited into the STP throughout the reporting period.

Bathymetric surveys were completed by FRO in June, September, and October 2018 to confirm the capacity in the facility. Based on the 27 October 2018 survey and FRO (2018c), the remaining storage in the STP as of 27 October 2018 was approximately 660,487 m^3. The projected annual tailings deposit volume is estimated to be 1,012,000 m^3/year. The pond volume at 23 September 2018 was 460,000 m^3.

The tailings pipeline from the plant was extended and raised at the north single point discharge in July 2018 during the plant shut down. The elevation of the invert of the single point discharge was extended 20 m into the facility and raised to an invert elevation 1,638.75 m and.

Site drainage was sent to the STP in September and October 2017, and in February 2018; it was diverted to the North Loop Settling Pond the rest of the time. Site drainage includes wash water from the dryer building, clean coal building, water used in the plant site area, and surface water runoff from the plant site area and nearby waste rock piles. FRO plans to divert site drainage to the North Loop Settling Pond going forward except when undertaking sediment removal from the North Loop Settling Pond.

A workshop was held on 1 June 2018 which included the FRO processing plant staff, environment staff and tailings engineer along with the EoR team to discuss change in STP facility water management in response to the updated hydraulic assessments competed for the Very High dam class.

3.2.3 Dredging

Dredging from the STP to the Turnbull TSF began in 2016. Based on FRO (2018c) a total of 1.64 million dry metric tonne of tailings was dredged between 3 April and 24 October 2018.

3.2.4 Construction and Maintenance

The existing high-pressure gas pipeline that crosses the north and south abutments of the STP is scheduled to be relocated in Q3 2019 and this allows for the current pipeline to be decommissioned. Golder recommends FRO complete the north abutment tie-in as soon as feasible but recognizes the removal of the gas pipeline may not be completed before freeze-up in fall of 2019 to allow for the required north abutment dam construction earthworks. Completion of the north abutment tie-in may be scheduled to be completed in Q2 2020. Golder is in the process of preparing a scope of work for the abutment tie-in and it will be provided to FRO in Q1 2019.

An emergency riprap stockpile is maintained at the south end of the STP with an approximate volume of 4,500 m^3. In summer 2017, the stockpile was used in a rock drain project for the Swift expansion. The use of the stockpile was completed in consultation with the tailings engineer and the stockpile was replaced prior to the 2018 freshet. The riprap stockpile was replaced with material considered to be of better quality (as confirmed by KWL personnel) in late 2017. The riprap stockpile was in place during the 11 September 2018 site visit and is marked with signage.

3.2.5 Inspections

The STP dams are inspected monthly by FRO geotechnical personnel throughout the year, weekly between May and October, and twice per month between November and April. A summary of the dam inspection action items are included in Appendix E and the EoR team has reviewed them as part of the annual review.

Water quality testing is completed quarterly by environmental personnel. Water quality testing results are provided in (Appendix F).

3.3 North and South Tailings Pond

Following the reclassification of the NTP and STP dams from High to Very High consequence structures, Golder (2018a) updated the liquefaction assessment, seismic stability analysis, and IDF and freeboard assessment. Details of the assessments and results are provided in Golder (2018a) and summarized in Sections 5.4 and 5.5.

4.0 REVIEW OF CLIMATE DATA, WATER BALANCE, AND DAM REGISTRY

4.1 Climatic Review

Three climate monitoring stations exist at FRO: waste water treatment plant, A Spoil, and Brownie Spoil. For the reporting period of 1 September 2017 to 31 August 2018, precipitation data were available from all three stations; however, the A Spoil station did not measure snowfall during the reporting period, and the entire climate data record was incomplete or missing November 2017 through April 2018 at the Brownie Spoil station. Given the large data gap in its record, the Brownie Spoil station was not used in the review.

The Fording River Cominco station is the closest regional Environment and Climate Change Canada station to the FRO site; however, the station did not publish precipitation data over the reporting period.

The total precipitation recorded at the waste water treatment plant and A Spoil stations over the reporting period is shown in Table 10, and the monthly total precipitation at the waste water treatment plant station is presented in Chart 1. For comparison purposes, the long-term (1970 to 2017) average monthly precipitation at FRO (as estimated based on Golder 2018e) is also presented in Chart 1, while the long-term (1970 to 2017) average annual precipitation at the mine site is estimated to be 657 mm (Golder 2018e).

Note that all data presented for the waste water treatment plant and A Spoil stations in Table 10 and Chart 1 are raw data; no adjustments for station elevation or undercatch were made.

Table 10: Total Precipitation from 1 September 2017 to 31 August 2018

Weather Station	Total Precipitation (mm)
Waste water treatment plant weather station	538
A Spoil weather station (does not include snowfall)	415

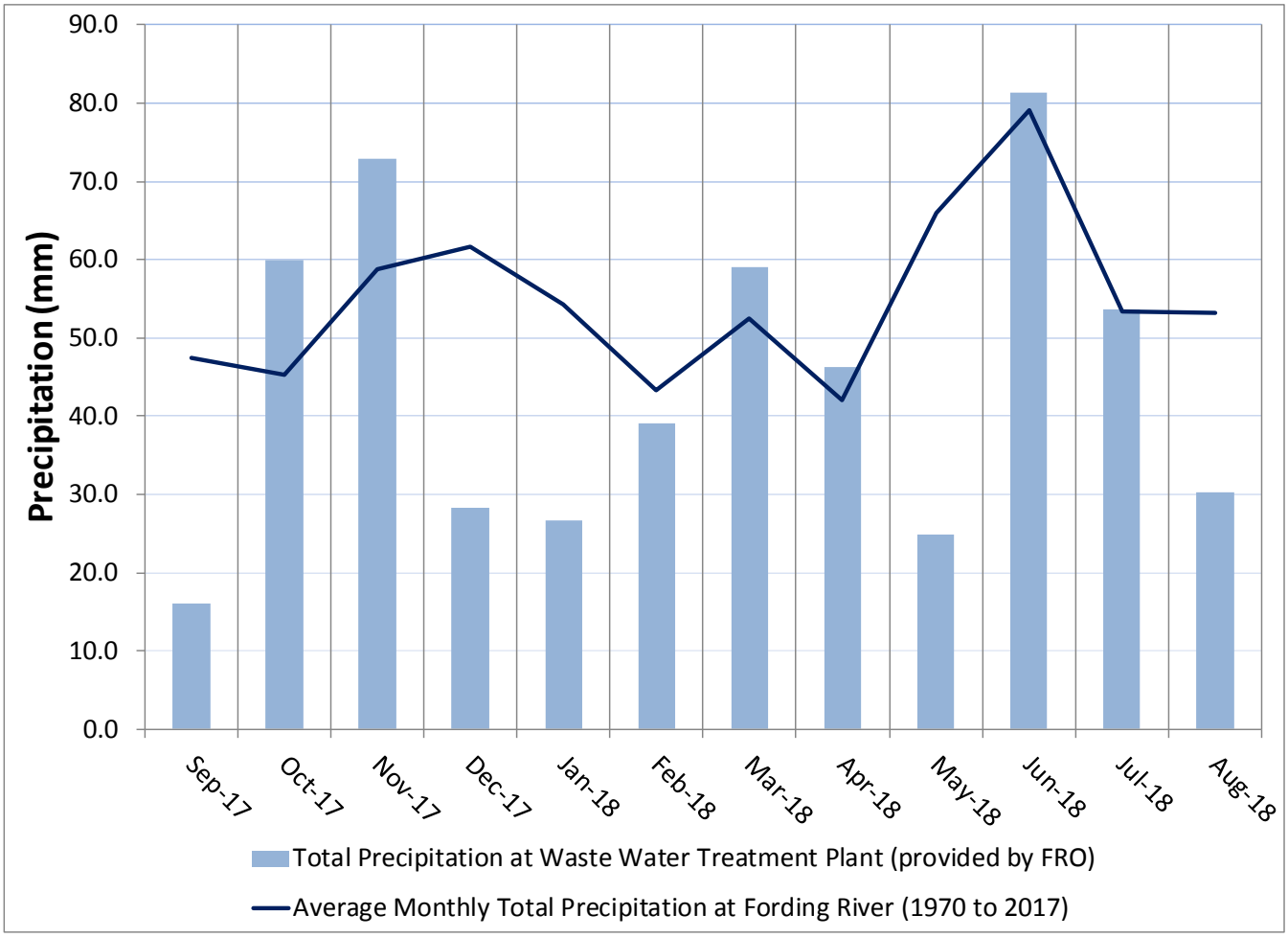


Chart 1: 1 September 2017 to 31 August 2018 Monthly Precipitation Data

The climate data in Table 10 indicate the annual precipitation received at FRO from 1 September 2017 to 31 August 2018 was lower than the long-term annual average of 657 mm. A similar observation could be made from Chart 1, where the total monthly precipitation data recorded at the waste water treatment plant station were generally lower than the long-term average except for the months of October and November 2017 and March, April, and June 2018.

Winter snowfall accumulation typically melts and runs off starting in April to May at FRO, and higher flow events are expected to occur as a result of combined rainfall and snowmelt events. However, while selected areas of BC experienced a larger than normal snowpack and flooding during freshet in 2018, the Elk Valley did not experience spring flooding to the same degree, attributed in part to the lower than average precipitation observed in May 2018.

4.2 Water Balance

4.2.1 North Tailings Pond Water Balance

The 2017/2018 NTP water balance from 1 September 2017 to 31 August 2018 is summarized in Table 11 using climate inputs from the waste water treatment plant station.

Table 11: 1 September 2017 to 31 August 2018 – North Tailings Pond Water Balance

IN	Annual Volume (m^3)	OUT	Annual Volume (m^3)	Total Inventory Change (m^3)
Surface water runoff	280,000	Evaporation	48,000	-
Precipitation	28,000	Seepage loss	250,000	
Sum	**308,000**	**Sum**	**298,000**	**10,000**

For the period from 1 September 2017 to 31 August 2018, the water balance model estimates a small increase in inventory change of 10,000 m^3, which is consistent with the small year over year pond elevation increase and estimates a seepage loss of 250,000 m^3 which is lower than the previous year's estimate.

The reported water balance for NTP does not raise any concerns and appears to reflect observed conditions.

4.2.2 South Tailings Pond Water Balance

The 2017/2018 STP water balance from 1 September 2017 to 31 August 2018 using climate inputs from the waste water treatment plant station is summarized in Table 12.

Table 12: 1 September 2017 to 31 August 2018 – South Tailings Pond Water Balance

IN	Annual Volume (m^3)	OUT	Annual Volume (m^3)	Total Inventory Change (m^3)
Surface water runoff	354,000	Evaporation	128,000	-
Makeup Water	4,440,000	Seepage loss	2,560,000	
Precipitation	98,000	Retained in tailings	56,300	
Miscellaneous	172,000	Dredge slurry to Turnbull TSF	1,730,000	
Tailings slurry	23,600,000	Clarified water return	23,700,000	
Sum	**28,664,000**	**Sum**	**28,174,300**	**85,600**

Note: 12-month Volumes and Total inventory change may not exactly equal the sum of inflows and/or outflows due to rounding error.

For the period from 1 September 2017 to 31 August 2018, the water balance model estimates an increase in inventory change of 85,600 m^3, which is consistent with the pond elevation increase as shown in Chart 6. The water balance estimates a seepage loss of 2,560,000 m^3, which is lower than the previous year's estimate.

4.3 Water Quality Monitoring

FRO Environment carries out water quality monitoring in and around the STP facility at the following locations:

- STP north seep (at culverts)
- STP northwest pond (pond west of wastewater cells)
- STP southwest corner (pond at toe of dam)
- STP west seep (embankment below West Dam)
- STP groundwater wells (3 wells, northwest of STP)
- STP at discharge line

It is understood that FRO Environment submits water quality monitoring results to the BC Ministry of Environment as part of compliance reporting. Water quality testing results at the above locations were provided by FRO and are included in Appendix F of this report for completeness; the assessment of the water quality results is beyond the scope of this DSI.

4.4 Tailings Storage Facility Registry

The tailings storage facility registry for the NTP and STP are included in Appendix G.

5.0 TAILINGS FACILITY DAM SAFETY ASSESSMENT

This section presents the dam safety assessment of the NTP and STP facilities based on the observations and data review for each of the failure modes that are most relevant to this type of dam.

5.1 Method

5.1.1 Site Visit

The site inspections at the STP and NTP were carried out on 11 and 12 September 2018, respectively, by Mr. John Cunning, P.Eng., and Ms. Clara Lee, P.Eng., of Golder, accompanied by Ms. Heather Brickner, P.Eng., of FRO.

The temperature during the visit was between approximately 1°C and 18°C and the weather was clear and sunny.

Appendix A presents a summary of photographs of the NTP and STP from the site inspection. The location, direction, and number for each photograph are noted in Figures 2 and 5.

A summary of the observations is included in the inspection reports in Appendices B and C, for the NTP and STP respectively. In general, the NTP and STP were observed to be in good condition at the time of the 2018 annual inspection.

Details of the site inspection are discussed in Sections 5.4 and 5.5.

5.1.2 Review of Background Information

FRO provided the following information for this DSI:

- 2018 FRO site LiDAR survey data
- 2018 FRO site air photo
- 2018 tailings pond bathymetric surveys data for the STP
- STP 2018 tailings deposition update from FRO
- 2018 dredging data for STP
- 2017 and 2018 FRO site climate data
- VW piezometer and pond water level data
- dam movement data: GPS monitoring data and slope inclinometers on the NTP and STP
- records of visual inspections

5.2 Dam Consequence Classification

Guidelines for the classification of dams are presented in the HSRC Guidance Document, Section 3.4 (Ministry of Energy and Mines 2016), which references the *Dam Safety Guidelines* (CDA 2013).

Table 13 presents the dam classification criteria. Consequence categories are based on the incremental losses that a failure of the dam may inflict on downstream or upstream areas, or at the dam location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. The consequences of a dam failure are ranked as Low, Significant, High, Very High, or Extreme for each category. The classification assigned to a dam is the highest rank determined among the categories.

Table 13: 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 loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary only (e.g., seasonal cottage use, passing through on transportation routes, participating in recreation activities)	The appropriate level of safety required depends on the number of people, the exposure time, the nature of their activities, and other considerations	No significant loss or deterioration of fish or wildlife habitat, *or* 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 – ordinarily located in the dam-breach inundation zone (e.g., as permanent residents)	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent – ordinarily located in the dam-breach inundation zone (e.g., as permanent residents)	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 – ordinarily located in the dam-breach inundation zone (e.g., as permanent residents)	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).

Source: HSRC Guidance Document (Ministry of Energy and Mines 2016) Table 3-3 based on CDA (2013) Table 2-1.

5.2.1 Facility Consequence Classification

An inundation study considering both flood-induced (overtopping) and sunny day (piping) failure modes for the NTP and STP dams was performed to understand the potential incremental impacts on downstream receptors (Golder 2014e). The flood-induced (overtopping) inundation assumed a 1-in-2-year flood event (bankfull conditions) in the Fording River (Golder 2014e). A single classification for the dam system is based on the failure scenario that would result in worse consequences: either sunny-day failure or flood-induced failure (CDA 2013).

The rationale applied for assigning the consequence level for each attribute for the NTP and STP facilities is as follows:

- **Population at risk (High consequence)**—Permanent: as identified by Golder (2014e), some 18 permanent residences are located on the flood plains downstream of the dams within the flood inundation extents. Mine and construction workers can be in the inundation areas downstream of the facilities.
- **Loss of life (Significant to High consequence)**—Since people may be present in the inundation zone, it is foreseeable that there is a possibility for loss of life (for STP and NTP permanent downstream residences and for Maxam Yard [site explosive storage facility including Maxam personnel offices]). Quantification of loss of life has been conservatively inferred from population at risk (Golder 2014e; KCB 2014).
- **Environmental and cultural (High to Very High consequence)**—Presence of critical habitat for Westslope Cutthroat Trout, a species of Special Concern. Restoration is considered to be possible but difficult. The classification is Very High for and sunny day failure scenario and High for flood-induced failure scenarios (Teck 2016).
- **Infrastructure and economics (High consequence)**—Economic losses are anticipated to be high in the event of a failure (Golder 2014e).

Table 14 presents a summary of the current dam consequence classifications for the FRO facilities.

Table 14: Dam Consequence Classification Results

FRO Facility	Dam Class	Population at Risk	Consequences of Failure		
			Loss of Life	Environment and Cultural Values	Infrastructure and Economics
NTP	**Very High**	High	Significant to High	High to Very High	High
STP	**Very High**	High	Significant to High	High to Very High	High
NTP and STP river flood-induced components	**High**	High	Low to Significant	High	Significant

Note: River flood induced component classification based on dam inundation concurrent with major flood event. Lower design criteria related to “High” classification is for the riprap components of the NTP and STP only and does not change the overall classification of the facility. Refer to Section 2.5.4, CDA 2013.

FRO = Fording River Operations; NTP = North Tailings Pond; STP = South Tailings Pond.

The NTP and STP dams are classified as Very High consequence, while the components for a river flood-induced failure are classified as High consequence. The NTP and STP classifications are governed by the consequences of a potential fair-weather failure scenario.

5.2.2 River Flood Component Consequence Classification

An incremental inundation assessment was completed (Golder 2017d) to assess the consequence of failure of the NTP and STP during 200-year and 500-year Fording River flood events. The assessment concluded that the consequence of a failure occurring coincident with the flood events considered is High.

A risk-informed assessment, which would be supported by a design level flood-induced dam break and inundation assessment, is recommended to determine the appropriate criteria for the flood protection requirements along the downstream toes of the NTP and STP dams.

5.2.3 Review of Downstream and Upstream Conditions

The following are changes to upstream and downstream conditions during the reporting period:

- FRO are undertaking a feasibility study for replacement of the multiplate culvert crossing the Fording River upstream of the NTP and STP facilities.
- FRO are undertaking construction of an active water treatment facility downstream of the STP Main Dam. The facility is located above the 500-year return period flood level of the Fording river, however, it is recommended to undertake a review of the potential for the water treatment facility to be located in the inundation zone for a failure of the STP Main Dam.

5.3 Review of Operational Documents

5.3.1 Operation, Maintenance and Surveillance Manual

FRO completed an update of its tailings facility OMS manual (FRO 2018a). Golder reviewed the updated OMS manual and approved the issue of Version 2018.02 in a letter dated 3 August 2018.

5.3.2 Emergency Preparedness Plan / Emergency Response Plan

An emergency response plan (ERP) was developed in draft for the NTP and STP in conjunction with all tailings storage facilities on site at FRO in 2018 (SP&P EP.009; FRO 2018b). This document is under final review by senior staff at FRO at the time of writing this report. This document was developed to meet the regulations and related guidelines of the HSRC
(Ministry of Energy and Mines 2016, 2017), the CDA (2013), the Mining Association of Canada (MAC 2011), and Teck Resources Limited (Teck 2014).

FRO has also developed a *Tailings Impoundment Flood Response Protocol for the Fording River*. This document was issued on 26 September 2017 (FRO 2017) and will be updated prior to the 2019 freshet.

The emergency preparedness plan (EP.008.R1) was last updated on 15 December 2015 (FRO 2015a). FRO plans to update the emergency preparedness plan once the ERP is finalized as the document will outline the warnings FRO will issue and the expected actions of local authorities and other responders for dam breach flood emergencies.

The emergency planning documents should continue to be reviewed at least annually, with updates incorporated when required. The ERP should be tested annually. FRO carried out an internal tabletop exercise to test the ERP on 18 December 2018. The ERP was considered useful by Teck for the purposes of the test (FRO 2018d).

5.3.3 Dam Safety Review

The most recent DSR of the NTP and STP was completed in 2014 (KCB 2014). A DSR is required every five years for all water and tailings storage facilities regardless of dam consequence classification according to HSRC Section 10.5.4 (Ministry of Energy and Mines 2017). The next DSR is required in and scheduled for 2019.

5.4 North Tailings Pond

The record of the site inspection for the FRO NTP by the EoR team is included in Appendix B. A plan of the NTP with the location of the monitoring points is shown in Figure 3, and a typical section of the NTP retaining dam is shown in Figure 4.

This section presents an assessment of dam safety for the NTP dam based on observations and data review and includes a review of the 2017 recommendations for the facility.

5.4.1 Assessment of Dam Safety Relative to Potential Failure Modes

A summary of the assessment and potential failure modes is presented in Table 15.

Table 15: Assessment of NTP Dam Safety Relative to Potential Failure Modes

Potential Failure Mode	Observations/Data	Comments
Internal erosion (suffusion and piping)	Filter compatibility is generally met between dam fill materials and foundation flood plain sand and gravel; however, this is not met for the tailings and the foundation flood plain sand and gravel	The potential filter inadequacy between the foundation and tailings will not impact the stability of the dam, as the stability is not reliant on the tailings. Migration of the tailings through the sand and gravel is expected to be contained by the till cut-off, and therefore a low risk.
Overtopping	Within acceptable range based on pond elevations over reporting period	Updated IDF and freeboard assessment completed for Very High dam classification (Golder 2018a), freeboard increased to 1.9 m.

Potential Failure Mode	Observations/Data	Comments
Instability	No evident instability	Static and seismic stability assessments completed (Golder 2018a) and the results indicated that the FoS of the dam meet or exceed the Very High consequence static and pseudo-static slope stability FoS design criteria considering the 2017 maximum phreatic conditions.

NTP = North Tailings Pond; IDF = inflow design flood; FRO = Fording River Operations; FoS = Factors of Safety.

5.4.1.1 Internal Erosion (Suffusion and Piping)

Internal erosion of a dam can be caused by materials migrating out of the dam, leaving voids. This generally happens with materials that do not have filter compatibility; that is, the fines fraction of one material can migrate into or through the voids of the adjacent material under a sufficient hydraulic gradient. Piping is induced by regressive erosion of particles towards an outside environment until a continuous pipe is formed. Suffusion is the migration of soil particles through the soil matrix and can occur in a single material. If a material is internally stable, it is considered resistant to suffusion.

Design Basis

The following filter relationships were checked for the NTP:

- compatibility between the tailings and the upstream till blanket
- compatibility between the upstream till blanket and CR or the CCFR shell
- compatibility between the till cut-off and flood plain sand and gravel foundation
- compatibility between the CR or CCFR shell and the flood plain sand and gravel foundation
- compatibility between the tailings and the flood plain sand and gravel foundation
- internal stability of the CR shell

Filter compatibility was reviewed based on grain size distributions in the construction records (Golder Brawner 1973, 1974b); obtained during an investigation of the existing coal tailings in 2 Pit, 3 Pit, and the NTP (Golder 2012b); the 2013 NTP flood repair works; and the 2015 site investigation results (FRO 2016).

Various methods are available to check filter compatibility including the Terzaghi method, the Sherard and Dunningan criteria, and the US Army Corps of Engineers criteria. The CR shell, which acts as a filter for the upstream till blanket, was constructed in accordance with the design. While not explicitly stated in the reports (Golder Brawner 1973, 1974b), the Terzaghi method was likely the method used to confirm filter compatibility during design and construction. A filter compatibility and internal stability assessment was completed by Golder in 2015 in response to a February 2015 Ministry of Energy, Mines and Petroleum Resources (formerly the Ministry of Energy and Mines) order to undertake an assessment to determine if the tailings facilities dams may be at risk of internal erosion (Golder 2015a). The Sherard and Dunningan criteria and the US Army Corps of Engineers criteria were also checked in this document. Filter compatibility was rechecked using the Sherard and Dunningan criteria after additional foundation information was obtained in 2015.

All materials generally have filter compatibility by all methods except between the tailings and the flood plain sand and gravel. The potential filter inadequacy between the foundation and tailings will not impact the stability of the dam, as the dam stability is not reliant on the tailings. Migration of the tailings through the sand and gravel is expected to be contained by the till cut-off, and therefore a low risk.

The internal stability of the CR shell was confirmed (Golder 2015a).

It is noted that there are some gaps in construction quality control records. Where data were available, they indicated that filter compatibility was achieved. The gaps in the quality control records are considered to be low risk to confirming filter compatibility.

Based on the performance of the dam over the last 45 years, piping due to filter-incompatible material or suffusion of internally unstable material is not expected to be an issue.

Observed Performance

The key observations made during the NTP dam inspection were as follows:

- No significant zones of external seepage were observed that would indicate the possible development of internal piping.
- No zones of subsidence or sinkholes were observed that would indicate voids due to either suffusion or piping.

5.4.1.2 Overtopping

Design Basis

The CDA (2013) provides two calculations for freeboard; the more critical of the two cases sets the minimum freeboard:

- no overtopping by 95% of the waves caused by the most critical wind with a return period of 1 in 1,000 years, with the pond at its maximum normal operating elevation
- no overtopping by 95% of the waves caused by the most critical wind with a return period of 1 in 2 years (for Very High consequence structures), with the pond at the maximum level during the passage of IDF

The current minimum crest elevation of the dam at the NTP is 1,652.6 m (confirmed with 2018 LiDAR).

The HSRC Guidance Document (Ministry of Energy and Mines 2016) recommends that the IDF be designed to 2/3 between the 1,000-year flood/storm event and the probable maximum flood for a structure classified as Very High consequence. Furthermore, for impoundments with no emergency spillway, the HSRC Section 10.1.8 requires a minimum storage volume to contain runoff from a 72-hour IDF. As a result of the reclassification of the NTP dam from High to Very High, its freeboard assessment was updated with the above-mentioned HSRC requirements. The result of the updated assessment indicated that:

- To store the IDF while maintaining the minimum freeboard, the maximum operating pond elevation is 1,650.7 m, 1.9 m below the minimum dam crest.

- The required minimum freeboard is 0.35 m with the IDF level at elev. 1652.25 m.

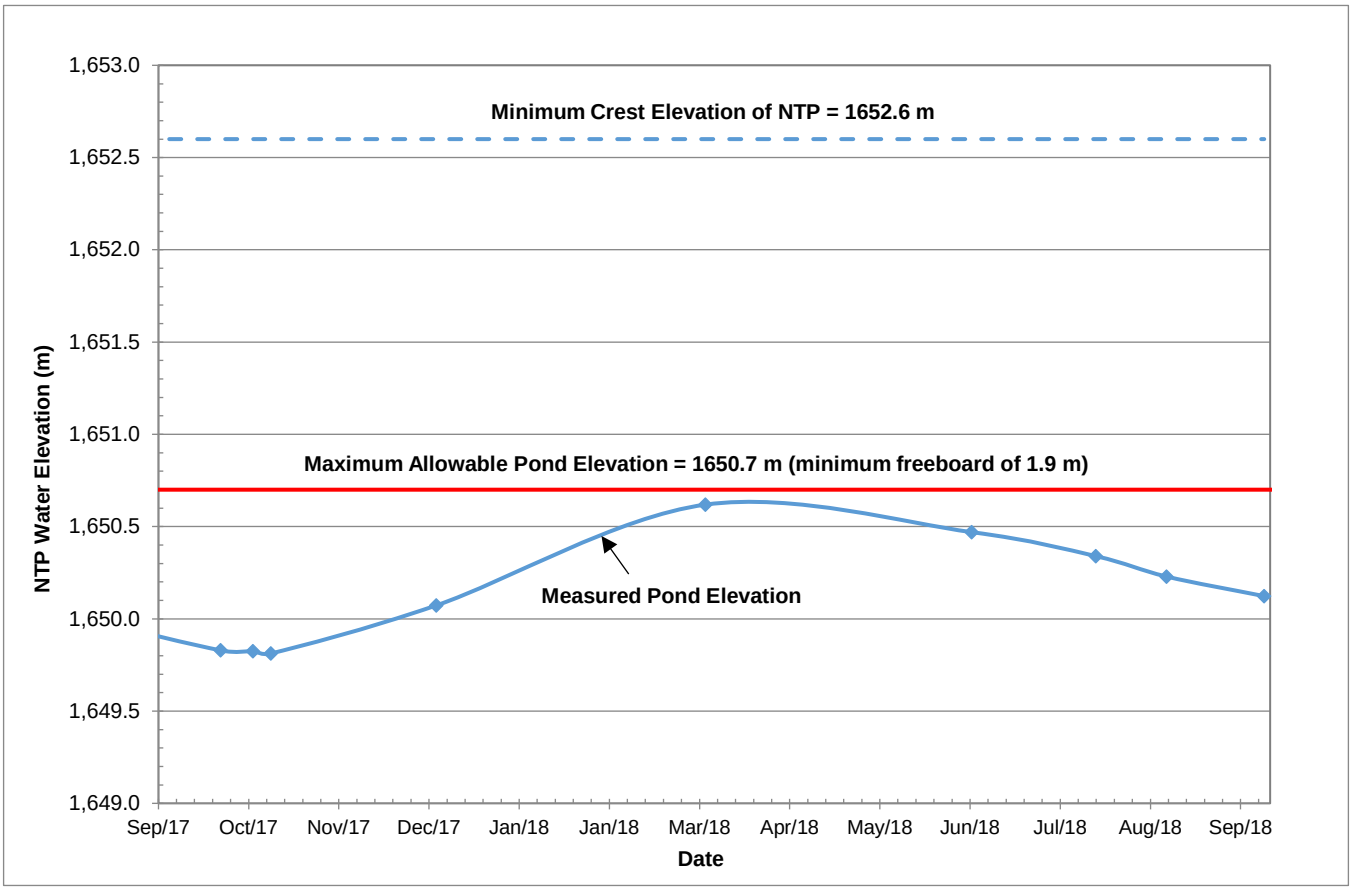
The NTP currently has no inputs of water except direct precipitation and some runoff from a small local catchment area, with outputs from the retained pond being evaporation and seepage. The water levels are generally maintained with 2 m of freeboard, and pumping and dewatering is not required under normal annual conditions. If critical water levels in the pond are approached, the tailings OMS manual (FRO 2018a) includes pumping and water diversion strategies for the NTP. Pumping could be established to transfer NTP water to the STP or Shandley Pit. The freeboard of 1.9 m (as assessed for Very High consequence) will be maintained with normal operations or emergency pumping as necessary.

The NTP is not equipped with an emergency spillway. A passive method of controlling water elevation would be a best practice. Golder has produced feasibility level drawings for an emergency spillway on the NTP (Golder 2015b).

An overtopping failure caused by landslide is a possible failure mode for the NTP due to the adjacent CR spoil to the west of the NTP. The CR spoil was resloped in 2015 per previous Golder recommendations and FRO analyses (Golder 2014a,e; FRO 2014). This work was performed to reduce the hazard of a potential spoil failure to impact the NTP and create wave action that could potentially overtop and breach the NTP dam. Based on stability and runout analyses, failure of the reconfigured CR spoil and subsequent wave generation is considered unlikely.

Instrumentation

Pond elevation data for the NTP were received from FRO, and Chart 2 presents the variation in pond elevation from 1 September 2017 to 31 August 2018 based on this information.



Note: Pond elevations reported in Elk Valley Elevation Datum.

Chart 2: North Tailings Pond Water Elevation from 1 September 2017 to 31 August 2018

The NTP water level is shown to be maintained below the maximum allowable water level. A total of eight readings were taken during the period between 1 September 2017 and 31 August 2018, with two readings in October 2017 and readings missing in November 2017, January, February, April, and May 2018, due to ice cover on the pond. FRO should record the pond elevation monthly, as required and stated in the OMS manual (FRO 2018a), and should consider as a best practice, installing a real-time water level instrument and connecting this to the site GeoExplorer system.

Observed Performance

The key observations made during the NTP dam inspection were as follows:

- The tailings have filled most of the area upstream of the NTP dam, and there is a small reclaim pond at the southern end. The fetch distance on the surface of the NTP is short, so the potential for generation of significant waves when a pond is present is small.

- Unused and damaged pipelines that extend through the crest of the dam should ideally be removed or grouted to eliminate the hazard of future deformation or settlement of the abandoned pipes creating low points in the dam crest (locations shown in Golder 2017b).
- All pipes should continue to be inspected as part of the monthly NTP inspections to confirm that they remined capped. Pipes should be removed or grouted as part of the NTP decommissioning plan.

5.4.1.3 Instability

The stability of the NTP is monitored with piezometers, inclinometers, GPS units, and regular visual inspections. As mentioned in Section 2.5.2, FRO had ceased the use of the use of prisms on the NTP dam since May 2018 and replaced them with GPS units, with three additional units installed in June 2018.

Design Basis

The drainage conditions beneath the NTP dam are favourable with respect to structural stability. The downstream slope of sections rebuilt after the June 2013 flood is less steep (1.5 to 1.75H:1V) than the original design (1.3 to 1.4H:1V).

As a result of the re-classification of the NTP dam from High to Very High, its slope stability and liquefaction assessments were updated to comply with the Very High consequence design criteria (Golder 2018a). An earthquake of ½ between the 1-in-2,475-year and 1-in-10,000-year event was used for Very High consequence dams as per the HSRC Guidance Document (Ministry of Energy and Mines 2016). This event corresponded to a PGA of 0.23 g and a mean moment magnitude of 6.2 based on the probabilistic analysis results from the site-specific hazard assessment (Golder 2016a). Details of the assessment and results were provided in Golder (2018a). A brief summary of the conclusions is provided below:

- The liquefaction assessment update considered the 2017 topography along with the 2016 and 2017 riprap construction along the toes of the NTP dam and the maximum piezometer readings up to the end of 2017. The results indicated that the saturated soils below the dam are unlikely to liquefy during the design earthquake event.
- The dam stability update used design criteria based on the HSRC Guidance Document (Ministry of Energy and Mines 2016) Section 3.3 and CDA (2014) for minimum factor of safety. A sensitivity case was analyzed for post-earthquake conditions for loose CR layers identified in the NTP. Both static and pseudo-static conditions were considered in the stability assessment. However, the post-earthquake conditions were not analyzed in the foundation because the liquefaction assessment results indicated that the alluvial soils below the dams and dam materials are unlikely to liquefy during the design earthquake event. The results of the stability assessment indicated that the factor of safety of the NTP dam exceeded the Very High consequence static and pseudo-static slope stability design criteria.
- The HSRC Part 10 (Ministry of Energy and Mines 2017) Section 10.1.9 indicates that design downstream slopes steeper than 2H:1V require the manager to submit justification from the Engineer of Record for the design slope and receive authorization prior to construction. The NTP downstream slopes were constructed before this requirement. As noted above, the results of the stability assessment indicated that the stability factor of safety met or exceeded the design criteria.

The NTP is also susceptible to instability from erosion during flooding of the Fording River. River erosion has been assessed by KWL, and riprap was placed on the toe of the dam in late 2016 and 2017 (KWL 2017b) to mitigate against river erosion up to a 200-year return period design flow. Risk-informed criteria should be established for the flood erosion protection along the toe of the NTP dam.

Instrumentation Data – Crest Displacement Monitoring

Seven survey prisms (NT1 to NT7) are installed along the crest of the NTP dam with one backsight (reference) prism located at the wash plant location (NT10), as shown in Figure 3. Four GPS monitors, three of which were installed in June 2018 (NTP-GPS 02 to 04) are located on the dam crest and will replace the prisms to monitor crest displacement.

Prism and GPS data were provided by FRO from August 2017 to May 2018. The survey data are summarized in Appendix H.

The prisms and GPS units at the NTP are listed in Table 16.

Table 16: Instrument Monitoring Locations on NTP

Instrument Identification	Instrument	Northing (m)	Easting (m)	Elevation (m)
NT1	Prism	5,562,034.0	651,126.3	1,654.3
NT2	Prism	5,561,884.1	651,130.1	1,653.9
NT3	Prism	5,561,735.3	651,087.4	1,653.8
NT4	Prism	5,561,597.1	651,028.4	1,654.4
NT5	Prism	5,561,462.6	650,957.7	1,654.2
NT6	Prism	5,561,326.9	650,876.2	1,654.1
NT7	Prism	5,561,225.1	650,766.9	1,653.7
NT10 (back sight)	Prism	5,561,586.7	651,257.6	1,655.5
NTP-GPS 01	GPS	5,562,143.7	651,102.6	1,645.5
NTP-GPS 02	GPS	5,561,994.1	651,130.2	1,659.5
NTP-GPS 03	GPS	5,561,641.8	651,047.0	1,659.5
NTP-GPS 04	GPS	5,561,379.6	650,902.6	1,659.1

Note: Northing and Easting reported in FRO UTM, Elevations reported in Elk Valley Elevation Datum. Sensor locations downloaded from GeoExplorer. NTP = North Tailings Pond; FRO = Fording River Operations; UTM = Universal Transverse Mercator.

FRO switched coordinate systems in October 2016 and the prisms were reset. The total movement (3D displacement, or cumulative relative displacement) measured for each survey prism relative to their positions since the reset in October 2016 is shown in Chart 3. The total displacement presented is the vector sum of the horizontal and vertical displacements.

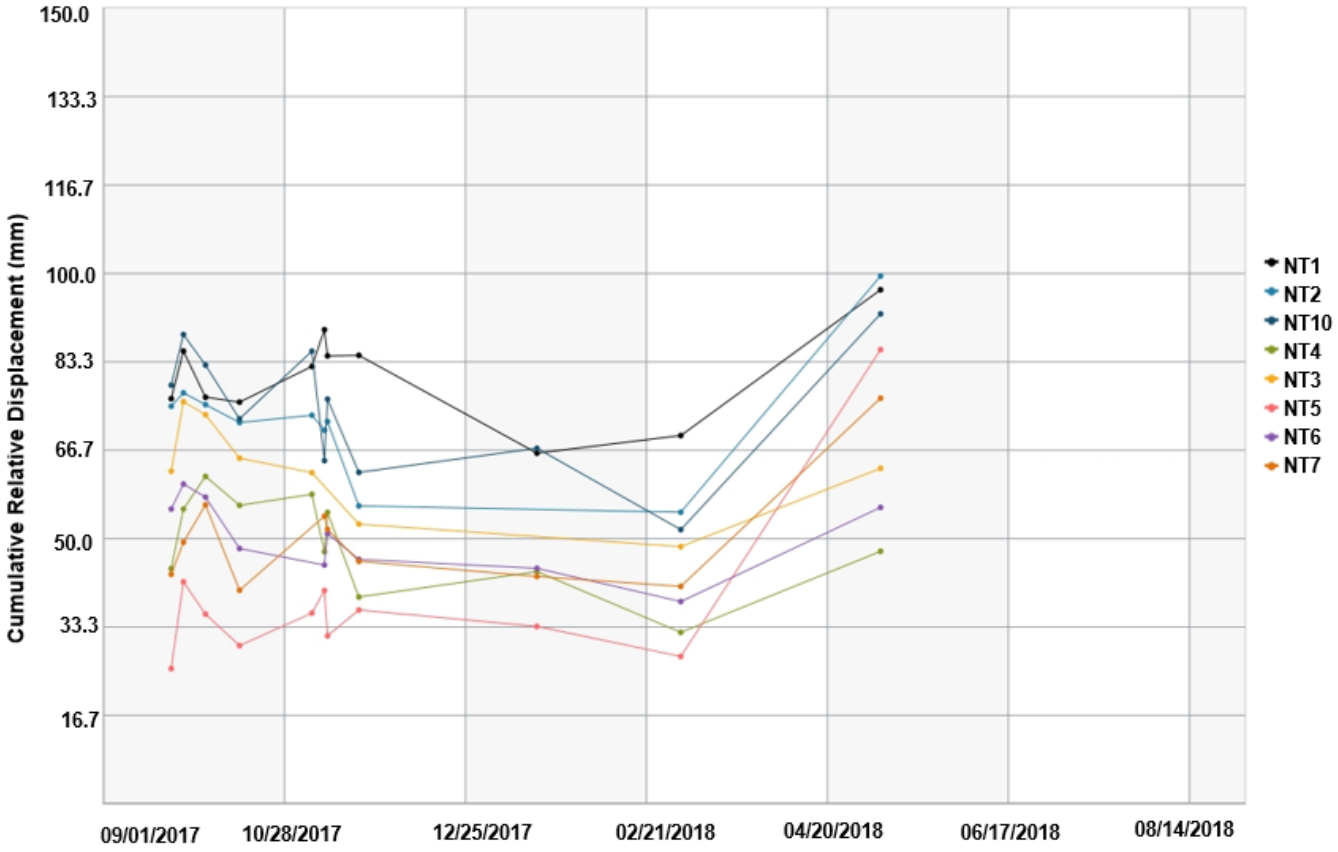


Chart 3: North Tailings Pond Prism Total Cumulative Relative Displacement from 1 September 2017 to May 2018

Generally, the prism data are surveyed once a month; however, in this reporting period, multiple readings were taken per month until November 2017, then every second month until the prisms were stopped in May 2018. The survey data indicate little crest displacement during the reporting period. Most of the prisms show a slight increase in movement during the spring freshet (March to April 2018). Movements are well below the GeoExplorer trigger for 3D movement (200 mm, GeoExplorer warning) and the updated QPOs provided by Golder (2018a) and listed in Section 2.5.

The OMS manual (FRO 2018a) states that the prisms are to be shot once a month, three times each, to ensure accuracy. FRO followed this practice for the beginning of the reporting period until November 2017, then at a reduced frequency and ultimately FRO has stopped reading the prisms and is reading additional GPS units instead.

The 3D point velocity for GPS unit NTP-GPS 01 to NTP-GPS 04 is presented in Chart 4.

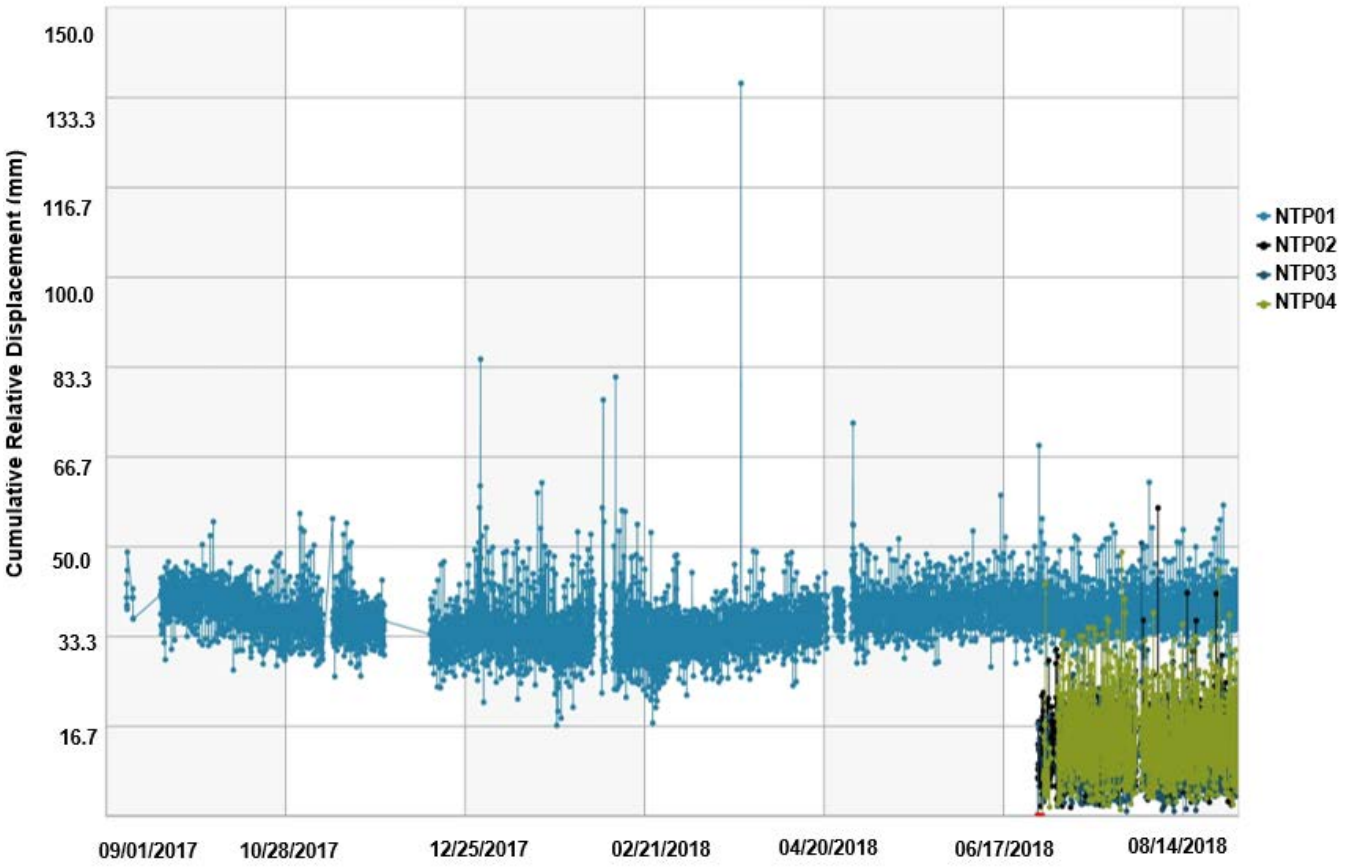


Chart 4: North Tailings Pond GPS Cumulative Relative Displacement from 1 September 2017 to 31 August 2018

Generally, the GPS devices recorded on an hourly frequency. The survey data indicate little crest displacement during the reporting period. Minor spikes in the data are most likely noise in the system and are not a concern. Movements are well below the GeoExplorer alarm trigger for 3D point velocity (300 mm/day, GeoExplorer alarm) and the updated QPOs provided by Golder (2018a) and listed in Section 2.5. No warnings were triggered in the reporting period.

