REPORT

2020 Annual Inspection for Turnbull Tailings Storage Facility

Teck Coal Limited, Fording River Operations

Submitted to:

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

Attention: Ms. Robyn Gaebel, P.Eng., FRO & LCO Tailings and Water Retaining Structures Qualified Professional

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 2020 annual inspection of the Turnbull Tailings Storage Facility (Turnbull TSF) at the Teck Coal Limited, Fording River Operations (FRO) site, located near Elkford, British Columbia. This report was prepared based on a site visit carried out by Golder Associates Ltd. (Golder) on 19 August 2020 and discussion with FRO staff. The reporting period for the data review is from 1 September 2019 to 31 August 2020, unless otherwise noted. The inspection report and photographs from the site visit are appended to this report.

The report was prepared considering 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 tailings storage facilities and associated dams. The scope and format of this annual inspection report follows the HSRC Guidance Document (Section 4.2, Ministry of Energy and Mines 2016b).

Summary of Facility Description

The Turnbull South (TBS) Pit is located on the east side of the Fording River and is approximately 3.5 km north of the FRO plant facility. The pit was excavated into the west side of the east–west trending Turnbull Ridge. The pit is accessed from the west side, and access ramps were developed on the easterly dipping footwall slope.

In 2012, an assessment of the TBS Pit as a potential area to store tailings was completed by Golder (2012), and FRO subsequently applied for and received a permit to operate the Turnbull TSF. This report includes a summary of deviations between the 2012 design and current operations up to August 2020. This summary should be included in the next update of the facility's operation, maintenance, and surveillance (OMS) manual (recommended action 2020-04 in Table E-2).

Mining ceased in the TBS Pit in early 2016. A pipeline to convey dredged tailings from the South Tailings Pond (STP) to the Turnbull TSF was constructed from late 2015 through mid-2016 and dredging was initiated in June 2016. Tailings and water deposited into this facility are filling the TBS Pit and the void space of the waste rock within the pit. Seasonal dredging from the STP to the Turnbull TSF is planned to continue for approximately the next 13 years until 2034 when the Turnbull TSF reaches capacity (base case in Golder 2018b).

The Turnbull TSF does not include any engineered fills as part of tailings containment. The design of the Turnbull TSF is for the tailings to be contained by the bedrock of the pit. Based on current conditions of the facility and a review of the credible failure modes, the in situ pillars of rock containing the tailings within the Turnbull TSF are not considered to be dams. An area of a backfill spoil over the footwall forms a low point along the west side of the facility, and this is now considered a dam based on the credible failure mode of overtopping due to wave generation as a result of significant highwall failure.

Summary of Key Hazards

An assessment of hazards and related credible failure modes was completed for the facility. Failure modes were considered based on current conditions and at the end of the facility's lifetime. The facility safety assessment for the Turnbull TSF was completed based on the observations and data review for each of the hazards that were determined to be relevant for the facility. The credible failure modes for the Turnbull TSF are as follows:

- Overtopping due to highwall failure—This credible failure mode considers the preliminary results from the wave generation study (empirical analysis; Phase 1) from Golder (2019), current tailings/water elevations, and pit wall conditions. Additional analysis (numerical analysis; Phase 2), which would further assess the potential wall failure slide impact velocity and model the wave runup height, may be carried out following completion of Phase 1 work (recommended action 2020-03).
- Release of tailings or tailings-affected water through a pipeline failure (credible failure mode at current conditions and being managed by routine inspections during active use).
- Overtopping due to flooding or pond elevation (not a credible failure mode at current tailings/water elevation).
- Tailings migration or contaminated groundwater seepage through waste rock or bedrock (not a credible failure mode at current tailings/water elevation).

Consequence Classification

Based on the HSRC definitions, the Turnbull TSF is a tailings storage facility.

The consequence classification for a failure of the Turnbull TSF was assessed as part of the design basis as High consequence (Golder 2012). The consequence classification remains High based on the assessment of the incremental environmental losses for a potential failure of the TSF.

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

The 2020 dredging season was between 18 April and 16 October 2020. A total of 1.65 million dry metric tonnes of tailings was dredged from the STP and sent to the Turnbull TSF. Tailings were deposited from the low point outlet location in 2020.

In July 2020, the electrical shed for the reclaim pumping infrastructure was relocated to elev. 1,680 m; the pumps remained on the surface of the pond.

A bathymetry survey was conducted in August 2020. Only partial results were obtained from the survey due to technical difficulties with the drone.

A water balance analysis (Golder 2020c) was undertaken as part of the Eagle 4 Saturated Rock Fill (SRF) project to evaluate the impact of pumped water discharge from the Eagle 4 SRF on the TSF's storage volume and freeboard. Water from the Eagle 4 SRF was pumped to the Turnbull TSF from 17 August to 8 September 2020, with average daily flow of 7,500 m³/day.

An updated inflow design flood (IDF) assessment for the Turnbull TSF (Golder 2021a) was completed.

An empirical assessment of the potential for wave generation in the Turnbull TSF due to a theoretical failure of the TBS Pit wall was carried out and the results provided in a draft report (Golder 2019).

As of 27 July 2020, the TSF pond elevation was 1,656.3 m and 24.7 m below the bedrock low point of elev. 1,681 m.

Twelve new prisms were installed along the north end of the TSF in November 2019. The first reading of the new prisms was in May 2020.

Review of Operation, Maintenance, and Surveillance Manual

The OMS manual for the Turnbull TSF is Version 2020-04, dated 27 May 2020 (FRO 2020a), and it includes the dredge pipeline as part of the facility infrastructure. The OMS manual was reviewed and approved by the Engineer of Record (EoR).

Review of Emergency Response and Preparedness Plans

An emergency response plan (ERP) for the tailings facilities at FRO was updated in 2020 (EP.009.R1; FRO 2020b). The ERP was developed considering the guidelines provided by the HSRC (Ministry of Energy and Mines 2016b, 2017), the Canadian Dam Association (CDA 2013), the Mining Association of Canada (MAC 2011, 2017), and Teck Resources Limited (Teck Resources 2019). The EoR reviewed and provided input to the updated ERP and considered the ERP adequate.

The current emergency preparedness plan for tailings facilities is EP.008.R2 dated 25 May 2020 (FRO 2020c).

The emergency planning documents should continue to be reviewed at least annually, with updates incorporated when required. The ERP should be tested every year. FRO carries out annual testing of the ERP, with the most recent internal tabletop exercise (with a field component) carried out on 26 November 2019.

Dam Safety Review

According to Section 10.5.4 of the HSRC (Ministry of Energy and Mines 2017), all TSFs must undergo an independent dam safety review every five years, starting a minimum of five years from the effective date of the HSRC requirement (i.e., 2016). FRO plans to have the first dam safety review of the Turnbull TSF completed in 2021.

Annual Inspection Performance Summary

The Turnbull TSF was observed to be in good condition at the time of the 2020 site inspection. An annual inspection of the pit walls was completed by Golder on 22 September 2020. A summary of the observations from the pit wall inspection was provided under separate cover (Golder 2021b).

Status of Previous and New Priority Recommended Actions

Table E-1 summarizes the status of recommended actions from the 2019 TSF inspection (Golder 2020b) and new recommended actions from the 2020 annual inspection. Completed actions are shown with grey shading. For recommended actions carried over from previous years or new recommendations, only those of priority level 1 or 2 are listed in Table E-1. Recommendations of other priorities are presented in the report body.

Table E-1: Status of 2019 Recommended Actions and New Actions from the 2020 Annual Inspection for the Turnbull Tailings Storage Facility