A latent alarm is triggered in GeoExplorer when the measurement age of the GPS unit is greater than a day and the prisms is greater than five days on the NTP. Any offline monitors will be inspected and repaired within one week (FRO 2018a).

Instrumentation Data – Slope Inclinometers

Slope inclinometers were installed at three locations in 2015 along the NTP crest (Figure 3) to monitor horizontal movement in the dam. The A axis is oriented in the upstream to downstream direction (with negative displacements in the downstream direction) and the B axis is oriented along the dam centreline. The location of the inclinometers at the NTP is presented in Table 17.

Table 17: North Tailings Pond Inclinometers

Inclinometer ID	Northing (m)	Easting (m)	Elevation (m)	A-A Axis Azimuth (°)	Probe Serial No.	Reel Serial No.
TH15-05	5,561,992.0	651,130.8	1,653.6	235	DP15600000	DR21300000
TH15-06	5,561,641.0	651,047.2	1,653.7	290		
TH15-07	5,561,379.7	650,904.4	1,653.4	305		

Note: Azimuth is approximate. The upper wheel should face the indicated direction.

Elevations reported in Elk Valley Elevation Datum.

Slope inclinometer data were supplied to Golder by FRO. Readings were collected approximately quarterly at the NTP inclinometers since December 2015. Starting in September 2018, and as discussed with the EoR, FRO have been reading the inclinometer on a tri-annual basis (three times per year at late spring, summer, fall). A total of three readings were taken at both TH15-05 and TH15-06 and two readings at TH15-07 within the DSI reporting period. Received inclinometer data were plotted by Golder (Appendix I). Data readings are from 23 January 2017 to 26 September 2018 and include the initial reading from 18 December 2015 as a reference line.

The inclinometer readings do not indicate any significant trends in deformation and the maximum cumulative downstream deflection does not exceed 5 mm over a year which is in the acceptable range for the slope inclinometer QPO (Table 7).

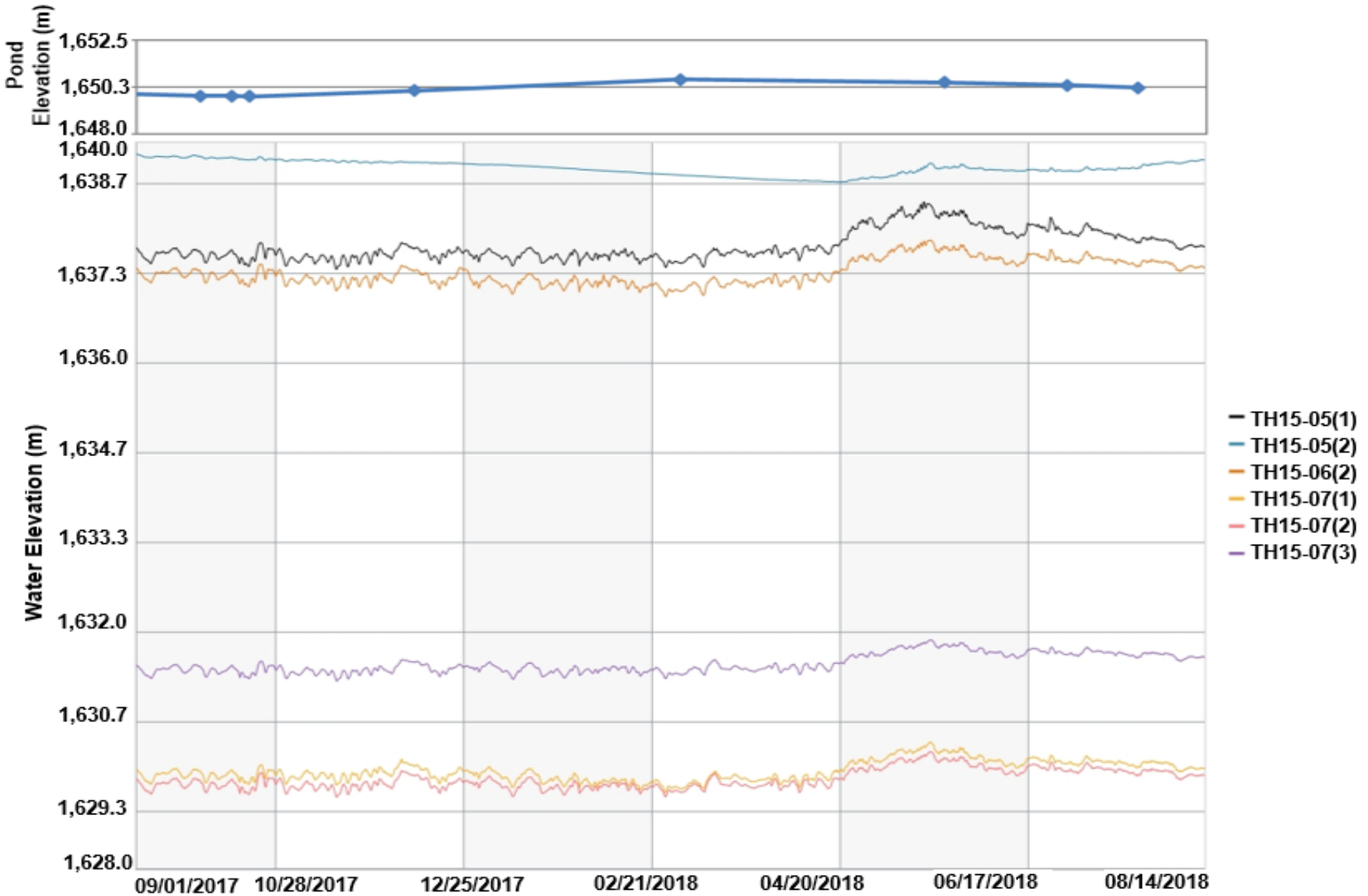
Instrumentation Data – Piezometers

VW piezometers were installed in 2015 at three locations along the NTP crest to monitor water levels in and below the dam (Figure 3) and in 2018 Norwest (2018) installed seven new piezometers at three locations near the NTP crest on the tailings surface. The new Norwest piezometers are not plotted here as they do not monitor the water levels in the dam, though they are shown in plan view on Figure 3. The piezometers located in the NTP are listed in Table 18. Data for the piezometers was downloaded from GeoExplorer. The piezometer readings from 1 September 2017 to 31 August 2018 are presented in Chart 5. Readings have been taken at TH15-05, TH15-06, and TH15-07 since August 2015.

Table 18: North Tailings Pond Piezometer Installation Details and Performance Summary

Borehole/Piezometer ID	Northing (m)	Easting (m)	Collar Elevation (m)	Data Logger Serial No.	Piezometer Serial No.	GeoExplorer Sensor No.	Piezometer Tip Elevation (m)	Minimum Water Elevation (2017/2018)	Maximum Water Elevation (2017/2018)	Comments
TH15-05	5,561,992.0	651,130.8	1,653.6	DT09633	VW33222	3	1,641.3	n/a	n/a	Reading negative pressure head (dry).
				DT09636	VW33223	2	1,638.7	1,638.7	1,639.1	
				DT09638	VW33241	1	1,635.6	1,637.4	1,638.4	
TH15-06	5,561,641.0	651,047.2	1,653.7	DT09641	VW33240	2	1,628.5	1,637.0	1,637.8	
				DT09643	VW33239	1	1,626.3	n/a	n/a	Likely malfunctioning, reporting negative water level.
TH15-07	5,561,379.7	650,904.4	1,653.4	DT094501	VW33231	3	1,630.0	1,631.3	1,631.9	
					VW33230	2	1,624.0	1,629.5	1,630.2	
					VW33242	1	1,614.7	1,629.6	1,630.4	

Note: Coordinates reported in Universal Transverse Mercator and elevations reported in Elk Valley Elevation Datum.



Note: Elevations reported in Elk Valley Elevation Datum. TH15-05 (VW33222) and TH15-06 (VW33239) are dry and not presented in Chart 5.

Chart 5: North Tailings Pond Vibrating Wire Piezometers and Pond Elevation from 1 September 2017 to 31 August 2018

The phreatic level readings for the time period were generally stable with minor increases noted around spring freshet in early May 2018, and likely were responding to freshet conditions. No warnings were triggered in GeoExplorer for these piezometers.

TH15-05 (1) or VW33241 showed a decrease in head elevation from September 2017 to May 2018, when it increased again during spring freshet.

The upper VW sensor in TH15-05 (3) or VW33222, was above the phreatic surface and was dry (negative water level readings). The lower VW sensor in TH15-06 (VW33239) is likely malfunctioning because it recorded negative water level while the upper piezometer was reading approximately 9 m of water above the piezometer.

All piezometers on NTP collect data in real-time. The piezometers should continue to be monitored on a regular basis as outlined in the OMS manual (FRO 2018a).

GeoExplorer shows “No Communication” and “No Frequency” alarms that alert FRO when the piezometers are not reading data. FRO uses these alarms as an indication that the piezometers are malfunctioning and will send someone to check on the instrument in question.

Observed Performance

No evidence of major slope instability was observed during the 2018 DSI. The key observations made during the NTP dam inspection were as follows:

- A wet area of ponding water was noted downstream of the NTP dam near Stn 0+970 (Appendix A, Photograph A-6).
- The FRO Tailings Engineer and FRO Environment inspected the animal burrows at the south end of NTP, near Sta. 1+400, in October 2017. Photos from the inspection were provided to a biologist for preliminary assessment and the biologist visited the area in August 2018. During the site visit, the biologist indicated the animal burrows were likely those of ground squirrels but there was no evidence of animal activity in recent months. An animal burrow removal plan is under development by FRO Environment and is planned for implementation in 2019/2020.

5.4.1.4 River Erosion Protection (KWL)

KWL completed an inspection of the riprap along the toe of NTP in 2018 (KWL 2019), and the inspection report is included in Appendix D. KWL reports that the exposed riprap along the NTP and STP dams is generally in good condition. This inspection report was reviewed by Golder as part of this DSI.

5.4.2 Review of Previous Deficiencies and Non-conformances

The deficiencies and non-conformances presented in Table 19 were noted in the previous DSI in 2017 (Golder 2018c). Table 19 provides the current status of the 2017 DSI recommendations for the NTP. Items from the 2017 DSI that are incomplete have been brought forward into the 2018 DSI recommendations (Table 27).

A number of recommendations are in progress and some are incomplete, but Golder considers the work to be appropriately prioritized based on good communication between the EoR team and the FRO Tailings Engineer.

Table 19: Current Status of 2017 Dam Safety Inspection Recommended Actions for North Tailings Pond Facility

ID Number	Deficiency or Non-conformance	Recommended Action	Updated Status as of March 2019
2015-05a,b	No passive emergency system against overtopping; emergency system requires active response	Assess the need for spillway after finalizing the NTP closure plan.	**Incomplete –** see Table 27 for updated recommendation and timeline
		If required, determine a construction schedule.	**Incomplete –** see Table 27 for updated recommendation and timeline
2015-06a,b,c	Risk-informed criteria for flood erosion protection along toe of dams not defined	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along the Fording River and the timeline to implement.	**Incomplete –** see Table 27 for updated recommendation and timeline
		Implement required protection measures for the operational phase according to the as-defined schedule.	**Incomplete –** see Table 27 for updated recommendation and timeline
		Execute the flood risk mitigation plan until the flood protection requirements defined by the risk-informed assessment are in place.	**Ongoing**
2015-07a,b	Buried pipes passing through crest locations	Inspect steel pipes as part of regular dam inspections until NTP closure plans are finalized. Include inspections in OMS manual update.	**Ongoing**
		Execute abandonment plan for PVC pipes.	**Incomplete –** see Table 27 for updated recommendation and timeline
2016-05a	North abutment excavated without input or approvals from Engineer of Record or Qualified Person	Assess and revise required internal and external communication for work and construction activities carried out near the site TSFs.	**Complete**
2016-06	No closure plan for NTP	Develop closure plan for NTP based on results of feasibility investigation into NTP decommissioning.	**Incomplete –** see Table 27 for updated recommendation and timeline
2015-03	Roles of Geotechnical and Hydraulics Engineers of Record undocumented	Golder, FRO, and KWL to document the roles of the Engineer of Record for the geotechnical and hydraulics related works in the OMS manual.	**Complete –** FRO (2018a)
2016-01	Seismic design criteria for stability out of date due to dam reclassification from High to Very High	Complete updated seismic stability assessment and liquefaction based on revised design criteria. Update QPOs based on revised stability assessment.	**Complete –** Golder (2018a)
2016-02	IDF and freeboard out of date due to dam reclassification from High to Very High	Update the IDF and freeboard assessment for the NTP and STP.	**Complete –** Golder (2018a)

ID Number	Deficiency or Non-conformance	Recommended Action	Updated Status as of March 2019
2016-03	OMS manual requires updating	Update OMS manual as follows: ■ Update all references to consequence classification of structures—change from High to Very High. ■ Include design criteria. ■ Review the manual using the updated HSRC and Guidance Document (Ministry of Energy and Mines 2017, 2016). ■ Review the manual using most recent Mining Association of Canada guidelines ■ Include QPOs for surveillance. ■ Update the dredging section to identify that dredging is currently operating to the Turnbull TSF. ■ Include safe work plans. ■ Include incident reporting procedures. ■ Include non-compliance reporting procedures. ■ Include animal burrow inspection and procedures ■ Include NTP pipe inspections ■ Include hydroseeding records ■ Include Liverpool and NTP boundaries Complete minor updates identified in the 2015 DSI report (Golder 2016b).	**Complete –** FRO (2018a)
2016-04	EPP & ERP require updating	Reference to the TARPs needs to be included for actions required based on instrumentation warnings and alarms.	**In progress** – draft ERP is being finalized. EPP will be updated after ERP is finalized
2016-09	No QPOs set for inclinometers	QPOs and frequency of readings should be set for the inclinometers.	**Complete** – see Golder (2018a) and FRO (2018a)
2017-05	Potential overtopping hazard due to tailings liquefaction and redistribution during seismic event needs to be assessed	Complete liquefaction and overtopping assessment for tailings within facility.	**Retracted** – redistribution of tailings as a result of a seismic event was determined to have a close to non-credible likelihood in the risk assessment
2017-06	Trigger-action-response plans (TARPs) and related QPOs not strongly tied to risk assessment results	TARPs with related monitoring plans and QPOs should be reviewed with consideration of the results from the 2017 TSF risk assessment	**Complete** – TARPs added to OMS manual

NTP = North Tailings Pond; OMS = operation, maintenance and surveillance; PVC = polyvinyl chloride; TSF = tailings storage facility; FRO = Fording River Operations; KWL = Kerr Wood Leidal Associates Ltd.; STP = South Tailings Pond; IDF = inflow design flood; HSRC = Health, Safety and Reclamation Code; QPO = quantitative performance objectives; DSI = dam safety inspection; EPP = Emergency Preparedness Plan; ERP = Emergency Response Plan; TARP = trigger-action-response plan.

5.5 South Tailings Pond

The record of inspection for the FRO STP by the EoR team is included in Appendix C. A plan of the STP with the location of the monitoring points is shown in Figure 6, and typical sections of the STP dams are shown in Figures 7 and 8.

This section presents an assessment of dam safety for the STP dam based on observations and data review and includes a review of the 2017 recommendations for the facility.

5.5.1 Assessment of Dam Safety Relative to Potential Failure Modes

A summary of the assessment and potential failure modes is presented in Table 20.

Table 20: Assessment of STP Dam Safety Relative to Potential Failure Modes

Potential Failure Mode	Observations/Data	Comments
Internal erosion (suffusion and piping)	Filter compatibility is generally met between dam fill materials and foundation flood plain sand and gravel, however, it is not met for the tailings and the flood plain sand and gravel. Ongoing seepage monitoring since 2015.	The potential filter inadequacy between the foundation and tailings will not impact the stability of the dam (i.e. it does not contribute to potential failure of the dam due to internal erosion), as the stability is not reliant on the tailings. Migration of the tailings through the sand and gravel is considered low risk. Seasonal trends evident in seepage data collected.
Overtopping	Pond elevation maintained below maximum allowable throughout reporting period. Operated near maximum pond elevation during spring 2018. The STP Water level TARP and the STP Water level TARP for interim operations at high levels were developed and followed through the 2018 freshet period.	IDF and freeboard assessment completed (Golder 2018a) with a list of IDF accommodation recommendations provided for STP. See no. 2018-03 in Table 27 for the recommendations.
Instability	No evident instability.	Static and seismic stability assessments completed (Golder 2018a) and the results indicated that the FoS of the dam meet or exceed the Very High consequence static and pseudo-static slope stability FoS design criteria considering 2017 maximum phreatic conditions.

STP = South Tailings Pond; TARP = trigger-action-response plan; IDF = inflow design flood; EoR = Engineer of Record.

5.5.1.1 Internal Erosion (Suffusion and Piping)

Design Basis

The following filter relationships were checked for the STP:

- compatibility between the tailings and the upstream till blanket
- compatibility between the upstream till blanket and CR/CCFR shell
- compatibility between the till cut-off and flood plain sand and gravel foundation
- compatibility between the CR or CCFR shell and the flood plain sand and gravel foundation
- compatibility between tailings and the flood plain sand and gravel foundation
- internal stability of the CR/CCFR shell

Filter compatibility was reviewed based on gradation quality control data from the 2008, 2012, and 2013 as-built reports, as well as the 2002 till evaluation, were used to confirm filter compatibility of all materials placed (Golder 2002, 2009, 2013, 2014d).

Various methods were used to check filter compatibility, including the United States Department of the Interior, Bureau of Reclamation (USBR 1977), the Sherard criteria (Sherard et al. 1984; Sherard and Dunningan 1989), the Terzaghi method (Terzaghi 1922), US Army Corps of Engineers (US ACE 2004), Kenney and Lau (1985), Li et al (2009), and Fell et al. (2005).

A filter compatibility and internal stability assessment was completed by Golder in 2015 in response to a February 2015 Ministry of Energy, Mines and Petroleum Resources (formerly the Ministry of Energy and Mines) order to undertake an assessment to determine if the tailings facilities dams may be at risk of internal erosion (Golder 2015a).

All materials generally have filter compatibility by all methods expect between the tailings and the flood plain sand and gravel. The potential filter inadequacy between the foundation and tailings will not impact the stability of the dam, as the dam stability is not reliant on the tailings. Migration of the tailings through the sand and gravel is expected to be contained by the till cut-off, and therefore a low risk. No tailings have been observed downstream to date.

The internal stability of the CR shell was confirmed (Golder 2015a).

It is noted that there are some gaps in construction quality control records, particularly for the 1983 to 1984, 1985 to 1990, and 1993 raises; however, the gradation of the CR and CCFR filter/shell material created by the wash plant appears to have remained relatively consistent from the 1970s to present day (Golder 2015a). Where data were available, they indicated that filter compatibility between the local till and the CR/CCFR was achieved. Gaps in the construction quality control records are considered to be very low risk.

Based on the performance of the dam over the last 40 years, piping through the dam due to filter-incompatible materials is not expected to be an issue. Continual seepage is evident in the foundation materials below the toe of the STP dam, particularly along the West Dam, and has been reported for many years. Cloudy seepage water can indicate internal erosion, but records of the seepage from the STP indicate clear water. Regular inspections for evidence of increased seepage and piping should continue.

Quantitative monitoring of seepage at the West Dam began in late 2015 in response to a visual observation of increased year-over-year seepage rates.

Instrumentation Data – Seepage Monitoring

In 1979, shortly after the STP was put into operation, it became apparent that at some location beneath the bottom of the STP, the lower gravel stratum has hydraulic connection with the surficial flood plain gravels that extend over the base of the pond. It is understood that the STP water balance showed unexpected losses.

The total seepage losses from the pond are not measured directly. The estimated rate of seepage loss noted in previous water balances for the STP contains uncertainties resulting from inaccuracies in the water balance modeling, such as not accounting for the mass balance.

Seepage losses from the STP from 1989, 2000, 2003, and 2006 through 2018 are shown in Table 21.

Table 21: Fording River Operations Reported Seepage Losses from the South Tailings Pond

Year	Approximate Average Pond Elevation (m)	Historical FRO Reported Seepage (m^3/min)	GoldSIM Seepage (m^3/min)
1989	1,629.1	7.5	n/a
2000	1,629.7	4.3	n/a
2003	1,629.5	5.5	n/a
2006	1,629.7	0.4	n/a
2007	1,629.0	3.2	n/a
2008	1,629.5	2.8	n/a
2009	1,630.0	2.3	n/a
2010	1,630.1	1.5	n/a
2011	1,631.9	3.4	n/a
2012	1,632.9	3.9	n/a
2013	1,634.5	10.6	n/a
2014	1,635.5	13.1	n/a
2015	1,636.3	n/a	9.9
2016	1,636.3	n/a	10.4
2017	1,636.2	n/a	5.0
2018	1,636.4	n/a	4.8

Note: Pond elevations reported in Elk Valley Elevation Datum.

n/a = not applicable.

In response to an increase in the observed seepage below the West Dam, FRO installed two seepage collection pipes within the seepage area in 2015 and has started to collect seepage data. These data should be collected regularly to develop long-term trending of seepage rates in this area. Seepage data from the collection pipes were only taken during the site inspection visit on 11 September 2018. Photograph A-33 in Appendix A shows the location of the collection pipes and the estimated flow measurements during the site inspection.

Observed Performance

The key observations made during the STP dam inspection were as follows:

- Seepage continues along the presumed till/bedrock contact below the West Dam (Appendix A, Photograph 33). The seepage has pushed up mats of organics and created a hummocky, broken surface area. This is consistent with previous years. Seepage from the collection pipes at the time of the site visit was between 0.21 and 0.26 L/s from the W Seep North and South pipes. Red staining was noted in some areas of seepage along the bedrock contact.
- Water flow was observed in the ditch along the downstream toe of the north end of the West Dam as seen in previous years. Water was observed in the ditch along the toe downstream of the south end of the West Dam. The water is likely due to seepage exiting the dam and surface water. Vegetation growth was also observed along these ditches (Appendix A, Photograph 41).
- All observed seepage, including external seepage water, was clear and had no sediments.
- No zones of subsidence or any sinkholes were observed that would indicate voids due to either suffusion or piping.

5.5.1.2 Overtopping

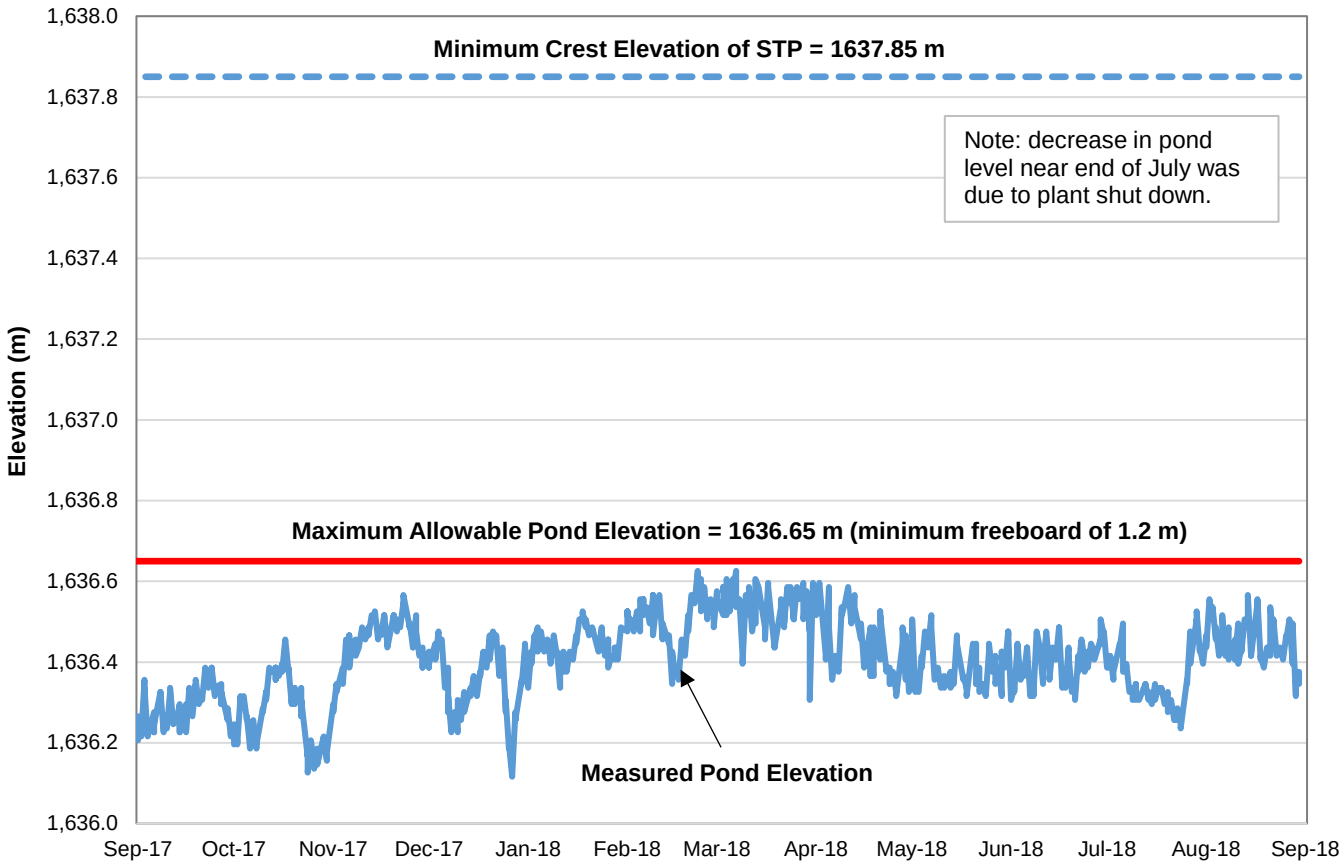
Design Basis

An updated IDF and freeboard assessment for the Very High consequence classification was completed in 2018 (Golder 2018a). The HSRC Guidance Document (Ministry of Energy and Mines 2016) recommends that the IDF be designed to 2/3 between the 1,000-year flood/storm event and the probable maximum flood for a structure classified as Very High consequence. Furthermore, for impoundments with no emergency spillway, the HSRC Section 10.1.8 requires a minimum storage volume to contain runoff from a 72-hour IDF. As a result of the reclassification of the NTP dam from High to Very High, its freeboard assessment was updated with the above-mentioned HSRC requirements. The result of the updated assessment indicated that:

- The current maximum operating water level of elev. 1636.65 m, which is 1.2 m below the minimum dam crest, provides the required freeboard during the 72-hours IDF if all external catchment areas are diverted.
- The required minimum freeboard above the IDF is 0.4 m with the maximum flood level (IDF) at elev. 1637.45 m. This is based on the maximum operating water level of elev. 1636.65 m and all external catchment areas are diverted.

Instrumentation Data

Pond elevation data for 1 September 2017 to 31 August 2018 at the STP were received from FRO (Chart 6).



Note: Pond elevations reported in Elk Valley Elevation Datum.

Chart 6: South Tailings Pond Water Elevation from 1 September 2017 to 31 August 2018

The STP water level is shown to have been maintained below the maximum allowable water elevation during the reporting period. Water levels in the STP are monitored in real time with a water level sensor located on the water reclaim barge, and levels are actively managed by the FRO Processing Plant personnel. In the event of high water levels at the STP, the STP Water Level TARP from Appendix B or C of the OMS manual would be followed (FRO 2018a). Water management options for STP during freshet are also included in the OMS.

Observed Performance

As a result of the volume of tailings deposited into the STP facility during the 2017/2018 winter, the operating pond size was significantly reduced by early Spring 2018 and pond water levels were operated near the freeboard limit (Chart 6) during the spring freshet period. In response, FRO developed the TARP and followed this through the spring period. The TARP is included in Appendix C of the updated OMS manual (FRO 2018a). In addition, the updated OMS manual includes Section 4.8, which addresses Freshet Contingency Water Management.

Dredging operations at the STP were started in early April as part of the plan to manage the high tailings volume in the facility. FRO also increased the annual dredging total plan for the 2018 season, targeting 1.5 million tonnes and achieving 1.64 million tonnes. FRO is planning for a dredge volume of 1.3 million tonnes for the 2019 season and to start dredging as soon as possible in April 2019. Frequent bathymetry analysis will be conducted, and it will inform any required increase to the planned dredging tonnage.

The updated IDF and freeboard assessment (Golder 2018a) considers diversion of the external catchment which reports to the STP via Blackmore Creek during the IDF event to maintain the 1.2 m freeboard. FRO has Golder working on a conceptual design for the Blackmore Creek diversions at the time of preparation of this report.

The key observations made during the STP dam inspection were as follows:

- The pond was clear and free of major debris.
- Make up Water is sent to the STP pond. Water from the seepage return wells and the Kilmarnock Pond was being pumped to the south end of the STP. Water from the North Loop Pond, Shandley pit and Maxam yard were being pumped to the north end of the STP at the time of the inspection.

In response to high water levels during normal operations, the TARP listed in Appendix B of the OMS manual (FRO 2018a) and ERP should be followed.

The STP is not equipped with an overflow emergency spillway. An emergency spillway is considered to be best practice as it allows excess water to exit the facility passively (i.e., without any active intervention). Golder has prepared a conceptual design for an emergency spillway (Golder 2018f).

5.5.1.3 Instability

The STP West Dam is susceptible to instability from erosion during flooding of the Fording River. This has been assessed by KWL, and riprap was placed on the toe of the dam in late 2016 to prevent erosion (KWL 2017b). The south section of the West Dam from the pipe bridge southward does not have any erosion protection but consists partially of bedrock, which provides some erosion protection.

Design Basis

As a result of the re-classification of the STP dam from High to Very High, its slope stability and liquefaction assessments were updated to comply with the Very High consequence design criteria (Golder 2018a). An earthquake of ½ between the 1-in-2,475-year and 1-in-10,000-year event was used for Very High consequence dams as per the HSRC Guidance Document (Ministry of Energy and Mines 2016). This event corresponded to a PGA of 0.23 g and a mean moment magnitude of 6.2 based on the probabilistic analysis results from the site-specific hazard assessment (Golder 2016a). Details of the assessment and results were provided in Golder (2018a). A brief summary of the conclusions is provided below:

- The liquefaction assessment update considered the 2017 topography along with the 2016 riprap construction along the toes of the STP dam. The results indicated that the saturated soils below the dam are unlikely to liquefy during the design earthquake.
- The dam stability update used design criteria based on the HSRC Guidance Document (Ministry of Energy and Mines 2016) Section 3.3 and CDA (2014) for minimum factor of safety. Both static and pseudo-static conditions were considered in the stability assessment. However, the post-earthquake conditions were not analyzed in the foundation because the liquefaction assessment results indicated that the alluvial soils below the dams and dam materials are unlikely to liquefy during the design earthquake event. The results of the stability assessment indicated that the factor of safety of the STP dam met or exceeded the Very High consequence static and pseudo-static slope stability design criteria.
- The HSRC Part 10 (Ministry of Energy and Mines 2017) Section 10.1.9 indicates that design downstream slopes steeper than 2H:1V require the manager to submit justification from the Engineer of Record for the design slope and receive authorization prior to construction. The STP downstream slopes were constructed before this requirement. As noted above, the results of the stability assessment indicated that the stability factor of safety met or exceeded the design criteria.

Instrumentation Data – Dam Displacement Monitoring

- There are 11 operational GPS units on the STP West and Main Dams. Three of these units, STP-GPS 04, STP-GPS 08 and STP-GPS 11, were replaced during the reporting period. GeoExplorer renamed the replaced units by adding "_old" at the end of the unit's name and the new units kept the original name as shown in Table 22.

GPS unit STP-GPS 10 was decommissioned, and its name changed to STP-GPS 10_old in GeoExplorer. its last reading was taken on 14 November 2018. It is understood from FRO that this GPS will be relocated.

Hourly readings from 1 September 2017 to 31 August 2018 were recorded in GeoExplorer and are presented in Charts 7 and 8. The initial readings of the GPS units were used for locations of the GPS monitors and are shown in Figure 6.

A summary of the GPS units in use for the 2018 DSI reporting period is presented in Table 22.

Table 22: GPS Monitoring Locations on South Tailings Pond

GPS Identification	Reading Start Date	Northing (m)	Easting (m)	Location Description
STP-GPS 01	December 2013	5,560,728.9	651,109.0	West Dam – crest
STP-GPS 02	August 2016	5,560,621.6	651,163.7	West Dam – crest above flood construction
STP-GPS 03	April 2016	5,560,537.4	651,186.9	West Dam – flood construction toe
STP-GPS 04_old	February 2017	5,560,540.1	651,239.9	West Dam – crest above flood construction
STP-GPS 04	May 2017	5,560,540.1	651,239.9	West Dam – crest above flood construction
STP-GPS 05	October 2014	5,560,441.9	651,355.6	West Dam – crest above flood construction
STP-GPS 06	April 2016	5,560,349.1	651,369.2	West Dam – flood construction toe
STP-GPS 07	December 2013	5,560,259.9	651,525.9	West Dam – crest
STP-GPS 08_old	August 2015	5,560,152.6	651,659.4	West Dam – crest
STP-GPS 08	July 2018	5,560,152.6	651,659.4	West Dam – crest
STP-GPS 09	April 2016	5,560,081.3	651,844.4	Main Dam – crest
STP-GPS 10_old [(a)]	April 2016	5,560,022.7	652,029.4	Main Dam – toe
STP-GPS 11_old	April 2016	5,560,089.4	652,051.2	Main Dam – crest
STP-GPS 11	July 2018	5,560,089.4	652,051.2	Main Dam – crest

Note: Northings and Eastings reported in Universal Transverse Mercator.

(a) GeoExplorer indicated this GPS unit is replaced but the new unit is not found on GeoExplorer.

STP = South Tailings Pond

The 3D displacement for the GPS monitors were downloaded from GeoExplorer for the Main Dam and West Dam and are presented in Charts 7 and 8, respectively.

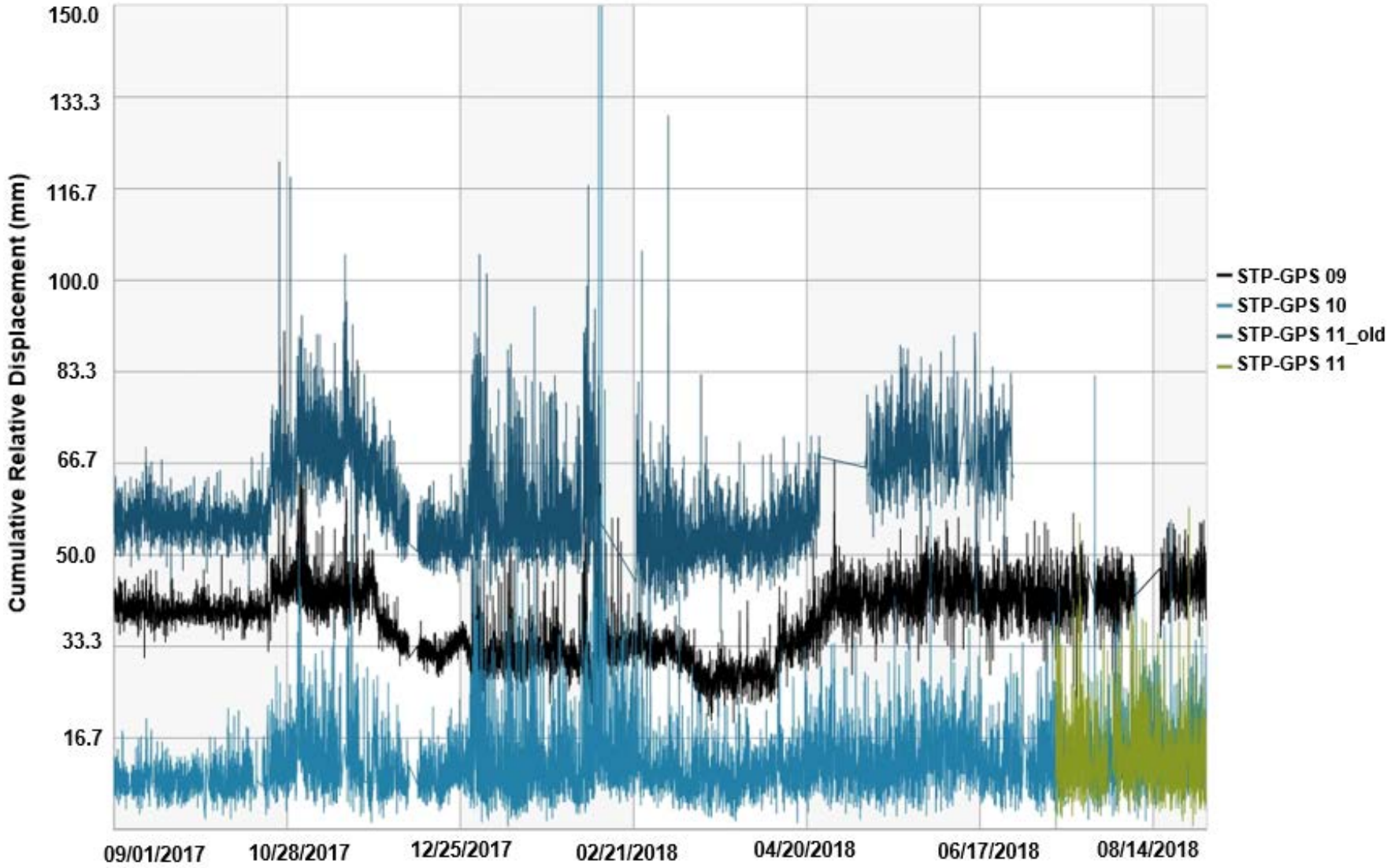


Chart 7: South Tailings Pond Main Dam GPS Monitors Cumulative Relative Displacement from 1 September 2017 to 31 August 2018

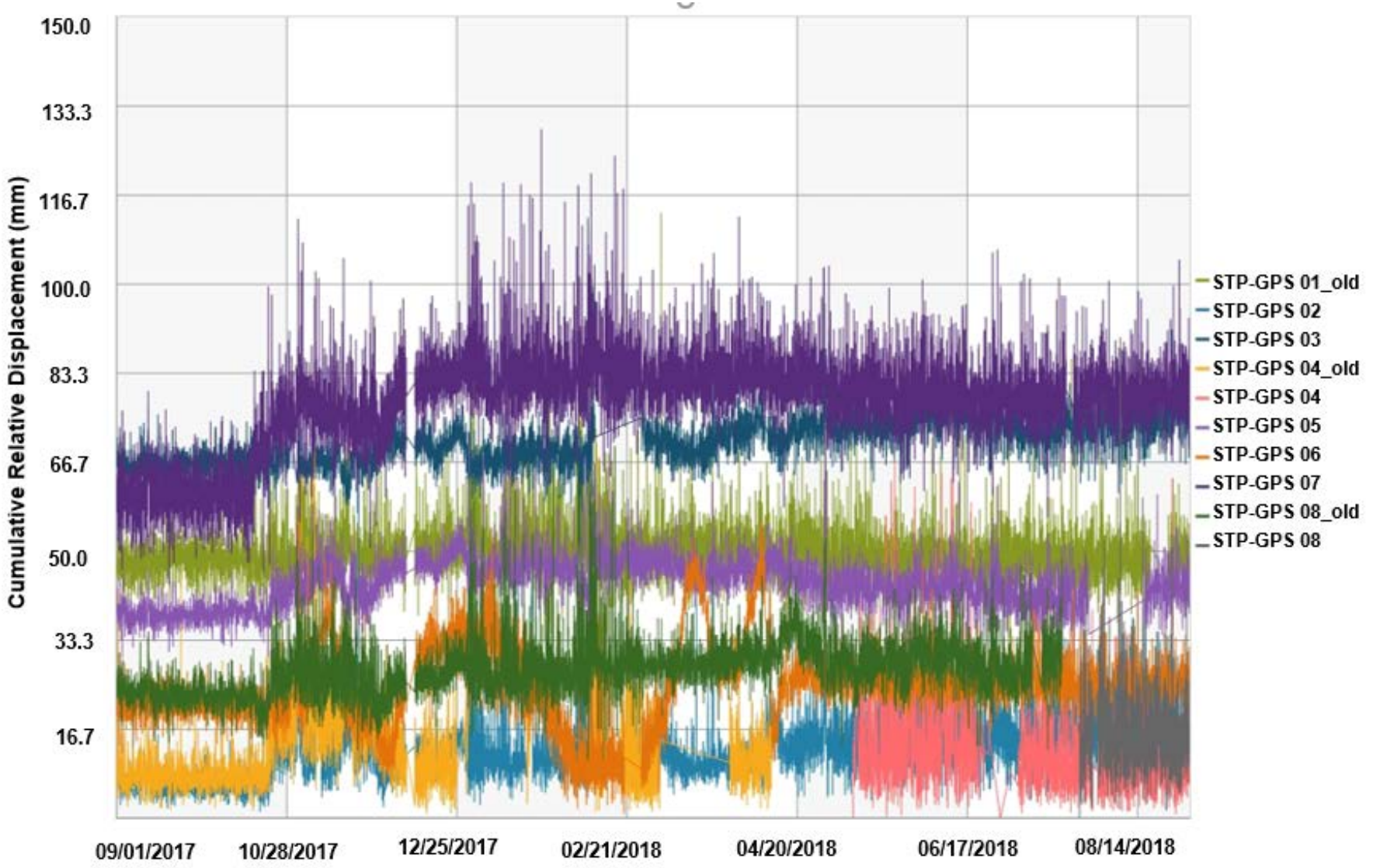


Chart 8: South Tailings Pond West Dam GPS Monitors Cumulative Relative Displacement from 1 September 2017 to 31 August 2018

The GPS units record on an hourly frequency and provide monitoring data in real time to FRO via GeoExplorer.

The survey data on the Main and West Dams indicated little crest displacement during the reporting period. Spikes in the data which are above the 100 mm displacement warning recorded between October 2017 and February 2018 do not support any trends and are not a concern.

No GPS units recorded any data from 8 December 2017 to 11 December 2018. GPS units STP-GPS 04, STP-GPS 08, and STP-GPS 11 were replaced with new units during this reporting period.

Any offline monitors should be inspected and repaired within one week (FRO 2018a).

Instrumentation Data – Slope Inclinometers

Slope inclinometers were installed at four locations in 2015 along the STP crest (Figure 6) to monitor horizontal movement in the dam in addition to the GPS data. The A axis is oriented in the upstream to downstream direction (with negative displacements in the downstream direction) and the B axis is oriented along the dam centreline. The location of the inclinometers on the STP is presented in Table 23.

Table 23: South Tailings Pond Inclinometers

Inclinometer ID	Northing (m)	Easting (m)	Elevation (m)	A-A Axis Azimuth (°)	Probe Serial No.	Reel Serial No.
TH15-01	5,560,086.2	652,037.3	1,638.2	310	DP15600000	DR21300000
TH15-02	5,560,093.0	651,786.4	1,638.3	10		
TH15-03	5,560,550.6	651,227.5	1,638.7	30		
TH15-04	5,559,997.8	652,003.4	1,604.6	15		

Note: Azimuth is approximate. The upper wheel should face the indicated direction for the first set of readings.

Northings and Eastings reported in Universal Transverse Mercator and elevations reported in Elk Valley Elevation Datum.

Inclinometer data were supplied to Golder by FRO. Readings have been taken approximately quarterly at the STP inclinometers since December 2015. A total of two readings were taken at inclinometers TH15-01, TH15-02, TH15-03, and TH15-04 within the DSI reporting period, on 20 March 2018 and 13 July 2018.

Inclinometer data are plotted by Golder. Data readings from January 2017 to 23 September 2018, including the initial reading from 18 December 2015 as a reference line, were plotted and provided in Appendix H.

The inclinometer readings do not indicate any significant trends in deformation and the maximum cumulative downstream deflection does not exceed 5 mm over a year which is in the acceptable range for the slope inclinometer QPO (Table 7).

Instrumentation Data – Piezometers on Main Dam

The VW piezometer and standpipe locations are shown in plan in Figure 6. A summary of the VW piezometer locations and sensor depths on the Main Dam are shown in Table 24. The performance at each VW piezometer was evaluated by assessing whether the warning levels were exceeded. The warning levels were confirmed in Golder (2018a) and are used in GeoExplorer.

Table 24: South Tailings Pond Main Dam Piezometer Installation Details and Performance Summary

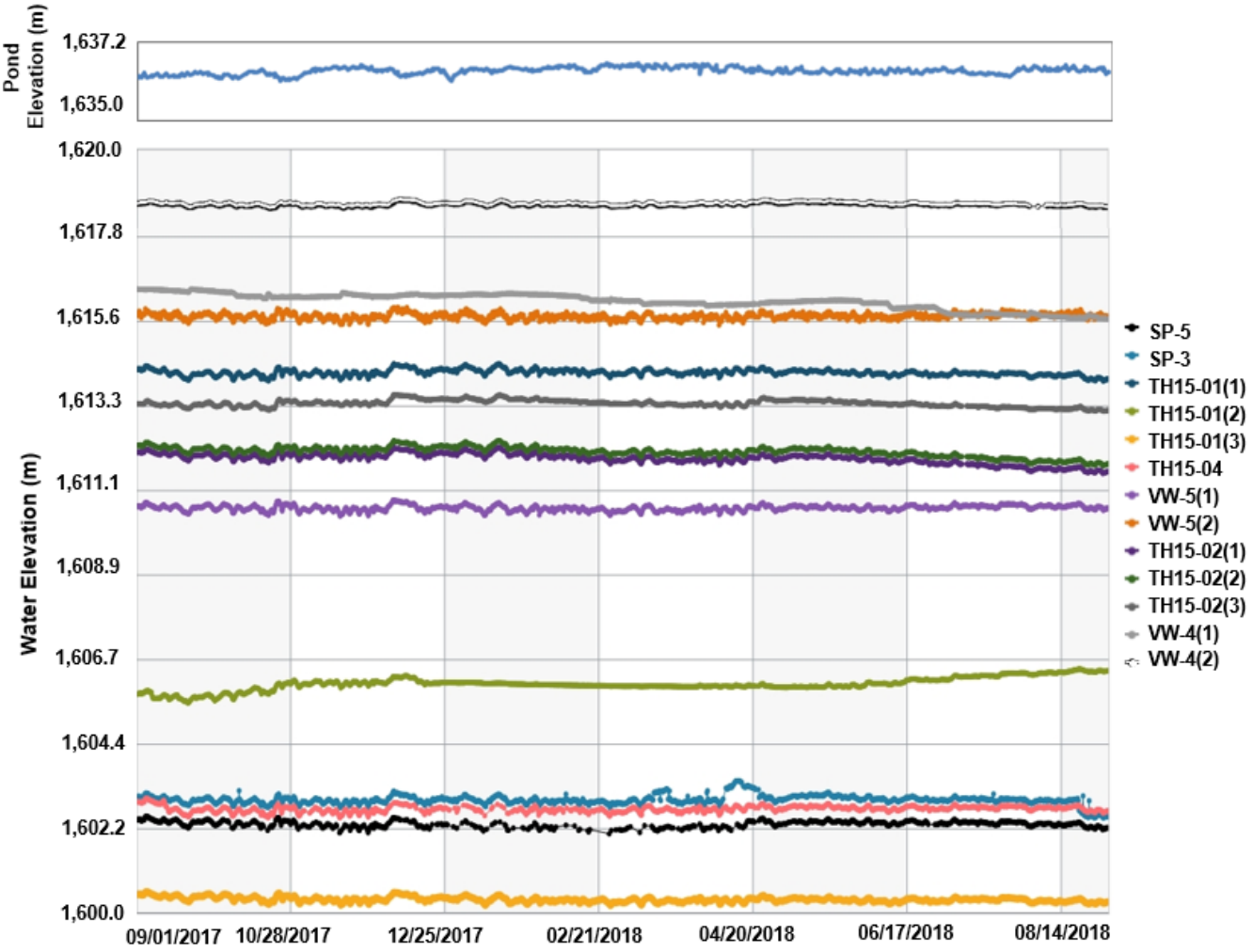
Borehole/Piezometer ID	Northing (m)	Easting (m)	Top of Well Elevation (m)	Data Logger Serial	Piezometer Serial No.	GeoExplorer Sensor No.	Piezometer Tip Elevation (m)	Soil unit of Piezometer Sensor	Warning Water Elevation (m)	Minimum Recorded Water Level (2017/2018)	Maximum Recorded Water Level (2017/2018)	Comments
VW-4	5,560,100.6	651,758.7	1,639.2	DT08079	VW27921	2	1,617.2	Coarse rejects (compacted)	> 1,624.0	1,618.4	1,618.7	No concerns.
				DT08082	VW27920	1	1,615.0			1,615.6	1,616.4	No concerns.
VW-5	5,560,106.2	652,102.4	1,639.2	DT08073	VW27929	2	1,615.5	Coarse rejects (compacted)	> 1,617.5	1,615.5	1,615.9	No concerns.
				DT08075	VW27930	1	1,610.4			1,610.4	1,610.9	No concerns.
TH15-01	5,560,086.2	652,037.3	1,638.2	DT04498	VW33227	1	1,611.1	Dam Fill	> 1,617.5	1,614.0	1,614.4	No concerns.
					VW33229	2	1,604.9	Dam Fill / Foundation fluvial sands and gravel		1,605.5	1,606.4	Trending upwards from June to August 2018.
					VW33244	3	1,600.9	Foundation fluvial sands and gravel		n/a	n/a	Likely malfunctioning, negative water level, still see similar trend in piezometer data to other sensors
TH15-02	5,560,093.0	651,786.4	1,638.3	DT04499	VW33238	3	1,612.2	Granular drain	> 1,624.0	1,613.2	1,613.6	No concerns.
					VW33233	2	1,605.5	Foundation fluvial sands and gravel		1,611.8	1,612.4	No concerns.
					VW33243	1	1,601.5	Bedrock		1,611.6	1,612.2	No concerns.
TH15-04	5,559,997.8	652,003.4	1,604.6	DT09637	VW33224	-	1,599.6	Foundation fluvial sands and gravel	> 1,603.5	1,602.5	1,603.0	No concerns.
SP-3	5,560,032.4	652,043.8	1,610.4	DT08083	VW27931	-	1,600.6	Foundation fluvial sands and gravel	> 1,604.0	1,602.5	1,603.5	No concerns.
SP-5	5,560,057.5	652,163.7	1,605.0	DT08074	VW27918	-	1,595.9		Not available	1,602.1	1,602.6	No concerns.

Note: Northings and Eastings reported in Universal Transverse Mercator and elevations reported in Elk Valley Elevation Datum.

Warning water elevations from GeoExplorer.

n/a = not applicable.

Chart 9 presents the piezometer readings for 1 September 2017 to 31 August 2018, as well as the pond elevation over the same time period. The piezometer plots were taken from GeoExplorer.



Note: Elevations reported in Elk Valley Elevation Datum.

Chart 9: Main Dam Vibrating Wire Piezometer and Standpipe Water Elevations and South Tailings Pond Elevation from 1 September 2017 to 31 August 2018

The phreatic level readings for the time period were generally stable with very little to no reaction to spring freshet. No warnings were triggered in GeoExplorer for these piezometers as shown in Table 24.

TH15-01 (VW33229, GeoExplorer sensor no. 2) shows an increase in water elevation starting from May 2018.

Instrumentation Data – Piezometers on West Dam

A summary of the VW piezometer locations and sensor depths on the West Dam is shown in Table 25.

No data were available from GeoExplorer for VW-3 (VW27917); therefore, it is not reported.

Table 25: South Tailings Pond West Dam Piezometers Installation Details and Performance Summary

Piezometer ID	Northing (m)	Easting (m)	Elevation (m)	Data Logger Serial	Piezometer Serial No.	GeoExplorer Sensor No.	Piezometer Elevation (m)	Warning Water Elevation (m)	Minimum Recorded Water Level (2017/2018)	Maximum Recorded Water Level (2017/2018)	Warning Water Elevation Exceeded?	Comments
VW-1	5,560,710.9	651,118.1	1,640.0	DT08070	VW27922	2	1,620.4	> 1,627.5	1,620.9	1,621.5	No	No concerns.
				DT08078	VW27923	1	1,606.4		1,621.8	1,622.7	No	Decreasing pressure head from end of May to September 2018.
VW-2	5,560,494.1	651,310.0	1,639.3	DT08076	VW27926	2	1,616.9	> 1,627.5	1,617.7	1,618.1	No	No concerns.
				DT08077	VW27928	1	1,610.5		1,616.3	1,616.8	No	No concerns.
VW-3	5,560,278.9	651,509.5	1,638.9	DT08071	VW27925	2	1,622.3	> 1,627.0	1,623.2	1,623.8	No	No concerns.
				DT08072	VW27924	1	1,611.4		1,620.4	1,622.1	No	Decreasing pressure head from end of May to September 2018.
TH15-03	5,560,550.6	651,227.5	1,638.7	DT04500	VW33225	3	1,618.2	> 1,627.5	1,618.5	1,618.9	No	Missing data from 6 February to 21 June 2018, except for a single reading on 24 May 2018. The sensor was re-entered into GeoExplorer on 24 May 2018 per the notes on this instrument.
					VW33228	1	1,614.2		1,620.5	1,621.0	No	No concerns.
					VW33226	2	1,612.2		1,617.5	1,618.0	No	No concerns.
SP-W1	5,560,273.7	651,497.3	1,633.9	DT08081	VW27927	-	1,613.4	> 1,623.1	1,620.4	1,622.0	No	Decreasing pressure head from end of May to September 2018.
SP-W3	5,560,255.0	651,481.4	1,624.5	DT08080	VW27919	-	1,615.0	> 1,623.0	1,618.8	1,619.8	No	Decreasing pressure head from end of May to September 2018.

Note: Northings and Eastings reported in Universal Transverse Mercator and elevations reported in Elk Valley Elevation Datum.

> = greater than.

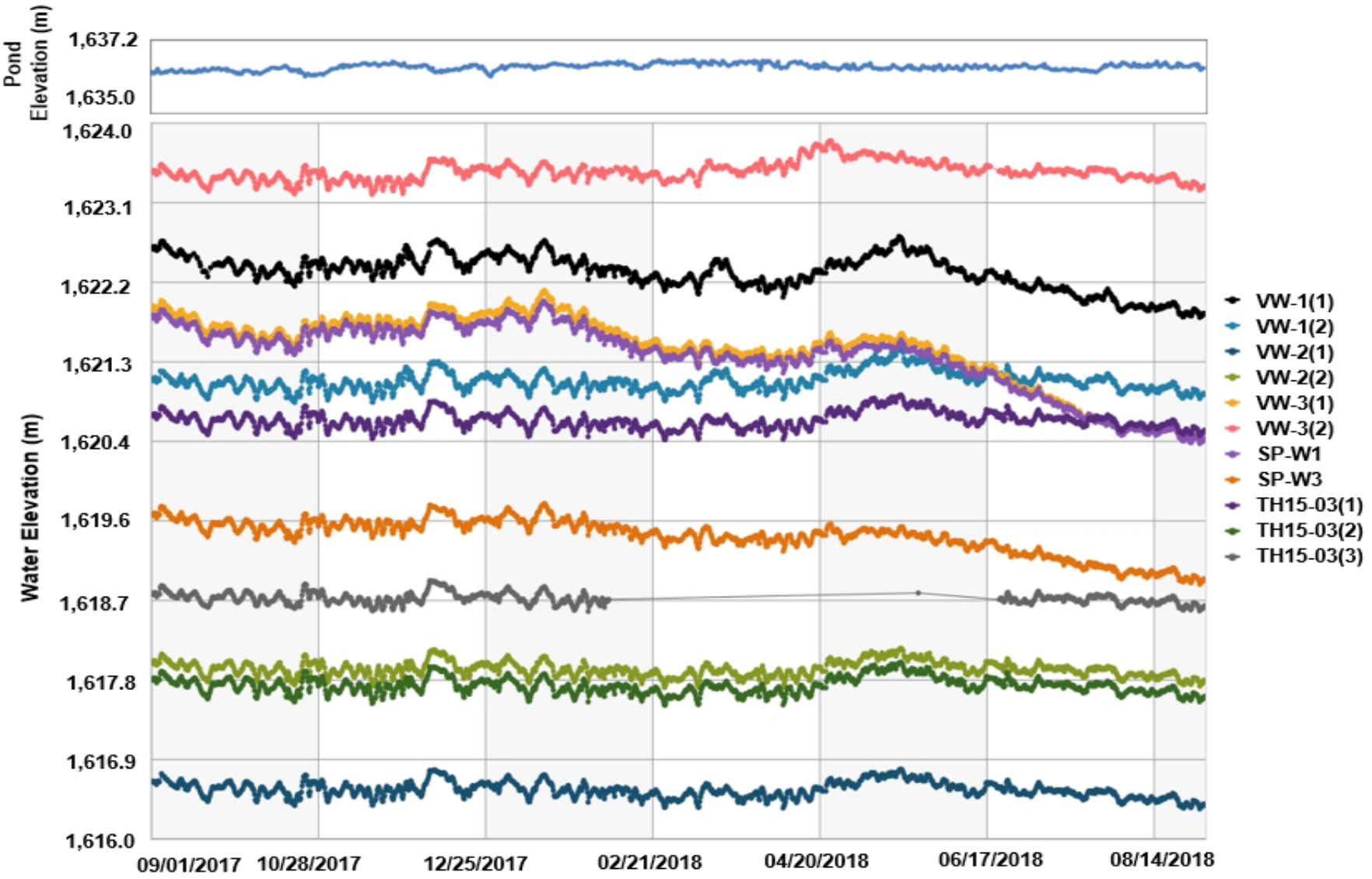
The VW piezometers and standpipes are presented in plan in Figure 6. Chart 10 presents the piezometer readings for 1 September 2017 to 31 August 2018, as well as the pond elevation over the same time period. The piezometer data were taken from GeoExplorer and the pond elevation was provided by FRO.

The phreatic level readings for the time period were generally stable with trends related to spring freshet seen in most sensors in April and May 2018 and decreased water level in the summer. No warnings were triggered in GeoExplorer for these piezometers.

FRO noted that the data logger for TH15-03 has been damaged by water and a replacement is required.

TH15-03 (VW33225, GeoExplorer sensor no. 3) is missing data from February 2017 to June 2018, with a single point being read in May 2018.

GeoExplorer shows “No Communication” and “No Frequency” alarms that alert FRO when the piezometers are not reading data. FRO uses these alarms as an indication that the piezometers are malfunctioning and will send someone to check on the instrument in question.



Note: Elevations reported in Elk Valley Elevation Datum.

Chart 10: West Dam Vibrating Wire Piezometer and Standpipe Water Elevations and South Tailings Pond Elevation from 1 September 2017 to 31 August 2018

Observed Performance

The key observations made during the STP dam inspection related to assessment of instability were as follows:

- No significant evidence of slope instability on the constructed dam (i.e., significant sloughing, cracking, crest subsidence) was observed during the 2018 DSI.
- Minor erosion has been noted on the downstream slope over the years, generally in the CCFR material, with the exception of a major vertical erosion/gully on the downstream slope of the Main Dam above the seepage collection well. This gully was deemed not deep enough for repair and it should continue to be monitored. FRO has repaired previous erosion channels present on the STP by placing breaker rock over geotextile on the eroded areas, creating armoured channels. Current and future erosion should continue to be monitored and repaired in a similar or equivalent manner as part of ongoing maintenance.
- The downstream slope has sections steeper than the design, but the overall embankment has been constructed wider than the design. The over-steepened areas are prone to increased erosion, but are not an overall stability concern.
- The FRO Tailings Engineer and FRO Environment inspected the animal burrows downstream of the southern end of the Main Dam in October 2017. Photos from the inspection were provided to a biologist for preliminary assessment and the biologist indicated there was evidence of badgers in the vicinity but not in the embankment. No animal burrows have been found in the embankment. During a site visit in August 2018, the biologist did not see any badgers and indicated there was no evidence of recent animal activity in the area.
- It was observed during the site inspection that water was not draining well in the ditch along the West Dam and had areas of standing water along the toe of the dam, which is next to the lower access road. The ditch should be regraded to drain ponded water.

5.5.1.4 River Erosion Protection (KWL)

KWL completed an inspection of the riprap along the toe of STP in 2018 (KWL 2019), and the inspection report is included in Appendix D. KWL reports that the exposed riprap along the NTP and STP dams is generally in good condition. This inspection report was reviewed by Golder as part of this DSI.

5.5.2 Review of Previous Deficiencies and Non-conformances

The following deficiencies and non-conformances for the STP were raised in the previous DSI in 2017 (Golder 2018c). The current status of the 2017 DSI recommendations for the STP are provided in Table 26. Items from the 2017 DSI that are incomplete have been brought forward into the 2018 DSI recommendations (Table 27).

A number of recommendations are in progress and some are incomplete, but Golder considers the work to be appropriately prioritized based on good communication between the EoR team and the FRO Tailings Engineer.

Table 26: Current Status of 2017 Dam Safety Inspection Recommended Actions for South Tailings Pond Facility

ID Number	Deficiency or Non-conformance	Recommended Action	Current Status as of March 2019
2013-16	No passive emergency system against overtopping; emergency system requires active response	Assess the best combination of active and passive emergency systems during various stages of the pond life cycle. If the assessment determines that passive systems are warranted, then develop a construction schedule for the selected system(s).	**Complete** – Assessment of best combination of active and passive emergency systems were reviewed at the 1 June 2019 workshop. See Table 27 for Recommended action related to a passive emergency spillway system.
2015-12a,b,c	Riprap erosion protection along downstream toe north of STP Stn. 0+680, no riprap south of STP Stn. 0+680; risk-informed protection requirements not yet defined	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along Fording River and timeline to implement.	**Incomplete** – see Table 27 for updated recommendation and timeline
		Implement required protection measures for the operational phase according to the as-defined schedule.	**Incomplete** – see Table 27 for updated recommendation and timeline
		Execute flood risk mitigation plan until flood protection requirements defined by the risk-informed assessment are in place.	**Ongoing**
2017-01	North abutment construction deficiencies	Address construction deficiency, finish dam construction.	**Incomplete** – see Table 27 for updated recommendation and timeline
2017-02	Tailings that were excavated along upstream slope to place the riprap zone impede water flow towards main pond	The tailings should be regraded with an excavator so that water will preferentially flow into the pond.	**Complete**
2017-03	Inspection frequency inadequate for active, Very High consequence facility	Increase geotechnical inspections to weekly from May to October and twice per month from November to April for STP	**Complete** – included in OMS manual (FRO 2018a)
2017-04	Planned dredging of Tailings to Turnbull TSF is behind schedule and the result is a very high level of tailings in STP which is causing operational issues (e.g., disposition line backing up and reclaimed process water with too much sediment)	Dredging to Turnbull TSF should be started as soon as possible with an increased annual dredging target.	**Complete**
2015-03	Roles of Geotechnical and Hydraulics Engineers of Record undocumented	Golder, FRO, and KWL to document the roles of the Engineer of Record for the geotechnical and hydraulics related works in the OMS manual.	**Complete** – FRO (2018a)
2016-01a, b	Seismic design criteria for stability out of date due to dam reclassification from High to Very High	Complete updated seismic stability assessment and liquefaction based on revised design criteria. Update QPOs based on revised stability assessment.	**Complete** – Golder (2018a)
2016-02	IDF and freeboard out of date due to dam reclassification from High to Very High	Update the IDF and freeboard assessment for the NTP and STP.	**Complete** – Golder (2018a)

ID Number	Deficiency or Non-conformance	Recommended Action	Current Status as of March 2019
2016-03	OMS manual requires updating	Update OMS manual as follows: ■ Update all references to consequence classification of structures—change from High to Very High. ■ Include design criteria. ■ Review the manual using the updated HSRC and Guidance Document (Ministry of Energy and Mines 2017, 2016). ■ Review the manual using most recent Mining Association of Canada guidelines ■ Include QPOs for surveillance. ■ Update the dredging section to identify that dredging is currently operating to the Turnbull TSF. ■ Include safe work plans. ■ Include incident reporting procedures. ■ Include non-compliance reporting procedures. ■ Include animal burrow inspection and procedures ■ Include NTP pipe inspections ■ Include hydroseeding records ■ Include Liverpool and NTP boundaries Complete minor updates identified in the 2015 DSI report (Golder 2016b).	**Complete –** FRO (2018a)
2016-04	EPP & ERP require updating	Reference to the TARPs needs to be included for actions required based on instrumentation warnings and alarms.	**In progress** – draft ERP is being finalized. EPP will be updated after ERP is finalized.
2016-09	No QPOs set for inclinometers	QPOs and frequency of readings should be set for the inclinometers.	**Complete** – see Golder (2018a) and FRO (2018a)
2017-05	Potential overtopping hazard due to tailings liquefaction and redistribution during seismic event needs to be assessed	Complete liquefaction and overtopping assessment for tailings within facility.	**In progress**
2017-06	Trigger-action-response plans (TARPs) and related QPOs not strongly tied to risk assessment results	TARPs with related monitoring plans and QPOs should be reviewed with consideration of the results from the 2017 TSF risk assessment	**Complete** – TARPs added to OMS manual

IDF = inflow design flood; STP = South Tailings Pond; NTP = North Tailings Pond; FRO = Fording River Operations; KWL = Kerr Wood Leidal Associates Ltd.; OMS = operation, maintenance and surveillance; CDA = Canadian Dam Association; HSRC = Health, Safety and Reclamation Code; QPO = quantitative performance objectives; EPP = Emergency Preparedness Plan; ERP = Emergency Response Plan; Stn. = Station; n/a = not applicable; DSI = dam safety inspection; TSF = tailings storage facility; PVC = poly vinyl chloride.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary of Activities

Activities completed for the NTP during the reporting period were:

- Monthly inspections by FRO geotechnical personnel.
- A bathymetric survey was carried out over two dates, 24 August and 16 October 2018 (Golder 2018b).
- The FRO Tailings Engineer and FRO Environment inspected the animal burrows at the south end of NTP, near Sta. 1+400, in October 2017. Photos from the inspection were provided to a biologist for preliminary assessment and the biologist visited the area in August 2018. During the site visit, the biologist indicated the animal burrows were likely those of ground squirrels but there was no evidence of animal activity in recent months. An animal burrow removal plan is under development by FRO Environment and is planned for implementation in 2019/2020.

Activities completed for the STP during the reporting period were:

- Monthly inspection by FRO geotechnical personnel throughout the year and weekly inspection in the summer and fall months (in September 2017 and from May through August 2018). Water sampling and testing by FRO Environment team.
- Three bathymetric surveys were conducted in June, September, and October 2018 by FRO to monitor remaining capacity in the facility.
- The FRO Tailings Engineer and FRO Environment inspected the animal burrows downstream of the southern end of the Main Dam in October 2017. Photos from the inspection were provided to a biologist for preliminary assessment and the biologist indicated there was evidence of badgers in the vicinity but not in the embankment. No animal burrows have been found in the embankment. During a site visit in August 2018, the biologist did not see any badgers and indicated there was no evidence of recent animal activity in the area.
- Dredging of 1.64 million dry metric tonnes of tailings to the Turnbull TSF from 3 April to 24 October 2018.
- Site drainage was sent to the STP in September and October 2017, and in February 2018; it was diverted to the North Loop Settling Pond the rest of the time.

Design assessments Golder (2018a) completed for both the NTP and STP during the reporting period due to the reclassification of the dams from High to Very High consequence structure, were:

- update of liquefaction assessment
- update of seismic stability analysis
- update of IDF and freeboard assessment of both structures.

6.2 Summary of Climate and Water Balance

The climate data indicated the annual precipitation received at FRO from 1 September 2017 to 31 August 2018 was lower than the long-term annual average.

For the period from 1 September 2017 to 31 August 2018:

- The NTP water balance model estimates a small increase in inventory and it is consistent with the small year over year pond elevation increase. It estimates a smaller seepage loss in the pond compared to previous year's.
- The STP water balance model estimates an increase in inventory change, which is consistent with the small year over year pond elevation increase. The water balance estimates a lower seepage loss compared to the previous year's estimate.

The reported water balance for NTP and STP does not raise any concerns and appears to reflect observed conditions.

6.3 Summary of Performance and Changes

The STP and NTP facilities were observed to be in good condition at the time of the 2018 DSI field inspection.

Prisms on the NTP dam were replaced with new GPS units in addition to 1 pre-existing GPS unit in May 2018. Three GPS units were installed in June 2018. Three GPS units on the STP dams were replaced.

No significant changes in visual monitoring records, dam stability, and surface water control were noted.

6.4 Consequence Classification

Both of the dams are classified as Very High consequence, following the dam consequence classification guidelines from HSRC Guidance Document Section 3.4 (Ministry of Energy and Mines 2016).

6.5 Current Deficiencies and Non-conformances

Table 27 summarizes the recommended actions for both the STP and NTP facilities.

Table 27: 2018 Dam Safety Inspection Recommended Actions for the North and South Tailings Pond Facilities

Structure	ID Number	Deficiency or Non-conformance	Applicable Guideline or OMS Reference	Recommended Action	Priority Level	Recommended Timing for the Action
NTP	2015-05a,b	No passive emergency system against overtopping; emergency system requires active response	n/a	Assess the need for spillway after establishing an NTP closure plan.	4	2019
				If required, determine a construction schedule.	4	2020
	2015-06a,b,c	Risk-informed criteria for flood erosion protection along toe of dams not defined	CDA 2013 §6.2	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along the Fording River and the timeline to implement.	2	2019
				Implement required protection measures for the operational phase according to the as-defined schedule.	2	2020
				Execute the flood risk mitigation plan until the flood protection requirements defined by the risk-informed assessment are in place.	1	Ongoing
	2015-07a,b	Buried pipes passing through crest locations	n/a	Inspect identified pipes as part of regular dam inspections until NTP closure plans are finalized.	3	Ongoing
				Execute abandonment plan for identified pipes.	3	2019
	2016-06	No closure plan for NTP	n/a	Develop a closure plan for NTP.	4	Q4 2019
	2018-01	Real time water level readings are not available, and water level readings are limited during winter months when there is ice cover on the pond.	OMS §6.4.2	Install a real time water level instrument in the NTP pond and connect this to the site GeoExplorer system	4	Q3 2019
STP	2015-12a,b,c	Riprap erosion protection along downstream toe north of STP Stn. 0+680, no riprap south of STP Stn. 0+680; risk-informed protection requirements not yet defined	HSRC §10.1.8	Perform risk-informed assessment to determine appropriate flood protection requirements for downstream toe of dam along Fording River and timeline to implement.	2	2019
				Implement required protection measures for the operational phase according to the as-defined schedule.	2	2020
				Execute flood risk mitigation plan until flood protection requirements defined by the risk-informed assessment are in place.	1	Ongoing
	2017-01	North abutment construction deficiencies	HSRC §10.5.1(3)	Address construction deficiency, finish dam construction following gas line relocation. Office engineering is currently planned for Q3 2019 with construction in either Q3 2019 before freeze-up) or Q2 2020.	2	2019 or 2020
	2017-05	Potential overtopping hazard due to tailings liquefaction and redistribution during seismic event needs to be assessed	n/a	Complete liquefaction and overtopping assessment for tailings within facility.	2	Q2 2019

Structure	ID Number	Deficiency or Non-conformance	Applicable Guideline or OMS Reference	Recommended Action	Priority Level	Recommended Timing for the Action
STP	2018-02	Planned dredging of Tailings to Turnbull TSF is behind schedule and the result is a very high level of tailings in STP which is causing operational issues (e.g. high levels of solids in STP causing operational difficulties)	n/a	Dredging to Turnbull TSF should be started as soon as possible in April 2019 with a minimum annual dredging target of 1.3 million tonnes.	2	Q2 2019
	2018-03a, b	The current spillway design does not meet the Very High dam consequence classification IDF	HSRC §10.6.10	Update design of permanent spillway as per the new inflow design flood and requirements from HSRC Guidance Document (Ministry of Energy and Mines 2016). Develop a construction schedule accordingly.	2	Q3 2019
	2018-04a, b, c	Current operation of the facility for water management do not meet the Very High dam consequence classification IDF	HSRC §10.1.8 CDA 2013	Design upstream diversion to divert runoff from upstream catchment (Blackmore Creek). The diversion should be sized to allow the STP to manage the IDF, if possible.	2	2019
				Construct the upstream diversion.	3	2019 to 2020
				Design a permanent emergency spillway to pass the peak outflow from the 24-hour IDF.	3	2019 to 2020
	2018-05	No closure plan for STP	HSRC §10.6.7	Develop a closure plan for STP.	4	Q4 2019
	2018-06	Construction of the active water treatment facility is underway downstream of the STP main dam, potentially increasing the number of workers in the dam breach inundation zone.	HSRC §10.1.7 CDA 2013	Review potential inundation for failure of the Main Dam relative to the downstream facility and develop an emergency response plan for the downstream workers if required	2	Q3 2019
NTP/STP	2016-04	EPP & ERP require updating	HSRC §10.4.2(1)	Reference to the QPOs needs to be included for actions required based on instrumentation warnings and alarms.	4	Q2 2019
	2018-07	GPS, inclinometer, and NTP freeboard QPOs in the OMS manual do not reflect the most recent recommendations in Golder (2018a)	HSRC §10.5.2	Update OMS manual with recommended GPS, inclinometer, and NTP freeboard QPOs from Golder (2018a).	4	Q3 2019

IDF = inflow design flood; STP = South Tailings Pond; NTP = North Tailings Pond; FRO = Fording River Operations; KWL = Kerr Wood Leidal Associates Ltd.; OMS = operation, maintenance and surveillance; CDA = Canadian Dam Association; HSRC = Health, Safety and Reclamation Code; QPO = quantitative performance objectives; EPP = Emergency Preparedness Plan; ERP = Emergency Response Plan; Stn. = Station; n/a = not applicable; DSI = dam safety inspection; TSF = tailings storage facility.

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

Source: HSRC Guidance Document, Section 4.2 (Ministry of Energy and Mines 2016).

As presented in Golder (2018a), a loose CR layer was identified in the NTP dam at TH15-07, which is currently unsaturated. The conditional recommendation listed in Table 28 must be completed prior to the NTP facility being put back into operations or for any proposed dam modification.

Table 28: Conditional Recommendation to be Completed Prior to Restarting Tailings Deposition into the North Tailings Pond Facility

ID Number	Deficiency or Non-conformance	Applicable Regulation or Guideline	Recommended Action
NTP-01	A loose CR layer was identified in the NTP dam investigation, which is currently unsaturated. This loose CR layer may liquefy if it becomes saturated during the design earthquake event.	HSRC §10.1.8	Carry out liquefaction and stability assessments considering the loose CR layer if NTP is put back into operation or for any proposed modification to the dam.

CR = coarse rejects; HSRC = Health, Safety and Reclamation Code; NTP = North Tailings Pond.

7.0 CLOSURE

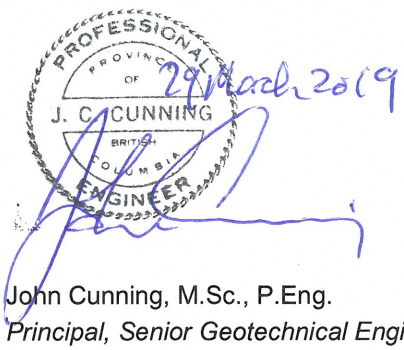
The reader is referred to the Study Limitations section, which precedes the text and forms an integral part of this report.

We trust the above meets your present requirements. If you have any questions or further requirements, please contact the undersigned.

Signature Page

Golder Associates Ltd.

Clara Lee, M.Eng., P.Eng.
Geotechnical Engineer



John Cunning, M.Sc., P.Eng.
Principal, Senior Geotechnical Engineer

CYL/JCC/cr

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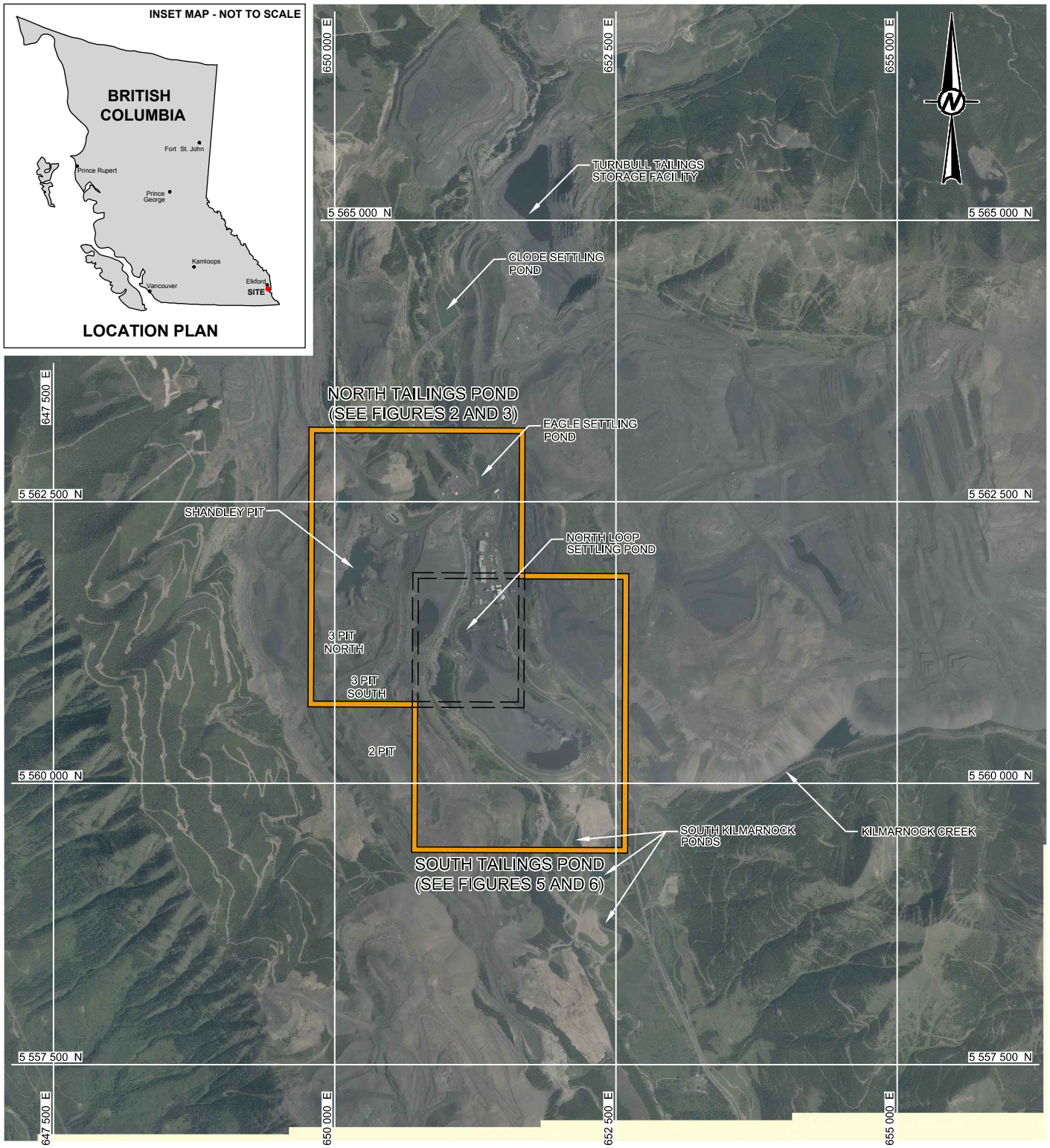

REFERENCE

1. 2018 AERIAL PHOTO PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS. FLOWN ON 15 TO 16 JULY 2018.

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES ARE IN UTM ZONE 11, ELEVATIONS ARE REFERENCED TO THE ELK VALLEY ELEVATION DATUM.

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CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

TITLE
FORDING RIVER OPERATIONS SITE PLAN

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
18106689	1000/1006/2018-156	0	01

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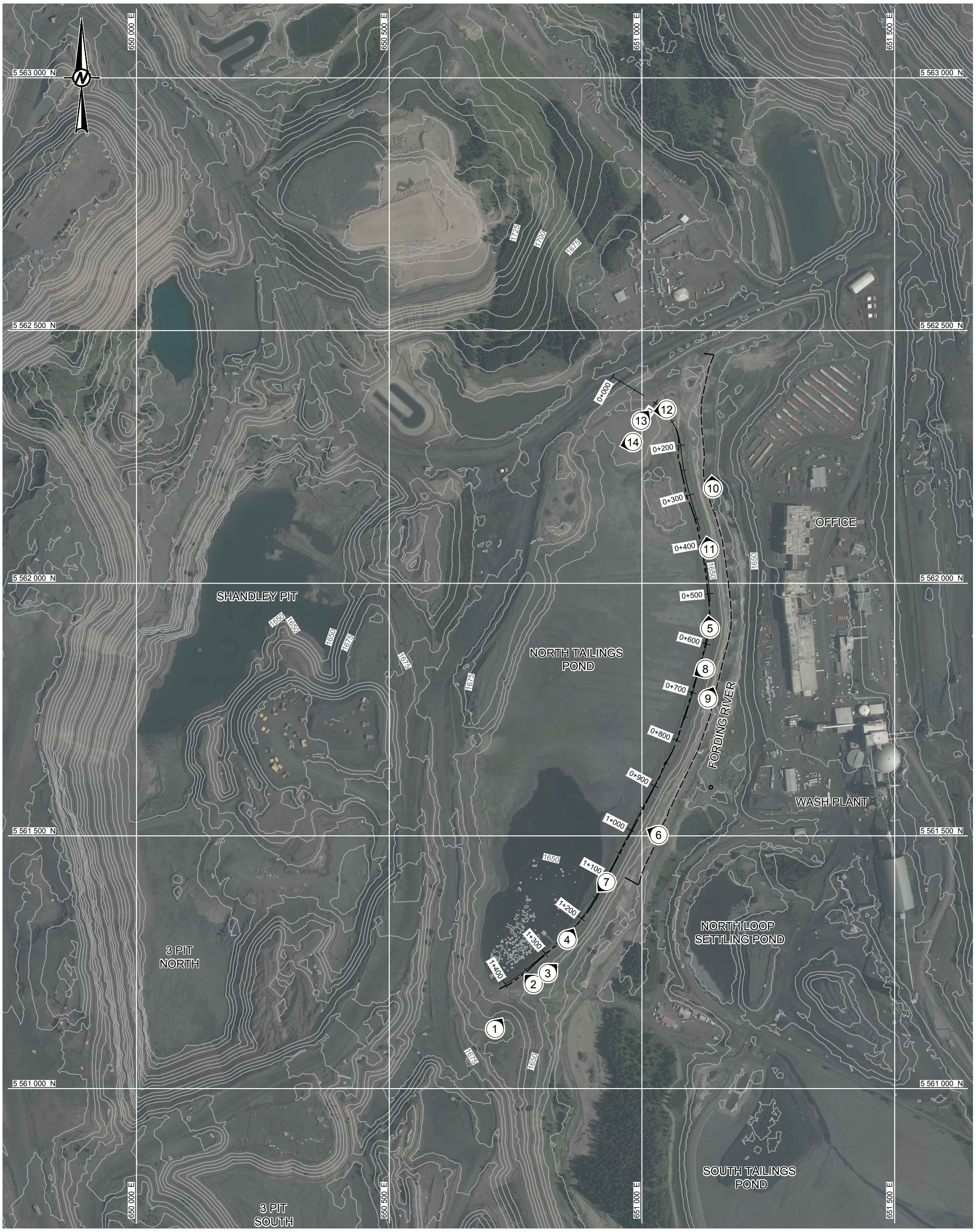

LEGEND

- TOPOGRAPHIC CONTOURS
- BATHYMETRY CONTOURS
- 2017 NTP CREST SURVEY
- EXTENT OF NTP DOWNSTREAM RIPRAP
- (#) 2018 SITE VISIT PHOTOGRAPH LOCATION

NOTES

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2. COORDINATES ARE IN UTM ZONE 11, ELEVATIONS ARE REFERENCED TO THE ELK VALLEY ELEVATION DATUM.
3. TOPOGRAPHIC CONTOURS SHOWN AT 5.0 m MINOR AND 25.0 m MAJOR INTERVAL.
4. BATHYMETRY CONTOURS SHOWN AT 1.0 m MINOR AND 5.0 m MAJOR INTERVAL.

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4. NTP RIPRAP EXTENTS PROVIDED BY KERR WOOD LEIDAL ASSOCIATES LTD. RECEIVED: 17 JANUARY 2018.