ID Number	Deficiency or Non-conformance	Applicable Regulation or Guideline	Recommended Action	Priority Level	Recommended Timing for the Action	Status as of March 2021
2016-04	Risk of tailings exiting the facility via wave generated from pit wall and/or spoil failure not quantified.	Permit condition (Ministry of Energy and Mines 2013) HSRC 2017 §10.1.11	Undertake numerical assessment for wave generation due to pit wall and/or spoil failures to determine whether the wave would be able to overtop the facility and the tailings and pond elevations at which the facility would be overtopped and reach the Fording River. The assessment should include the likelihood and probability of failure of pit wall and of waves being able to overtop the facility and reach the Fording River. Finalize draft report (Golder 2019) on empirical wave assessment (Phase 1). See recommendation 2020-03 for additional numerical wave assessment (Phase 2).	2	Q2 2021	**In Progress** – results of empirical wave assessment (Phase 1) provided in draft report (Golder 2019) indicated there is a low likelihood of a pit wall failure, and existing controls are in place to monitor the pit wall as part of the operations of the TSF. This recommendation can be closed once the report (Golder 2019) is finalized.
2018-06	Higher warning trigger levels were set for GPS units to offset noise in the data.	HSRC §10.5.2	The TSF Qualified Person or their designate is to conduct monthly review of the GPS data to check for movements or trends of concern that are below the warning triggers that have been adjusted upwards to account for data noise. Update the OMS manual to include the above requirements.	2	2020	**Complete**
2019-02	No inundation study completed.	HSRC §10.1.11	Perform an inundation study for the TSF. If Phase 2 numerical assessment of wave run-up study is to be carried out (recommended action 2020-03), perform the inundation study after results from the Phase 2 assessment is available. Update the population at risk and potential loss of life with results from the inundation study. Review the consequence classification based on the assessment of the population at risk and potential loss of life.	2	2021/2022	**Incomplete**
2019-07	Backfill spoil over the footwall forms a low point along the west side of the facility and this is now considered a dam based on the credible failure mode of overtopping due to wave from a significant highwall failure; this assessment was not covered in the design or current OMS manual.	HSRC Guidance Document §3.4	Develop a plan as part of the 2020 annual inspection to address dam safety assessment of this area of the facility.	2	2020	**Complete** – backfill spoil area inspected in 2020 by EoR
2020-02	A bathymetry survey of TSF's pond volume and storage capacity has not been updated since 2018.	OMS Manual § 4.3	FRO should collect a complete bathymetry data set before end of 2021, then review results from the survey and update the TSF's underwater beach slopes, pond volume, storage capacity, and estimate in situ tailings deposit density with results from the survey.	2	Q3 2021	**New** – to be implemented
2020-03	Uncertainty in assessment for wave generated from pit wall failure resulting in a wave that could run up and overtop the TSF low point.	Permit condition (Ministry of Energy and Mines 2013) HSRC 2017 §10.1.11	If included in recommendations of the empirical wave assessment (Phase 1, from recommended action 2016-04), carry out Phase 2 numerical assessment to further assess the potential wall failure slide impact velocity and model the wave runup height.	2	Q2 2021	**New** – to be implemented

IDF = inflow design flood; HSRC = Health, Safety and Reclamation Code; TSF = tailings storage facility; OMS = operation, maintenance, and surveillance; n/a = not applicable; STP = South Tailings Pond; EoR = Engineer of Record; FRO = Fording River Operations.

Priority Level	Description
1	A high probability or actual 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 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 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 2016b).

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Turnbull Tailings Storage Facility Inspection Report

1.0 INTRODUCTION

1.1 Purpose, Scope of Work, Method

Golder Associates Ltd. (Golder) has completed an annual tailings storage facility inspection (TSFI) for the Turnbull Tailings Storage Facility (Turnbull TSF) at the Teck Coal Limited (Teck), Fording River Operations (FRO) site, located near Elkford, BC. The reporting period for the data review is from 1 September 2019 to 31 August 2020, unless otherwise noted. The Turnbull TSF has also been referred to as the Turnbull South Pit TSF and the Turnbull South (TBS) TSF in some documents and permits.

The report is based on a site visit carried out by Golder on 19 August 2020 and discussions with FRO staff. This report consists of the following and was prepared with consideration of the Teck Resources Limited *Guideline for Tailings and Water Retaining Structures* (Teck Resources 2019):

- a summary of the site conditions and background information for the facility
- a summary of the construction, operating, and/or maintenance activities for the reporting period
- facility consequence classification and review of required documentation
- site photographs and records of routine facility visual inspections
- review of dredging data
- review of potential hazards and failure modes, design basis, and facility performance
- recommended actions

Photographs of the Turnbull TSF site inspection are presented in Appendix A, and the inspection report is included as Appendix B.

An inspection to review the TBS Pit walls' stability and performance was completed by Ms. J. Kelly Hood, P.Eng., and Ms. Alannah Gray Hubbard, P.Eng., of Golder on 22 September 2020. A summary of the observations from the pit wall inspection has been provided in a separate report (Golder 2021b).

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.

The previous annual inspection for this facility was carried out in September 2019 and is reported in the 2019 TSFI report (Golder 2020b).

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

1.2 Regulatory Requirements

1.2.1 BC Health, Safety and Reclamation Code

The TSFI report was prepared considering 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 tailings storage facilities and associated dams. It is understood that this report will be submitted by FRO to the Chief Inspector of Mines.

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

1.2.2 Permits and Licences

Specific sections and amendments to the permits concerning the Turnbull TSF are as follows:

- 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 deferment of permit conditions – South Tailings Pond Dredging – Turnbull Pit. Issued by the Ministry of Energy and Mines. 1 June 2016. (Ministry of Energy and Mines 2016a)
- Permit 424 Amendment to authorize discharges – amendment to discharges to the North Tailings Pond (NTP) and South Tailings Pond (STP) from authorized sources. Issued by the Ministry of Environment. 6 December 2016.
- Permit 424 Amendment to authorize discharges – disposal of liquids from the West Line Creek Active Water Treatment Facility to the Fording River Operation Turnbull South Tailings Storage Facility. Issued by the Ministry of Environment. 7 October 2018. A permit amendment update is under review by the Ministry of Environment at the time of writing of this report.

2.0 BACKGROUND

2.1 Fording River Operations Tailings Storage

The FRO site is an active open pit coal mine located near Elkford, BC, which currently has two tailings dam facilities on site along the Fording River: the inactive NTP and the active STP. There are also two in-pit tailings storage facilities: the active in-pit Turnbull TSF and the inactive 2 Pit and 3 Pit Tailings Storage Area.

FRO continues to deposit tailings into the STP, and tailings are transferred seasonally via dredging operation from the STP to Turnbull TSF, which started in 2016. Seasonal dredging from the STP to the Turnbull TSF is planned to continue for approximately the next 13 years until 2034 when it reaches capacity (base case in Golder 2018b).

The FRO site plan and the location of the Turnbull TSF is shown in Figure 1.

2.2 Overview of Design, Construction, and Previous Operation as a Pit

2.2.1 Turnbull South Pit Design and Development

The TBS Pit is located on the east side of the Fording River (Figure 1). It is approximately 3.5 km north of the FRO plant facility. The pit was excavated into the west side of the east–west trending Turnbull Ridge.
The configuration of the TBS Pit upon completion of mining in early 2016 is described in the list below, and is shown in plan in Figure 2 and in section in Figure 3:

- The pit consists of a west-facing highwall slope along the east side of the pit, a north-facing endwall slope along the south side, southeast- and south-facing endwall slopes along the northwest and north sides, respectively, and an east-facing footwall and low wall slopes along the west side.
- The crest of the as-built pit ranges between approximately elev. 2,020 and 1,680 m. The highest crest elevation is located in the southern portions of the highwall. The lowest mined-out crest elevation is on the west side of the pit. The pit floor ranges between approximately elev. 1,690 m on the west side of the pit and approximately elev. 1,580 m on the east side.
- A footwall slope has been excavated along the west side of the pit and is generally 100 m in height. The footwall follows the dip of bedding, which is inclined at approximately 5 to 25 degrees within the pit.
- The highwall excavated along the east side of the pit ranges in height between approximately 250 and 380 m.
- The endwalls excavated along the north and northwest sides of the pit range in height between approximately 80 and 110 m.
- The endwall excavated along the south side of the pit ranges in height between approximately 60 and 200 m, with an average height of 140 m.
- The low wall excavated along the southwest portion of the pit, above the footwall slope, ranges in height between approximately 40 and 55 m.

The pit is accessed from the west side, and access ramps were developed on the easterly dipping footwall slope. For further details regarding previous operation as a pit, refer to the Golder (2021b) pit wall slope stability review.

In 2012, Golder undertook assessments for the TBS Pit as a potential area to store tailings (Golder 2012) to support Teck in obtaining a corresponding amendment to the C-3 Permit. The following assessments were carried out by Golder to support development of the Turnbull TSF:

- pit slope stability assessment
- geotechnical assessment for the tailings facility
- hydrogeological assessment
- water quality assessment

Key recommendations from these assessments became conditions in the C-3 Permit Amendment issued on 14 November 2013, approving the Turnbull South Pit TSF (Ministry of Energy and Mines 2013) and the East Pipeline Route (Ministry of Energy and Mines 2015), with some conditions deferred in the C-3 Permit Amendment issued in 2016 (Ministry of Energy and Mines 2016a).

Mining ceased in the TBS Pit in early 2016. A geotechnical stability review was completed in 2016 to assess the validity of previous Golder stability assessments against the mined-out ultimate pit (Golder 2016b). It was determined that the ultimate design pit shell used in previous stability analyses is comparable to the as-built ultimate pit shell.

For background information related to the TBS Pit and its development into a TSF, refer to Golder (2012).

2.2.2 Tailings Storage Facility Description and Key Components

Key components of the Turnbull TSF are as follows:

- TBS Pit (described in Section 2.2.1)
- in-pit spoils
- dredge pipeline from the STP
- reclaim water lines and associated pumps
- instrumentation
- freeboard requirement
- signage
- diversion ditch

In-pit spoil areas are noted in Figure 2 and consist of waste rock that was end-dumped into the pit during mining operations, portions of which buttress a portion of the south endwall and cover much of the footwall and low wall.

A pipeline to convey dredged tailings from the STP to the Turnbull TSF was constructed from late 2015 through mid-2016. Deposition of dredged tailings from the STP started in June 2016. Dredged tailings from the STP can be discharged along the southwest side of the pit at one of the three locations shown in Figure 2. Dredging from the STP to the Turnbull TSF is planned for every year, to be completed seasonally between approximately April and October.

In May 2018, a temporary reclaim pipeline was installed, and in June 2018 it began to transfer water from the Turnbull TSF pond to the STP. The non-winterized temporary pipeline was used until freeze-up in 2018. The temporary pipeline, which was not used in 2019, was used again in early 2020.

In July 2019, construction was completed on a permanent reclaim pipeline, to be used during dredging operations, and began to transfer water from the Turnbull TSF pond to the STP. A flowmeter was installed on the pipeline, but it was damaged shortly after installation and has not been functional until April 2020; flows in the reclaim pipeline were being estimated by FRO based on the number of pumps running when the flowmeter was not working.

All instrumentation locations are shown in Figure 2. GPS units are installed on the highwall and north endwall of the TBS Pit and on the in-pit spoils to monitor movement in the facility. The south endwall GPS (unit TB12) was installed in September 2018 on the spoils above the TBS Pit, above TB05. Prisms were installed on the highwall during mining and there is a total station on the footwall, as well as two backsights (one on the highwall and one on the northwest endwall). Piezometers were installed at eight locations in the highwall to monitor pore pressures behind the wall: three were installed in 2012, two were installed in 2017, and an additional three were installed in 2018. Six potable water wells exist approximately 60 m east of the pit within the Fording River floodplain. There are two water quality monitoring locations near the Turnbull TSF: one at the Turnbull Bridge and one near the Clode Settling Pond. There are no monitoring wells installed immediately around the facility at this time.

The Turnbull TSF does not include any engineered fills as part of tailings containment. The design of the Turnbull TSF is for the tailings to be contained by the bedrock of the mined-out pit. The ponded water is to be maintained below the lowest point of bedrock along the mined-out pit crest. The lowest point of bedrock is located on the west side of the pit, and has been established to be elev. 1,681 m following discussions between the Engineer of Record (EoR) team and FRO based on results from a ground-penetrating radar survey conducted on 10 September 2018 (FRO 2018). The bedrock low point is used to establish the TSF maximum pond elevation.

Based on current conditions of the facility and a review of the credible failure modes, the in situ pillars of bedrock containing the tailings within the Turnbull TSF are not considered dams. Based on the current assessment, an area of backfill spoil over the footwall forms a low point along the west side of the facility and is considered a dam based on the credible failure mode of overtopping due to wave from a significant highwall failure.

Signage has been placed at the facility crest, before the pond, and in the vicinity of the Turnbull TSF to notify passersby that the structure contains tailings and to provide direction and contact information to report any issues observed or any proposed work in the vicinity.

2.2.3 Tailings Transfer Summary

Tailings started being transferred to the Turnbull TSF in June 2016 via dredging from STP. A summary of annual dredging and water transfer totals is summarized in Table 1.

Table 1: Summary of Tailings Transfer from South Tailings Pond to Turnbull Tailings Storage Facility

Year	Dry Metric Tonnes of Tailings Dredged from STP from Annual Dredging Records	% Solids by Weight in Dredge Slurry	Water in Dredge Slurry, Discharged into Turnbull TSF (m^3)
2016	215,892	30	503,748
2017	850,076	38.9	1,335,209
2018	1,635,590	41	2,353,654
2019	1,655,032	41	2,381,631
2020	1,648,701	40.7	2,402,161
Total to October 2020	**6,005,291**	**38.3% (average)**	**8,976,404**

Note: Some of the numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

STP = South Tailings Pond; TSF = tailings storage facility.

2.2.4 Changes in Turnbull Tailings Storage Facility Operations Since 2012 Design

Golder (2012) presents the assessments undertaken to support permitting of the Turnbull TSF. FRO received a C-3 Permit Amendment on 14 November 2013, approving the Turnbull South Pit TSF (Ministry of Energy and Mines 2013). Tailings were first deposited into Turnbull TSF in June 2016. FRO has since made adjustments to facility operations, some of which deviate from the assumption used in the Golder (2012) design report. This section presents a summary of key changes and comments on the impact of these deviations.

Prior to deposition of dredged tailings into the TSF, a geotechnical stability review of the pit walls (Golder 2016b) was completed to assess the validity of the previous Golder stability assessments against the mined-out ultimate pit. It was determined that the ultimate design pit shell used in previous stability analyses is comparable to the as-built ultimate pit shell. Pit wall stability continues to be monitored and its performance reviewed annually.

Table 2 presents key tailings geotechnical assumptions used to support the 2012 design (Golder 2012) compared to the currently understood values, and includes comments of the deviations, if any, on impact to the TSF's operations.

Table 2: Summary of Key Changes in Turnbull Tailings Storage Facility Design and Operations Since 2012

Design Parameter / Assumption	Considered in Golder (2012)	Considered as of 31 August 2020	Source of Current Value	Impact of Change to TSF
Low point in mined-out bedrock	Elevation 1,682.5 (EVED) (1,683 m in Mine Grid).	Elevation 1,681 m (EVED).	Confirmed by geophysics survey (FRO 2018).	Increase in water and tailings storage volume available in TSF compared to design.
Porosity of in-pit waste rock backfill spoils	30%	20% to 40%	Considered in the updated deposition plan (Golder 2018b) based on volume and geometry of waste rock in final pit.	Small; value should be confirmed, possibly through regular bathymetry surveys.
Facility tailings storage volume	19.6 to 20.2 million m^3	19.2 million m^3	Updated deposition plan (Golder 2018b).	Lower available storage was based on interim low point in bedrock at elev. 1,679.89 (EVED). This available volume should be updated using current low point and an updated deposition plan based on measured in situ conditions (tailings density and slopes).
Annual tailings transferred from STP	1 million DMT over 6 months each year.	Range from 216,000 to 1.65 million DMT over 6 to 7 months each year.	Dredging records from FRO.	Average of 1.2 million DMT per year over 5 years of operations. This is about 1 million DMT ahead of the schedule considered in the design, resulting in shorter overall lifetime for facility.
Slurry density of dredge tailings transported to TSF (solids content in pipeline)	22% by weight.	30% to 41% by weight.	Dredging records from FRO.	Less water is being transferred with the dredged tailings with the higher slurry solids content.
In situ density for tailings	1 t/m^3	1 t/m^3	Estimated.	No change; estimate should be check using an annual bathymetry surveys.
Reclaim pond	250,000 m^3 pond volume with minimum 5 m depth to operate reclaim barge.	5.6 million m^3 pond volume with 24 m water depth.	Based on July 2020 pond elevation, using the 2018 volume by elevation curve and 2020 bathymetry survey.	Significantly higher quantity of water is currently stored in the facility compared to design.
Annual reclaim water quantity to STP	3.5 million m^3 returned to STP each 6 month dredge season, reducing to 3.2 million m^3 returned to STP each 6 months in later years of operations.	0 to 2.2 million m^3 per year.	FRO records.	No change in tailings storage at this time; a plan to reduce the volume of water stored should be prepared.
Tailings beach slope	0.3% for beach above water and 2% for beach below water.	2% beach below water.	Estimated from 2020 bathymetry survey.	Continue to track and estimate with annual bathymetry surveys.
Deposition plan and life of facility	From Golder (2012), 20 years from start of deposition i.e., 2036.	Updated in 2018, facility at capacity in June 2034.	Golder (2018b).	Deposition study should be updated with bedrock low point, and beach slopes and in situ density from bathymetry surveys.
Additional water inflows	None considered.	Added 245,430 m^3 of water from Eagle 4 SRF in 2020 (17 August to 31 December 2020).	Pumping records from FRO.	Increase to pond volume stored, a plan to reduce the volume of water stored should be prepared.
Groundwater flows	150 to 450 m^3/day inflow to pit, 300 m^3/day outflow when pond at final elevation.	784 m^3/day inflow to pit in 2018 decreasing to 473 m^3/day, as used in the deposition study (Golder 2018b) and water balance (Golder 2018a).	Estimated.	Small increase in volume to be stored based on updated groundwater rates.

TSF = tailings storage facility; EVED = Elk Valley Elevation Datum; DMT = dry metric tonnes; STP = South Tailings Pond; SRF = saturated rock fill.