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CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
PHOTOGRAPH LOCATION

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
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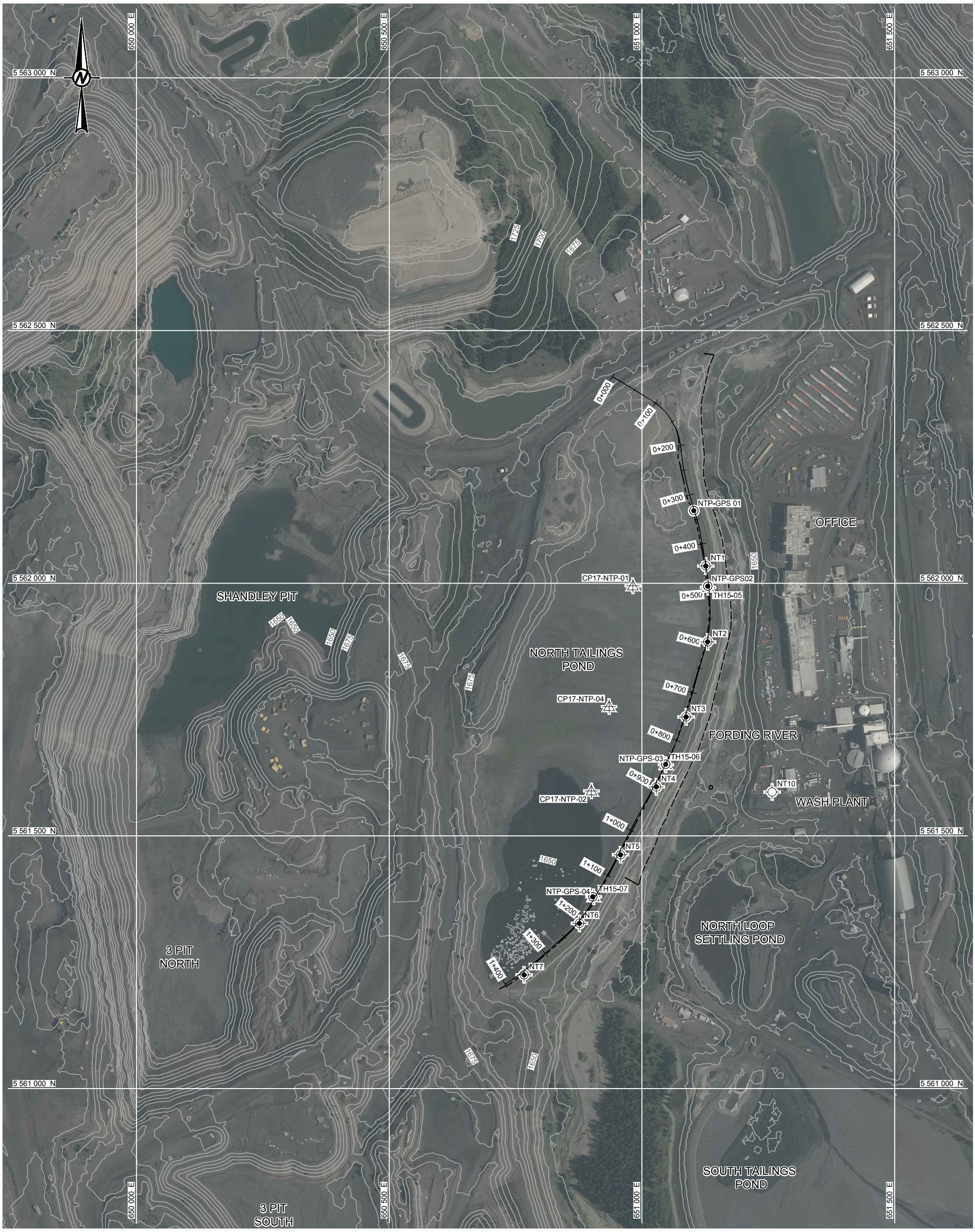

LEGEND

- TOPOGRAPHIC CONTOURS
- BATHYMETRY CONTOURS
- 2017 NTP CREST SURVEY
- EXTENT OF NTP DOWNSTREAM RIPRAP
- VIBRATING WIRE PIEZOMETER AND INCLINOMETER LOCATION
- GPS MONITORING LOCATION
- PRISM LOCATION
- REFERENCE PRISM LOCATION

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1:7,500 METRES

NOTES

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REFERENCES

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3. GPS AND PRISM MONITORING LOCATIONS BASED ON INITIAL READINGS OF DATA FROM GEOEXPLORER, ACCESSED: 13 DECEMBER 2017.
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CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

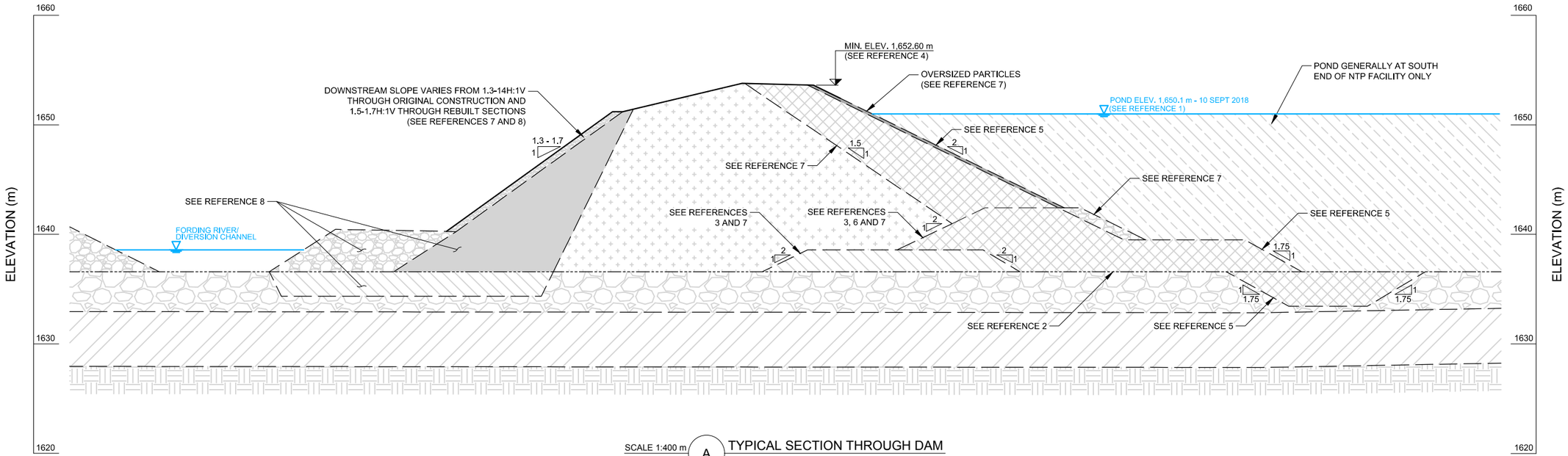
CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INVESTIGATION

TITLE
NORTH TAILINGS POND
MONITORING LOCATIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
18106689	1000/1006/2018-156	0	03



SCALE 1:400 m — A — TYPICAL SECTION THROUGH DAM

LEGEND

- APPROXIMATE GROUND SURFACE
- APPROXIMATE POND ELEVATION
- APPROXIMATE ORIGINAL GROUND SURFACE
- APPROXIMATE MATERIALS BOUNDARY BENEATH SURFACE
- APPROXIMATE TAILINGS SURFACE
- COARSE REJECTS (CR)
- COARSE REJECTS (CR) OR REBUILT WITH COMBINED COARSE AND FINE REJECTS (CCFR)
- TILL
- IN SITU TILL
- FLOODPLAIN DEPOSITS (SAND AND GRAVEL)
- FLOODPLAIN DEPOSITS (SAND AND GRAVEL) OR REBUILT RIPRAP
- RIPRAP
- TAILINGS
- TOPSOIL
- BEDROCK

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. MATERIAL ZONING SHOWN SCHEMATICALLY ONLY.
3. ELEVATIONS ARE REFERENCED TO THE ELK VALLEY ELEVATION DATUM.

REFERENCES

1. POND ELEVATION IS LAST RECORDED READING FROM DATA PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, RECEIVED: 19 OCTOBER 2018.
2. ORIGINAL GROUND ESTIMATED BASED ON 1968 ORIGINAL GROUND SURFACE CONTOURS PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, FILE NAME: "1968_CONTOURS_BG.dwg", RECEIVED: 8 DECEMBER 2015.
3. COMINCO (COMINCO LTD.). 1973. FEASIBILITY PROPOSAL FOR FORDING OPERATIONS TAILINGS DIKE EXTENSION TO ELEVATION 5,400 FEET. SUBMITTED 3 JULY 1973.
4. 2017 NTP CREST SURVEY PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS. RECEIVED 8 JANUARY 2018. FILE NAME: NTP CREST SURVEY - 171121C.xls
5. GOLDER BRAWNER (GOLDER BRAWNER ASSOCIATES). 1970. SECOND REPORT TO COMINCO LTD., ON TAILINGS POND AND DYKE PROPOSED FORDING RIVER COAL PROJECT FORDING RIVER BRITISH COLUMBIA. REPORT PREPARED FOR COMINCO LTD. REFERENCE NO. V6994. SUBMITTED APRIL 1970.
6. GOLDER BRAWNER. 1974. REPORT TO FORDING COAL LTD. ON PHASE II TAILINGS DAM CONSTRUCTION SPARWOOD B.C. REPORT PREPARED FOR FORDING COAL LTD. REFERENCE NO. V73020-5. SUBMITTED FEBRUARY 1974.
7. GOLDER (GOLDER ASSOCIATES). 1975. REPORT TO FORDING COAL LTD. RE CONSTRUCTION OF PHASE 4, ZONE 1b OF THE FORDING COAL TAILINGS DYKE. REPORT PREPARED FOR FORDING COAL LTD. REFERENCE NO. V75013. SUBMITTED 17 FEBRUARY 1975.
8. GOLDER. 2014. NORTH TAILINGS POND DAM 2013 FLOOD REPAIRS CONSTRUCTION SUMMARY. REPORT PREPARED FOR TECK COAL LIMITED FORDING RIVER OPERATIONS. PROJECT NO. 1314270098-2014-R-REV0-7000. SUBMITTED OCTOBER 30, 2014.

0 10 20
1:400 METRES

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
TYPICAL SECTION THROUGH DAM

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
18106689	1000/1006/2018-156	0	04

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

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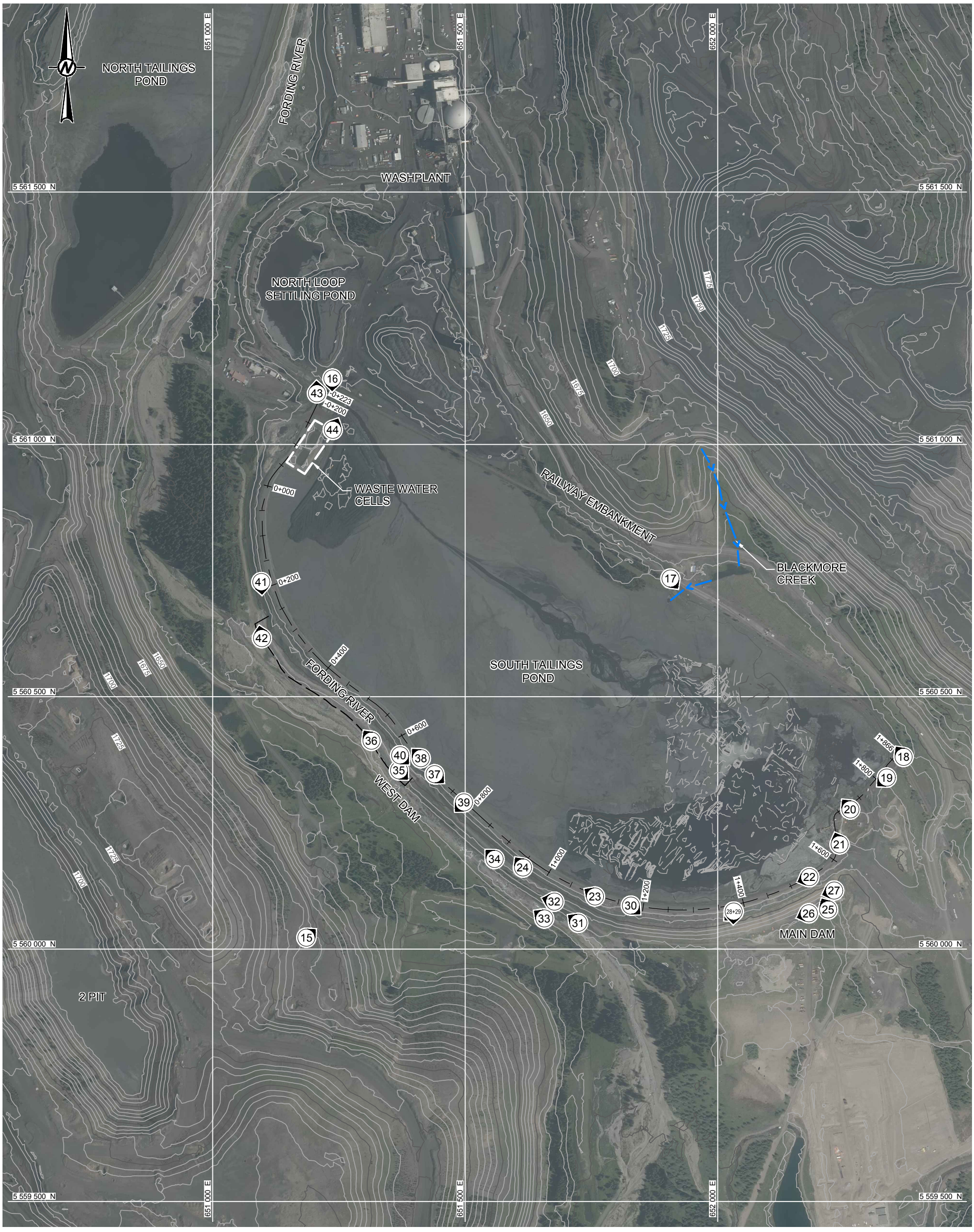


LEGEND

- TOPOGRAPHIC CONTOURS
- BATHYMETRY CONTOURS
- EXTENT OF STP DOWNSTREAM RIPRAP
- (#) 2018 SITE VISIT PHOTOGRAPH LOCATION

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES ARE IN UTM ZONE 11, ELEVATIONS ARE REFERENCED TO THE ELK VALLEY ELEVATION DATUM.
3. TOPOGRAPHIC CONTOURS SHOWN AT 5.0 m MINOR AND 25.0 m MAJOR INTERVAL.
4. BATHYMETRY CONTOURS SHOWN AT 1.0 m MINOR AND 5.0 m MAJOR INTERVAL.

REFERENCES

1. 2018 AERIAL PHOTO AND TOPOGRAPHY PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS. FLOWN 15 TO 16 JULY 2018.
2. GOLDER. 2018. TECK COAL LIMITED, FORDING RIVER OPERATIONS - TURNBULL TSF AND NORTH TAILINGS POND BATHYMETRY SURVEY. GOLDER DOC. NO. 18100013-2018-130-TM-REV0-1000. 29 NOVEMBER 2018.
3. STP RIPRAP EXTENTS PROVIDED BY KERR WOOD LEIDAL ASSOCIATES LTD. RECEIVED: 17 JANUARY 2018.
4. 2018 BATHYMETRY DATA PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS ON 30 OCTOBER 2018. FILE NAME: STP COMBINED SURFACE 2018-09-23.dxf."

0 125 250
1:7,500 METRES

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

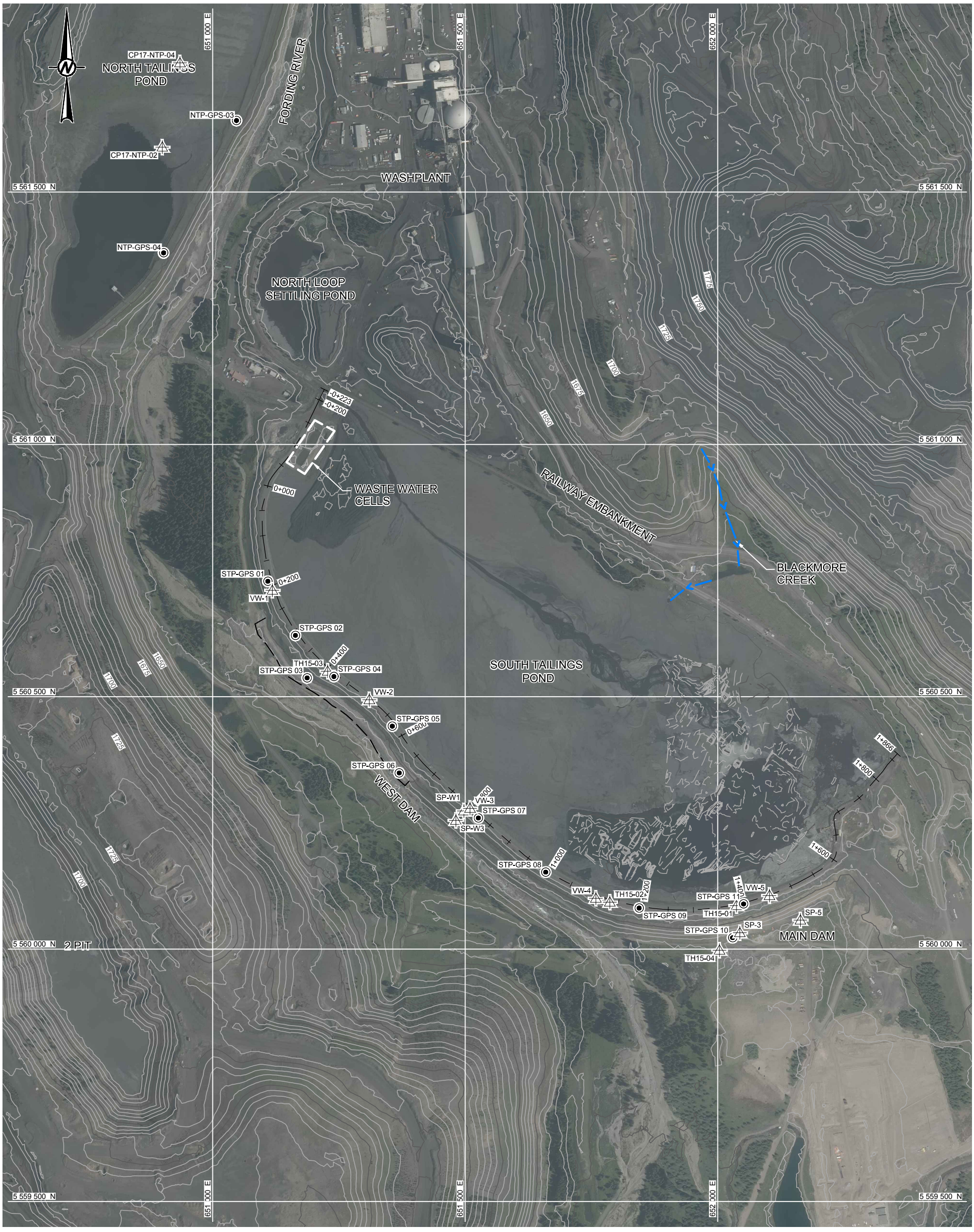
CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTIONS

TITLE
SOUTH TAILINGS POND PHOTOGRAPH LOCATIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
18106689	1000/1006/2018-156	0	05



LEGEND

- TOPOGRAPHIC CONTOURS
- BATHYMETRY CONTOURS
- EXTENT OF STP DOWNSTREAM RIPRAP
- GPS MONITORING LOCATION
- VIBRATING WIRE PIEZOMETER AND INCLINOMETER LOCATION
- STANDPIPE PIEZOMETER LOCATION
- RETROFIT STANDPIPE WITH VIBRATING WIRE PIEZOMETER LOCATION
- SEEPAGE RETURN WELL LOCATION

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES ARE IN UTM ZONE 11, ELEVATIONS ARE REFERENCED TO THE ELK VALLEY ELEVATION DATUM.
3. TOPOGRAPHIC CONTOURS SHOWN AT 5.0 m MINOR AND 25.0 m MAJOR INTERVAL.
4. BATHYMETRY CONTOURS SHOWN AT 1.0 m MINOR AND 5.0 m MAJOR INTERVAL.

REFERENCES

1. 2018 AERIAL PHOTO AND TOPOGRAPHY PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS. FLOWN 15 TO 16 JULY 2018.
2. GOLDER. 2018. TECK COAL LIMITED, FORDING RIVER OPERATIONS - TURNBULL TSF AND NORTH TAILINGS POND BATHYMETRY SURVEY. GOLDER DOC. NO. 18100013-2018-130-TM-REV0-1000. 29 NOVEMBER 2018.
3. STP RIPRAP EXTENTS PROVIDED BY KERR WOOD LEIDAL ASSOCIATES LTD. RECEIVED: 17 JANUARY 2018
4. GPS MONITORING LOCATIONS BASED ON INITIAL READINGS OF DATA PROVIDED FROM GEOEXPLORER ACCESSED 13 DECEMBER 2017.
5. LOCATIONS OF STANDPIPE PIEZOMETERS AND SEEPAGE RETURN WELLS BASED ON SURVEY DATA FROM GEOEXPLORER, ACCESSED 13 DECEMBER 2017.
6. LOCATIONS OF 2014 VIBRATING WIRE PIEZOMETERS BASED ON SURVEY DATA FROM GEOEXPLORER, ACCESSED 13 DECEMBER 2017.
7. LOCATIONS OF 2015 VIBRATING WIRE PIEZOMETERS AND INCLINOMETERS BASED ON SURVEY DATA FROM GEOEXPLORER, ACCESSED 13 DECEMBER 2017.
8. 2017 BATHYMETRY DATA PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS. FILE NAME: Combined Surface (good).msr RECEIVED: 13 DECEMBER 2017.

0 125 250
1:7,500 METRES

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND MONITORING LOCATIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
18106689	1000/1006/2018-156	0	06

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
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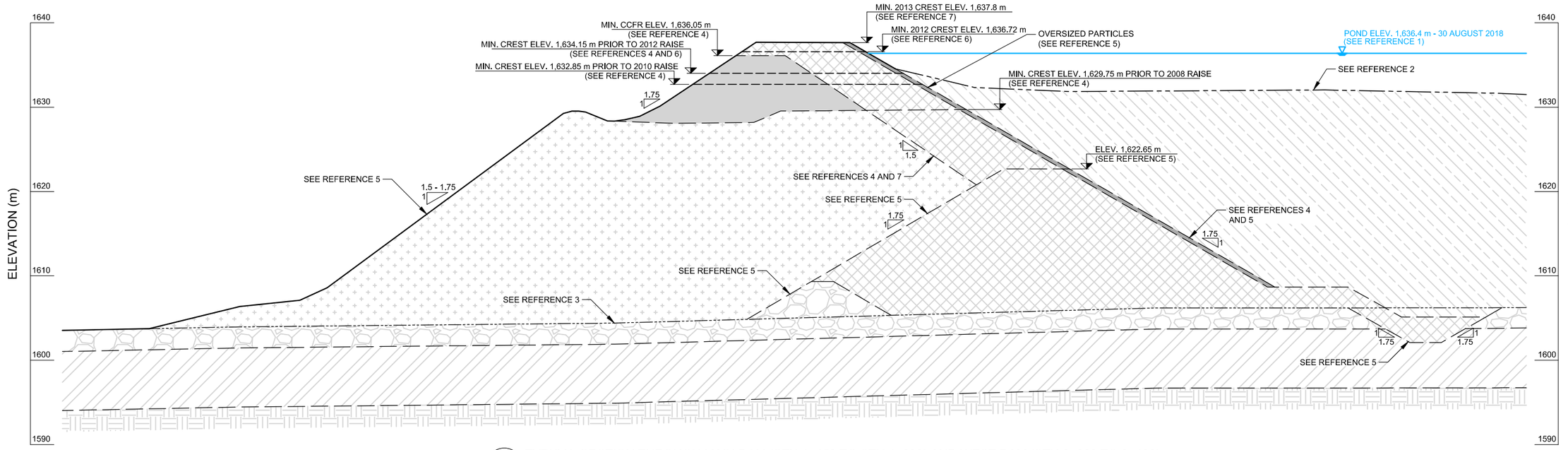

SCALE 1:500 m

B

TYPICAL SECTION THROUGH MAIN DAM (STN 1+150 TO STN 1+600) AND WEST DAM (STN 0+000 TO 0+400)

LEGEND

- APPROXIMATE GROUND SURFACE
- APPROXIMATE POND ELEVATION
- APPROXIMATE PREVIOUSLY DESIGNED CREST
- APPROXIMATE ORIGINAL GROUND SURFACE
- APPROXIMATE MATERIALS BOUNDARY BENEATH SURFACE
- APPROXIMATE TAILINGS SURFACE
- COARSE REJECTS (CR)
- COMBINED COARSE AND FINE REJECTS (CCFR)
- TILL
- IN SITU TILL
- FLOODPLAIN DEPOSITS (SAND AND GRAVEL)
- TAILINGS
- BEDROCK

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. MATERIALS SHOWN SCHEMATICALLY ONLY.
3. RIPRAP PRESENT FROM APPROXIMATELY 0+205 TO 0+680, NOT SHOWN ON SECTION.
4. ELEVATIONS ARE REFERENCED TO THE ELK VALLEY ELEVATION DATUM.

REFERENCES

1. POND ELEVATION IS LAST RECORDED READING FROM DATA PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, RECEIVED: 4 OCTOBER 2018.
2. TAILINGS SURFACE SHOWN FOR MAIN DAM SECTION AND ESTIMATED BASED ON 2017 BATHYMETRY PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, RECEIVED: 28 NOVEMBER 2017. SURVEYED: 11 SEPTEMBER 2017.
3. ORIGINAL GROUND ESTIMATED BASED ON 1968 ORIGINAL GROUND SURFACE CONTOURS PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, FILE NAME: "1968_CONTOURS_BG.dwg", RECEIVED: 8 DECEMBER 2015 AND GOLDER. 1976. TAILINGS STORAGE PROPOSED 1977 EXTENSION. REPORT PREPARED FOR FORDING COAL LTD. REFERENCE NO. V75193. SUBMITTED JANUARY 1976 (GROUND SURFACE DIGITIZED BY GOLDER FROM COMINCO DRAWING (UNNAMED), FIGURE 1 LOCATION OF BOREHOLES).
4. FRO (TECK COAL LIMITED FORDING RIVER OPERATIONS). 2010. SOUTH TAILINGS POND DESIGN AND CONSTRUCTION REPORT JULY-SEPTEMBER 2010. SUBMITTED NOVEMBER 2010.
5. GOLDER (GOLDER ASSOCIATES). 1976. REPORT TO FORDING COAL LTD. ON TAILINGS STORAGE PROPOSED 1977 EXTENSION. REPORT PREPARED FOR FORDING COAL LTD. REFERENCE NO. V75193. SUBMITTED JANUARY 1976.
6. GOLDER (GOLDER ASSOCIATES LTD.). 2013. SOUTH TAILINGS POND DAM 2012 CONSTRUCTION DAM RAISE AS-BUILT REPORT. REPORT PREPARED FOR TECK COAL LIMITED FORDING RIVER OPERATIONS. PROJECT NO. 1214270098-2013-303-R-REV0-6400. SUBMITTED 1 APRIL 2013.
7. GOLDER. 2014. SOUTH TAILINGS POND DAM CONSTRUCTION RECORD REPORT FOR THE 2013 DAM RAISE. REPORT PREPARED FOR TECK COAL LIMITED FORDING RIVER OPERATIONS. REFERENCE NO. 1314270098-2014-542-R-REV0-6000. SUBMITTED 30 OCTOBER 2014.

0 10 20
1:500 METRES

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
TYPICAL SECTION THROUGH MAIN DAM (STN. 1+150 TO 1+600) AND WEST DAM (STN. 0+000 TO 0+400)

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
18106689	1000/1006/2018-156	0	07

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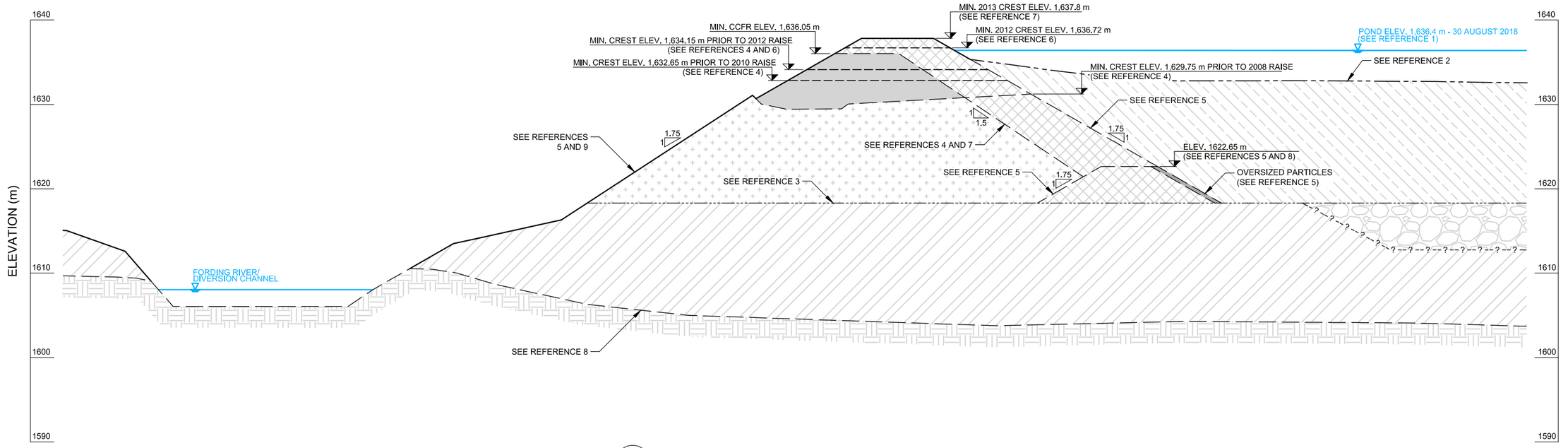

SCALE 1:500 m C TYPICAL SECTION THROUGH WEST DAM (STN 0+400 TO 1+150)

LEGEND

- APPROXIMATE GROUND SURFACE
- APPROXIMATE POND ELEVATION
- APPROXIMATE PREVIOUSLY DESIGNED CREST
- APPROXIMATE ORIGINAL GROUND SURFACE
- APPROXIMATE MATERIALS BOUNDARY BENEATH SURFACE
- APPROXIMATE TAILINGS SURFACE
- COARSE REJECTS (CR)
- COMBINED COARSE AND FINE REJECTS (CCFR)
- TILL
- IN SITU TILL
- FLOODPLAIN DEPOSITS (SAND AND GRAVEL)
- TAILINGS
- BEDROCK

NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. MATERIALS SHOWN SCHEMATICALLY ONLY.
3. RIPRAP PRESENT FROM APPROXIMATELY 0+205 TO 0+680, NOT SHOWN ON SECTION.
4. ELEVATIONS ARE REFERENCED TO THE ELK VALLEY ELEVATION DATUM.

REFERENCES

1. POND ELEVATION IS LAST RECORDED READING FROM DATA PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, RECEIVED: 4 OCTOBER 2018.
2. TAILINGS SURFACE ESTIMATED BASED ON 2017 BATHYMETRY PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, RECEIVED: 28 NOVEMBER 2017. SURVEYED: 11 SEPTEMBER 2017.
3. ORIGINAL GROUND ESTIMATED BASED ON 1968 ORIGINAL GROUND SURFACE CONTOURS PROVIDED BY TECK COAL LIMITED FORDING RIVER OPERATIONS, FILE NAME: "1968_CONTOURS_BG.dwg", RECEIVED: 8 DECEMBER 2015 AND GOLDER. 1976. TAILINGS STORAGE PROPOSED 1977 EXTENSION. REPORT PREPARED FOR FORDING COAL LTD. REFERENCE NO. V75193. SUBMITTED JANUARY 1976 (GROUND SURFACE DIGITIZED BY GOLDER FROM COMINCO DRAWING (UNNAMED), FIGURE 1 LOCATION OF BOREHOLES).
4. FRO (TECK COAL LIMITED FORDING RIVER OPERATIONS). 2010. SOUTH TAILINGS POND DESIGN AND CONSTRUCTION REPORT JULY-SEPTEMBER 2010. SUBMITTED NOVEMBER 2010.
5. GOLDER (GOLDER ASSOCIATES). 1976. REPORT TO FORDING COAL LTD. ON TAILINGS STORAGE PROPOSED 1977 EXTENSION. REPORT PREPARED FOR FORDING COAL LTD. REFERENCE NO. V75193. SUBMITTED JANUARY 1976.
6. GOLDER (GOLDER ASSOCIATES LTD.). 2013. SOUTH TAILINGS POND DAM 2012 CONSTRUCTION DAM RAISE AS-BUILT REPORT. REPORT PREPARED FOR TECK COAL LIMITED FORDING RIVER OPERATIONS. REFERENCE NO. 1214270098-2013-303-R-REV0-6400. SUBMITTED 1 APRIL 2013.
7. GOLDER. 2014. SOUTH TAILINGS POND DAM CONSTRUCTION RECORD REPORT FOR THE 2013 DAM RAISE. REPORT PREPARED FOR TECK COAL LIMITED FORDING RIVER OPERATIONS. REFERENCE NO. 1314270098-2014-542-R-REV0-6000. SUBMITTED 30 OCTOBER 2014.
8. GOLDER (GOLDER ASSOCIATES LTD.). 2015. SOUTH TAILINGS POND WEST DAM GEOPHYSICAL INVESTIGATION. REPORT PREPARED FOR TECK COAL LIMITED FORDING RIVER OPERATIONS. REFERENCE NO. 1522835-2015-002-R-REV0-3000. SUBMITTED 26 MAY 2015.
9. KWL (KERR WOOD LEIDAL ASSOCIATES LTD.). 1976. DRAWING NO. 8-76-3. DRAWING PREPARED FOR FORDING COAL LTD. SUBMITTED 1976.

0 10 20
1:500 METRES

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	CYL
PREPARED	JY/JH
REVIEWED	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
TYPICAL SECTION THROUGH WEST DAM (STN. 0+400 TO 1+150)

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
18106689	1000/1006/2018-156	0	08

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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APPENDIX A

Site Photographs

Photograph A-1: North Tailings Pond (NTP) overview, looking northeast, 12 September 2018.

Photograph A-2: NTP barge, looking northeast, 12 September 2018.

Photograph A-3: NTP dam upstream slope with small tress and vegetation growing, and unused reclaim pipes, looking northeast, 12 September 2018.

Photograph A-4: NTP unused reclaim pipelines on upstream slope, caped pipelines that go into dam section and crossing under crest, looking north, 12 September 2018.

Photograph A-5: NTP crest and upstream slope, looking north, 12 September 2018.

Photograph A-6: NTP dam downstream slope with stepped erosion and minor area of ponded water observed at the toe near Stn 0+970, looking northeast, 12 September 2018.

Photograph A-7: NTP crest and upstream slope, looking southwest, 12 September 2018.

Photograph A-8: NTP, tailings surface with silt fencing for dust control, looking southwest, 12 September 2018.

Photograph A-9: NTP downstream slope and toe near Stn 0+700, riprap along Fording River, looking northeast, 12 September 2018.

Photograph A-10: NTP downstream slope and riprap along Fording River, looking north, 12 September 2018.

Photograph A-11: Looking north at NTP dam, downstream slope and riprap along Fording River, looking northeast, 12 September 2018.

Photograph A-12: Liverpool Pond outlet channel downstream of the fish barrier structure north of NTP, looking west, 12 September 2018.

Photograph A-13: Liverpool Pond outlet channel upstream of the fish barrier structure north of NTP, looking northeast, 12 September 2018.

Photograph A-14: At NTP north abutment, stockpile areas to west, surface runoff from haul road and ditch reporting to tailings beach in this area, and emergency overflow from Liverpool pond outlet, looking west, 12 September 2018.

Photograph A-15: South Tailings Pond (STP) overview from haul road near 2 Pit, looking east, 11 September 2018.

Photograph A-16: STP north single point discharge, which was recently extended and raised, adjacent to railway line, looking south, 11 September 2018.

Photograph A-17: Tailings dredge pipeline and emergency bypass in foreground, temporary reclaim pipeline from Turnbull TSF discharging water along with Blackmore creek culverts, looking south, 11 September 2018.

Photograph A-18: STP south abutment area near gas line crossing location, looking northeast, 11 September 2018.

Photograph A-19: STP south abutment till blanket area and upstream slope, looking southwest, 11 September 2018.

Photograph A-20: STP south abutment till blanket area, makeup waterlines from Kilmarnock Pond with riprap protection on blanket, looking northwest, 11 September 2018.

Photograph A-21: On STP Main Dam, reclaim barge at south end of pond, looking northwest, 11 September 2018.

Photograph A-22: On STP Main Dam, upstream slope and riprap 1.4H:1V, looking west, 11 September 2018

Photograph A-23: STP West Dam, crest and upstream slope with riprap, looking northeast, 11 September 2018.

Photograph A-24: STP upstream slope and crest, looking north, 11 September 2018.

Photograph A-25: STP Main dam downstream slope from toe, showing area with on-going vertical erosion, 11 September 2018.

Photograph A-26: STP Main Dam downstream slope and toe at seepage return well, looking west, 11 September 2018.

Photograph A-27: STP Main Dam downstream slope at bench (~elev. 1,630 m), looking west, 11 September 2018.

Photograph A-28: STP Main Dam, looking south at riprap emergency stockpile and Fording River flood plain, 11 September 2018.

Photograph A-29: STP Main Dam, persistent ponding downstream of toe in old river channel, looking southwest, 11 September 2018.

Photograph A-30: STP corner of West and Main dams, looking southeast. Vegetation not taking root in CCFR in this area, 11 September 2018.

Photograph A-31: On STP West Dam access road, looking north west, 11 September 2018.

Photograph A-32: On STP West Dam access road, Fording River to the left and STP downstream slope to the right, looking east, 11 September 2018.

Photograph A 33: On slope of STP West Dam access road, seepage collection point along the downstream slope (Stn. 1+000). Seepage collection points monitor flow. Note discolouration. The flow rate at the time of inspection was approximately 0.21 L/sec from the south pipe (closer to the page) and 0.26 L/sec from the north pipe (further into the page). 11 September 2018.

Photograph A-34: On Slope of STP West Dam access road, looking northwest along Fording River, 11 September 2018.

Photograph A-35: STP West Dam, till cut and riprap along downstream toe up to old pipeline bridge, looking southeast, 11 September 2018.

Photograph A-36: STP West Dam, riprap along dam toe, looking northwest, 11 September 2018.

Photograph A-37: STP West Dam crest overview, looking southeast, 11 September 2018

Photograph A-38: STP West Dam, downstream slope overview and Fording River, looking northwest, 11 September 2018.

Photograph A-39: On STP West Dam, downstream slope and Fording River, looking southwest, 11 September 2018.

Photograph A-40: STP unused dredge pipeline to 2P-3P TSA on pipe bridge and West Dam access road's downstream slope, looking southeast, 11 September 2018.

Photograph A-41: STP West Dam downstream slope with vegetation and ditch at downstream toe, looking south, 11 September 2018.

Photograph A-42: STP West Dam, twin culverts beneath access road at toe, looking east, 11 September 2018. The flow rate at the time of inspection was approximately 1.4 L/sec from the eastern pipe (closest to the page). The other pipe (further into the page) was dry.

Photograph A-43: STP north abutment, upstream till berm, looking northeast 11 September 2018.

Photograph A-44: At STP north abutment and north single point discharge, outlet of tailings pipe from the processing plant (larger pipe) and discharge from Shandley Pit (smaller pipe), looking east, 11 September 2018.

APPENDIX B

North Tailings Pond Inspection Report

Client:	**Teck Coal Limited, Fording River Operations**	**By:**	**John Cunning, P.Eng., Clara Lee, P. Eng.**
Project:	**18106689 FRO Dam Safety Inspection**	**Date:**	**12 September 2018**
Location:	**North Tailings Pond**	**Reviewed:**	**John Cunning, P.Eng.**

GENERAL INFORMATION			
Dam Type:	Zoned Earth Fill		
Weather Conditions:	Clear and Sunny	**Temp:**	1°C to 18°C

Inspection Item	Observations/Data	Photo	Comments & Other Data
1.0 DAM CREST		1, 5, 7	
1.1 Crest Elevation	Elev. 1,652.6 m (minimum)		Confirmed with 2018 LiDAR survey.
1.2 Reservoir Level/ Freeboard	Elev. 1,650.1 m / 2.5 m freeboard (10 September 2018)		From 2018 pond elevation survey data provided by FRO.
1.3 Distance to Tailings Pond (if applicable)	**0 m (south end)** Approx. Stn. 1+000 to 1+400; **Full beach** Approx. Stn 0+000 to 1+100	1 8	Usually no beach at south end.
1.4 Surface Cracking	None		
1.5 Unexpected Settlement	None		
1.6 Lateral Movement	None		

Inspection Item	Observations/Data	Photo	Comments & Other Data
1.7 Other Unusual Conditions	Yes	4	Abandoned pipes crossings under the crest all closed on upstream at time of inspection: ■ Site 1: old tailings delivery pipe at former bridge abutment – capped. ■ Site 2: dual steel pipes – capped. ■ Site 3: steel pipe valve closed on upstream, leading to pipe in culvert on downstream face. ■ Site 4: black shallow PVC pipes only observed on downstream face.
2.0 UPSTREAM SLOPE		2,3,4,5	
2.1 Slope Angle	1.4 to 1.5H:1V		
2.2 Signs of Erosion	Minor surficial erosion		
2.3 Signs of Movement (Deformation)	None		
2.4 Cracks	None		
2.5 Face Liner Condition (if applicable)	N/A		
2.6 Other Unusual Conditions	Yes	3, 4	■ Unused reclaim pipes near barge. ■ Small trees and vegetation growth.
3.0 DOWNSTREAM SLOPE		1, 6, 9, 11	
3.1 Slope Angle	1.4 to 1.75 H:1 V		Original design of 1.4 H:1 V; rebuilt design of 1.5 to 1.75H:1 V following 2013 flood repairs.

Inspection Item	Observations/Data	Photo	Comments & Other Data
3.2 Signs of Erosion	Minor surficial erosion, not a stability concern	6	■ Minor stepped erosion throughout downstream slope. ■ Repaired vertical channel at south abutment remains stable following 2016 repairs.
3.3 Signs of Movement (Deformation)	None		
3.4 Cracks	None		
3.5 Seepage or Wet Areas	Dry		
3.6 Vegetation Growth	Variable		■ Good grass growth on soil cover placed on rebuilt slopes. ■ Grasses appropriate on old slopes.
3.7 Other Unusual Conditions	Yes		Vertical culvert and abandoned pipes on downstream slope.
4.0 DOWNSTREAM TOE AREA			
4.1 Seepage from Dam	None		
4.2 Signs of Erosion	No	9, 10	Riprap placed to protect from Fording River erosion, in good condition.
4.3 Signs of Turbidity in Seepage Water	None		
4.4 Discoloration/Staining	None		
4.5 Outlet Operating Problem (if applicable)	N/A		
4.6 Other Unusual Conditions	None	6	Ponded water near Stn 0+970.
5.0 ABUTMENTS		14	
5.1 Seepage at Contact Zone (Abutment/Embankment)	None		
5.2 Signs of Erosion	Minor		

Inspection Item	Observations/Data	Photo	Comments & Other Data
5.3 Excessive Vegetation	None		
5.4 Presence of Rodent Burrows	Yes		Animal burrows in downstream toe area near south abutment.
5.5 Other Unusual Conditions	Yes	12, 13, 14	■ Surface runoff from haul road reports to north end of tailings beach. ■ Ponded water in Liverpool outlet channel at fish barrier at north end of NTP.
6.0 RESERVOIR		1, 5	
6.1 Stability of Slopes	Good, Spoils west of tailings storage facility Till stockpile operated west of north end of NTP	14	Spoils resloped in March 2015.
6.2 Distance to Nearest Slide (if applicable)	N/A		
6.3 Estimate of Slide Volume (if applicable)	N/A		
6.4 Floating Debris	None		
6.5 Other Unusual Conditions	Yes	2	■ Barge is crooked from being stuck in tailings, barge not in use. ■ Silt fences installed on tailings surface for dust control.
7.0 EMERGENCY SPILLWAY/ OUTLET STRUCTURE	None		No spillway or emergency outlet.
7.1 Surface Condition	N/A		
7.2 Signs of Erosion	N/A		
7.3 Signs of Movement (Deformation)	N/A		
7.4 Cracks	N/A		

Inspection Item	Observations/Data	Photo	Comments & Other Data
7.5 Settlement	N/A		
7.6 Presence of Debris or Blockage	N/A		
7.7 Closure Mechanism Operational	N/A		
7.8 Slope Protection	N/A		
7.9 Instability of Side Slopes	N/A		
7.10 Other Unusual Conditions	N/A		
8.0 INSTRUMENTATION			
8.1 Piezometers	Yes		■ Piezometers installed in three vertical boreholes drilled form dam crest in 2015. ■ Seven new piezometers installed in tailings in 2017 at CP17-NTP-01, -02, and -04 to support closure studies. ■ See Section 5.3.1.3 of DSI report for details of the instrumentation. ■ Locations shown in plan in Figure 3 of the DSI report.
8.2 Settlement Cells	None		
8.3 Thermistors	None		

Inspection Item	Observations/Data	Photo	Comments & Other Data
8.4 Settlement Monuments	Yes		■ Both prisms and GPS units were used to monitor crest movements up until May 2018. FRO phase out prisms after May 2018 and now using 4 GPS units along dam crest. ■ New GPS (NTP04_GPS600) next to piezometer/SI TH15-07. ■ New GPS (NTP03_GPS600) next to piezometer/SI TH15-06. ■ New GPS (NTP02_GPS600) next to piezometer/SI TH15-05. ■ Locations shown in plan in Figure 3. ■ Plots of data from GPS units in Appendix F of the DSI report.
8.5 Accelerograph	None		
8.6 Inclinometer	Yes		■ Three inclinometers installed in 2015 – see Appendix G of the DSI report. ■ Locations shown in plan in Figure 3 of the DSI report.
8.7 Weirs and Flow Monitors	None		
8.8 Data Logger(s)	Yes		On piezometers and GPS, all instrumentation connected to GeoExplorer system.
8.9 Other	None		
9.0 DOCUMENTATION			
9.1 Operation, Maintenance and Surveillance (OMS) Manual 9.1.1 OMS Manual Exists	Yes		FRO Tailings Facility OMS Manual Version 2018.02.

Inspection Item	Observations/Data	Photo	Comments & Other Data
9.1.2 OMS Manual Reflects Current Dam Conditions	Yes		
9.1.3 Date of Last Revision	October 2018		
9.2 Emergency Preparedness Plan (EPP) 9.2.1 ERP Exists	Yes ERP: Internal to Teck EPP: External to Teck		**ERP:** NTP included in site tailings facilities ERP (SP&P EP.009). **EPP:** SP&P EP.008.R1.
9.2.2 ERP Reflects Current Conditions	ERP reflects current conditions on site, EPP to be updated based on ERP once finalized.		
9.2.3 Date of Last Revision	**ERP**: September 2017, in draft **EPP**: 15 December 2015		

10. NOTES

- Currently, there is no active deposition of tailings into the NTP. The barge is not being operated and pipes are not connected. The ability to pump water from the pond may be needed as part of freeboard or storm water management; temporary pumps are required to be available in the event pumping is necessary. The temporary pipeline that crosses the Fording River from Shandley Pit to the STP would be used in an emergency pumping event.
- The future use of the NTP is under review by FRO.

Inspectors:	Clara Lee, P.Eng., and John Cunning, P.Eng.	**Date:**	12 September 2018

APPENDIX C

South Tailings Pond Inspection Report

Client:	**Teck Coal Limited, Fording River Operations**	**By:**	**John Cunning, P.Eng., Clara Lee, P.Eng.**
Project:	**18106689 FRO Dam Safety Inspection**	**Date:**	**11 September 2018**
Location:	**South Tailings Pond**	**Reviewed:**	**John Cunning, P.Eng.**

GENERAL INFORMATION			
Dam Type:	Zoned Earth Fill		
Weather Conditions:	Clear and Sunny	**Temp:**	1°C to 18°C

Inspection Item	Observations/Data	Photo	Comments & Other Data
1.0 DAM CREST		23, 24, 37, 38	
1.1 Crest Elevation	Elev. 1,637.85 m (minimum)		Confirmed with 2018 LiDAR survey.
1.2 Reservoir Level / Freeboard	Elev.1,636.38 m (30 August 2018) 1.47 m freeboard		From 2018 pond elevation survey data provided by FRO.
1.3 Distance To Tailings Pond (if applicable)	0 m at south along Main Dam Variable beach along West Dam	15	Usually no beach along Main Dam.
1.4 Surface Cracking	None		
1.5 Unexpected Settlement	None		
1.6 Lateral Movement	None		
1.7 Other Unusual Conditions or Structures	No		

Inspection Item	Observations/Data	Photo	Comments & Other Data
2.0 UPSTREAM SLOPE		22, 23, 24	
2.1 Slope Angle	Generally 1.4 H to 1.75 H : 1 V		■ Crest graded to drain upstream. ■ Riprap placed along upstream slope of Main Dam and part of West Dam in 2017.
2.2 Signs of Erosion	None		
2.3 Signs of Movement (Deformation)	None		
2.4 Cracks	None		
2.5 Face Liner Condition (if applicable)	N/A		
2.5 Other Unusual Conditions	Yes		Small area of upstream slope near reclaim barge was disturbed by equipment and needs repair.
3.0 DOWNSTREAM SLOPE		15, 25, 26, 27, 30, 38, 39 - 41	
3.1 Slope Angle	± 1.5 to 1.75H:1V		■ Lower portion of Main Dam slope locally oversteepened with respect to design, bench in Main Dam slope provides and overall slope around 1.75 H:1 V.

Inspection Item	Observations/Data	Photo	Comments & Other Data
3.2 Signs of Erosion	Yes. No new erosion observed in repaired erosion channels	25	■ One area of a larger vertical erosion channel down face of Main Dam above seepage collection well observed. Monitoring of this erosion channel should continue during regular inspections. ■ Minor erosion channels on till and CCFR faces of downstream slope. ■ Erosion channels in Main and West Dam should continue to be monitored and be filled with coarse rock fill as per previously repaired channels.
3.3 Signs of Movement (Deformation)	None		
3.4 Cracks	None		
3.5 Seepage or Wet Areas	None		
3.6 Vegetation Growth	Good on lower portion of Main Dam Poor on West Dam	41, 26, 27	Limited growth noted along Till and CCFR downstream slopes.
3.7 Other Unusual Conditions	None		
4.0 DOWNSTREAM TOE AREA		28, 29, 32	
4.1 Seepage from Dam	Yes, below West and Main Dams	29	West Dam ■ Ponding in ditch along downstream toe at north and south ends. ■ Persistent seepage from till bench above Fording River diversion channel below West Dam. Main Dam ■ Ponding downstream south of dam toe.

Inspection Item	Observations/Data	Photo	Comments & Other Data
4.2 Signs of Erosion	None	22	
4.3 Signs of Turbidity in Seepage Water	None		
4.4 Discoloration/Staining	Yes (green, red), below West Dam	33	■ Green mineral (possible calcite) deposits and minor areas with red colored staining in seepage face at bedrock contact in Fording River diversion channel cut below West Dam.
4.5 Outlet Operating Problem (if applicable)	N/A		
4.6 Other Unusual Conditions	None		
5.0 ABUTMENTS		18, 19, 43, 44	
5.1 Seepage at Contact Zone (abutment/embankment)	None		
5.2 Signs of Erosion	None		
5.3 Excessive Vegetation	None		
5.4 Presence of Rodent Burrows	None		
5.5 Other Unusual Conditions	Yes	43	■ Gas main pipeline in north abutment area did not allow for abutment section of dam to tie into interim berm built. ■ Till berm constructed near north abutment in 2017 remains in good condition.

Inspection Item	Observations/Data	Photo	Comments & Other Data
6.0 RESERVOIR		15	
6.1 Stability of Slopes	Stable		■ Railway embankment on east side of impoundment has a buttress berm and tailings beach upstream. ■ Small natural ground slope present north of the railway embankment on east side of reservoir (low potential for slide generation).
6.2 Distance to Nearest Slide (if applicable)	Adjacent to impoundment		■ Slide from adjacent slopes would impact tailings beach.
6.3 Estimate of Slide Volume (if applicable)	Minor		■ Potential slide volume from railway embankment or small slope estimated to be small.
6.4 Floating Debris	None		
6.5 Other Unusual Conditions	Yes		■ Tailings beach at outlet elevation of Blackmore Creek culverts outlet. ■ Tailings being dredged to Turnbull TSF April to October 2018. Dredge operations active at time of inspection. ■ Waste water cells in operation near the north abutment.
7.0 EMERGENCY SPILLWAY/ OUTLET STRUCTURE	None		■ No spillway or emergency outlet.
7.1 Surface Condition	N/A		

Inspection Item	Observations/Data	Photo	Comments & Other Data
7.2 Signs of Erosion	N/A		
7.3 Signs of Movement (Deformation)	N/A		
7.4 Cracks	N/A		
7.5 Settlement	N/A		
7.6 Presence of Debris or Blockage	N/A		
7.7 Closure Mechanism Operational	N/A		
7.8 Slope Protection	N/A		
7.9 Instability of Side Slopes	N/A		
7.10 Other Unusual Conditions	N/A		
8.0 INSTRUMENTATION			
8.1 Piezometers	Yes		West Dam (see Section 5.4.1.3 of the DSI report): ■ 2 standpipes (not read). ■ 2 retrofit standpipes with vibrating wire. ■ 4 VW piezometers. Main Dam (see Section 5.4.1.3 of the DSI report): ■ 1 standpipe (not read). ■ 2 retrofit standpipes with vibrating wire. ■ 5 VW piezometers. Locations shown in plan in Figure 5 of the DSI report.
8.2 Settlement Cells	None		

Inspection Item	Observations/Data	Photo	Comments & Other Data
8.3 Thermistors	None		
8.4 Settlement Monuments	Yes		GPS units monitor crest and toe movements – see Appendix F of the DSI report. Locations shown in plan in Figure 5 of the DSI report.
8.5 Accelerograph	None		
8.6 Inclinometer	Yes		West Dam ■ 1 location. Main Dam ■ 3 locations. See Appendix G. Locations shown in plan in Figure 5.
8.7 Weirs and Flow Monitors	Yes		Below West Dam, seepage flow monitoring, see Section 5.4.
8.8 Data Logger(s)	Yes		On piezometers and GPS units, all instrumentation connected to GeoExplorer system.
8.9 Other	None		
9.0 DOCUMENTATION			
9.1 Operation, Maintenance and Surveillance (OMS) Manual 9.1.1 OMS Manual Exists	Yes		FRO Tailings Facility OMS Manual Version 2018.02.
9.1.2 OMS Plan Reflects Current Dam Conditions	Yes		
9.1.3 Date of Last Revision	October 2018		

Inspection Item	Observations/Data	Photo	Comments & Other Data
9.2 Emergency Preparedness Plan (EPP) 9.2.1 ERP Exists	Yes ERP: Internal to Teck EPP: External to Teck		**ERP:** STP included in site tailings facilities ERP (SP&P EP.009). **EPP:** SP&P EP.008.R1.
9.2.2 ERP Reflects Current Conditions	ERP reflects current conditions on site, EPP to be updated based on ERP once finalized.		
9.2.3 Date of Last Revision	**ERP**: September 2017, in draft **EPP**: 15 December 2015		

10. NOTES

The north abutment construction has been on hold since 2013 due to gas main pipeline; interim berm in place until gas main relocated or north abutment redesigned.

The STP is not equipped with an overflow emergency spillway. Operating pond size was reduced in Spring 2018 and operating water levels were near the freeboard limit. FRO has increased annual dredging plan for 2018 which should result increased operating pond size. Golder has prepared details for a conceptual overflow emergency spillway design.

Inspectors:	Clara Lee, P.Eng., and John Cunning, P.Eng.	**Date:**	11 September 2018

APPENDIX D

Kerr Wood Leidal Riprap Inspection Report

KERR WOOD LEIDAL
consulting engineers

Okanagan
202 - 3334 30th Avenue
Vernon, BC V1T 2C8
T 250 503 0841
F 250 503 0847

Technical Memorandum

DATE: March 28, 2019

TO: Heather Brickner, M.Sc., P.Eng.
Teck Coal Ltd. – Fording River Operations

CC: Julia Steele, P.Eng.
Golder Associates Ltd.

FROM: Jason Miller, P.Eng.

RE: **TECK COAL LIMITED – FORDING RIVER OPERATIONS**
2018 NTP and STP Riprap Inspection
Our File 0008.261-300

Introduction

Teck Coal Ltd. – Fording River Operations (FRO) retained Kerr Wood Leidal Associates Ltd. (KWL) to complete an inspection of the riprap along the North Tailings Pond (NTP) and South Tailings Pond (STP). Jason Miller, P.Eng. of KWL is the design engineer of record for bank protection works along the NTP and STP.

The riprap inspection is a component of the Annual Dam Safety Inspection (DSI) currently being completed by Golder Associates Ltd. (Golder). Golder is the Engineer of Record (EoR) for the tailings facilities at FRO. This technical memorandum summarizes the findings of KWL's riprap inspection and will be appended to the Golder 2018 Annual DSI.

Background

KWL has a long history working at FRO. KWL was involved in the design and construction of the Fording River diversion to allow the construction of the STP. KWL has also provided hydrotechnical support to FRO following major flood events on the Fording River.

A severe flood on the Fording River in June 2013 caused extensive damage to FRO infrastructure, and necessitated emergency mitigation works. Post-flood works included design and construction of a new riprap revetment to protect the NTP and part of the STP. Construction of bank protection works occurred in 2013 and 2014. Upon completion, continuous bank protection works had been constructed along the Fording River channel where it flows along the toe of the NTP dam, and along about one-third of the channel where it flows along the toe of the STP dam.

In 2016, KWL updated the Fording River hydraulic model and designed upgrades to the 2013 bank protection works that would further protect the NTP and STP against high flows on the Fording River[1]. Construction of the upgrades was completed in 2016 and 2017.

[1] Kerr Wood Leidal Associates Ltd. 2016 Bank Protection Design for NTP/STP – Design Brief. Prepared for Teck Coal Ltd. – Fording River Operations. January 2017.

The existing NTP and STP riprap is designed to the 200-year return period flood. The riprap design elevation is based on a 200-year return period flood water level plus 1 m of freeboard plus an additional 1.5 m of riprap to accommodate downward displacement of the revetment due to scour. FRO is continuing a parallel process to establish an appropriate Fording River design flow for long-term upgrading and operation of its tailings dams.

Field Inspection

A site visit was conducted on October 4, 2018 by Jason Miller, P.Eng. of KWL and Heather Brickner, M.Sc., P.Eng. of FRO to assess the condition of the NTP and STP riprap bank protection works. The assessment began at the north end of the NTP and moved downstream to the STP. At the time of the inspection, there was a thin layer of snow on the ground and riprap. Despite the snow cover, conditions allowed a satisfactory inspection of the riprap. Photos of the inspection are included at the end of this technical memorandum.

NTP Inspection

Riprap extends from upstream of the NTP to about Sta. 1+075 of the Golder NTP dam baseline as shown on Figure 1. Visual inspection of the lower riprap slope was impeded by gravel placed over the riprap during 2013 construction. The upper riprap slope placed during 2016/2017 was visible and appears to be well-interlocked. The exposed toe of the revetment was also observed and appears to be in good condition with no visual signs of scour or displacement. Riprap was visible on the entire slope in one short section approximately between Sta. 0+750 and Sta. 0+830. The exposed riprap is in good condition and appears to remain well interlocked. The slope of the exposed riprap is about 1.5H:1V.

Gravel-covered sections of the revetment were checked for signs of movement such as cracks or openings in the gravel along the slope that would indicate voids developing within the revetment or settlement of the upper riprap. No visual signs of movement were observed over the length of the revetment.

The buried section of riprap (Sta. 0+100 to 0+200) is not visible. The ground covering the riprap was checked for signs of movement such as cracks or settlement. No visual signs of movement were observed over the length of the buried riprap.

Locally-supplied sedimentary rock was used to construct the riprap revetment. This rock is known to weather and degrade over time. Degradation was observed on a few rocks along the revetment; however, the degradation is intermittent and has not yet affected the overall integrity of the protection works. This year's inspection did not include any test holes to review rock degradation below the visible rock layer.

Previously, test holes were excavated in 2016 and 2017 during riprap upgrades and found the riprap placed in 2013 to be of good quality, but the riprap gradation was smaller than the expected gradation at the top of the test holes, possibly a result of selective placement to construct an access road on top of the revetment. In the absence of further test holes, it is reasonable to assume that degradation of the buried rock is similar to that of exposed sections.

Generally, the NTP riprap is +/- 0.1 m of the design elevation; however, there are a few areas where the riprap is up to 0.4 m lower than the design elevation (refer to profile on record drawings in in completion report[2]). This reduces the freeboard in these areas from the design freeboard of 1.0 m to 0.6 m. A reduced freeboard means that the revetment has a reduced capacity to handle variations from the design conditions; 0.6 m freeboard is considered the minimum acceptable freeboard for many flood protection projects throughout BC. Particular attention should be paid to these areas on regular inspection. Signs of settling or subsidence should be

[2] Kerr Wood Leidal Associates Ltd. 2016/2017 Bank Protection for NTP/STP – Completion Report. Prepared for Teck Coal Ltd. – Fording River Operations. December 2017.

confirmed by survey and levels of protection should be raised if required. FRO should take advantage of future opportunities to cost-effectively raise the revetment to achieve the design freeboard (e.g., if future work is required along the river side slope of the NTP).

STP Inspection

A riprap revetment protects the STP embankment toe from Sta. 0+240 to 0+685 of the Golder STP dam baseline (refer to Figure 2). Most of the riprap slope is exposed and visible along the length of the revetment, with the exception of a 20 m length at the upstream end (Sta. 0+240 to 0+260) which is covered in finer rock (200 mm minus rock). The riprap is well interlocked with smaller riprap filling the voids of the larger riprap. The riprap slope is about 2H:1V.

The top of the riprap apron is covered in river gravel and is not visible for inspection; its condition is assumed similar to that observed along the revetment slope. The gravel-covered apron was checked for signs of movement such as cracks or openings in the gravel that would indicate voids or settlement developing within the toe apron. No signs of movement were observed. The Fording River currently flows on the opposite side of the channel for most of the length with the exception of the downstream end where the floodplain narrows to the edge of the channel. The Fording River was not flowing directly against the riprap during the inspection.

There is some weathering (cracking and flaking) of individual riprap pieces along the entire length of the STP protection works. Currently, the degradation is intermittent and has not affected the overall integrity of the protection works; however, should additional rock continue to degrade, the average size (mass) of the riprap will decrease and rock interlocking may be compromised.

General Observations

All riprap used for NTP and STP bank protection works was salvaged from toes of spoils or sorted from spoils or hauled directly from the pit. The resistance to weathering is therefore expected to vary locally throughout both revetments. Over time, inspections may identify pockets of more resistant and/or less resistant material. More frequent monitoring should occur in areas where a significant portion of the riprap slope (i.e., more than the occasional rock) is found to be showing signs of degradation. Remedial work will be required in the future as inspections identify continued weathering and degradation of the sedimentary rock clasts. Test pits should be completed to confirm (and if needed, remediate) the quality and integrity of buried riprap at any location where settlement, cracking, voids, or other signs of movement become visible on the surface. Future inspections will continue to monitor degradation and recommend timelines for any remedial work required.

FRO staff report that riprap inspections occurred daily for a couple of days during the 2018 freshet when the trigger action response plan (TARP) was initiated by the results of FRO's Fording River Flood Risk Assessment Tool (based on flows in the Fording River and forecast temperature and precipitation information). As part of FRO's flood preparedness and response protocols, such inspections typically focus on identifying any hydraulic disturbance or displacement of the riprap. However, any observations related to ongoing degradation of the rock should also be recorded for review during the next annual inspection.

Summary and Recommendations

Exposed riprap along the NTP and STP is designed to provide erosion protection during the 200-year return period flood and remains in generally good condition at this time. There is the occasional riprap piece that has degraded from weathering located intermittently along the NTP and STP riprap revetments. This is also expected to be the case for buried riprap. The field assessment did not identify any evidence that raises concerns about the performance of concealed (i.e., buried or gravel-covered) riprap, and its condition is assumed to be comparable or better than that of equivalent exposed sections.

Key recommendations following the 2018 NTP/STP riprap inspection are:

1. **Inspections of the riprap should be completed at least annually.** The riprap should continue to be monitored for weathering during these annual inspections. Test pits may be required if surface deformation suggests potential problems with buried riprap. Mitigative action (e.g., riprap replacement) may be required if several rocks in close proximity to one another show evidence of degradation. Supplementary inspections should be conducted after high water events on the Fording River, which could include freshet or precipitation driven events. Any deficient sections should be repaired as soon as possible to limit further degradation and risk to the NTP or STP.
2. **Additional riprap inspections may be required during high water events or when triggered by a TARP.** These inspections should be documented for review as part of the next annual inspection.
3. **There are a few areas along the NTP riprap where the riprap is up to 0.4 m lower than the design elevation.** This reduces the freeboard in these areas to 0.6 m. Particular attention should be paid to these areas on regular inspection. Signs of settling or subsidence should be confirmed by survey and levels of protection should be raised if required. **Teck should seek opportunities to cost-effectively achieve the intended 1 m freeboard** (e.g., by combining with an independent but adjacent construction project).
4. Design of the riprap erosion protection works is based on the 200-year return period flood, which is subject to numerous uncertainties. For example, the energy of the flood can significantly change channel conditions. In addition, larger floods are possible, including the breach of an upstream valley-spanning structure, the Fording River Multiplate embankment. Lastly, the sedimentary rock used to construct the revetment is known to weather and degrade over time. **The design and status of the NTP and STP riprap should be reviewed and revised as needed within the context of FRO's larger review of design and performance requirements for the NTP and STP tailings dams.**

Closure

We trust this provides a satisfactory assessment of the riprap protection along the NTP and STP. Should you have any questions, please contact the undersigned.

KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
2019-03-28
J. W. MILLER
34433

Jason Miller, P.Eng.
Water Resources Engineer

Reviewed by:

David Roche, M.A.Sc., P.Eng.
Senior Water Resources Engineer

JM/

Encl.: Photos, Figure 1, Figure 2

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of the intended recipient. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

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Revision History

Revision #	Date	Status	Revision Description	Author
0	March 28, 2019	Original		JM

Photos

Photo 1: Looking upstream along alignment of NTP riprap that is buried (approx. Sta. 0+100)

Photo 2: Looking downstream at NTP riprap covered by gravel (approx. Sta. 0+175 to 0+350)

Photo 3: Looking upstream at NTP riprap (approx. Sta. 0+400 to 0+500)

Photo 4: Riprap degradation due to weathering on a surface of a piece of riprap (red outline)

		
Photo 5: Looking upstream at NTP riprap (approx. Sta. 0+775 to 0+850)		Photo 6: Looking downstream at NTP riprap (approx. Sta. 1+000 to 1+075)
		
Photo 7: Looking downstream at STP downstream tie-in of raised riprap (approx. Sta. 0+275 to 0+325)		Photo 8: Looking upstream at STP riprap with minor erosion of gravel at the toe of the slope (approx. Sta. 0+300 to 0+325), no impact to riprap stability

Photo 9: Riprap degradation due to weathering on a surface of a piece of riprap (red outline)

Photo 10: Looking downstream at STP riprap (approx. Sta. 0+550 to 0+660)

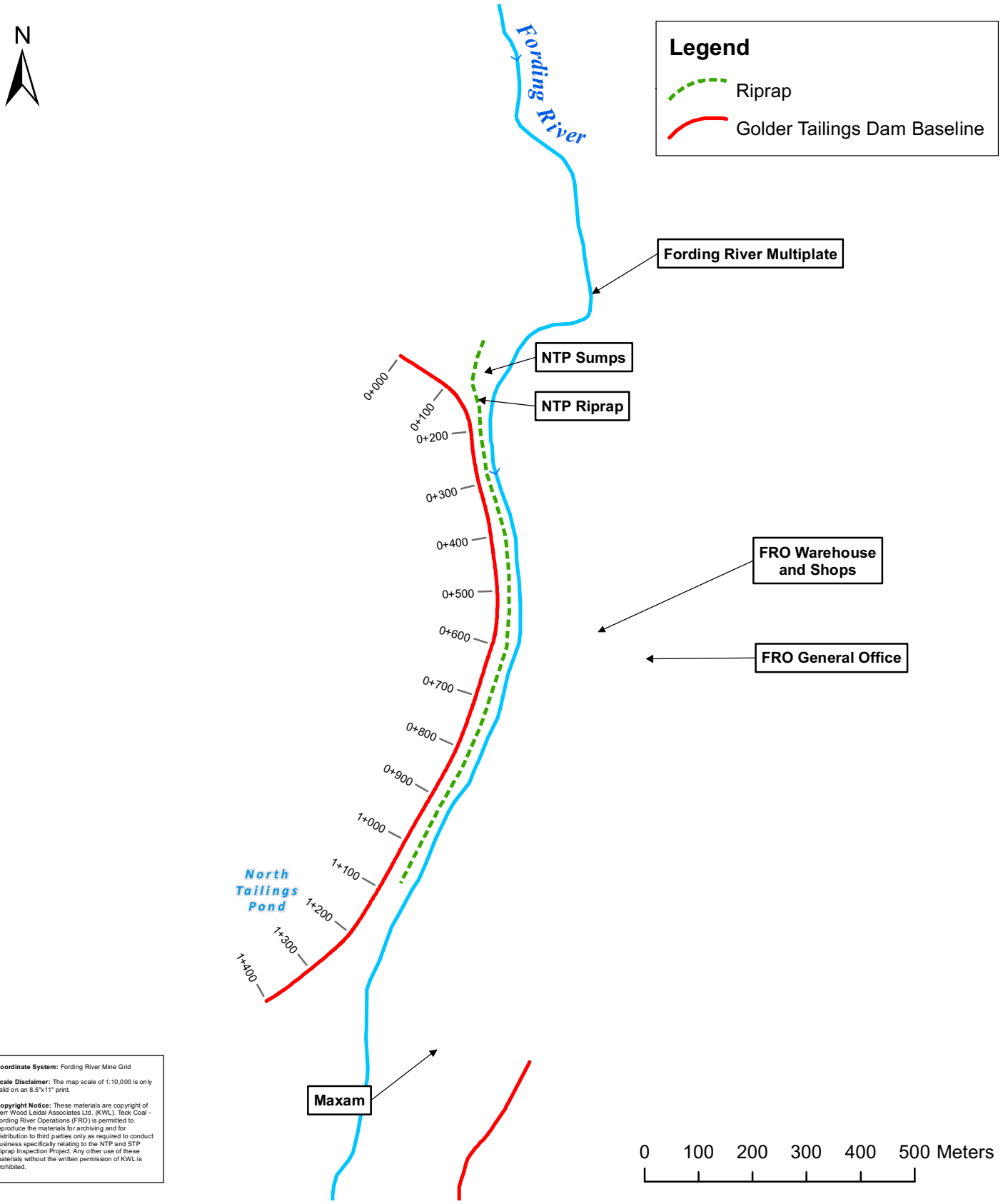
Photo 11: Looking downstream at STP riprap (approx. Sta. 0+620 to 0+660)

Photo 12: Looking upstream at STP riprap tie-in to pipe bridge abutment (approx. Sta. 0+650 to 0+685)

Teck Coal - Fording River Operations (FRO)

NTP and STP Riprap Inspection

KERR WOOD LEIDAL consulting engineers



Coordinate System: Fording River Mine Grid

Scale Disclaimer: The map scale of 1:10,000 is only valid on an 8.5"x11" print.

Project No.	8-261
Date	February 2019
Scale	1:10,000

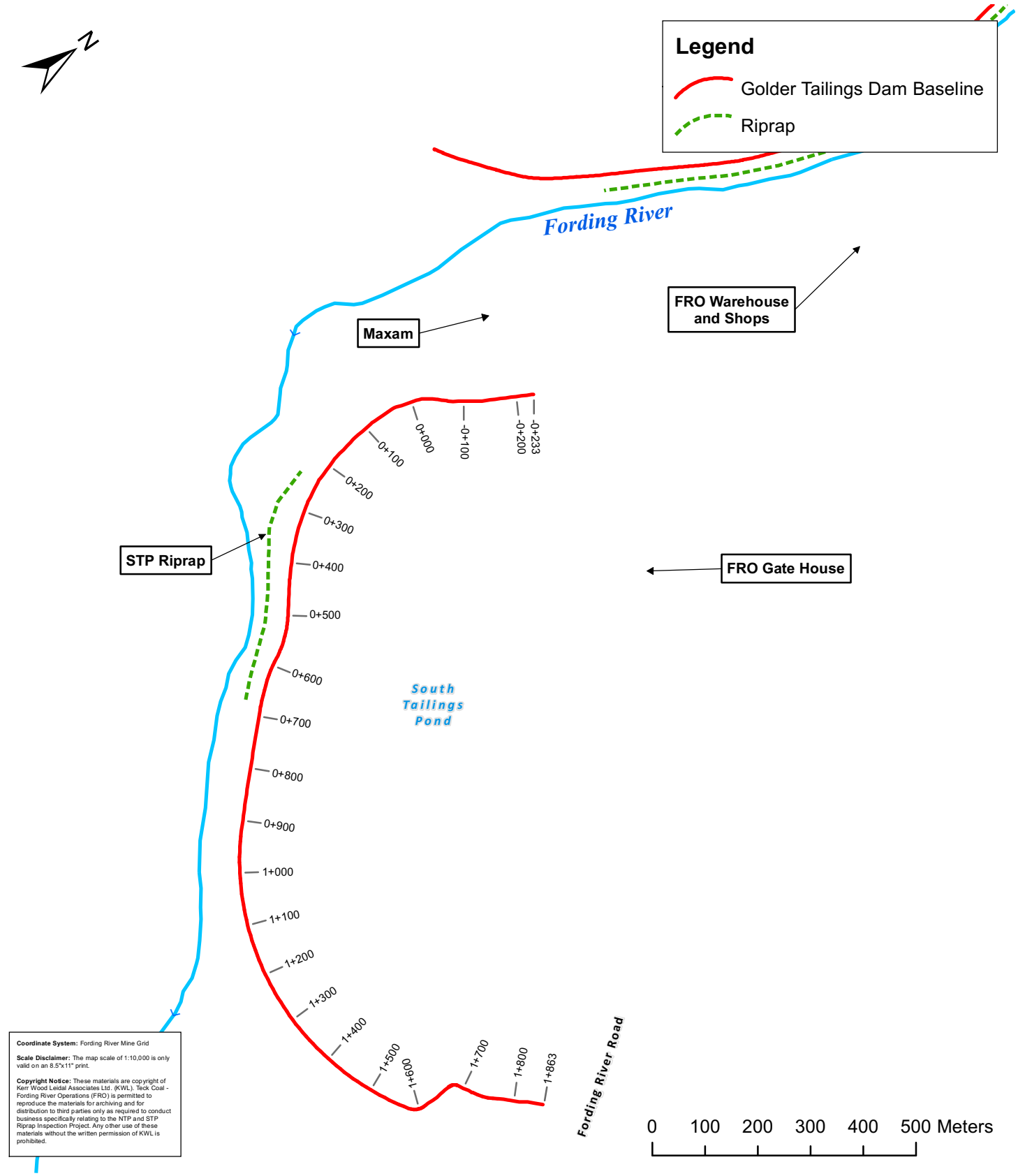
North Tailings Pond

Figure 1

Teck Coal - Fording River Operations (FRO)

NTP and STP Riprap Inspection

KERR WOOD LEIDAL consulting engineers



Coordinate System: Fording River Mine Grid

Scale Disclaimer: The map scale of 1:10,000 is only valid on an 8.5"x11" print.

Project No.	8-261
Date	February 2019
Scale	1:10,000

South Tailings Pond

Figure 2

APPENDIX E

Summary of FRO Dam Inspection Action Items

Fording River Operations

Weekly STP Dam Inspection Form

Teck

Inspected By: H. Bruckner

Inspection Date: September 8/2017

Weather & Temperature: Smokey 22°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date

Fording River Operations

Weekly STP Dam Inspection Form

Teck

Inspected By: H. Brickner

Inspection Date: Sept. 13 | 2017

Weather & Temperature: 16°C, cloudy

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
STP Riprap stockpile	Ensure Swift Project replaces emergency rip rap material they removed.	2	March 31, 2018
STP lower road	Review area where lower road ditch was cleaned out, small area of embankment undercut	3	October 6, 2017

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: H. Brickner

Inspection Date: Sept. 20/21/22, 2017

Weather & Temperature: 1°C cloudy / -4°C snow / -1°C cloudy

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
STP main Dam, NTP south end.	Animal burrow inspection at NTP and STP by biologist required.	2	December 2017.

Fording River Operations

Weekly STP Dam Inspection Form

Teck

Inspected By: H. Brickner

Inspection Date: Sept. 26/2017

Weather & Temperature: sunny, 15°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date

Inspected By: H. Brickner
Inspection Date: Oct. 3/4, 2017
Weather & Temperature: sunny 3°C / sunny 5°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
NTP	Obtain permit and develop plan for removal/relocation of NTP ground squirrels.	2	Feb. 2018

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: Heather Buckner

Inspection Date: November 22 - 28, 2017

Weather & Temperature: 2°C rain | -2°C flurries

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no concerns/items		

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: H. Brickner

Inspection Date: December 19, 2017

Weather & Temperature: light snow, -8°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date

Inspected By: H. Brickner
Inspection Date: Jan. 29 & 31, 2018
Weather & Temperature: 3°C cloudy / -6°C cloudy

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Inspected By: H Brickner
Inspection Date: Feb. 27/2018 & Feb. 28/2017
Weather & Temperature: -9°C cloudy/flurries, -5°C cloudy

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
STP Main Dam	Monitor erosion gully at south end. Not a concern at this time.	4	on-going inspection
STP Blackmore Culverts	Monitor inlet culverts for Blackmore Creek to ensure drainage occurring during freshet.	4	on-going inspection
Henretta culvert	Ensure area is inspected during March and subsequent inspections.	4	March 2018 inspection

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: H Bruckner

Inspection Date: March 28 & 29, 2018

Weather & Temperature: -5°C, partly cloudy / -5°C sunny

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
Henretta Culvert	Inspect area prior to spring melt beginning	3	April 15, 2018

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: H Brickner

Inspection Date: April 26/18 & April 30/2018

Weather & Temperature: sunny 6°C / light snow 0°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
NTP	Develop pumping/dewatering plan for NTP.	2	in progress

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: May 9 + 10, 2018

Weather & Temperature: 5°C cloudy

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: May 17, 2018 + May 18, 2018

Weather & Temperature: cloudy 8°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: May 23/2018

Weather & Temperature: Mostly sunny 20°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: SPRING QUIN / SOPHIE PENHALL

Inspection Date: 2018-05-24

Weather & Temperature: SUNNY, 15°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
~~NTP~~			

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: May 28/2018

Weather & Temperature: sunny, 26°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: June 6, 2018

Weather & Temperature: sunny 20°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
STP	monitor erosion gully on Main Dam	3	on-going

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: June 13/2018

Weather & Temperature: cloudy/rain, 5°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
STP	potholes developing in dam crest, needs crush.	3	July 2018

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: June 18/2018

Weather & Temperature: cloudy 12°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Inspected By: H. Brickner
Inspection Date: June 18, 27, 28, 29 / 2018
Weather & Temperature: See specific forms

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: July 5/2018

Weather & Temperature: Sunny 24°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
Main Dam + West Dam	Crest needs gravel / road crush	3	August 2018

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: July 9, 2018

Weather & Temperature: sunny 28°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
West Dam	erosion gully at north end of West Dam	3	August 2018

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: July 20/2018

Weather & Temperature: Sunny 26°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues		

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H.Bnckner

Inspection Date: July 27/2018

Weather & Temperature: partly cloudy, 23°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: H. Brickner

Inspection Date: July 29/2018

Weather & Temperature: sunny 26°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues		

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: Ross Rosenquist

Inspection Date: Aug 10th 2018

Weather & Temperature: Sunny 24°

Reviewed: H. Bnckner 2018-08-13 10:00 AM

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Brickner

Inspection Date: August 13/18

Weather & Temperature: cloudy, 14°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues		

Fording River Operations

STP Dam Inspection Form

Weekly Inspections from May – October, Inspections twice per month from November – April

Teck

Inspected By: H. Bruckner

Inspection Date: August 24/2018

Weather & Temperature: smoky/cloudy, 12°C

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues		

Fording River Operations

Monthly Tailings Dam Inspection Form

Teck

Inspected By: H. Brickner

Inspection Date: Aug 29 + Aug 30/2018

Weather & Temperature: 10℃ mainly sunny / 11°C overcast

ACTION ITEMS

Record any items of concern noted during the inspection; location of each action item shall be marked on the attached facility maps. If required, additional items can be included in the "Additional Comments" section.

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant regulatory concern.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory action; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice as a suggestion for continuous improvement towards industry best practices that could further reduce potential risks. This typically includes ongoing construction items within the appropriate construction cycle.

Location	Item Description & Responsibility	Priority	Target Completion Date
	no issues.		

APPENDIX F

FRO Water Quality Data

Appendix F:
FRO Water Quality Data (STP North Seep)

		Location	FR_STPNSEEP	FR_STPNSEEP	FR_STPNSEEP	FR_STPNSEEP	FR_STPNSEEP	FR_STPNSEEP	FR_STPNSEEP	FR_STPNSEEP	FR_STPNSEEP
		Date	31/10/2017	01/11/2017	01/11/2017	02/11/2017	02/11/2017	12/12/2017	12/12/2017	19/06/2018	19/06/2018
		Sample Type	N	NP	N	NP	N	NP	N	NP	N
Fraction	Analyte	Unit	Result	Result	Result	Result	Result	Result	Result	Result	Result
D	ALUMINUM	mg/l	< 0.0030	< 0.0030			< 0.0030	0.0064		< 0.0010	
D	ANTIMONY	ug/l	0.16	0.16			0.15	0.12		0.16	
D	ARSENIC	ug/l	< 0.10	< 0.10			< 0.10	< 0.10		< 0.10	
D	BARIUM	mg/l	0.122	0.108			0.118	0.118		0.0726	
D	BERYLLIUM	ug/l	< 0.020	< 0.020			< 0.020	< 0.020		< 0.020	
D	BISMUTH	mg/l	< 0.000050	< 0.000050			< 0.000050	< 0.000050		< 0.000050	
D	BORON	mg/l	0.018	0.019			0.020	0.019		0.014	
D	BROMIDE	mg/l	0.236	0.244			0.240	0.181		0.067	
D	CADMIUM	ug/l	0.0745	0.0582			0.0760	0.672		0.111	
D	CARBON, DISSOLVE	mg/l	0.73	1.33			0.64	0.80		0.74	
D	CHLORIDE	mg/l	16.6	16.3			16.7	17.5		8.55	
D	CHROMIUM	ug/l	0.10	0.12			< 0.10	0.12		0.10	
D	COBALT	ug/l	0.20	0.22			0.23	0.59		0.33	
D	COPPER	ug/l	< 0.50	< 0.50			< 0.50	0.54		0.20	
D	FLUORIDE	mg/l	0.177	0.162			0.157	0.206		0.221	
D	IRON	mg/l	< 0.010	< 0.010			< 0.010	< 0.010		< 0.010	
D	LEAD	ug/l	< 0.050	< 0.050			< 0.050	< 0.050		< 0.050	
D	LITHIUM	mg/l	0.0311	0.0305			0.0306	0.0447		0.0296	
D	MANGANESE	mg/l	0.00032	0.00023			0.00052	0.00073		0.00216	
D	MERCURY	ug/l	< 0.0050	< 0.0050			< 0.0050	< 0.0050		< 0.0050	
D	MOLYBDENUM	mg/l	0.00105	0.00108			0.00108	0.00115		0.00119	
D	NICKEL	ug/l	0.94	0.96			1.01	1.28		0.80	
D	SELENIUM	ug/l	20.2	22.7			20.8	26.5 23.9		16.2	
D	SILVER	ug/l	< 0.010	< 0.010			< 0.010	< 0.010		< 0.010	
D	STRONTIUM	mg/l	0.213	0.193			0.189	0.215		0.144	
D	SULFATE (AS SO4)	mg/l	180	179			181	251		148	
D	THALLIUM	ug/l	< 0.010	< 0.010			< 0.010	< 0.010		< 0.010	
D	TIN	mg/l	< 0.00010	< 0.00010			< 0.00010	< 0.00010		< 0.00010	
D	TITANIUM	ug/l	< 10	< 10			< 10	< 10		< 10	
D	URANIUM	ug/l	1.95	2.10			1.67	3.34		1.81	
D	VANADIUM	ug/l	< 0.50	< 0.50			< 0.50	< 0.50		< 0.50	
D	ZINC	ug/l	< 3.0	< 3.0			< 3.0	6.1		1.4	
N	ALKALINITY, TOTAL	mg/l	225	226			221	230		197	
N	CONDUCTIVITY, FIE	us/cm				752.3		866		555.2	
N	CONDUCTIVITY, LAB	us/cm	787	799			795	977		649	
N	DISSOLVED OXYGEN	mg/l				7.54		6.68		8.12	
N	Hardness, Total or D	mg/l	440	437			433	488		358	
N	INSTANT_FLOW	m3/s	0.0015		0.0015		0.0081		0.0111		0.005
N	NITRATE NITROGEN	mg/l	6.44	6.46			6.39	6.59		4.32	
N	NITRITE NITROGEN	mg/l	0.0014	0.0017			0.0014	< 0.0010		0.0011	
N	NITROGEN, AMMON	mg/l	< 0.0050	0.0058			< 0.0050	0.0070		0.0105	
N	ORTHO-PHOSPHATE	mg/l	0.0021	0.0022			0.0022	< 0.0010		0.0021	
N	pH, Field	ph units				7.63		7.47		7.47	
N	pH, LAB	ph units	8.16	8.20			8.30	7.91		8.26	
N	PHOSPHORUS	mg/l	0.0021	0.0101			0.0024	0.0028		< 0.0010	
N	TEMPERATURE, FIEL	deg c				7.0		4.9		6.5	
N	The sum of extracta	mg/l	< 0.50	< 0.50			< 0.50			< 0.50	
N	TOTAL DISSOLVED S	mg/l	593	570			563	672		491	
N	TOTAL KJELDAHL N	mg/l	0.098	< 0.050			< 0.050	0.275		0.218	
N	TOTAL SUSPENDED	mg/l	< 1.0	< 1.0			< 1.0	< 1.0		1.2	
N	TURBIDITY, LAB	ntu	0.28	0.24			0.46	0.20		0.13	
T	ALUMINUM	mg/l	0.0033	0.0040			< 0.015	< 0.0030		0.0048	
T	ANTIMONY	ug/l	0.16	0.15			< 0.50	0.17		0.15	
T	ARSENIC	ug/l	0.12	0.12			< 0.50	< 0.10		0.13	
T	BARIUM	mg/l	0.110	0.108			0.107	0.118		0.0705	
T	BERYLLIUM	ug/l	< 0.020	< 0.020			< 0.10	< 0.020		< 0.020	
T	BISMUTH	mg/l	< 0.000050	< 0.000050			< 0.00025	< 0.000050		< 0.000050	
T	BORON	mg/l	0.020	0.020			< 0.050	0.020		0.014	
T	CADMIUM	ug/l	0.0675	0.0734			0.072	0.678		0.113	
T	CALCIUM	mg/l	114	115			123	126		88.1	
T	CHROMIUM	ug/l	0.14	< 0.30			< 0.50	0.13		0.21	
T	COBALT	ug/l	0.22	0.22			< 0.50	0.61		0.33	
T	COPPER	ug/l	< 0.50	< 0.50			< 2.5	0.51		< 0.50	
T	IRON	mg/l	< 0.010	< 0.010			< 0.050	< 0.010		< 0.010	
T	LEAD	ug/l	< 0.050	< 0.050			< 0.25	< 0.050		0.173	
T	LITHIUM	mg/l	0.0307	0.0331			0.0341	0.0481		0.0303	
T	MAGNESIUM	mg/l	38.5	39.4			39.0	46.2		31.2	
T	MANGANESE	mg/l	0.00130	0.00200			0.00141	0.00090		0.00338	
T	MERCURY	ug/l	< 0.0050	< 0.0050			< 0.0050	< 0.00050		< 0.0050	
T	MOLYBDENUM	mg/l	0.00105	0.00101			0.00090	0.00118		0.00119	
T	NICKEL	ug/l	0.97	1.20			< 2.5	1.26		0.87	
T	POTASSIUM	mg/l	1.94	2.02			2.05	2.22		1.61	
T	SELENIUM	ug/l	18.3	19.8			18.1	25.1 24.0		13.5	
T	SILVER	ug/l	< 0.010	< 0.010			< 0.050	< 0.010		< 0.010	
T	SODIUM	mg/l	4.68	4.36			5.31	6.07		3.77	
T	STRONTIUM	mg/l	0.213	0.197			0.192	0.217		0.143	
T	THALLIUM	ug/l	< 0.010	< 0.010			< 0.050	< 0.010		< 0.010	
T	TIN	mg/l	< 0.00010	< 0.00010			< 0.00050	< 0.00010		< 0.00010	
T	TITANIUM	ug/l	< 10	< 10			< 10	< 10		< 10	
T	TOTAL ORGANIC CA	mg/l	0.77	1.01			0.61	0.80		0.70	
T	URANIUM	ug/l	2.18	2.08			2.30	3.40		1.92	
T	VANADIUM	ug/l	< 0.50	< 0.50			< 2.5	< 0.50		< 0.50	
T	ZINC	ug/l	< 3.0	< 3.0			< 15	6.8		< 3.0	