One of the main changes in the Turnbull TSF operations compared to design in 2012 is the large quantity of stored water currently in the facility. This stored volume of water is mainly a result of the decision to delay construction of the reclaim pump and pipeline system in 2016 due to high cost of construction and not requiring make-up water in the STP facility in 2016 and 2017.

This additional stored water volume will not impact the total tailings storage volume of the facility, provided that this water can be pumped out in the future before tailings storage capacity is required to support dredging from the STP facility. FRO should prepare a plan to reduce stored water in the long-term.

Assumptions for the deposited tailings density, tailings deposit slopes, and the portion of tailings stored within the voids of the waste rock dumps located in the pit were made in design. The intention was to confirm these estimates through a comparison of design parameters with results from annual bathymetry surveys and total tonnage of tailings transferred based on STP facility dredge records. However, it has proven difficult to obtain compete bathymetric surveys of the TSF. FRO should develop a plan to obtain annual bathymetry surveys as part of tracking these parameters.

The summary of deviations listed in Table 2 should be included in the next update of the facility's operation, maintenance, and surveillance (OMS) manual (recommended action 2020-04 in Table 14).

2.2.5 Wave Generation in Tailings Storage Facility

A study was undertaken in November 2019 to assess the potential for wave generation in the Turnbull TSF due to a theoretical failure of the TBS Pit wall and whether the waves would be able to overtop the facility and reach the Fording River. The purpose of the study was to address recommended action 2016-04, which is described in Table 13 (Section 5.7). The study considered a phased approach, with Phase 1 analysis considering an empirical subaerial landslide-generated wave equation. Preliminary results from the draft study (Golder 2019) indicated the following:

- There is a low likelihood of a pit wall failure.
- There are existing controls in place to monitor the pit wall as part of the operations of the Turnbull TSF.
- The Phase 1 empirical wave assessment results indicated a large critical wall failure would result in waves that would overtop the low point area. However, these results may not be considered representative as a result of a number of input parameters exceeding the range of values required for a valid result.
- If deemed required from results of Phase 1 assessment, a Phase 2 wave generation assessment should be carried out (recommended action 2020-03) using numerical modelling to assess the potential wall failure slide impact velocity and model the wave runup height. The numerical modelling method has the potential to yield a more comprehensive analysis than the empirical assessment.

2.2.6 Inflow Design Flood Assessment

An updated inflow design flood (IDF) assessment for the Turnbull TSF was completed and reported in Golder (2021a). The results indicated:

- The volume of water from an IDF event is 1,243,200 m³.
- Based on a stage storage curve generated from bathymetric data obtained in 2018 (Golder 2018c), the pond elevation in the TSF is expected to rise to 1,660.5 m when the IDF volume is added to the 27 July 2020 pond level of elev. 1,656.3 m.

- The maximum operating pond level of the TSF is elev. 1677.8 m to store the minimum freeboard of 0.5 m (Golder 2012) and IDF volume below the bedrock low point.
- Quantifiable performance objective (QPO) values for pond elevation (Table 6 in Section 2.4) had been updated to consider the IDF and updated maximum operating pond level of the TSF.

The next update of the OMS manual is to include the IDF volume and maximum operating pond level of the TSF (recommended action 2020-04 in Table 14).

2.2.7 Site Seismicity

The site is located in an area of relatively low seismicity for 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 values were evaluated for a soil Site Class C as described in the 2010 National Building Code of Canada (NRCC 2010).

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

Note: 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 guidelines (CDA 2013, 2019) is shown.

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

2.3 Key Personnel

The EoR for the Turnbull TSF is John Cunning, P.Eng., an employee of Golder. A succession plan for the EoR has been developed between Golder and FRO, where the EoR designate is Julia Steele, P.Eng., also an employee of Golder. In an event where neither Ms. Steele nor Mr. Cunning could be reached (e.g., they are travelling to site), Golder has provided FRO with contact details of backup EoRs.

As of 31 August 2020, the tailings engineer at FRO was Robyn Gaebel, P.Eng. The Qualified Professional for the Turnbull TSF was Adam Langer, P.Eng., Superintendent Engineering, who was an employee of Teck. Ms. Gaebel became the Qualified Professional for the 2P-3P TSA on 1 December 2020. Mr. Patrick Lea, P.Eng., is the tailings engineer at FRO.

2.4 Quantifiable Performance Objectives

This section summarizes QPOs for the Turnbull TSF.

Table 4 summarizes the QPOs or trigger levels in place for GPS and prism displacement monitoring instrumentation at the Turnbull TSF, which were recommended by the pit wall Designer of Record and reviewed by a Qualified Person and are discussed in Golder (2021b). These values have been included in the most recent Turnbull TSF OMS manual (FRO 2020a). In addition to the warning and alarm triggers listed below, the GPS and prism data are to be reviewed manually to check for movements or trends of concern on a monthly basis.

Table 4: GPS and Prism Displacement Trigger Levels for Turnbull Tailings Storage Facility

Monitoring Instrument	Displacement Trigger Levels	Warning	Alarm
Highwall GPS units	3D point velocity with 12-point averaging	100 mm/day	150 mm/day
GPS units on spoils	3D point velocity with 12-point averaging	150 mm/day	300 mm/day
Prisms on highwall	Change in slope distance[(a)]	n/a	>25 mm[(a)]
	OR 3D displacement[(a)]	n/a	>50 mm[(a)]

(a) The slope distance alarm trigger and 3D displacement trigger levels for the highwall prisms are based on an assumed three-month average time period between readings. The trigger levels should be adjusted accordingly for the first reading following the winter months.

n/a = not applicable.

The trigger level for water quality monitoring in the vicinity of the Turnbull TSF is presented in Table 5.

Table 5: Quantifiable Performance Objective for Water Quality Monitoring near Turnbull Tailings Storage Facility

Monitoring Requirement	Trigger Level	Action
Water quality monitoring in vicinity of Turnbull TSF	Elevation of tailings reaches 1,675 m above sea level (Ministry of Energy and Mines 2013)	Monitoring water quality as required by the permit (C-3, Ministry of Energy and Mines 2013)

TSF = tailings storage facility.

Trigger levels for the pond elevation in the Turnbull TSF are shown in Table 6. Based on 2018 deposition planning (Golder 2018b), the pond is estimated to approach the acceptable elevation threshold in about 2028. The pond elevation triggers have been updated to allow the IDF volume (Golder 2021a) and the minimum freeboard of 0.5 m (Golder 2012) to be stored above the maximum operating pond elevation, which together cannot exceed 3.2 m below the low point in bedrock elevation. The OMS manual (FRO 2020a) is to be updated with the QPOs from Table 6 (recommended action 2020-04 in Table 14).

Table 6: Quantifiable Performance Objective Response Framework for Pond Elevation in Turnbull Tailings Storage Facility

Frequency of Inspection	Threshold Criteria		
	Acceptable	Warning	Alarm
Monthly – visual inspection and survey of pond elevation Surveys are not to be completed when conditions are unsafe (e.g., excess snow preventing access, avalanche hazards)	Pond elevation is located more than 5 m below the low point in bedrock on west side of pit **(pond below elev. 1,676 m)**	Pond elevation is located between 3.2 and 5 m below the low point in bedrock on west side of pit **(between elev. 1,676 m and 1,677.8 m)**	Pond elevation is within 3.2 m of the low point in bedrock on west side of pit **(above elev. 1,677.8 m)**

Note: Elevations presented in Elk Valley Elevation Datum.

Recommended trigger levels for highwall piezometers are provided in Appendix D of the 2020 pit wall stability review report (Golder 2021b) and shown in Table 7. A new QPO was proposed for piezometer GTF17-08 (3) in 2020 (Golder 2021b) as this instrument was not functioning correctly in 2018 when the monitoring thresholds were originally developed. This new QPO for piezometer GTF17-08 (03) is to be added to the next update of the OMS manual (recommended action 2020-04 in Table 14).

Table 7: Quantifiable Performance Objectives for Turnbull Tailings Storage Facility Highwall Piezometers

Borehole ID	Piezometer Number	Total Head Trigger Elevation[(a)]	Severity
PZ12-01	3	1,839.7	Warning
	2	1,819.5	
	1	1,922.6	
PZ12-02	3	1,810.7	Warning
	2	1,794.4	
	1	1,893.4	
PZ12-03	3	1,827.3	Warning
	2	1,806.7	
	1	1,910.6	
GTF17-07	2	1,921.1	Warning
	1	1,899.1	
GTF17-08	4	1,830.3	Warning
	3	1,812.4	
	2	1,800.2	
	1	1,887.0	

Source: Golder 2021b.

(a) The recommended total head trigger level has been calculated based on the recommended r_u trigger level from Golder (2021b), where r_u is a pore water pressure coefficient and r_u = pore water pressure / total vertical stress.