Appendix F:
FRO Water Quality Data - STP Northwest Pond
(pond west of wastewater cells)

		Location	FR_STPNWP
		Date	13/03/2018
		Sample Type	NP
Fraction	Analyte	Unit	Result
N	TOTAL SUSPENDED	mg/l	72.2
N	TURBIDITY, LAB	ntu	84.8

Appendix F:
FRO Water Quality Data - STP Groundwater Well 4B
(northwest of STP)

		Location	FR_STPNWWELL4B	FR_STPNWWELL4B
		Date	02/11/2017	02/11/2017
		Sample Type	NP	N
Fraction	Analyte	Unit	Result	Result
D	ALUMINUM	mg/l		< 0.0030
D	ANTIMONY	ug/l		0.26
D	ARSENIC	ug/l		0.11
D	BARIUM	mg/l		0.0461
D	BERYLLIUM	ug/l		< 0.020
D	BISMUTH	mg/l		< 0.000050
D	BORON	mg/l		0.073
D	BROMIDE	mg/l		0.29
D	CADMIUM	ug/l		0.802
D	CARBON, DISSOLVE	mg/l		0.58
D	CHLORIDE	mg/l		4.7
D	CHROMIUM	ug/l		< 0.10
D	COBALT	ug/l		1.46
D	COPPER	ug/l		1.16
D	FLUORIDE	mg/l		0.35
D	IRON	mg/l		< 0.010
D	LEAD	ug/l		< 0.050
D	LITHIUM	mg/l		0.110
D	MANGANESE	mg/l		0.00594
D	MERCURY	ug/l		< 0.0050
D	MOLYBDENUM	mg/l		0.00151
D	NICKEL	ug/l		4.51
D	SELENIUM	ug/l		5.51
D	SILVER	ug/l		< 0.010
D	STRONTIUM	mg/l		0.293
D	SULFATE (AS SO4)	mg/l		381
D	THALLIUM	ug/l		0.035
D	TIN	mg/l		< 0.00010
D	TITANIUM	ug/l		< 10
D	URANIUM	ug/l		11.1
D	VANADIUM	ug/l		< 0.50
D	ZINC	ug/l		11.2
N	ALKALINITY, TOTAL	mg/l		396
N	CONDUCTIVITY, FIE	us/cm	1164	
N	CONDUCTIVITY, LAB	us/cm		1240
N	DISSOLVED OXYGEN	mg/l	0.53	
N	Hardness, Total or D	mg/l		759
N	NITRATE NITROGEN	mg/l		2.45
N	NITRITE NITROGEN	mg/l		< 0.0050
N	NITROGEN, AMMON	mg/l		< 0.0050
N	ORTHO-PHOSPHATE	mg/l		< 0.0010
N	pH, Field	ph units	7.16	
N	pH, LAB	ph units		8.19
N	PHOSPHORUS	mg/l		0.0019
N	TEMPERATURE, FIEL	deg c	8.4	
N	The sum of extracta	mg/l		< 0.50
N	TOTAL DISSOLVED S	mg/l		990
N	TOTAL KJELDAHL NI	mg/l		0.074
N	TOTAL SUSPENDED	mg/l		1.6
N	TURBIDITY, LAB	ntu		1.31
T	ALUMINUM	mg/l		< 0.015
T	ANTIMONY	ug/l		< 0.50
T	ARSENIC	ug/l		< 0.50
T	BARIUM	mg/l		0.0411
T	BERYLLIUM	ug/l		< 0.10
T	BISMUTH	mg/l		< 0.00025
T	BORON	mg/l		0.072
T	CADMIUM	ug/l		0.772
T	CALCIUM	mg/l		149
T	CHROMIUM	ug/l		< 0.50
T	COBALT	ug/l		1.98
T	COPPER	ug/l		< 2.5
T	IRON	mg/l		< 0.050
T	LEAD	ug/l		< 0.25
T	LITHIUM	mg/l		0.102
T	MAGNESIUM	mg/l		89.7
T	MANGANESE	mg/l		0.0184
T	MERCURY	ug/l		< 0.0050
T	MOLYBDENUM	mg/l		0.00122
T	NICKEL	ug/l		5.1
T	POTASSIUM	mg/l		4.30
T	SELENIUM	ug/l		4.38
T	SILVER	ug/l		< 0.050
T	SODIUM	mg/l		6.56
T	STRONTIUM	mg/l		0.280
T	THALLIUM	ug/l		0.050
T	TIN	mg/l		< 0.00050
T	TITANIUM	ug/l		< 10
T	TOTAL ORGANIC CA	mg/l		0.74
T	URANIUM	ug/l		11.6
T	VANADIUM	ug/l		< 2.5
T	ZINC	ug/l		< 15

Appendix F:
FRO Water Quality Data - STP Groundwater Well 5A
(northwest of STP)

		Location	FR_STPNWWELL5A	FR_STPNWWELL5A
		Date	02/11/2017	02/11/2017
		Sample Type	NP	N
Fraction	Analyte	Unit	Result	Result
D	ALUMINUM	mg/l		< 0.0030
D	ANTIMONY	ug/l		0.32
D	ARSENIC	ug/l		0.20
D	BARIUM	mg/l		0.0890
D	BERYLLIUM	ug/l		< 0.020
D	BISMUTH	mg/l		< 0.000050
D	BORON	mg/l		0.063
D	BROMIDE	mg/l		0.27
D	CADMIUM	ug/l		0.780
D	CARBON, DISSOLVE	mg/l		2.63
D	CHLORIDE	mg/l		3.9
D	CHROMIUM	ug/l		< 0.10
D	COBALT	ug/l		2.18
D	COPPER	ug/l		1.41
D	FLUORIDE	mg/l		0.30
D	IRON	mg/l		< 0.010
D	LEAD	ug/l		< 0.050
D	LITHIUM	mg/l		0.0915
D	MANGANESE	mg/l		0.475
D	MERCURY	ug/l		< 0.0050
D	MOLYBDENUM	mg/l		0.00148
D	NICKEL	ug/l		10.1
D	SELENIUM	ug/l		2.91
D	SILVER	ug/l		< 0.010
D	STRONTIUM	mg/l		0.300
D	SULFATE (AS SO4)	mg/l		379
D	THALLIUM	ug/l		0.035
D	TIN	mg/l		< 0.00010
D	TITANIUM	ug/l		< 10
D	URANIUM	ug/l		8.85
D	VANADIUM	ug/l		< 0.50
D	ZINC	ug/l		11.8
N	ALKALINITY, TOTAL	mg/l		412
N	CONDUCTIVITY, FIE	us/cm	1184	
N	CONDUCTIVITY, LAB	us/cm		1260
N	DISSOLVED OXYGEN	mg/l	0.60	
N	Hardness, Total or D	mg/l		767
N	NITRATE NITROGEN	mg/l		1.55
N	NITRITE NITROGEN	mg/l		0.0096
N	NITROGEN, AMMON	mg/l		< 0.0050
N	ORTHO-PHOSPHATE	mg/l		0.0010
N	pH, Field	ph units	7.04	
N	pH, LAB	ph units		8.14
N	PHOSPHORUS	mg/l		0.0098
N	TEMPERATURE, FIEL	deg c	10.6	
N	The sum of extracta	mg/l		< 0.50
N	TOTAL DISSOLVED S	mg/l		972
N	TOTAL KJELDAHL NI	mg/l		0.094
N	TOTAL SUSPENDED	mg/l		6.6
N	TURBIDITY, LAB	ntu		5.33
T	ALUMINUM	mg/l		0.032
T	ANTIMONY	ug/l		< 0.50
T	ARSENIC	ug/l		< 0.50
T	BARIUM	mg/l		0.0785
T	BERYLLIUM	ug/l		< 0.10
T	BISMUTH	mg/l		< 0.00025
T	BORON	mg/l		0.064
T	CADMIUM	ug/l		0.772
T	CALCIUM	mg/l		173
T	CHROMIUM	ug/l		< 0.50
T	COBALT	ug/l		4.24
T	COPPER	ug/l		< 2.5
T	IRON	mg/l		0.126
T	LEAD	ug/l		< 0.25
T	LITHIUM	mg/l		0.0933
T	MAGNESIUM	mg/l		84.1
T	MANGANESE	mg/l		0.619
T	MERCURY	ug/l		< 0.0050
T	MOLYBDENUM	mg/l		0.00120
T	NICKEL	ug/l		11.3
T	POTASSIUM	mg/l		3.61
T	SELENIUM	ug/l		2.19
T	SILVER	ug/l		< 0.050
T	SODIUM	mg/l		6.39
T	STRONTIUM	mg/l		0.285
T	THALLIUM	ug/l		0.067
T	TIN	mg/l		< 0.00050
T	TITANIUM	ug/l		< 10
T	TOTAL ORGANIC CA	mg/l		3.82
T	URANIUM	ug/l		9.74
T	VANADIUM	ug/l		< 2.5
T	ZINC	ug/l		< 15

Appendix F:
FRO Water Quality Data - STP Groundwater Well 6A
(northwest of STP)

		Location	FR_STPNWWELL6A	FR_STPNWWELL6A
		Date	02/11/2017	02/11/2017
		Sample Type	NP	N
Fraction	Analyte	Unit	Result	Result
D	ALUMINUM	mg/l		< 0.0030
D	ANTIMONY	ug/l		0.29
D	ARSENIC	ug/l		0.10
D	BARIUM	mg/l		0.0573
D	BERYLLIUM	ug/l		< 0.020
D	BISMUTH	mg/l		< 0.000050
D	BORON	mg/l		0.076
D	BROMIDE	mg/l		0.38
D	CADMIUM	ug/l		0.628
D	CARBON, DISSOLVE	mg/l		1.01
D	CHLORIDE	mg/l		4.5
D	CHROMIUM	ug/l		< 0.10
D	COBALT	ug/l		1.27
D	COPPER	ug/l		0.63
D	FLUORIDE	mg/l		0.37
D	IRON	mg/l		< 0.010
D	LEAD	ug/l		0.084
D	LITHIUM	mg/l		0.104
D	MANGANESE	mg/l		0.00420
D	MERCURY	ug/l		< 0.0050
D	MOLYBDENUM	mg/l		0.00104
D	NICKEL	ug/l		3.50
D	SELENIUM	ug/l		3.17
D	SILVER	ug/l		< 0.010
D	STRONTIUM	mg/l		0.319
D	SULFATE (AS SO4)	mg/l		404
D	THALLIUM	ug/l		0.038
D	TIN	mg/l		< 0.00010
D	TITANIUM	ug/l		< 10
D	URANIUM	ug/l		12.4
D	VANADIUM	ug/l		< 0.50
D	ZINC	ug/l		5.3
N	ALKALINITY, TOTAL	mg/l		393
N	CONDUCTIVITY, FIE	us/cm	1198	
N	CONDUCTIVITY, LAB	us/cm		1290
N	DISSOLVED OXYGEN	mg/l	0.73 10.73	
N	Hardness, Total or D	mg/l		782
N	NITRATE NITROGEN	mg/l		2.71
N	NITRITE NITROGEN	mg/l		< 0.0050
N	NITROGEN, AMMON	mg/l		< 0.0050
N	ORTHO-PHOSPHATE	mg/l		0.0014
N	pH, Field	ph units	7.14	
N	pH, LAB	ph units		8.09
N	PHOSPHORUS	mg/l		0.0065
N	TEMPERATURE, FIEL	deg c	11.3	
N	The sum of extracta	mg/l		< 0.50
N	TOTAL DISSOLVED S	mg/l		994
N	TOTAL KJELDAHL NI	mg/l		0.075
N	TOTAL SUSPENDED	mg/l		4.8
N	TURBIDITY, LAB	ntu		2.85
T	ALUMINUM	mg/l		0.028
T	ANTIMONY	ug/l		< 0.50
T	ARSENIC	ug/l		< 0.50
T	BARIUM	mg/l		0.0532
T	BERYLLIUM	ug/l		< 0.10
T	BISMUTH	mg/l		< 0.00025
T	BORON	mg/l		0.080
T	CADMIUM	ug/l		1.09
T	CALCIUM	mg/l		163
T	CHROMIUM	ug/l		< 0.50
T	COBALT	ug/l		2.66
T	COPPER	ug/l		< 2.5
T	IRON	mg/l		0.067
T	LEAD	ug/l		< 0.25
T	LITHIUM	mg/l		0.100
T	MAGNESIUM	mg/l		85.6
T	MANGANESE	mg/l		0.312
T	MERCURY	ug/l		< 0.0050
T	MOLYBDENUM	mg/l		0.00067
T	NICKEL	ug/l		5.5
T	POTASSIUM	mg/l		4.50
T	SELENIUM	ug/l		2.71
T	SILVER	ug/l		< 0.050
T	SODIUM	mg/l		6.38
T	STRONTIUM	mg/l		0.292
T	THALLIUM	ug/l		< 0.050
T	TIN	mg/l		< 0.00050
T	TITANIUM	ug/l		< 10
T	TOTAL ORGANIC CA	mg/l		1.35
T	URANIUM	ug/l		12.5
T	VANADIUM	ug/l		< 2.5
T	ZINC	ug/l		< 15

Appendix F:
FRO Water Quality Data - STP Southwest Corner
(pond at toe of dam)

		Location	FR_STPSWSEEP	FR_STPSWSEEP	FR_STPSWSEEP
		Date	12/12/2017	19/06/2018	19/06/2018
		Sample Type	NP	NP	N
Fraction	Analyte	Unit	Result	Result	Result
D	ALUMINUM	mg/l	< 0.0030	< 0.0010	
D	ANTIMONY	ug/l	< 0.10	< 0.10	
D	ARSENIC	ug/l	< 0.10	< 0.10	
D	BARIUM	mg/l	0.0806	0.0823	
D	BERYLLIUM	ug/l	< 0.020	< 0.020	
D	BISMUTH	mg/l	< 0.000050	< 0.000050	
D	BORON	mg/l	0.030	0.038	
D	BROMIDE	mg/l	< 0.25	< 0.050	
D	CADMIUM	ug/l	0.344	0.356	
D	CARBON, DISSOLVE	mg/l	0.98	0.85	
D	CHLORIDE	mg/l	4.8	7.03	
D	CHROMIUM	ug/l	< 0.10	< 0.10	
D	COBALT	ug/l	0.87	1.05	
D	COPPER	ug/l	< 0.50	< 0.20	
D	FLUORIDE	mg/l	0.28	0.340	
D	IRON	mg/l	< 0.010	< 0.010	
D	LEAD	ug/l	< 0.050	< 0.050	
D	LITHIUM	mg/l	0.0958	0.109	
D	MANGANESE	mg/l	0.551	0.432	
D	MERCURY	ug/l	< 0.0050	< 0.0050	
D	MOLYBDENUM	mg/l	0.00210	0.00222	
D	NICKEL	ug/l	5.26	5.39	
D	SELENIUM	ug/l	0.052 0.143	0.056	
D	SILVER	ug/l	< 0.010	< 0.010	
D	STRONTIUM	mg/l	0.223	0.238	
D	SULFATE (AS SO4)	mg/l	343	367	
D	THALLIUM	ug/l	0.029	0.039	
D	TIN	mg/l	< 0.00010	< 0.00010	
D	TITANIUM	ug/l	< 10	< 10	
D	URANIUM	ug/l	6.95	5.83	
D	VANADIUM	ug/l	< 0.50	< 0.50	
D	ZINC	ug/l	< 3.0	2.3	
N	ALKALINITY, TOTAL	mg/l	348	328	
N	CONDUCTIVITY, FIE	us/cm	1044	1107	
N	CONDUCTIVITY, LAB	us/cm	1190	1150	
N	DISSOLVED OXYGEN	mg/l	8.07	6.45	
N	Hardness, Total or D	mg/l	642	709	
N	INSTANT_FLOW	m3/s			0.002
N	NITRATE NITROGEN	mg/l	< 0.025	0.0135	
N	NITRITE NITROGEN	mg/l	< 0.0050	< 0.0010	
N	NITROGEN, AMMON	mg/l	0.0067	0.0092	
N	ORTHO-PHOSPHATE	mg/l	< 0.0010	< 0.0010	
N	pH, Field	ph units	7.60	7.43	
N	pH, LAB	ph units	7.98	8.28	
N	PHOSPHORUS	mg/l	0.0012	< 0.0010	
N	TEMPERATURE, FIEL	deg c	4.3	16.6	
N	The sum of extractal	mg/l		< 0.50	
N	TOTAL DISSOLVED S	mg/l	839	904	
N	TOTAL KJELDAHL NI	mg/l	< 0.050	0.057	
N	TOTAL SUSPENDED	mg/l	< 1.0	8.4	
N	TURBIDITY, LAB	ntu	0.17	0.35	
T	ALUMINUM	mg/l	< 0.0030	< 0.0030	
T	ANTIMONY	ug/l	< 0.10	< 0.10	
T	ARSENIC	ug/l	< 0.10	0.12	
T	BARIUM	mg/l	0.0803	0.0829	
T	BERYLLIUM	ug/l	< 0.020	< 0.020	
T	BISMUTH	mg/l	< 0.000050	< 0.000050	
T	BORON	mg/l	0.032	0.041	
T	CADMIUM	ug/l	0.416	0.444	
T	CALCIUM	mg/l	135	144	
T	CHROMIUM	ug/l	< 0.10	< 0.10	
T	COBALT	ug/l	0.87	1.03	
T	COPPER	ug/l	< 0.50	< 0.50	
T	IRON	mg/l	0.022	0.020	
T	LEAD	ug/l	< 0.050	< 0.050	
T	LITHIUM	mg/l	0.0953	0.112	
T	MAGNESIUM	mg/l	74.7	81.7	
T	MANGANESE	mg/l	0.524	0.427	
T	MERCURY	ug/l	< 0.00050	< 0.0050	
T	MOLYBDENUM	mg/l	0.00213	0.00230	
T	NICKEL	ug/l	5.12	5.39	
T	POTASSIUM	mg/l	6.12	5.93	
T	SELENIUM	ug/l	< 0.050 0.179	0.052	
T	SILVER	ug/l	< 0.010	< 0.010	
T	SODIUM	mg/l	6.41	6.81	
T	STRONTIUM	mg/l	0.228	0.238	
T	THALLIUM	ug/l	0.025	0.036	
T	TIN	mg/l	< 0.00010	< 0.00010	
T	TITANIUM	ug/l	< 10	< 10	
T	TOTAL ORGANIC CA	mg/l	0.85	0.80	
T	URANIUM	ug/l	6.74	6.01	
T	VANADIUM	ug/l	< 0.50	< 0.50	
T	ZINC	ug/l	< 3.0	< 3.0	

Appendix F:
FRO Water Quality Data - STP West Seep
(embankment below West Dam)

		Location	FR_STPWSEEP	FR_STPWSEEP	FR_STPWSEEP	FR_STPWSEEP
		Date	12/12/2017	12/12/2017	19/06/2018	19/06/2018
		Sample Type	NP	N	NP	N
Fraction	Analyte	Unit	Result	Result	Result	Result
D	ALUMINUM	mg/l	< 0.0030		< 0.0010	
D	ANTIMONY	ug/l	0.12		< 0.10	
D	ARSENIC	ug/l	< 0.10		< 0.10	
D	BARIUM	mg/l	0.110		0.0991	
D	BERYLLIUM	ug/l	< 0.020		< 0.020	
D	BISMUTH	mg/l	< 0.000050		< 0.000050	
D	BORON	mg/l	0.031		0.033	
D	BROMIDE	mg/l	< 0.25		< 0.050	
D	CADMIUM	ug/l	0.421		0.756	
D	CARBON, DISSOLVE	mg/l	1.17		0.69	
D	CHLORIDE	mg/l	4.5		5.84	
D	CHROMIUM	ug/l	< 0.10		< 0.10	
D	COBALT	ug/l	1.17		1.41	
D	COPPER	ug/l	< 0.50		< 0.20	
D	FLUORIDE	mg/l	0.30		0.404	
D	IRON	mg/l	< 0.010		< 0.010	
D	LEAD	ug/l	< 0.050		< 0.050	
D	LITHIUM	mg/l	0.101		0.108	
D	MANGANESE	mg/l	1.33		0.485	
D	MERCURY	ug/l	< 0.0050		0.0150	
D	MOLYBDENUM	mg/l	0.00291		0.00250	
D	NICKEL	ug/l	6.43		5.50	
D	SELENIUM	ug/l	0.156 0.204		0.129	
D	SILVER	ug/l	< 0.010		< 0.010	
D	STRONTIUM	mg/l	0.225		0.228	
D	SULFATE (AS SO4)	mg/l	323		323	
D	THALLIUM	ug/l	0.073		0.034	
D	TIN	mg/l	< 0.00010		< 0.00010	
D	TITANIUM	ug/l	< 10		< 10	
D	URANIUM	ug/l	7.95		7.29	
D	VANADIUM	ug/l	< 0.50		< 0.50	
D	ZINC	ug/l	< 3.0		2.0	
N	ALKALINITY, TOTAL	mg/l	365		369	
N	CONDUCTIVITY, FIE	us/cm	18.5		1083	
N	CONDUCTIVITY, LAB	us/cm	1180		1150	
N	DISSOLVED OXYGEN	mg/l	6.47		6.9	
N	Hardness, Total or D	mg/l	636		699	
N	INSTANT_FLOW	m3/s		0.0006		0.02
N	NITRATE NITROGEN	mg/l	< 0.025		0.0148	
N	NITRITE NITROGEN	mg/l	< 0.0050		< 0.0010	
N	NITROGEN, AMMON	mg/l	0.0265		0.0116	
N	ORTHO-PHOSPHATE	mg/l	< 0.0010		< 0.0010	
N	pH, Field	ph units	7.96		7.43	
N	pH, LAB	ph units	7.94		8.32	
N	PHOSPHORUS	mg/l	0.0014		< 0.0010	
N	TEMPERATURE, FIEL	deg c	8.1		9.9	
N	The sum of extractal	mg/l			< 0.50	
N	TOTAL DISSOLVED S	mg/l	813		866	
N	TOTAL KJELDAHL NI	mg/l	0.160		< 0.050	
N	TOTAL SUSPENDED	mg/l	< 1.0		< 1.0	
N	TURBIDITY, LAB	ntu	0.77		0.12	
T	ALUMINUM	mg/l	< 0.0030		< 0.0030	
T	ANTIMONY	ug/l	0.13		< 0.10	
T	ARSENIC	ug/l	0.11		< 0.10	
T	BARIUM	mg/l	0.111		0.0984	
T	BERYLLIUM	ug/l	< 0.020		< 0.020	
T	BISMUTH	mg/l	< 0.000050		< 0.000050	
T	BORON	mg/l	0.033		0.034	
T	CADMIUM	ug/l	0.452		0.768	
T	CALCIUM	mg/l	132		139	
T	CHROMIUM	ug/l	< 0.10		0.12	
T	COBALT	ug/l	1.16		1.35	
T	COPPER	ug/l	< 0.50		< 0.50	
T	IRON	mg/l	0.100		< 0.010	
T	LEAD	ug/l	< 0.050		< 0.050	
T	LITHIUM	mg/l	0.0988		0.107	
T	MAGNESIUM	mg/l	72.5		78.9	
T	MANGANESE	mg/l	1.37		0.501	
T	MERCURY	ug/l	< 0.00050		< 0.0050	
T	MOLYBDENUM	mg/l	0.00282		0.00263	
T	NICKEL	ug/l	6.36		5.47	
T	POTASSIUM	mg/l	6.20		5.78	
T	SELENIUM	ug/l	0.132 0.245		0.093	
T	SILVER	ug/l	< 0.010		< 0.010	
T	SODIUM	mg/l	6.22		6.02	
T	STRONTIUM	mg/l	0.216		0.224	
T	THALLIUM	ug/l	0.066		0.034	
T	TIN	mg/l	< 0.00010		< 0.00010	
T	TITANIUM	ug/l	< 10		< 10	
T	TOTAL ORGANIC CA	mg/l	1.51		0.70	
T	URANIUM	ug/l	7.80		7.42	
T	VANADIUM	ug/l	< 0.50		< 0.50	
T	ZINC	ug/l	< 3.0		< 3.0	

APPENDIX G

Tailings Storage Facility Registry

Mine Name: Fording River Operations
Permit No: No. C-3 (and amendments)

General Mine Information	
Owner/company	Teck Resources Ltd.
Nearest community	Elkford
Region	Elk Valley / East Kootenay
Ore(s) mined	Coal
Mine operational status	Operational
Number of tailings impoundments	4

TSF Documentation	
Date of last DSI	11 to 12 September 2018
Date of last DSR	November 2014
Date of next DSR	2019
Date of OMS update	October 2018
Date of EPRP update	September 2018
Date of EPRP test	December 2018
Date of dam breach and inundation study	28 November 2014
Tailings Management system (name)	FRO Tailings Management System
Tailings management system (last audit)	Legal compliance audit Aug. 2016
TSF risk assessment last reviewed	November 2017
Water balance and water management plan (last update)	2017, update in progress
Date of last as-built	2012 & 2013

TSF Information	
TSF name	**South Tailings Pond**
TSF operating status	Active, in use
Year facility was last used (if closed)	Currently in use
Number of dams	2
Engineer of record	John Cunning (Golder Associates Ltd.)
TSF qualified person	Heather Brickner
Spillway present	no
Spillway date of last maintenance	n/a
Quantitative Performance Objectives (QPOs)	yes
Volume of impoundment	12.1 million m^3

Dam Information	
Dam name	**Main Dam**
Height of dam	35 m
Consequence classification	Very High
Slope	1.5 to 1.75H : 1V
minimum factor of safety (long term steady state)	1.5
minimum factor of safety (pseudo-static)	1.2
Permitted elevation	1,637.85 m
Current elevation	1,637.85 m
Seismic design (AEP)	1/2 between 1/2,475 and 1/10,000 or Maximum Credible Earthquake
Flood design (AEP)	2/3 between 1/1,000 and PMF event
Type of dam construction (upstream, downstream, centre)	downstream
Type of dam core (till core, rock fill, cyclone sand, etc.)	till core

Dam Information	
Dam name	**West Dam**
Height of dam	35 m
Consequence classification	Very High
Slope	1.5 to 1.75H : 1V
minimum factor of safety (long term steady state)	1.6
minimum factor of safety (pseudo-static)	1.0
Permitted elevation	1,637.85 m to 1640 m
Current elevation	1,637.85 m to 1640 m
Seismic design (AEP)	1/2 between 1/2,475 and 1/10,000 or Maximum Credible Earthquake
Flood design (AEP)	2/3 between 1/1,000 and PMF event
Type of dam construction (upstream, downstream, centre)	downstream
Type of dam core (till core, rock fill, cyclone sand, etc.)	till core

TSF Information	
TSF name	**North Tailings Pond**
TSF operating status	Inactive
Year facility was last used (if closed)	2006
Number of dams	1
Engineer of record	John Cunning (Golder Associates Ltd.)
TSF qualified person	Heather Brickner
Spillway present	no
Spillway date of last maintenance	n/a
Quantitative Performance Objectives (QPOs)	yes
Volume of impoundment	3.8 million m^3

Dam Information	
Dam name	**North Tailings Pond Dam**
Height of dam	24 m
Consequence classification	Very High
Slope	1.5 to 1.75H : 1V
minimum factor of safety (long term steady state)	1.5
minimum factor of safety (pseudo-static)	1.2
Permitted elevation	1653.09 m
Current elevation	1,652.6 m
Seismic design (AEP)	1/2 between 1/2,475 and 1/10,000 or Maximum Credible Earthquake
Flood design (AEP)	2/3 between 1/1,000 and PMF event
Type of dam construction (upstream, downstream, centre)	downstream
Type of dam core (till core, rock fill, cyclone sand, etc.)	till core

Notes: Elevations reported in the Elk Valley Elevation Datum.

Sources: 2018 Dam Safety Inspection for North Tailings Pond and South Tailings Pond (Golder, March 2019)
C-3 Permit Amendments

General Mine Information	
Owner/company	
Nearest community	name of closest community
Region	mining region name - Southcoast, Northwest, Northeast, Kootenays, Okanagan
Ore(s) mined	
Mine operational status	Operating, Closed or Care and Maintenance
Number of tailings impoundments	

TSF Documentation	
Date of last DSI	dd/mm/yyyy of last inspection performed
Date of last DSR	dd/mm/yyyy of last inspection performed
Date of next DSR	yyyy of next DSR. NOTE DSRs now due every 5 years as per Code requirements
Date of OMS update	dd/mm/yyyy when OMS last updated
Date of EPRP update	dd/mm/yyyy when EPRP last updated
Date of EPRP test	dd/mm/yyyy when last EPRP test
Date of dam breach and inundation study	dd/mm/yyyy
Tailings management system (name)	name of system used (TSM, ISO, etc)
Tailings management system (last audit)	when last audit completed
TSF risk assessment last reviewed	dd/mm/yyyy when last risk assessment completed
Water balance and water management plan (last update)	dd/mm/yyyy last update
Date of last as-built	dd/mm/yyyy when as-built completed for TSF

TSF Information	
TSF name	name of TSF please fill in one box per TSF on site
TSF operating status	current status of TSF - operating or closed. If intention is to use facility in future, please include projected date of re-start
Year facility was last used (if closed)	yyyy that TSF last received tailings
Number of dams	provide number of dams associated with the TSF
Engineer of record	name of Engineer of Record for the TSF
TSF qualified person	name of TSF qualified person
Spillway present	yes or no
Spillway date of last maintenance	dd/mm/yyyy of last maintenance
Quantitative Performance Objectives (QPOs)	yes or no (included in OMS manual and DSI)
Volume of impoundment	volume of impoundment in cubic meters

Dam Information	
Dam name	provide dam name if applicable - please fill in one box per dam on mine site
Height of dam	current height of dam in m (measured toe of slope to crest of dam)
Consequence classification	consequence classification of the dam
Slope	Maximum slope angle (ex. 2H:1V)
minimum factor of safety (long-term steady state)	Minimum FOS (long term steady state analyses)
minimum factor of safety (pseudo-static)	Minimum FOS (pseudo-static analyses)
Permitted elevation	provide highest permitted elevation of the dam in m
Current elevation	provide current elevation of the dam in m
Seismic design (AEP)	Annual Exceedance Probability (Seismic design)
Flood design (AEP)	Annual Exceedance Probability (Flood design)
Type of dam construction (upstream, downstream, centre)	upstream, downstream or centre
Type of dam core (till core, rock fill, cyclone sand, etc.)	till core, rock fill, cyclone same or other

APPENDIX H

GPS Plots

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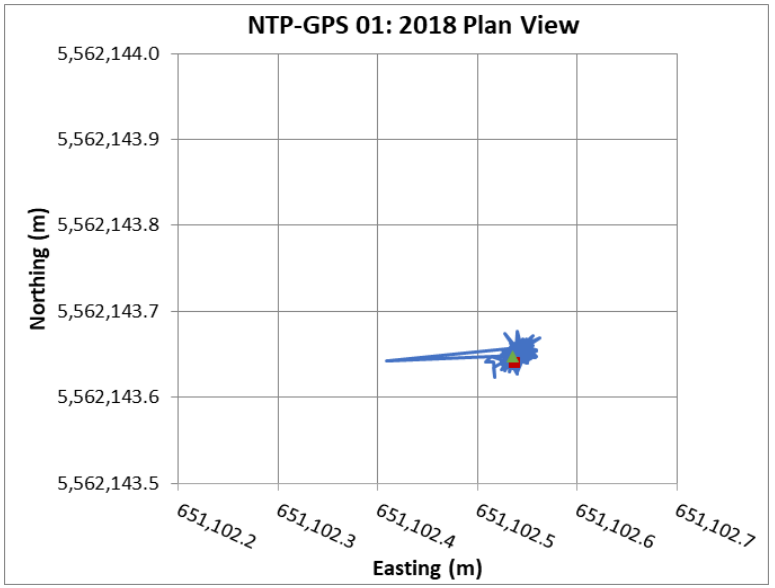

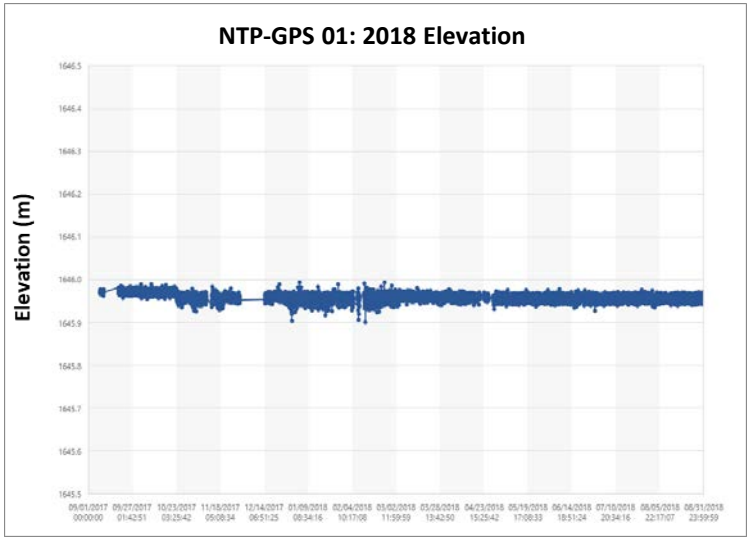

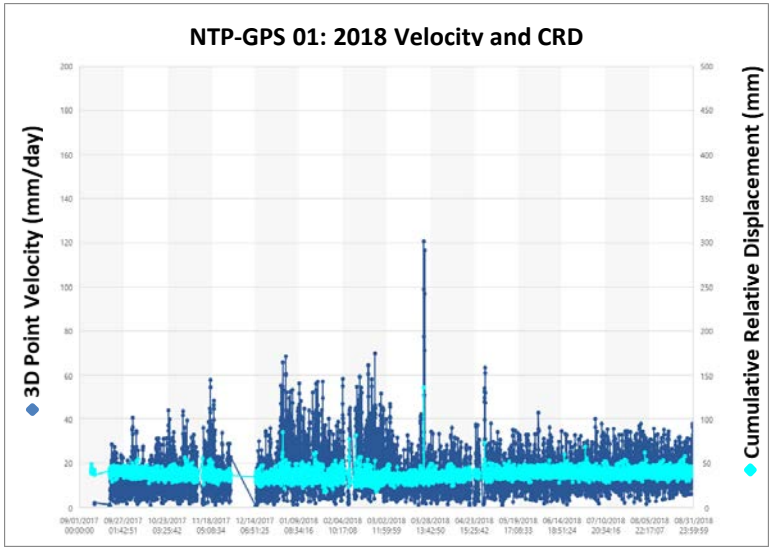

LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-08
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
NTP-GPS 01

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
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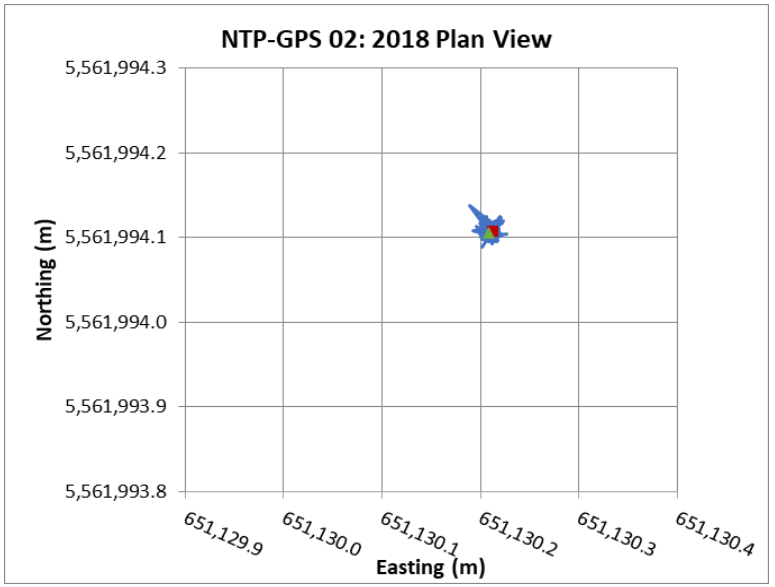

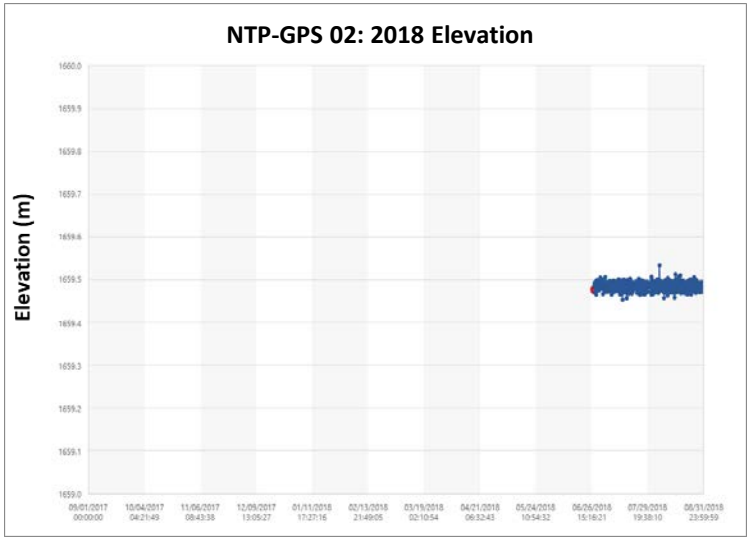

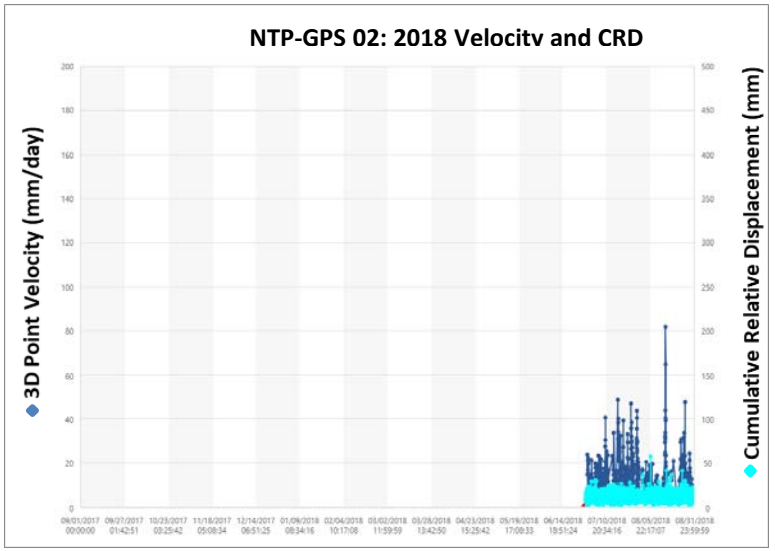

LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-08
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
NTP-GPS 02

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
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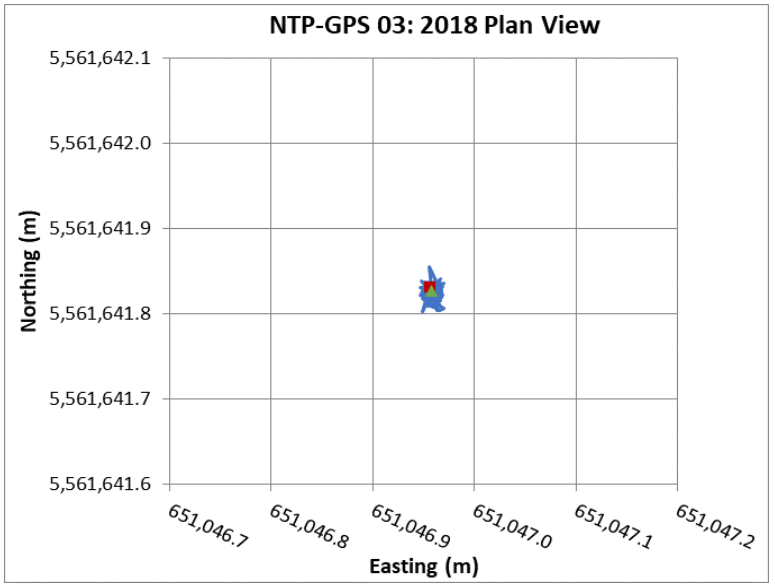

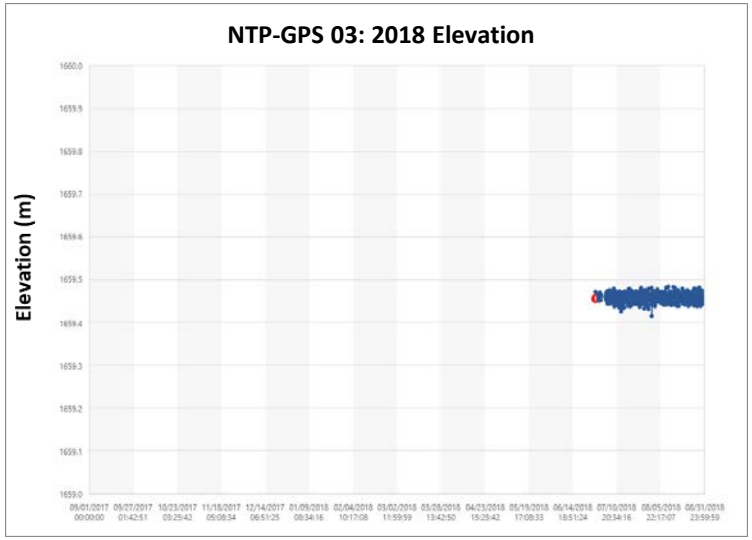

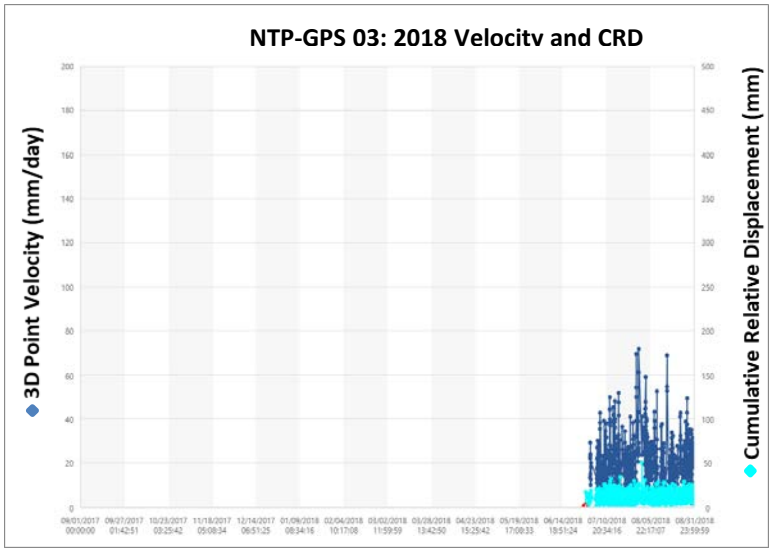

LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-08
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
NTP-GPS 03