3.0 OPERATIONS, MAINTENANCE, AND CONSTRUCTION DURING 2019/2020

There have been no incidents or required maintenance with the Turnbull TSF during the reporting period.

The 2020 dredging season was between 18 April and 16 October 2020. A total of 1,648,701 dry metric tonnes of tailings was dredged from the STP and sent to the Turnbull TSF. The total tonnage of tailings transferred from the STP to the Turnbull TSF to date is 6,005,291 dry metric tonnes. Tailings were deposited from the low point outlet location (Figure 2) throughout the 2020 period. The low point outlet had been used as the deposition location since 2019 to accommodate for potential spoils at the south end of Turnbull Pit related to the Turnbull West Project. The deposition location has remained the low point outlet following the Turnbull West Project being cancelled as the low point outlet is easier to access for the dredge pipeline operators.

As of 27 July 2020, the TSF pond elevation was 1,656.3 m and 24.7 m below the bedrock low point of elev. 1,681 m.

In July 2020, the electrical shed for the permanent reclaim pumping infrastructure was relocated to elev. 1,680 m, while the pumps remained on the surface of the pond. The flowmeter on the permanent reclaim water pipeline was repaired and it started measuring flow on 7 April 2020. The temporary reclaim pipeline remained as a backup to transfer water from Turnbull TSF to the STP.

As part of the Eagle 4 Saturated Rock Fill (SRF) project, water is planned to be pumped from a well in the Eagle 4 catchment area to the Turnbull TSF. Water from the Eagle 4 SRF was pumped to the Turnbull TSF from 17 August to 8 September 2020, with average daily flow of 7,500 m^3/day. Prior to permitting the additional water into the TSF, Golder supported FRO by conducting a water balance analysis (Golder 2020c) to evaluate the impact of discharge from Eagle 4 on the TSF's storage volume and freeboard. The results of the water balance analysis indicated the planned pumping would increase water level in the TSF.

A bathymetry survey of the Turnbull TSF was conducted in August 2020. Only partial results were obtained from the survey due to technical difficulties with the drone. An annual bathymetric survey is recommended to assist with current estimates on the tailings deposit slopes, tailings in situ density, and portion of tailings mixing with waste rock in the pit, and to update the TSF's volume by elevation capacity above the tailings surface.

FRO should plan to collect a complete bathymetry data set before the end of 2021 (recommended action 2020-02 in Table 14). FRO should continue to collect a complete bathymetry data set once a year.

A study to assess winterization options for the Turnbull TSF's reclaim water pipeline was done by Kerr Wood Leidal in May 2020. Assessment of the winterization options is being continued internally by FRO.

Twelve prisms were installed along the north end of the Turnbull TSF in November 2019 to address recommendations from the 2019 pit inspection (Golder 2020a). The locations of these prisms are plotted on Figure 2.

A risk assessment was completed as of 29 September 2020 and has been documented in a draft report.

The Turnbull TSF was inspected by qualified FRO geotechnical personnel once per month during the reporting period. During active discharge of dredged tailings, the tailings discharge location is inspected by the dredge crew. During winter, the routine TSF inspections are carried out from the causeway due to concerns over the safety of FRO personnel from snow and avalanche hazards in the pit area. The inspections were completed at the required frequency despite challenges and restrictions as a result of the COVID-19 pandemic. Golder has reviewed the FRO personnel inspection reports as part of this annual review.

4.0 REVIEW OF CLIMATE DATA AND WATER BALANCE

4.1 Climatic Review

Three local climate monitoring stations exist at FRO: waste water treatment plant, A Spoil, and Brownie Spoil. Records were available from the waste treatment plant and Brownie Spoil weather stations during the reporting period of 1 September 2019 to 31 August 2020. No precipitation data were available for the A Spoil station; data from the A Spoil station were not used for the climate 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 waste water treatment plant station has been used as the main precipitation station for the Fording River Cominco infilling gap process since December 2013. The waste water treatment plant station precipitation data were used over the majority of the reporting period with the exception of 7 July to 9 July 2020 (inclusive), when missing data were infilled with data from the Sparwood CS regional station.

The total precipitation recorded at the waste water treatment plant and Brownie Spoil stations over the reporting period is shown in Table 8, with their monthly total precipitation presented in Chart 1. For comparison purposes, the long-term (1970 to 2019) average monthly precipitation at FRO (from the Fording River Cominco infilled data set) is also presented in Chart 1. The long-term (1970 to 2019) average annual precipitation at the mine site is estimated to be 634 mm.

Note that data presented in Table 8 and Chart 1 for the waste water treatment plant and Brownie Spoil stations are raw data; no adjustments for station elevation or undercatch were made.

Table 8: Total Precipitation from 1 September 2019 to 31 August 2020

Weather Station	Total Precipitation (mm)
Waste water treatment plant	488
Brownie Spoil	510[(a)]

(a) The majority of data for January to March 2020 were omitted by FRO due to instrument malfunction or variable data.

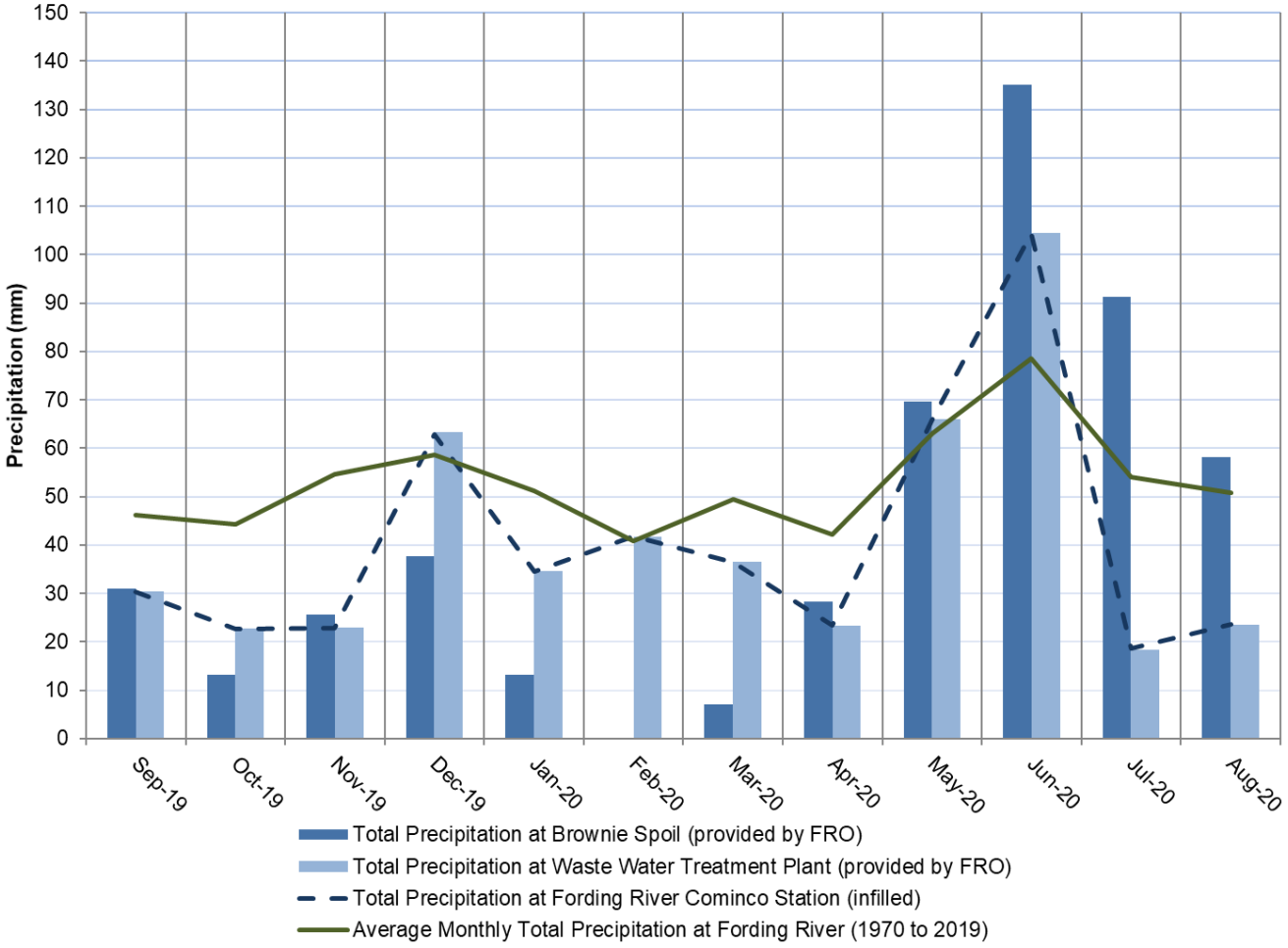


Chart 1: Monthly Precipitation Data from 1 September 2019 to 31 August 2020

The climate data in Table 8 indicate the annual precipitation received at the local FRO weather stations from 1 September 2019 to 31 August 2020 was lower than the long-term annual average of 634 mm. A similar observation could be made from Chart 1, where the total monthly precipitation data recorded at each of the local weather stations were generally at or lower than the long-term average except in:

- December 2019 at the waste water treatment plant station
- May and June 2020 at the waste water treatment plant station
- May through August 2020 at the Brownie Spoil station

Freshet typically starts in April to May at FRO with higher runoff flow events expected during those months as a result of combined rainfall and snowmelt. During the 2020 freshet, FRO observed a higher peak flow in the Fording River than in 2019. FRO started active flood season monitoring on 15 April 2020 and entered the following stages of flood monitoring:

- Level 1 (Flood Season Monitoring I) for active monitoring and no risk to site, from 15 April to 28 May, and from 11 June to 6 July 2020.
- Level 2 (Flood Season Monitoring II) for heightened awareness with elevated water levels and no risk to site, from 29 to 31 May, and from 4 to 10 June 2020.
- Level 3 (Active Flood Watch) for non-invasive response activities from 1 to 3 June 2020.