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
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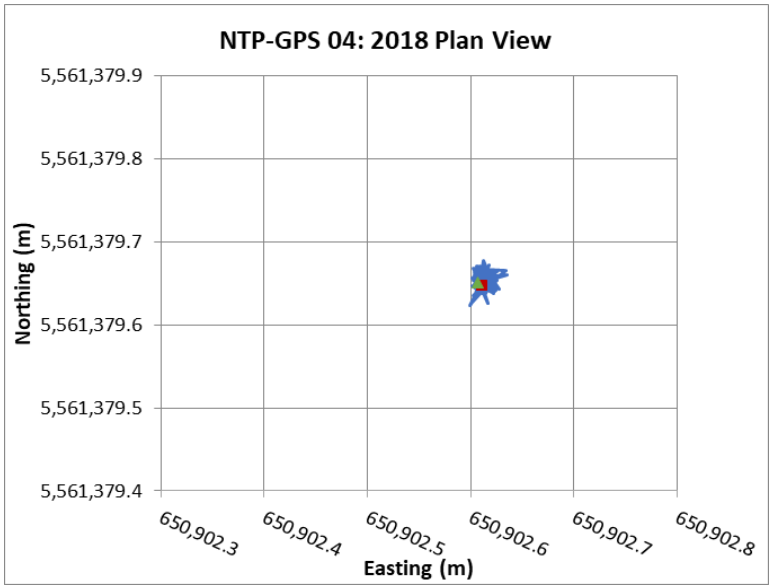

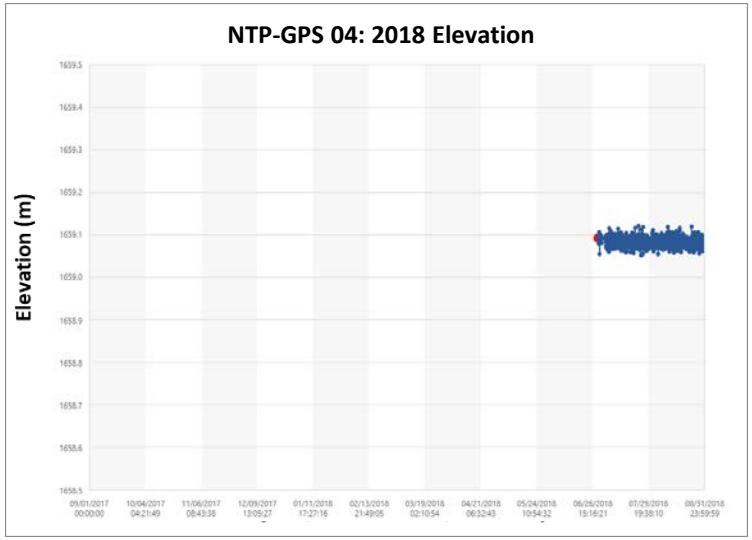

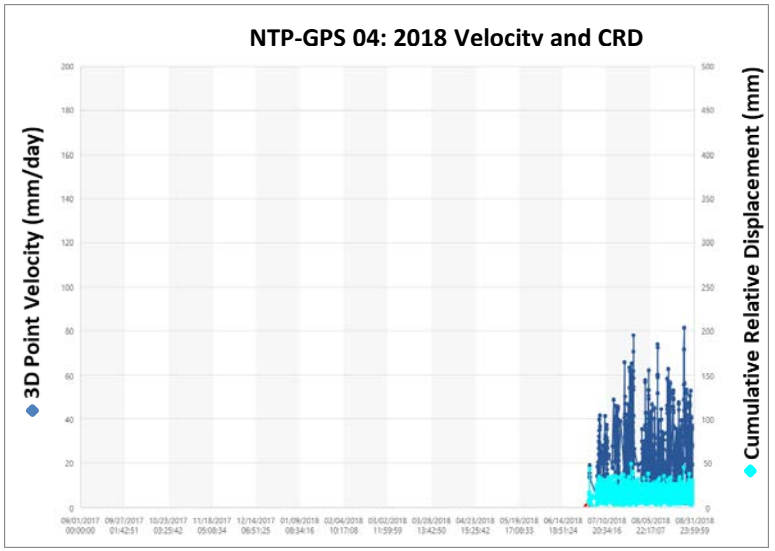

LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

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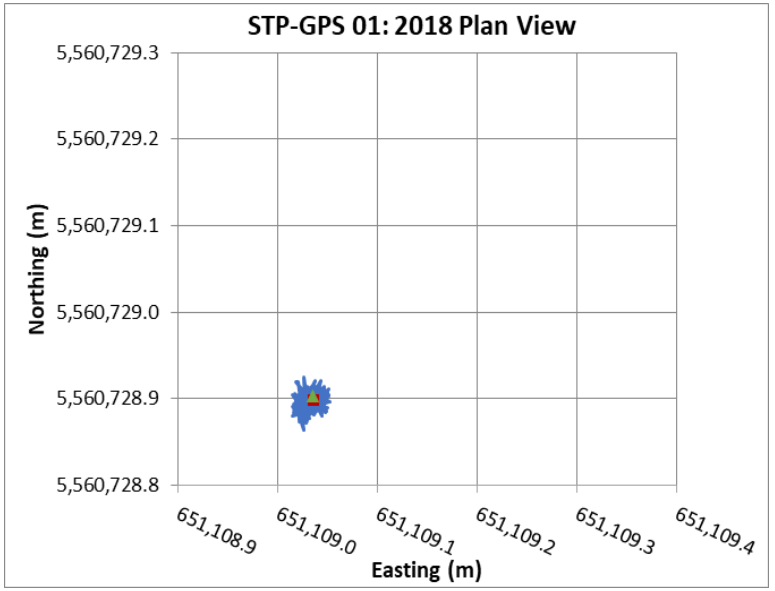
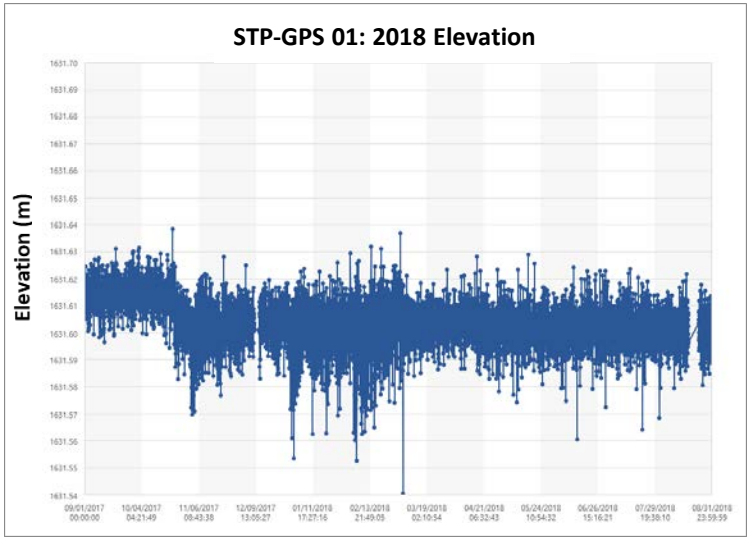
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

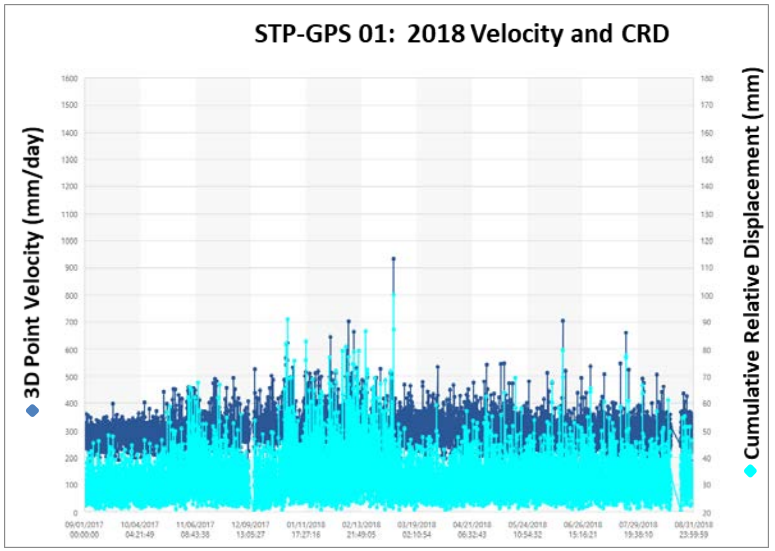
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
NTP-GPS 04

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-4**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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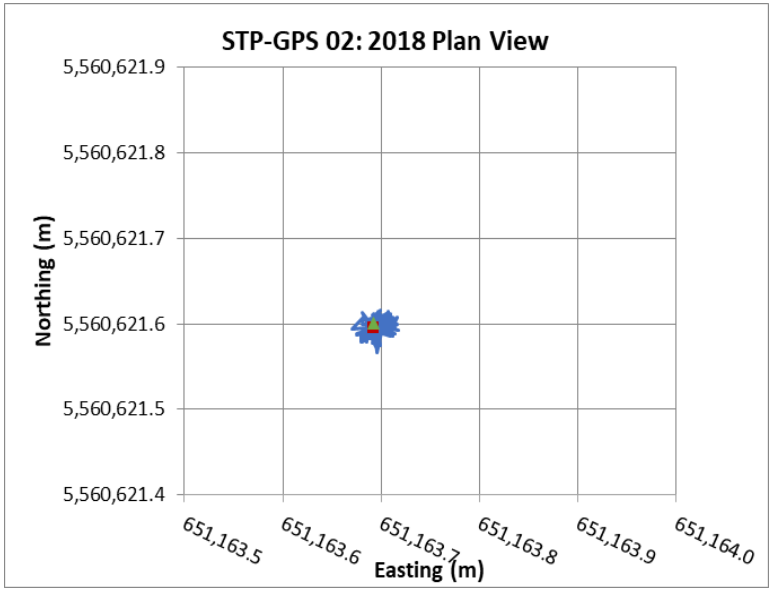
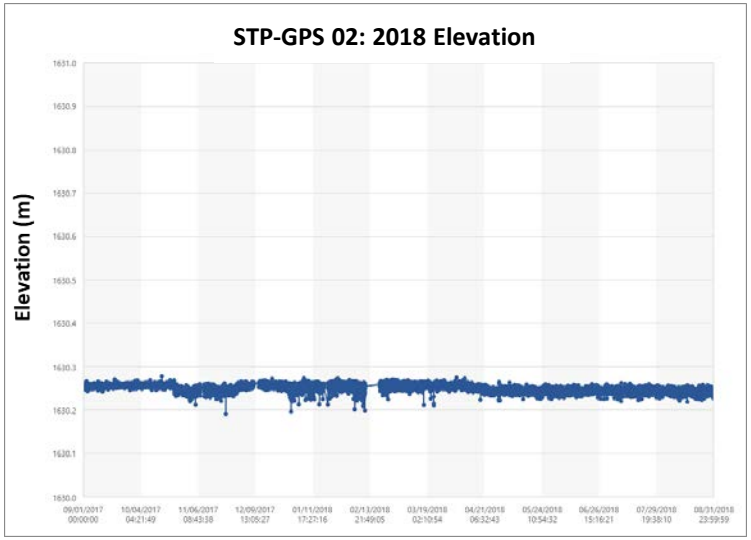
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

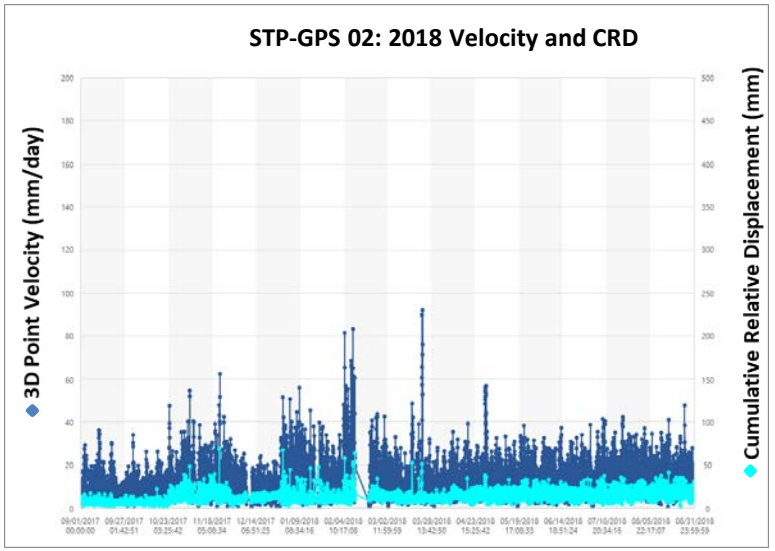
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 01

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-5**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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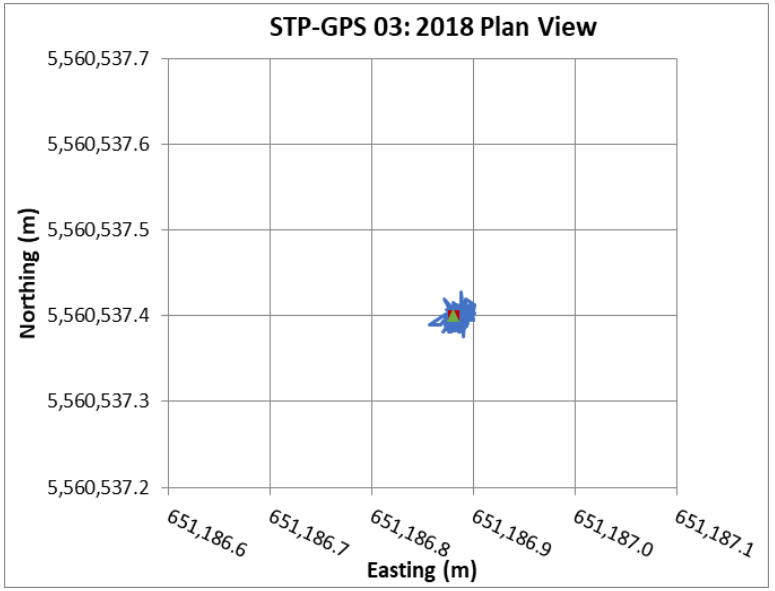
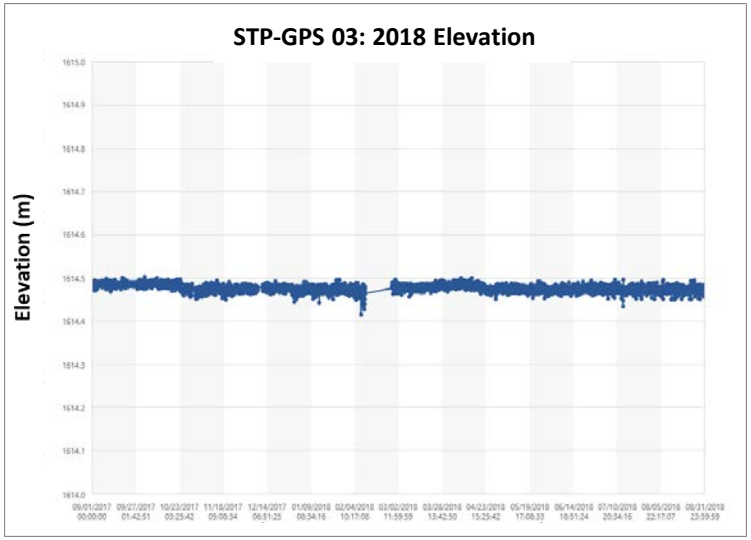
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

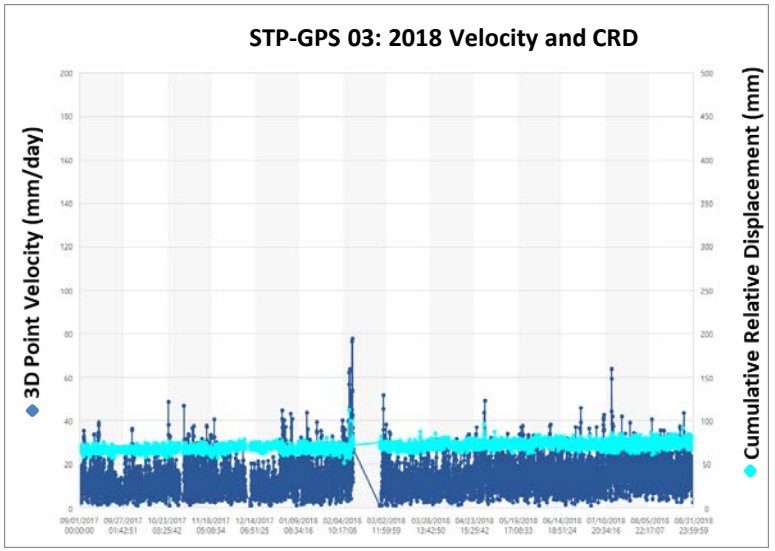
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 02

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-6**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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PREPARED	NC
DESIGN	NC
REVIEW	CYL
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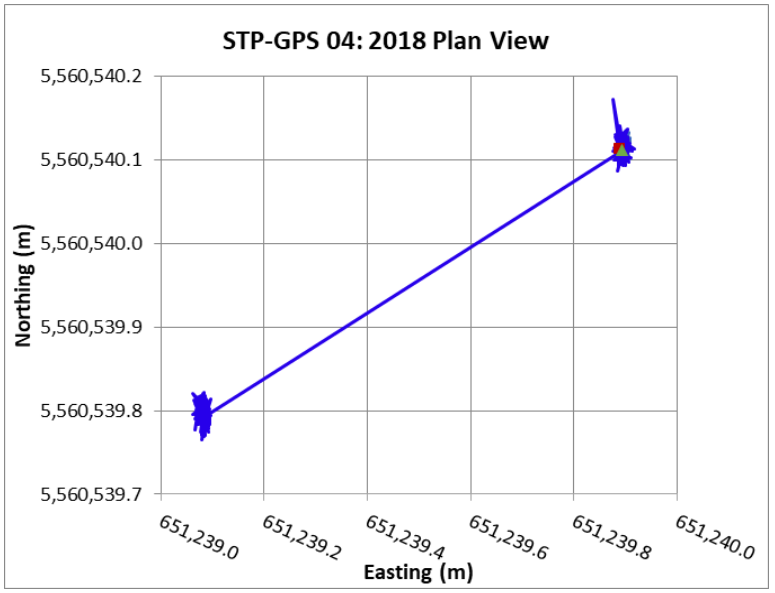
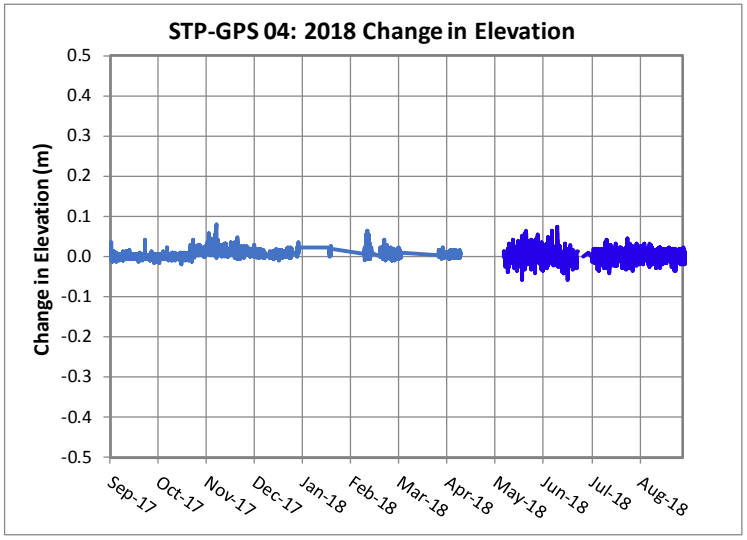
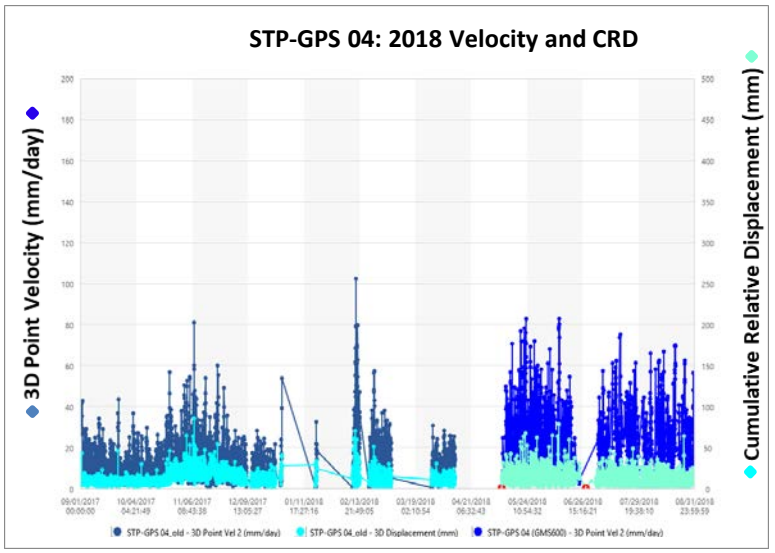
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 03

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-7**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- NEW GPS 2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.
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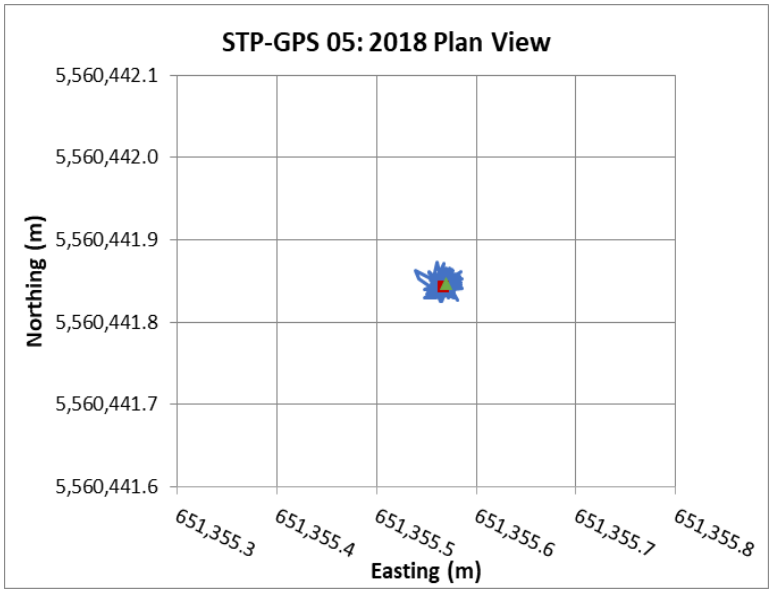
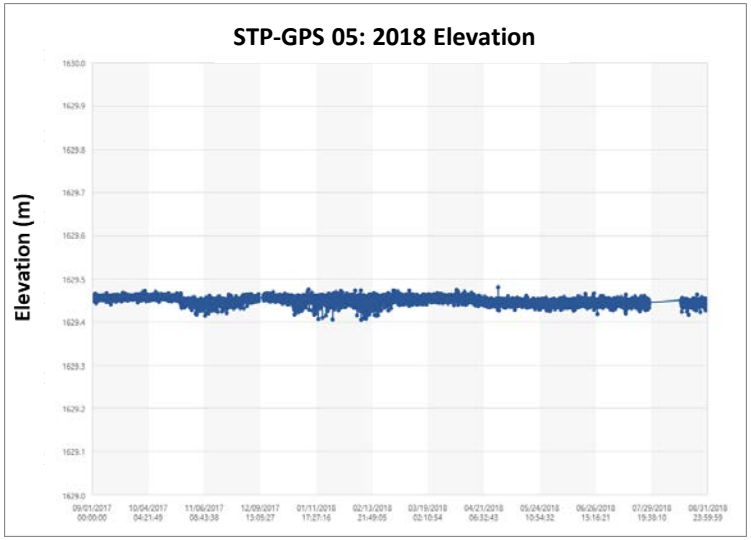
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

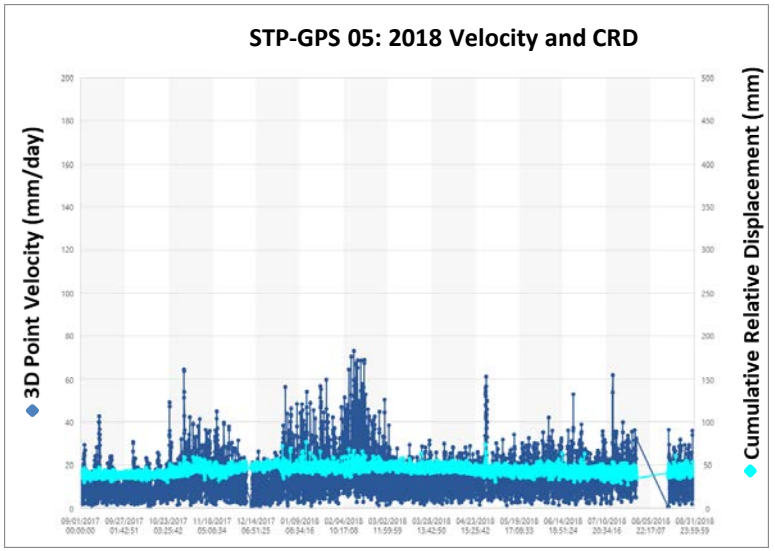
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 04

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-8**







LEGEND FOR PLAN VIEW:

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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DESIGN	NC
REVIEW	CYL
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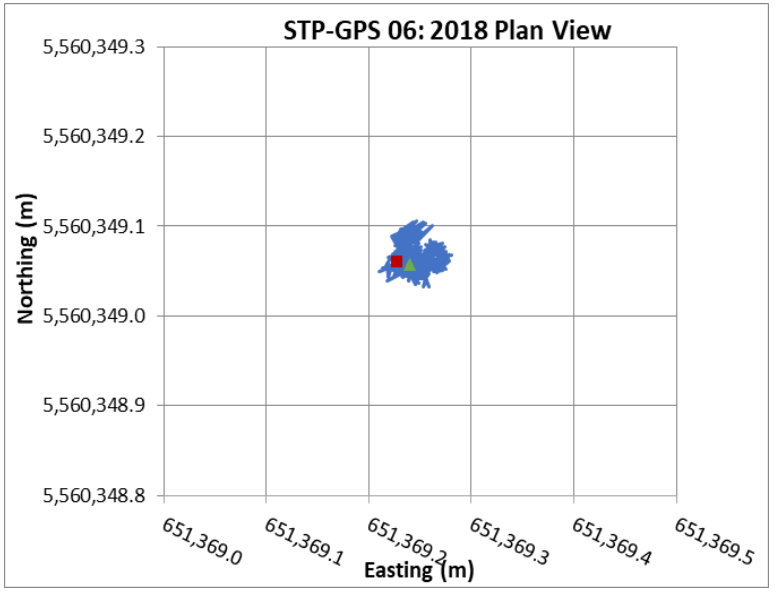
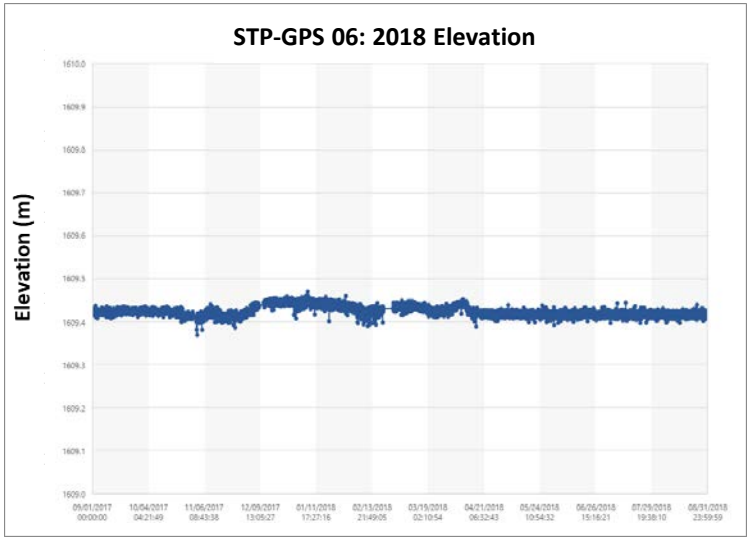
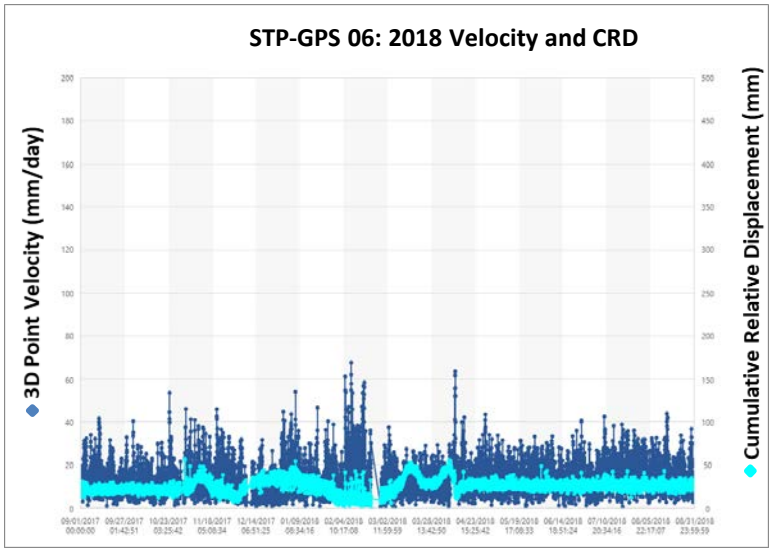
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 05

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-9**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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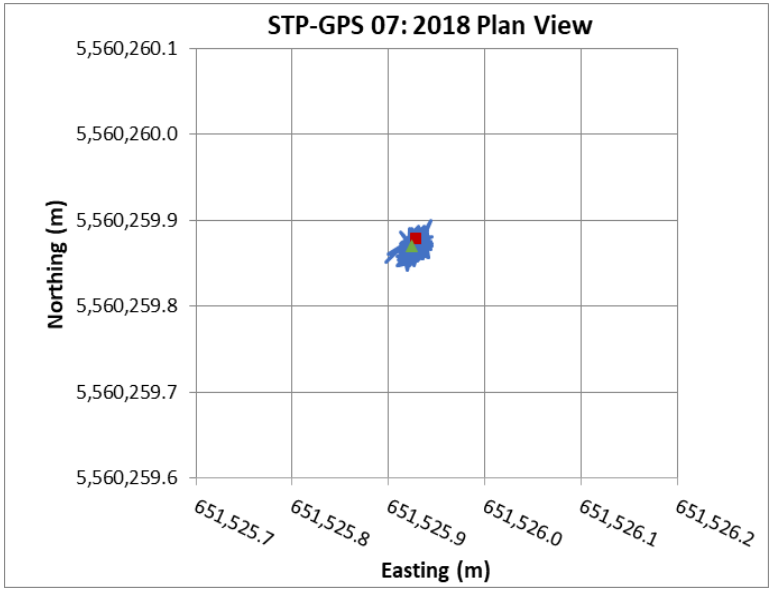
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

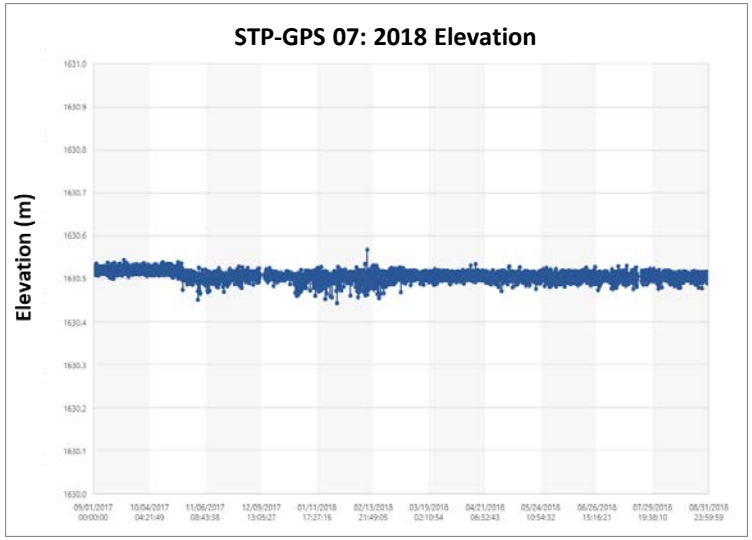
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

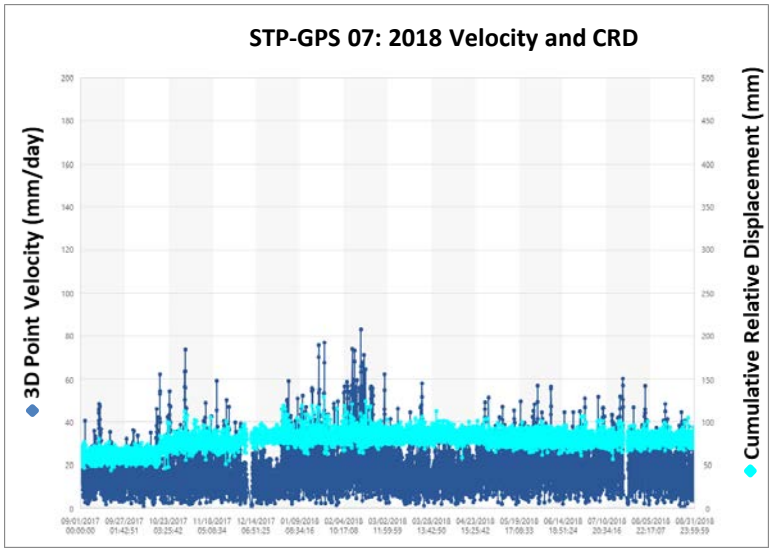
TITLE
SOUTH TAILINGS POND
STP-GPS 06

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-10**

Path: https://golderassociates.sharepoint.com/:p:/r/sites/30979g/Deliverables/Working/2018-156-NTP_STP%20DSI/Appendix%20F%20-%20GPS%20plots/Appendix%20G%20-%20FRO%20GPS%20Monitoring%20Data.ppt?d=w39e93fa4b3284d028ce1a7ab8ae577a3&csf=1&e=DDET8n







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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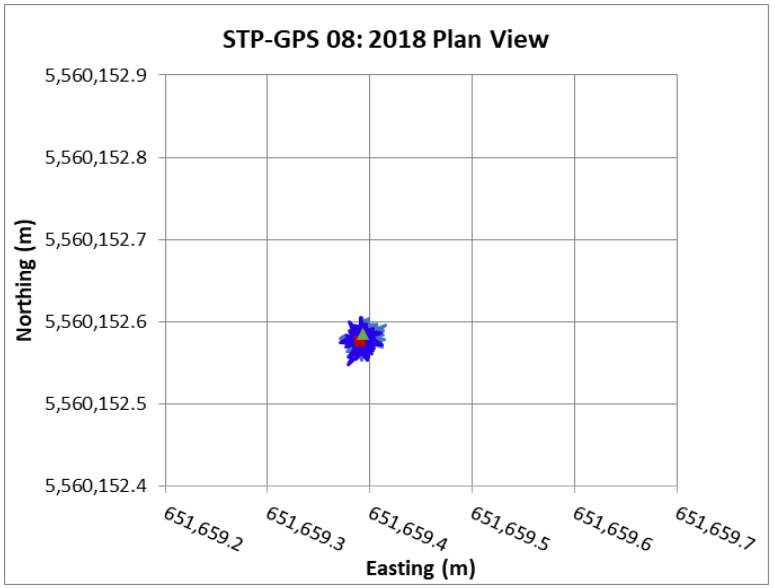
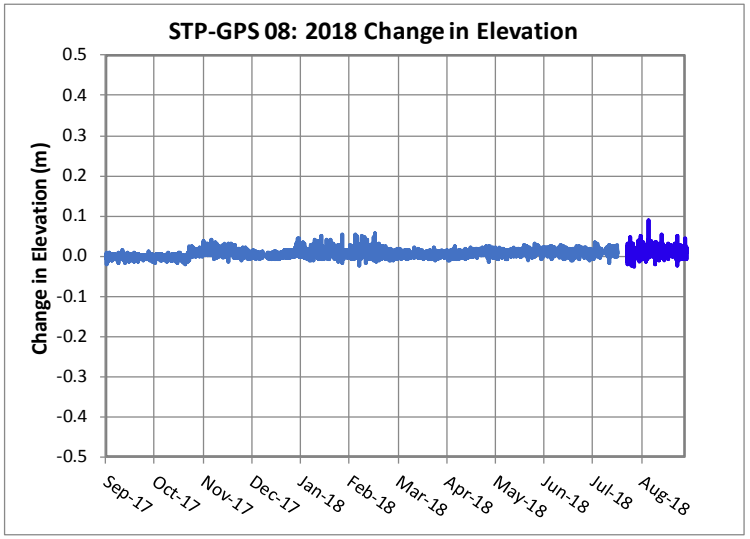
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

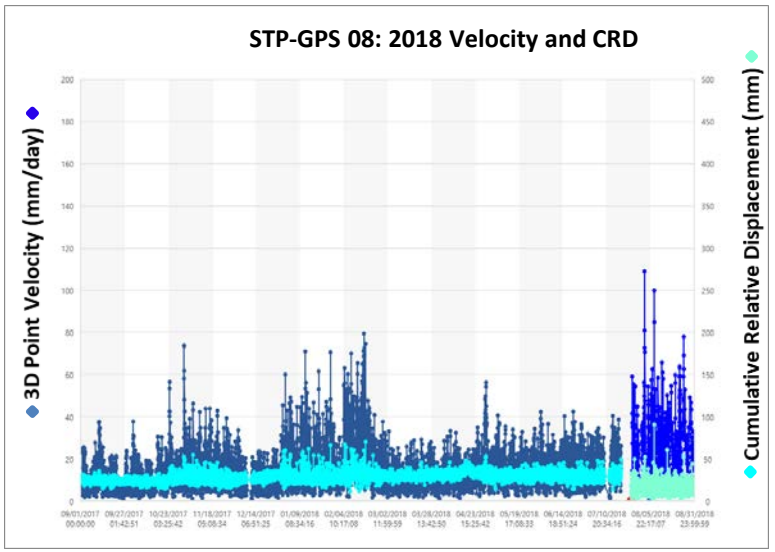
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 07

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-11**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- NEW GPS 2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.
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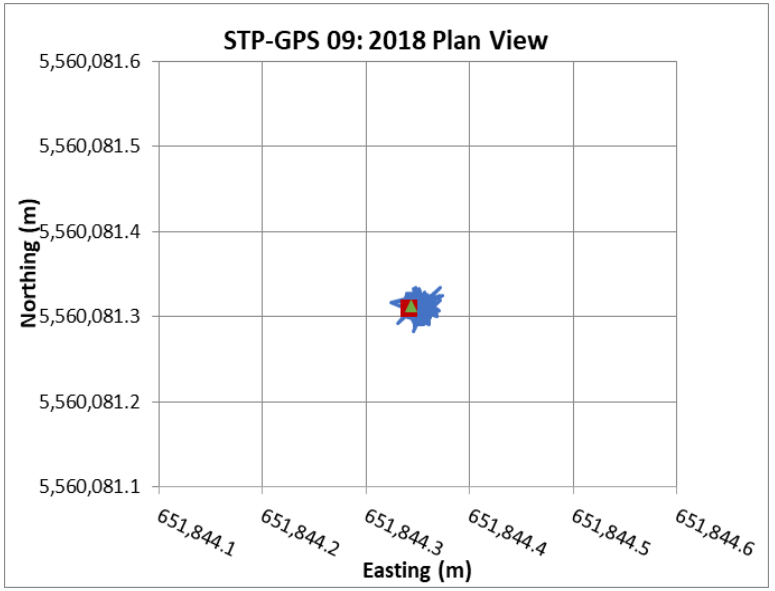
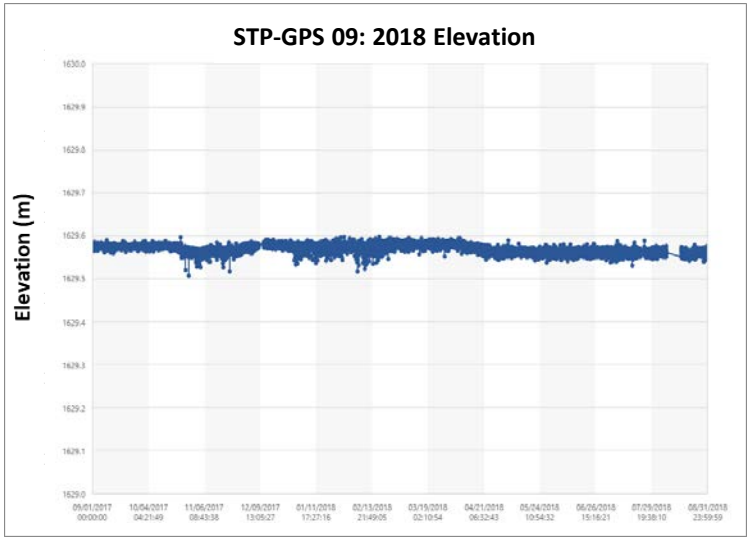
YYYY-MM-DD	2019-03-08
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

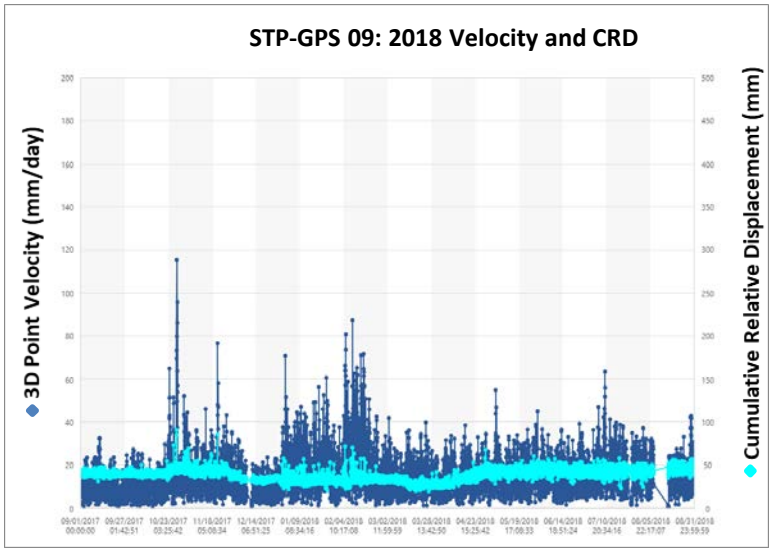
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 08

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-12**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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ELKFORD, B.C.

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GOLDER

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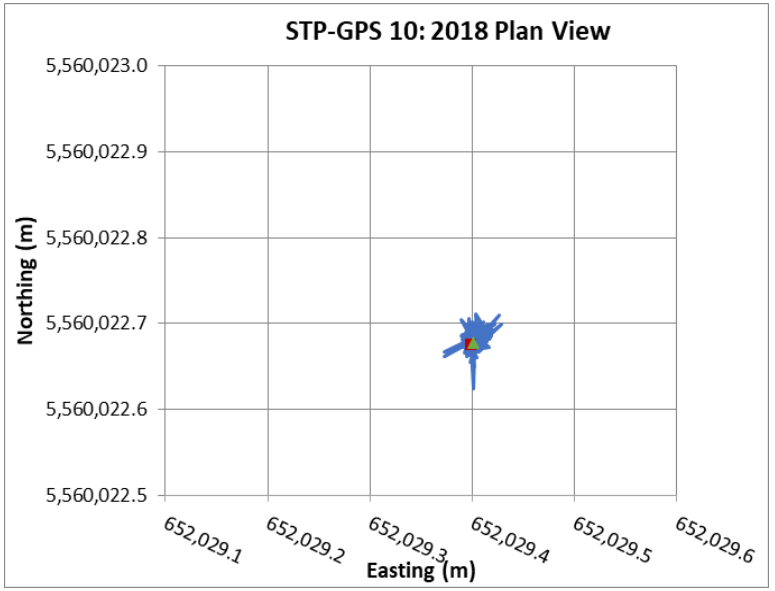
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

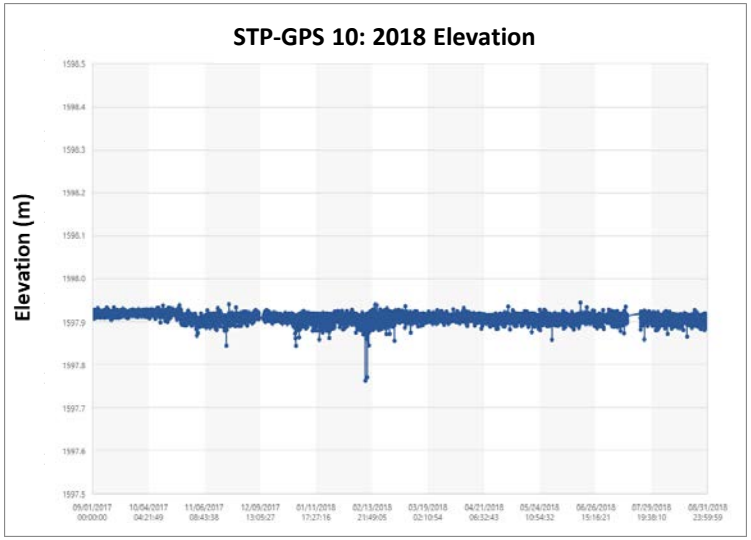
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

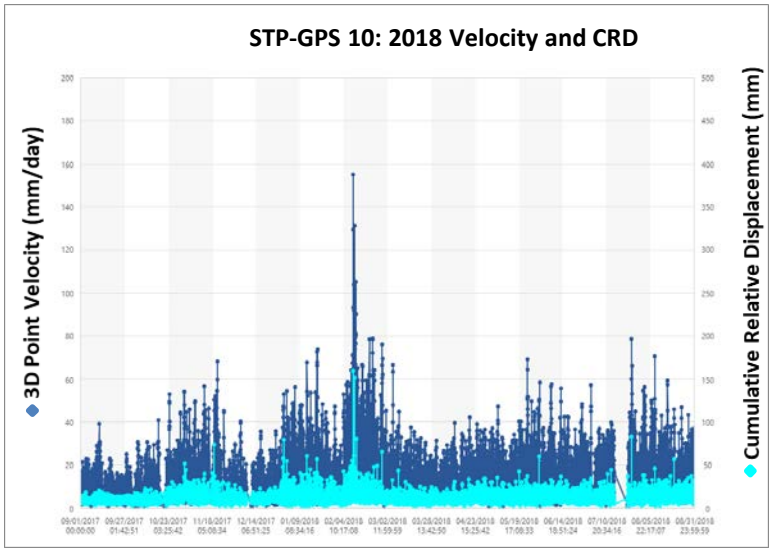
TITLE
SOUTH TAILINGS POND
STP-GPS 09

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-13**

Path: https://golderassociates.sharepoint.com/:p:/r/sites/30979g/Deliverables/Working/2018-156-NTP_STP%20DSI/Appendix%20F%20-%20GPS%20plots/Appendix%20G%20-%20FRO%20GPS%20Monitoring%20Data.ppt?d=w39e93fa4b3284d028ce1a7ab8ae577a3&csf=1&e=DDET8n







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.

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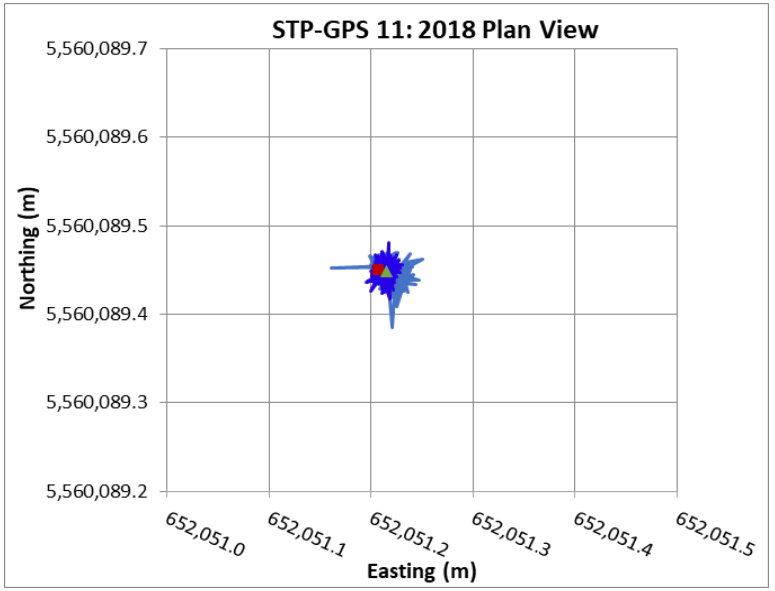
CONSULTANT
GOLDER

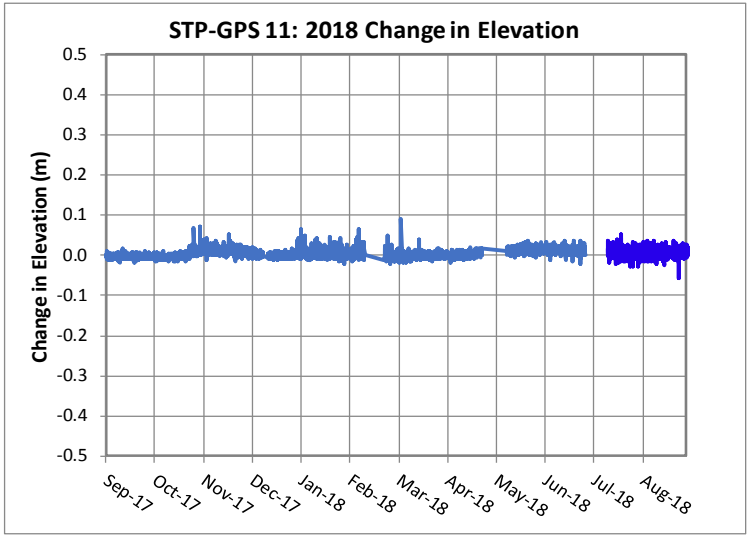
YYYY-MM-DD	2019-03-08
PREPARED	NC
DESIGN	NC
REVIEW	CYL
APPROVED	JCC

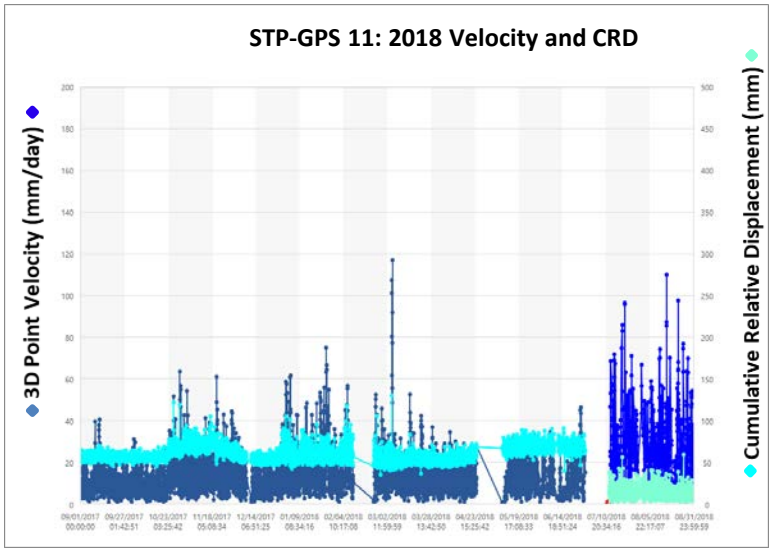
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
STP-GPS 10

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-14**







LEGEND

- INITIAL READING (SEPTEMBER 2017)
- 2017/2018 READINGS
- NEW GPS 2018 READINGS
- LAST READING (AUGUST 2018)

NOTES

1. DATA DOWNLOADED FROM GEOEXPLORER IN JANUARY 2019.
2. THIS GPS UNIT WAS REPLACED AND THE BASE STATION SWITCHED IN JULY 2018. CHANGE IN ELEVATION VS. TIME IS PLOTTED FOR COMPARISON WITH DATA OF OLD GPS, WHICH REFERENCED A DIFFERENT BASE STATION.

CLIENT
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DESIGN	NC
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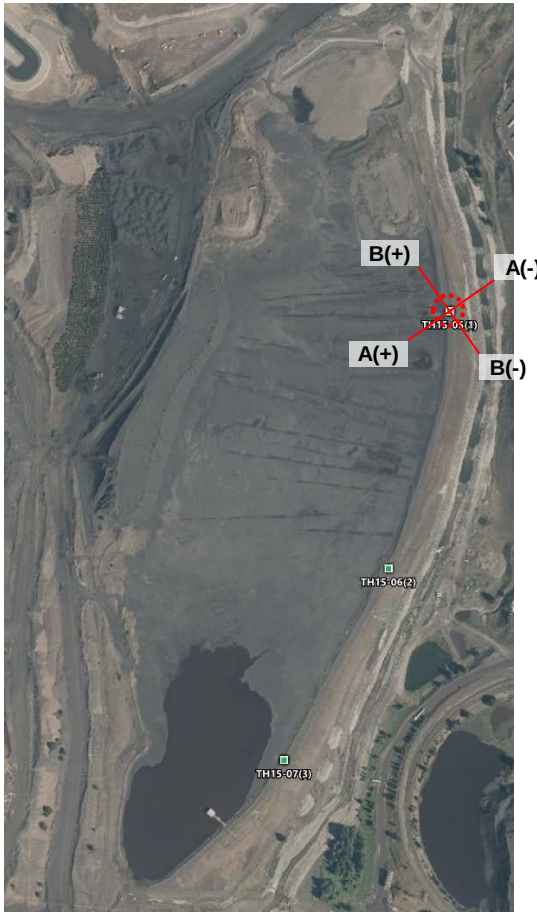
PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

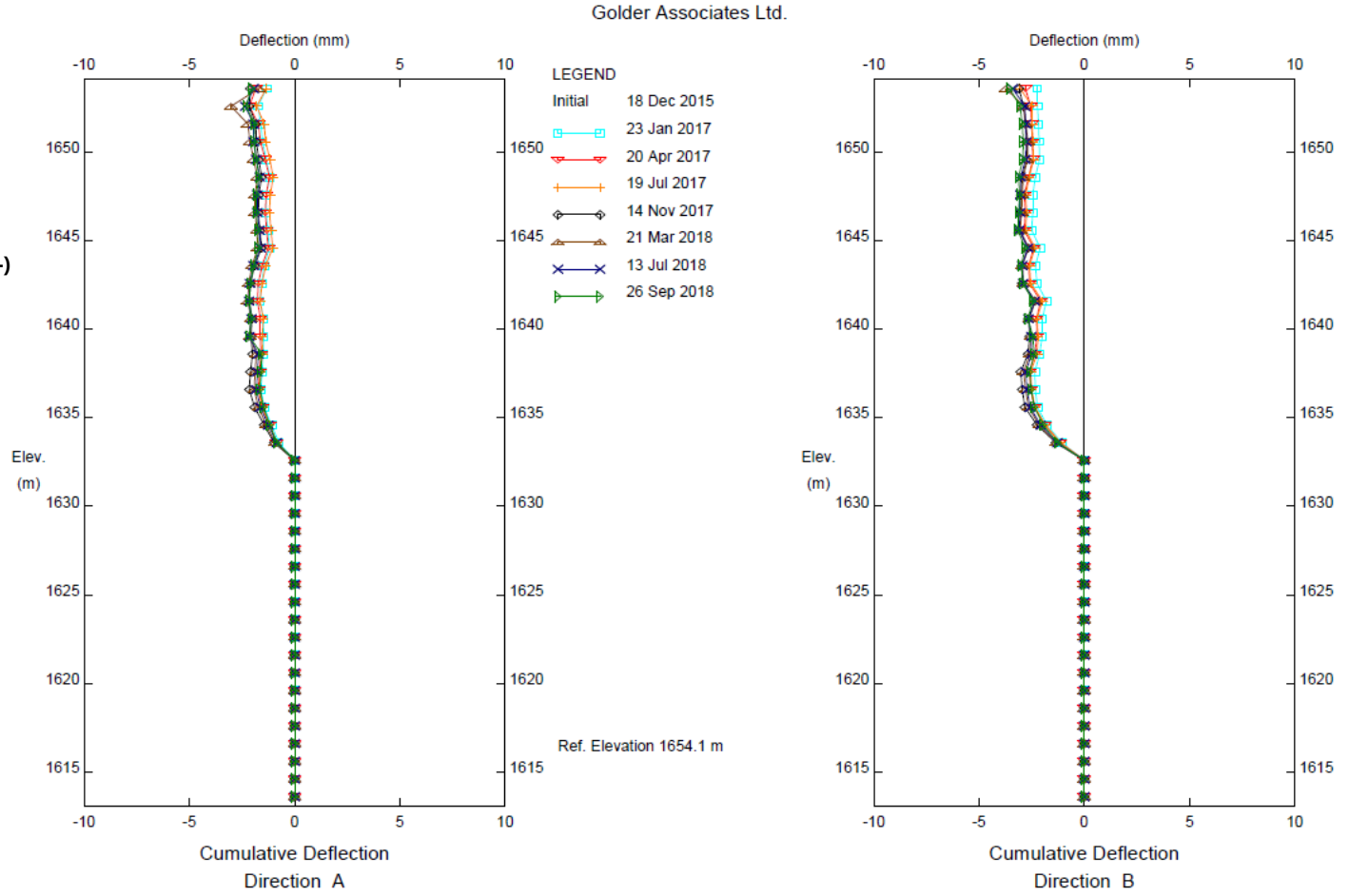
TITLE
SOUTH TAILINGS POND
STP-GPS 11

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**H-15**

APPENDIX I

Slope Inclinometer Data





North Tailings Pond, Inclinometer TH15-05
Fording River Operations

REFERENCES

1. DATA PROVIDED BY FRO OCTOBER 2018.
2. LOCATIONS FROM GEOEXPLORER.
3. A-A AXIS AZIMUTH PROVIDED BY FRO 15 NOVEMBER 2017.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-08
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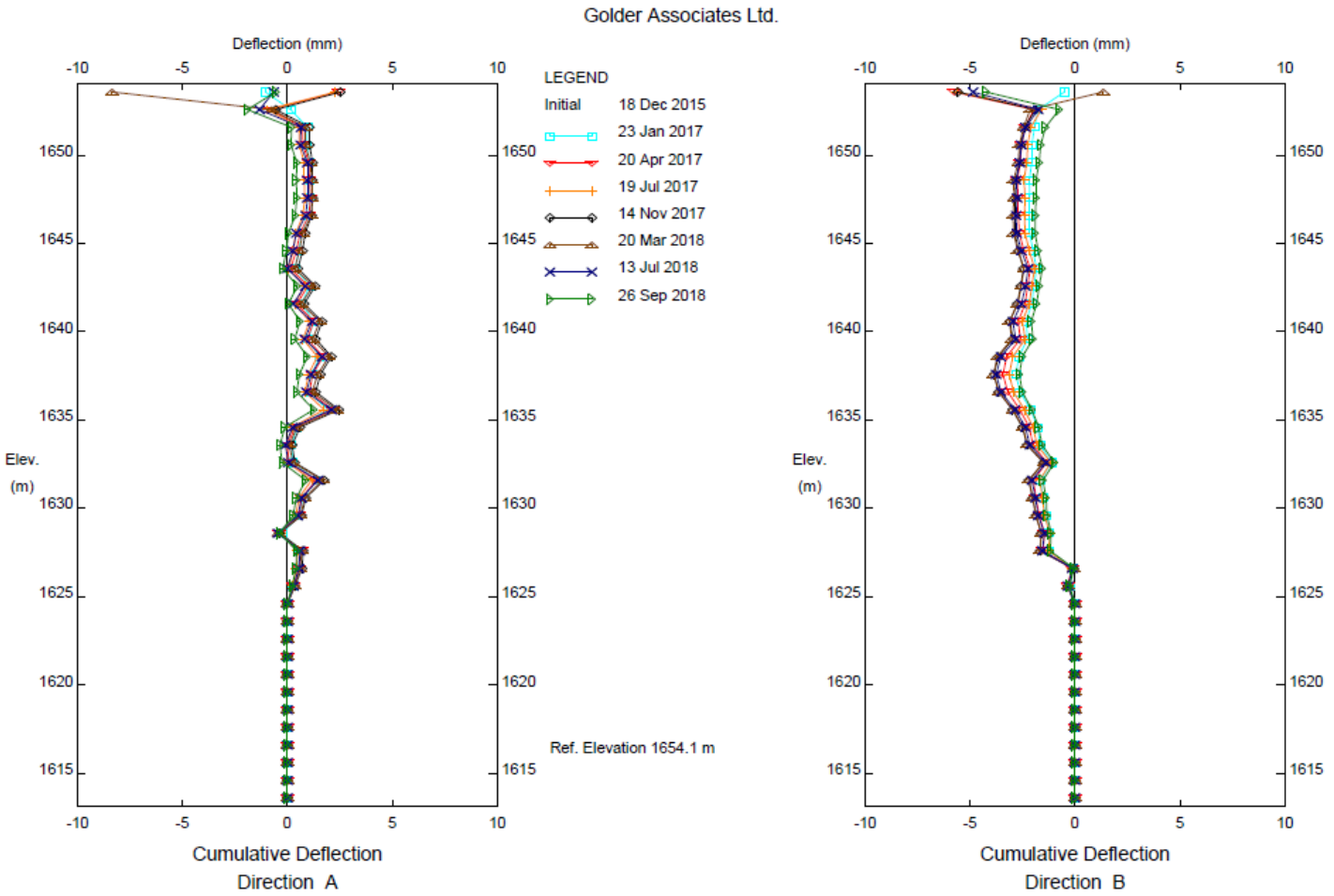
DESIGN	DA
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
TH15-05 INCLINOMETER

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**I-1**



North Tailings Pond, Inclinometer TH15-06
Fording River Operations

REFERENCES

1. DATA PROVIDED BY FRO OCTOBER 2018.
2. LOCATIONS FROM GEOEXPLORER.
3. A-A AXIS AZIMUTH PROVIDED BY FRO 15 NOVEMBER 2017.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

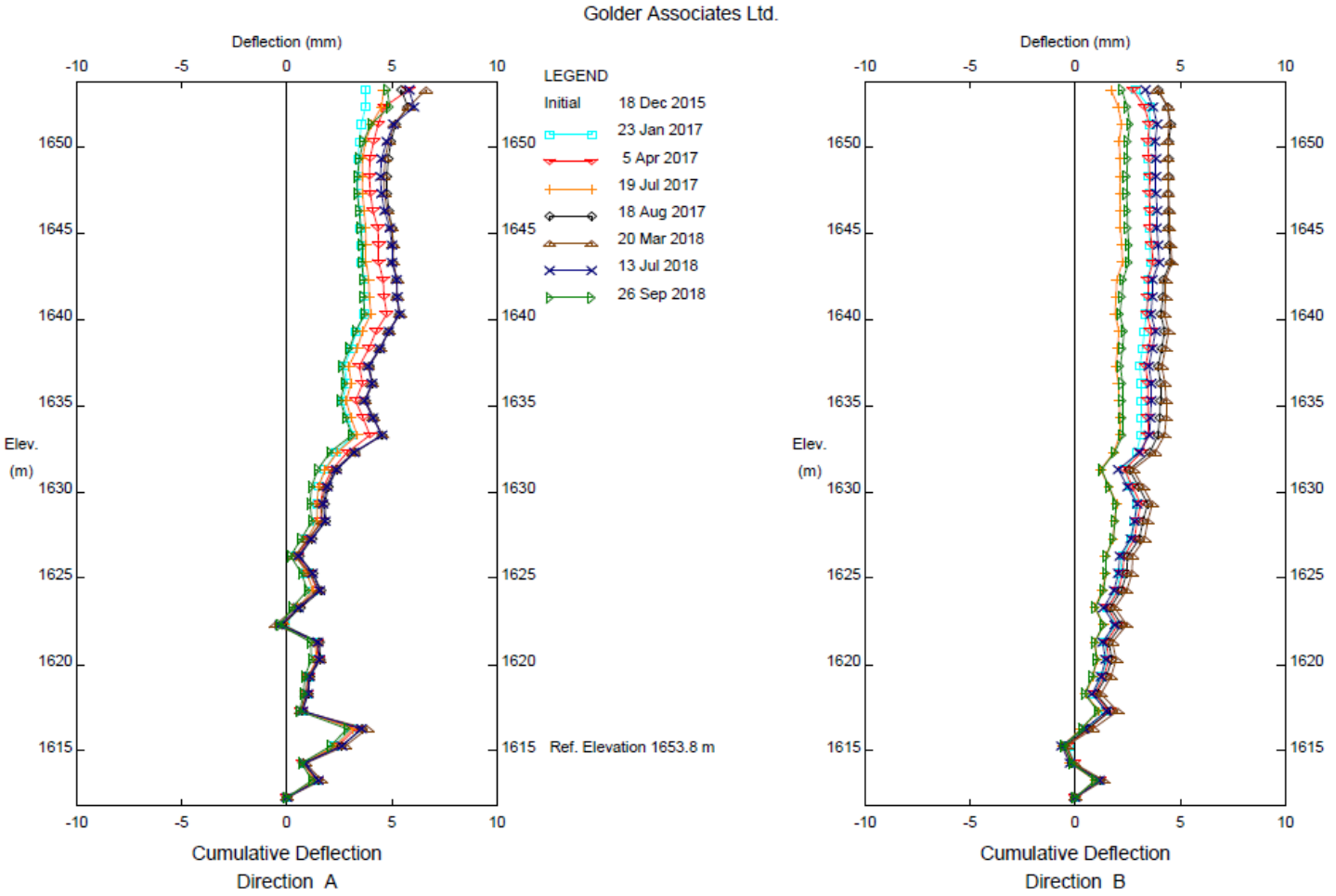
CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-08
PREPARED	DA
DESIGN	DA
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
TH15-06 INCLINOMETER

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**I-2**



North Tailings Pond, Inclinometer TH15-07
Fording River Operations

REFERENCES

1. DATA PROVIDED BY FRO OCTOBER 2018.
2. LOCATIONS FROM GEOEXPLORER.
3. A-A AXIS AZIMUTH PROVIDED BY FRO 15 NOVEMBER 2017.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-08
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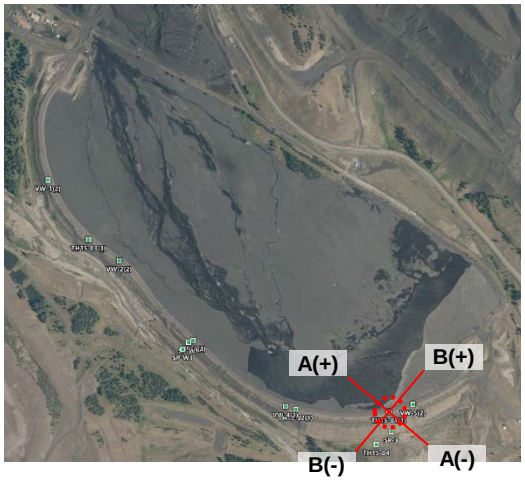
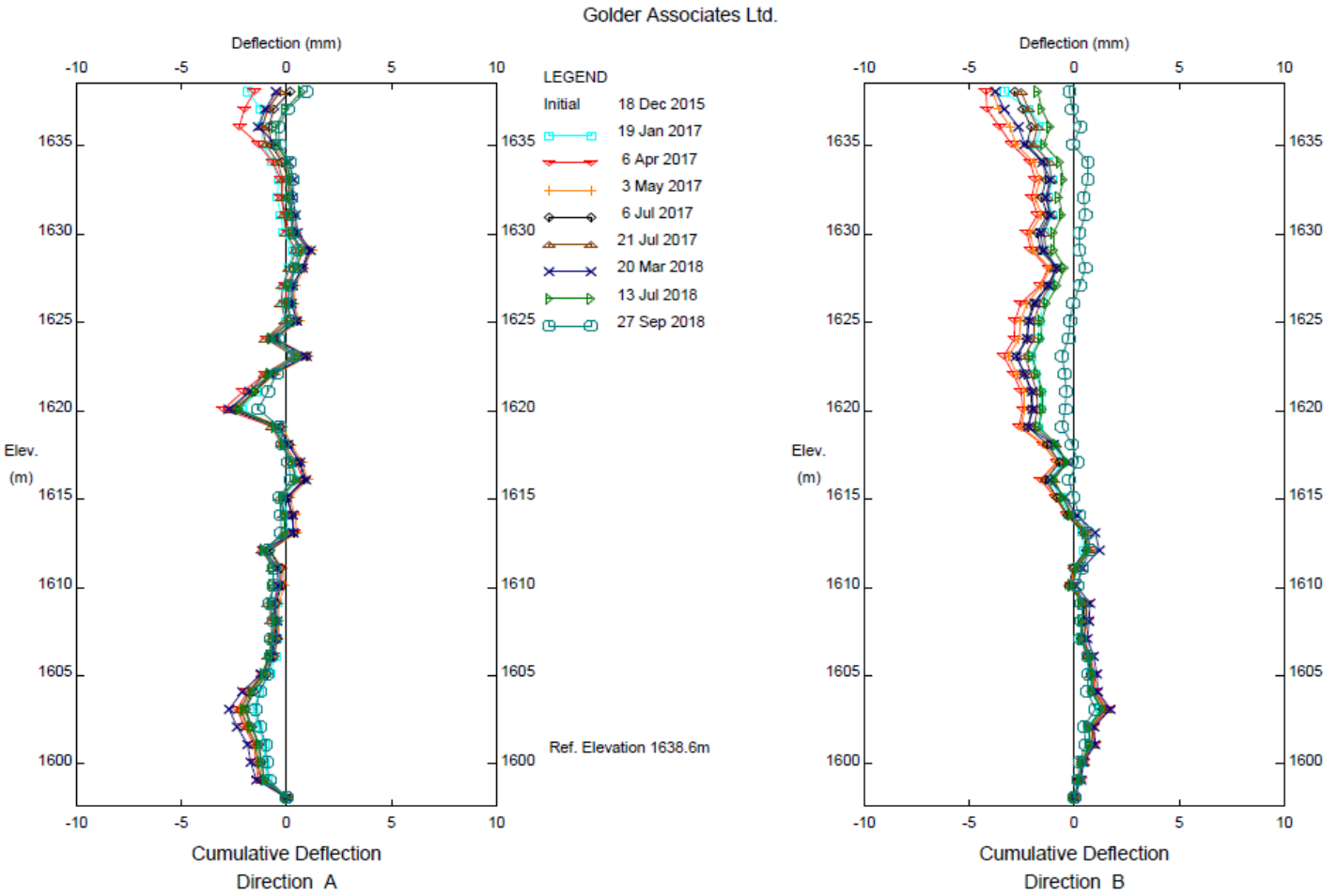
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
NORTH TAILINGS POND
TH15-07 INCLINOMETER

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**I-3**





South Tailings Pond Main Dam, Inclinometer TH15-01
Fording River Operations

REFERENCES

1. DATA PROVIDED BY FRO OCTOBER 2018.
2. LOCATIONS FROM GEOEXPLORER.
3. A-A AXIS AZIMUTH PROVIDED BY FRO 15 NOVEMBER 2017.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
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YYYY-MM-DD	2019-03-08
PREPARED	DA
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REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
TH15-01 INCLINOMETER

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**I-4**

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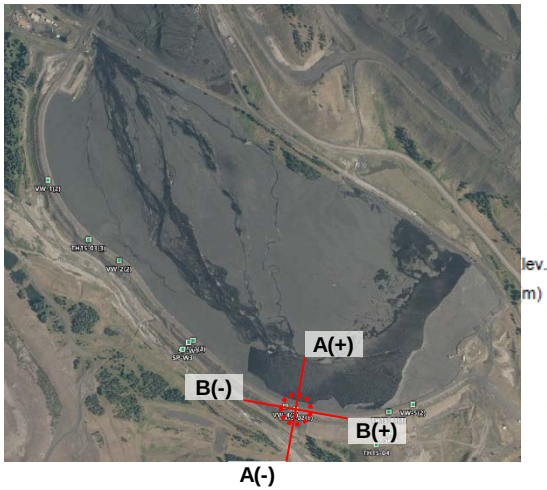
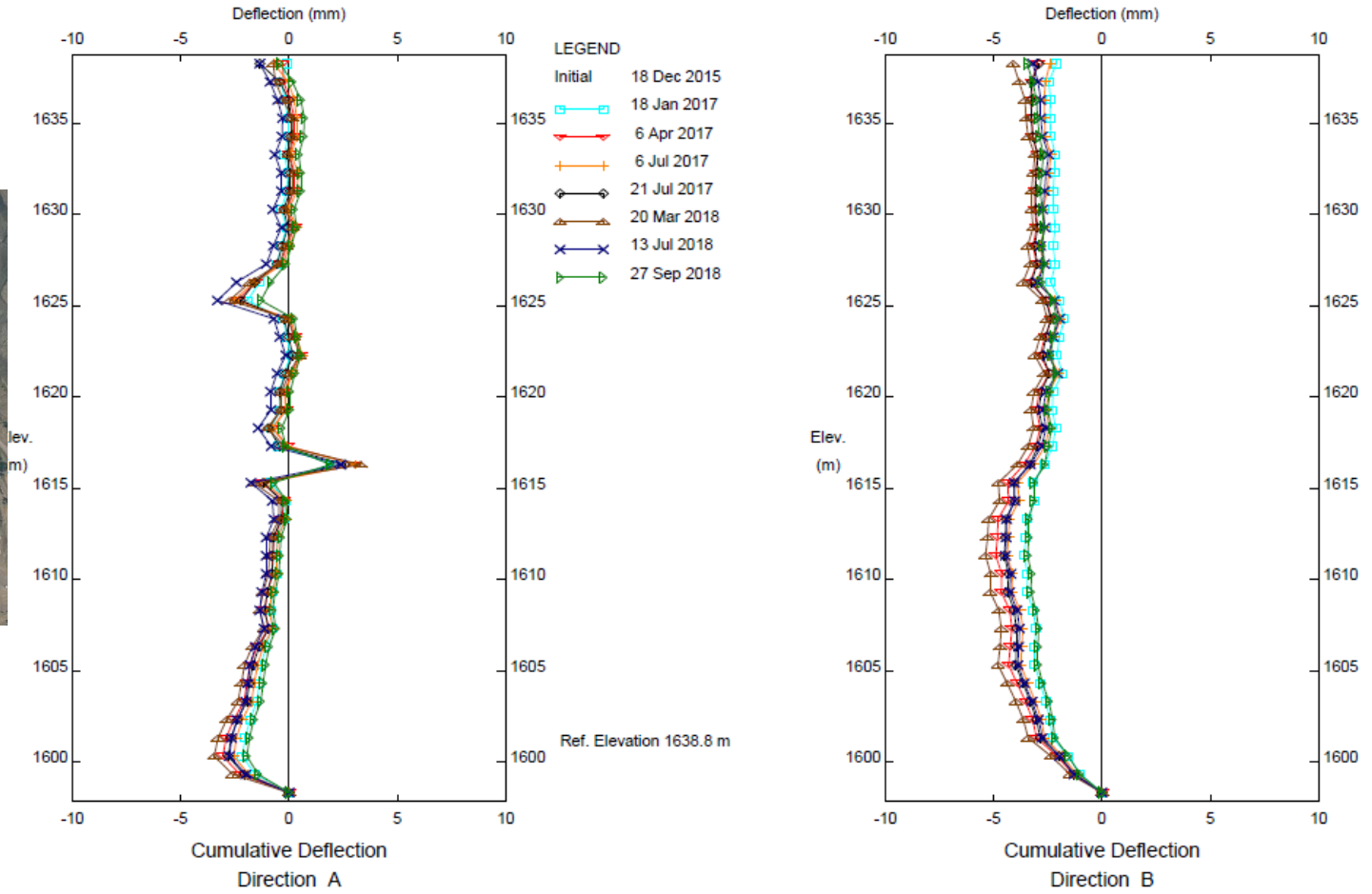




South Tailings Pond Main Dam, Inclinometer TH15-02

Fording River Operations

REFERENCES

1. DATA PROVIDED BY FRO OCTOBER 2018.
2. LOCATIONS FROM GEOEXPLORER.
3. A-A AXIS AZIMUTH PROVIDED BY FRO 15 NOVEMBER 2017.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

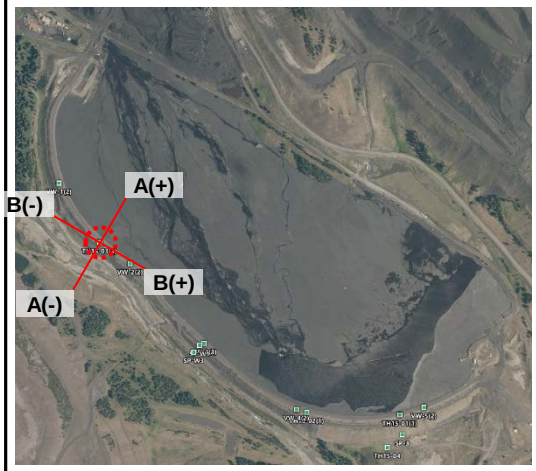
CONSULTANT
GOLDER

YYYY-MM-DD	2019-03-08
PREPARED	DA
DESIGN	DA
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
TH15-02 INCLINOMETER

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**I-5**



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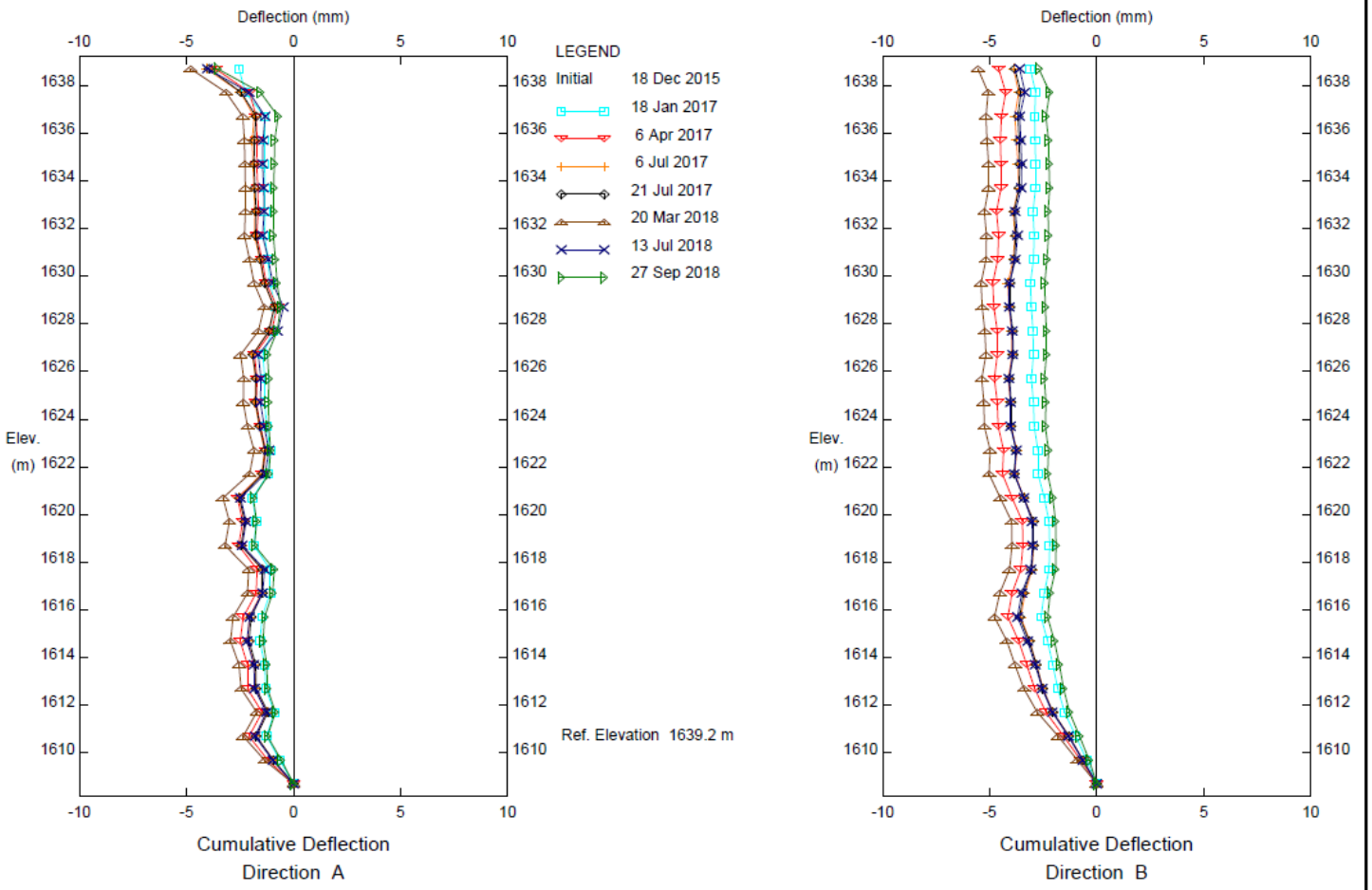

South Tailings Pond West Dam, Inclinometer TH15-03

Fording River Operations

REFERENCES

1. DATA PROVIDED BY FRO OCTOBER 2018.
2. LOCATIONS FROM GEOEXPLORER.
3. A-A AXIS AZIMUTH PROVIDED BY FRO 15 NOVEMBER 2017.

CLIENT
TECK COAL LIMITED
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ELKFORD, B.C.

CONSULTANT
GOLDER

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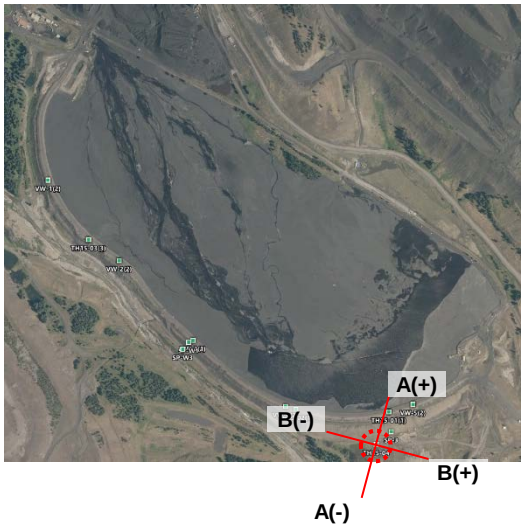
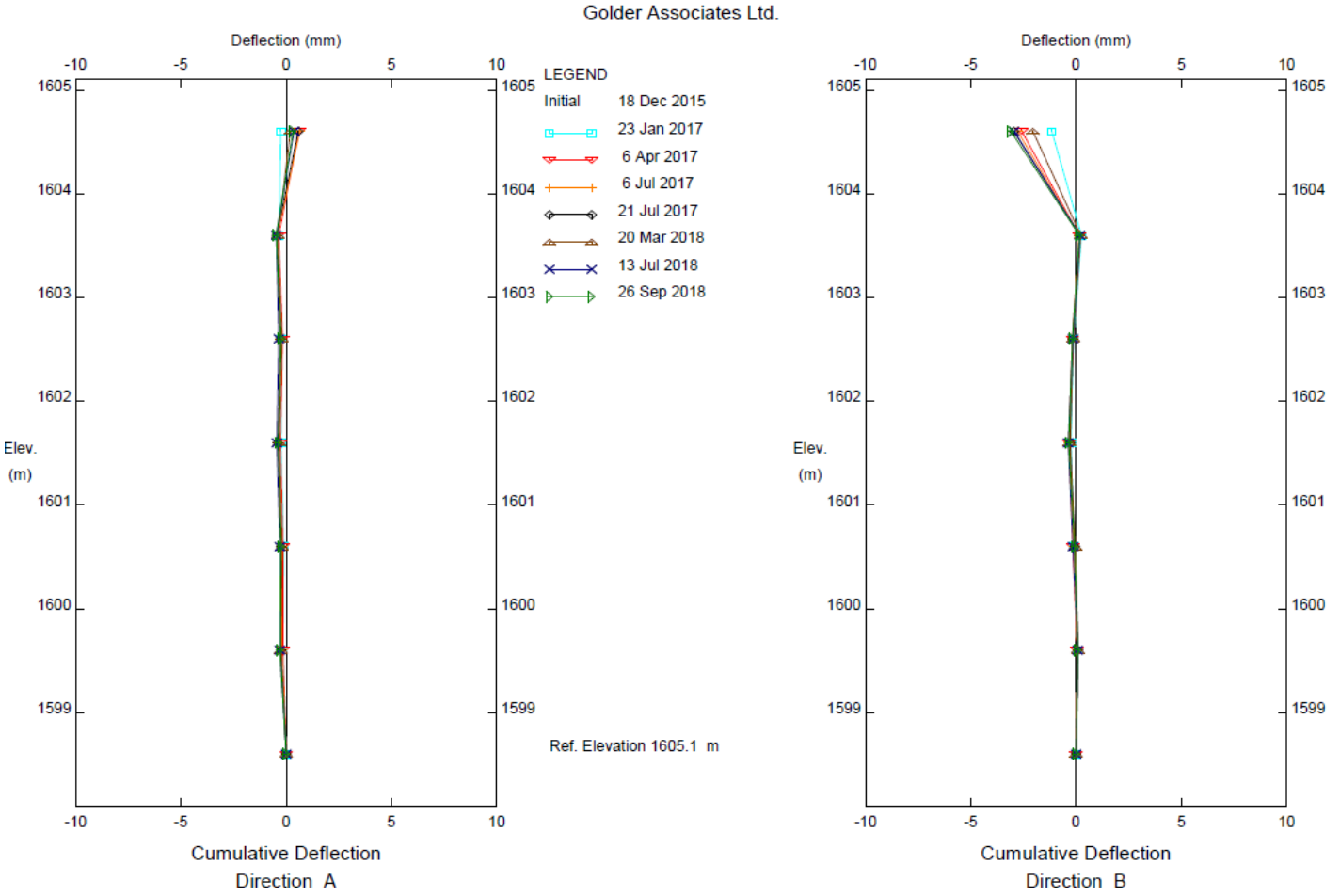
DESIGN	DA
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
TH15-03 INCLINOMETER

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**I-6**





South Tailings Pond Main Dam, Inclinometer TH15-04

Fording River Operations

REFERENCES

1. DATA PROVIDED BY FRO OCTOBER 2018.
2. LOCATIONS FROM GEOEXPLORER.
3. A-A AXIS AZIMUTH PROVIDED BY FRO 15 NOVEMBER 2017.

CLIENT
TECK COAL LIMITED
FORDING RIVER OPERATIONS
ELKFORD, B.C.

CONSULTANT
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DESIGN	DA
REVIEW	CYL
APPROVED	JCC

PROJECT
NORTH AND SOUTH TAILINGS PONDS
2018 ANNUAL DAM SAFETY INSPECTION

TITLE
SOUTH TAILINGS POND
TH15-04 INCLINOMETER

PROJECT No.	Phase/Task/Doc.	Rev.	FIGURE
18106689	**1000/1006/2018-156**	**0**	**I-7**

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