4.2 Water Balance

The Turnbull TSF water balance from 1 September 2019 to 31 August 2020 is summarized in Table 9 using climate inputs from the waste water treatment plant station.

Table 9: Turnbull Tailings Storage Facility Water Balance (1 September 2019 to 31 August 2020)

IN	12-Month Volume (m^3)	OUT	12-Month Volume (m^3)	Total Inventory Change (m^3)
Surface water runoff and precipitation	507,000	Evaporation and seepage loss	150,000	
		Water remaining in tailings deposit	629,000	
Groundwater	272,000	Reclaim water transferred to STP	2,227,000	
Water from Eagle 4 SRF	119,000			
Water in dredged slurry	**2,445,000**			
Sum	**3,340,000**	**Sum**	**3,006,000**	**335,000**

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

STP = South Tailings Pond; SRF = saturated rock fill.

The total inventory change of 335,000 m^3 represents an increase in the total water volume stored in the Turnbull TSF over the reporting period, which is consistent with the pond elevation increase observed over the same period (Chart 2 in Section 5.6.1). A total estimated volume of 5,580,000 m^3 of water is stored in the Turnbull TSF pond as of 31 August 2020.

No water was discharged from the Turnbull TSF during the reporting year; discharge from the TSF is not a part of the regular operation of the facility.

Golder completed an update to the site-wide water balance at FRO in 2020. The water balance was to support FRO to meet requirements from the Ministry of Energy, Mines and Low Carbon Innovation for a mine water management plan, information requirements from the *Joint Application Information Requirements for Mines Act and Environmental Management Act Permits*, and Teck's own internal water governance and health and safety requirements. The FRO site-wide water balance update was completed with climate and site data collected from 2014 to 2019.

4.3 Water Quality

FRO collects water quality samples at locations FR1 (near Turnbull bridge), CC1 (west of Clode Settling Pond), and at the Turnbull reclaim barge. The locations of monitoring locations FR1 and CC1 are shown in Figure 2. FRO plans to increase water quality sampling in 2021 to a quarterly frequency within the tailings facilities in addition to seep locations following a recommendation from the Independent Tailings Review Board.

5.0 TURNBULL TAILINGS STORAGE FACILITY SAFETY ASSESSMENT

This section presents the facility safety assessment for the Turnbull TSF based on observations and data review for each of the failure modes that are most relevant to this facility.

5.1 Site Visit

A site inspection of the Turnbull TSF was carried out on 19 August 2020 by Mr. John Cunning, P.Eng., of Golder. Mr. Cunning was accompanied by Mr. Patrick Lea, tailings engineer, and Mr. Ross Roseingrave, the senior geotechnical supervisor of FRO. The temperature during the visit was approximately 25°C and the weather was sunny with some light cloud cover.

Appendix A presents a summary of photographs of the Turnbull TSF from the site inspection. The location, direction, and number for each photograph are noted in Figure 2.

Considering the potential for a highwall failure to generate a wave in the TSF pond, the backfill spoil (also a haul road at the low point of the pit area) over the footwall is considered a dam (Photograph A-7 in Appendix A). The backfill spoil and downstream toe area were inspected during the 2020 site inspection. The haul road area includes pumping infrastructure and a laydown area (Photographs A-7 and A-8). The downstream toe of the haul road is located adjacent to the Fording River (Photographs A-9 and A-10).

Debris was observed to be collecting between tailings dredging pipeline berm and the spoils over the low wall (Photograph A-5). This debris should be cleaned out, which FRO reported it was planning to complete as part of maintenance activities.

A summary of the observations from the site visit is included in the inspection report in Appendix B.

The annual site visit for the pit wall review was completed on 22 September 2020 by Ms. J. Kelly Hood, P.Eng., and Ms. Alannah Gray Hubbard, P.Eng., of Golder. A summary of the annual pit wall slope stability review is provided in Golder (2021b), which includes pit wall geotechnical recommendations.

The Turnbull TSF was observed to be in good condition at the time of the 2020 annual inspection. Details of the performance of the facility based on observations during the site inspection are discussed in Section 5.5.

5.2 Review of Background Information

FRO provided the following information for this inspection:

- records of routine visual inspections by FRO qualified personnel
- pond water levels in Turnbull TSF
- dredging records for the STP to Turnbull TSF
- FRO site 2020 LiDAR topographic data and orthophoto
- site climate data from 1 September 2019 to 31 August 2020

5.3 Facility Consequence Classification Review

All TSFs require a failure consequence classification in accordance with the HSRC Guidance Document, Section 3.4 (Ministry of Energy and Mines 2016b). Guidelines for the classification of TSFs are presented in the HSRC Guidance Document.

The TSF classification criteria are presented in Table 10. Consequence categories are based on the incremental losses that a failure of the facility may inflict on downstream or upstream areas, or at the facility location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the facility not failed. The consequences of a TSF failure are ranked as Low, Significant, High, Very High, or Extreme for each of the loss categories. The classification assigned to a facility is the highest rank determined among the four loss categories.

Table 10: Tailings Storage Facility Classification

Consequence 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 2016b), Table 3-3 based on CDA (2013) Table 2-1.

A consequence classification of High was assessed as part of the Turnbull TSF design basis (Golder 2012). Based on the current facility assessment, an interim consequence classification is described below for the Turnbull TSF, based on an estimate of the potential inundation area downstream of the facility in lieu of the outcomes of the pending inundation study (recommended action 2019-02 from Table 14).

- **Population at risk (interim High consequence)**—mining facilities and activities are located and take place downstream of the TSF. The population at risk is estimated to be High; however, this is not based on a completed inundation study. This consequence should be reviewed and updated as required after completion of an inundation study.
- **Loss of life (interim Significant consequence)**—the loss of life is estimated to be Significant (from personnel driving on the nearby haul road); however, this is not based on a completed inundation study. This classification should be reviewed and updated as required after completion of an inundation study.
- **Environmental and cultural values (High consequence)**—potential significant impact to the environment should the containment fail, resulting in a release of water and tailings from the facility, including the potential for some loss of important fish or wildlife habitat; however, restoration or compensation in kind is considered possible.
- **Infrastructure and economics (Significant consequence)**—significant infrastructure and economic losses considering the impact to third parties beyond the limit of the mine. Economics losses could be high for the mine due to loss of infrastructure including access roads and potable wells, which are Teck's only source of potable water supply to the FRO process and wash plant. Impact on the wells can cause shutdown of the plant; however, similarly to dams, only third-party impacts are considered in the consequence classification for this TSF.

The interim consequence classification for the Turnbull TSF is High. The recommended inundation study is to delineate the inundation extents as a result of overtopping due to wave generation in the TSF after completion of the numerical wave assessment (recommended action 2020-03). The population at risk and potential loss of life are to be updated with the results of the inundation study and the consequence classification reviewed/updated subsequently.

5.4 Review of Facility Documentation

5.4.1 Operation, Maintenance, and Surveillance Manual

The OMS manual for the Turnbull TSF is Version 2020-04, dated 27 May 2020 (FRO 2020a).

This OMS manual was developed and meets the guidelines provided by the HSRC (Ministry of Energy and Mines 2016b) and the Mining Association of Canada (MAC 2011, 2017). The OMS manual was reviewed and approved by the EoR.

5.4.2 Emergency Preparedness and Response Plans

An emergency response plan (ERP) for the tailings facilities at FRO was updated in May 2020 (EP.009.R1; FRO 2020b). The ERP was developed and meets the guidelines provided by the HSRC (Ministry of Energy and Mines 2016b, 2017), the Canadian Dam Association (CDA 2013), the Mining Association of Canada (MAC 2011, 2017), and Teck Resources Limited (Teck Resources 2019). The EoR reviewed and provided input to the updated ERP and considered the ERP adequate.

The current emergency preparedness plan for tailings facilities is EP.008.R2, dated 25 May 2020 (FRO 2020c).

The emergency planning documents should continue to be reviewed at least annually, with updates incorporated when required. The ERP should be tested every year. FRO carries out annual testing of the ERP, with the most recent internal tabletop exercise (with a field component) carried out on 26 November 2020.

5.4.3 Dam Safety Review

According to Section 10.5.4 of the HSRC (Ministry of Energy and Mines 2017), all TSFs must undergo an independent dam safety review every five years, starting a minimum of five years from the effective date of the HSRC requirement (i.e., 2016). FRO plans to have the first dam safety review of the Turnbull TSF completed in 2021.

5.5 Review of Potential Hazards and Failure Modes, Design Basis, and Facility Performance

This section presents a summary of information related to the hazards to which the Turnbull TSF is exposed.

A summary of the assessed hazards and their related failure modes is provided in Table 11. For a full description of the hazards and potential failure modes, refer to the 2016 inspection report (Golder 2017).

Table 11: Assessment of Internal and External Hazards and Potential Failure Modes

Potential Hazard	Area of Concern	Observations/Data	Assessment of Failure Mode	
			At Current Conditions (at pond elev. 1,656.3 m on 27 July 2020, average tailings estimated at elev. 1,630 m)	At End of Facility Lifetime
Instability of rock pillar between pit and Fording River	North and northwest endwalls, low wall and footwall	Orientation of the bedding and the buttressing effect of the spoils are favourable to stability.	**Not credible**	**Not credible**
Tailings or contaminated water exiting the facility due to debris from a pit wall failure generating a wave in the TSF	North and northwest endwalls	No significant instability was observed during mining, and the pit wall is now buttressed by spoils. Orientation of these pit walls relative to the low point area leads to a very low likelihood of this potential hazard.	**Not credible** based on current pit wall stability and orientation relative to low point area	**Credible**, assessment to quantify stability hazard and elevation where wave generation could overtop facility required (recommended action 2019-03 in Table 14)
	Highwall and pit low point area	Failure through the poor quality rock of the 210/220 fault is possible but unlikely. Orientation of pit walls could lead to generation of waves that could overtop the backfill spoil in the pit low point area.	**Credible** based on preliminary assessment from Golder (2019, draft) and current pond elevation, which indicated there is a low likelihood of a pit wall failure and existing controls are in place to monitor the pit wall as part of the operations of the TSF.	**Credible**. Preliminary assessment from Golder (2019) indicated there is a low likelihood of a pit wall failure and existing controls are in place to monitor the pit wall as part of the operations of the TSF. At end of facility lifetime, the pond and tailings are higher in elevation and closer to low point area of pit, with potential to be displaced out of the facility in the event of a wall failure (recommended action 2020-03 in Table 14)
	South endwall	In-pit spoils have helped buttress the wall. This buttressing has improved the stability of the endwall. The current tailings beach and pond are located over 200 m from this wall	**Not credible** based on current pit wall stability and distance from low point area	**Credible**, assessment to quantify stability hazard and elevation where wave generation could overtop facility required (recommended action 2019-03)
Tailings or contaminated water exiting the facility due to debris from a spoil failure generating a wave in the TSF	All spoils in area	No available stability assessment has been completed for any of the in-pit spoils or nearby ex-pit spoils.	**Not credible** at current tailings/water elevation	**Credible**, assessment to quantify stability hazard for the pit walls, tailings, and pond elevations at which wave generation could overtop the facility required (recommendation action 2019-03)
Tailings or contaminated water exiting the facility due to debris from an external slope failure generating a wave in the TSF	Turnbull Ridge above highwall	Geology in the highwall and drilling done behind the highwall indicate conditions which are favourable to stability.	**Not credible** at current tailings/water elevation	**Credible**, but low risk and managed via highwall stability monitoring and with 3 GPS units monitoring the toe of Turnbull Ridge
Inflow flood and/or tailings elevation causing overtopping	n/a	Flood routing for the Turnbull TSF has been completed in draft.	**Not credible** at current tailings/water elevation	**Credible**, QPOs updated for freeboard based on the maximum pond elevation considering 0.5 m minimum freeboard (Golder 2012) and storing the IDF volume (Golder 2021a) below bedrock low point
Migration of tailings	Through bedrock	Bedrock discontinuities are not sufficiently wide to facilitate transport of tailings sediment.	**Not credible**	**Not credible**
	Through waste rock	Tailings are not intended to be placed such that they could migrate readily through waste rock above the lowest point of bedrock (elevation 1,681 m) along the crest of the pit.	**Not credible** at current tailings elevation	**Credible**, but controlled by low point in the bedrock around pit crest and development of tailings beach
Migration of contaminated water	Through bedrock	Potential impacts to the Fording River could occur when the tailings pond elevation exceeds the Fording River elevation. Westward flow potential could develop between the TSF and potable well field, when the tailings elevation exceeds 1,674 m (Golder 2012).	**Not credible** at current tailings/water elevation	**Credible**, future monitoring well required
	Through waste rock	The pond, plus freeboard and IDF volume, is not intended to exceed the lowest point of bedrock (elev. 1,681 m) along the crest of the pit.	**Not credible** at current tailings/water elevation	**Credible**, QPOs updated for freeboard based on the maximum pond elevation considering 0.5 m minimum freeboard (Golder 2012) and storing the IDF volume (Golder 2021a) below bedrock low point
Tailings or tailings water pipeline failure	Dredge pipeline, return water pipeline	Failure of dredge or return water pipeline could result in the release of tailings or tailings water. Lines are inspected by dredging contractor, who reports no leakage issues observed from the pipelines during active dredging.	**Credible**, being managed with routine inspection during active use.	**Credible**, being managed with routine inspection during active use.

TSF = tailings storage facility; QPO = quantifiable performance objective; n/a = not applicable; IDF = inflow design flood.

5.6 Assessment of Facility Safety Relative to Credible Failure Modes

A summary of the assessment of the facility's safety relative to credible failure modes identified is provided in Table 12.

Table 12: Assessment of Facility Safety Relative to Facility Lifetime Credible Failure Modes

Potential Failure Mode	Observations / Data	Comments
Overtopping by wave in the TSF generated by pit wall or spoil failure	No evident instability. Overtopping is credible at current tailings/water elevation (see Table 11).	Wave run-up assessment (Phase 1) due to failure of the highwall and potential overtopping wave from the facility was completed in draft (Golder 2019) and is being finalized at the time of writing this report (to address recommended action 2016-04 in Table 14). Phase 2 assessment should be carried out (recommended action 2020-03 in Table 14).
Overtopping due to water level in facility	The pond was at elev. 1,656.3 m (as of 27 July 2020, i.e., 24.7 m of freeboard) and the pond level is monitored.	Inflow design flood update completed (Golder 2021a). QPOs updated to allow for minimum freeboard and storing the IDF volume below the bedrock low point Section 2.4. The updated QPOs shall be added to the next update of the OMS manual (recommended action 2020-04 in Table 14).
Tailings migration and seepage	Water quality sampling stations are located downstream of TSF.	Not considered a credible failure mode at current pond elevation. Planning a groundwater monitoring program specific to the Turnbull TSF is recommended such that this can be implemented before the tailings pond level exceeds elev. 1,675 m above sea level, which is forecasted to be in about 2028 based on 2018 tailings deposition assessment (Golder 2018b). (recommended action 2017-06 in Table 14)
Tailings or tailings water pipeline failure resulting in the release of tailings or tailings water	No leakage was reported from active tailings or reclaim pipelines.	Continue to manage this failure mode by routine inspection of the pipelines.

TSF = tailings storage facility; QPOs quantifiable performance objectives; IDF = inflow design flood; OMS = operation, maintenance, and surveillance.

5.6.1 Instability Causing Overtopping

Design Basis

The results of the previous stability analyses indicate that the TBS Pit has exhibited adequate overall stability following the completion of mining and is expected to continue to exhibit adequate stability performance with the development of the Turnbull TSF (Golder 2012). The stability of the highwall was further assessed and updated as part of the Phase 1 subaerial landslide generated wave assessment for the Turnbull TSF (Golder 2019, draft), and found to support a low likelihood of highwall failure with existing controls in place for monitoring. Once this report is finalized, this can close out recommended action 2016-04.

If recommended in the finalized Phase 1 assessment report (Golder 2019), a Phase 2 wave assessment consisting of numerical analysis should be carried out to further assess the potential wall failure slide impact velocity and model the wave runup height is recommended (recommended action 2020-03 in Table 14).

Ongoing monitoring of the walls is recommended during the operation of the TSF. The frequency of monitoring should be increased when equipment and/or personnel are working near the pond in the TSF or close to the face of the walls. The monitoring procedures are included in Section 6.3.4 of the OMS manual (FRO 2020a). Further details of pit wall stability are presented in Golder (2021b).

Instrumentation – GPS and Prism Monitoring of Spoils and Highwall

There are 6 GPS units and 30 active prisms installed on the in-pit spoils and the highwall of the TBS Pit, including 12 new prisms that were installed along the north end of the Turnbull TSF in November 2019 (Figure 2). The spoils and highwall are monitored due to the potential for a failure to create a subaerial landslide that could result in a wave overtopping of the facility via the low point on the west side of the pit.

All the GPS monitors report to the GeoExplorer monitoring system in real time and readings are taken on an hourly basis.

There are 25 prisms that did not have location data collected over the past year and they are shown in red in Figure 2. Prisms along the lower portions of the highwall will become inactive as the TSF pond elevation rises. Although the prism coverage has improved since 2019 with the new prisms, it is recommended that additional prisms be installed along the crest of the highwall, to monitor potential overall slope instability (recommendation 2020-2 from Golder [2021b]). The areas of recommended additional coverage are marked in Figure 4 in Golder (2021b).

The highwall prisms are to be manually read three times per year per the OMS manual (FRO 2020a).

Instrumentation – Piezometers within Highwall

There are 15 vibrating wire (VW) piezometers at five locations within the highwall of the Turnbull TSF to monitor water levels behind the highwall. Three of the VW piezometers (PZ12-01, PZ12-02, PZ12-03) were installed in 2012 and two were installed in 2017 (GTF17-07 and GTF17-08). Three VW piezometers (GTF18-11, -12, and -13) were installed in the summer of 2018 and are monitored by Teck for another project unrelated to highwall stability; these piezometers are not included in this TSFI.

Data are to be collected from the piezometers at least three times per year and uploaded to GeoExplorer (FRO 2020a).

Observed Performance

The pit walls were exhibiting adequate stability during the 2020 annual site inspection, and the monitoring data review did not indicate any signs of large overall slope scale stability issues. An erosion gully was observed in the spoils on the west side of the low wall above the dredge pipeline and a recommendation to divert surface water from this area is included in the annual pit wall slope stability review report (recommendation 2020-1 in Golder 2021b). The deposition of water and tailings into the Turnbull TSF is not having an adverse impact of the stability of the pit walls. A detailed review of the monitoring instrumentation is provided in Golder (2021b). A summary of the instrumentation review is provided below.

The displacements exhibited by the GPS units during the reporting period are within the accuracy of the monitoring system and largely below the 3D velocity warning threshold of 100 mm/day. The total displacement values and directions indicate that no deep-seated, large-scale instability is being detected at the locations of the GPS units along the highwall.

FRO took prism measurements once in May 2020 and once in July 2020, but the readings from July 2020 were erroneous as the raw data were lost. Data from prism monitoring are to be reviewed and interpreted as soon as possible after they are downloaded, to allow enough time for additional readings to be collected if needed to meet the pit wall monitoring requirements in the TSF OMS manual. A recommendation for additional prism monitoring locations along the highwall crest is included in the annual pit wall slope stability review report (recommendation 2020-2 from Golder 2021b).

The total head data in the VW piezometers during the reporting period are relatively consistent with previous seasonal fluctuations except:

- PZ12-01 (2) has erroneous data after 24 June 2020.
- PZ12-02 (2) shows an increase in total head of approximately 30 m in February 2020, which is abnormally early for the typical seasonal fluctuation. In addition, the total head spikes up and down within several days, rather than showing the gradual rise that is typically observed during freshet.
- PZ12-02 (3) stopped recording consistent total head data on 24 June 2020. After 24 June 2020, this instrument did not seem to be functioning correctly as it recorded sudden and sporadic increase in total head readings.

A recommendation to review the 2018 series piezometer data to determine if there are any potential issues with these instruments is included in the annual pit wall slope stability review report (recommendation 2020-3 in Golder 2021b).

5.6.2 Pond Level Causing Overtopping

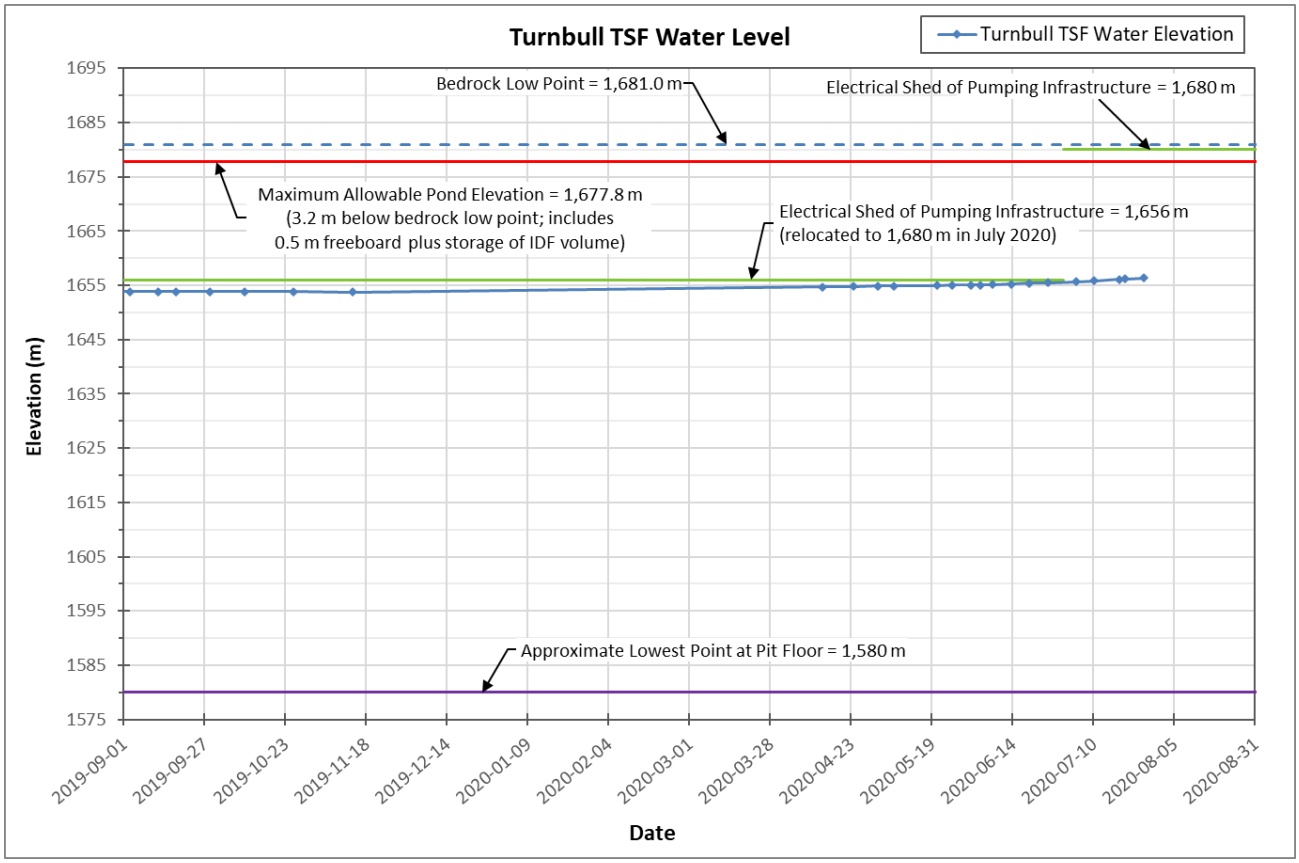
Design Basis

A design memorandum evaluating disposal of tailings into Turnbull TSF was previously completed and indicated that the normal operating freeboard be maintained at least 1.2 m below the low point in the bedrock around the pit crest (Golder 2012).

The IDF assessment (Golder 2021a) has updated the IDF volume based on a 72-hour rain and snow event as required by the HSRC, Section 10.1.8, since the facility is to contain the IDF and it does not have an emergency spillway (Ministry of Energy and Mines 2017). Based on the pond storage curve from the 2018 tailings deposition study (Golder 2018b), the IDF volume of 1,242,000 m³ (Golder 2021a), and minimum freeboard of 0.5 m (Golder 2012), the maximum operating pond elevation is 1,677.8 m in order to store the IDF and maintain the required freeboard.

Instrumentation – Pond Level

The Turnbull TSF pond level was surveyed two to six times per month during the reporting period, except for the winter months when there is no safe access due to snow cover and avalanche hazards to monitor freeboard. Since no tailings are deposited during the winter months, postponing the pond level survey until safe access is available is acceptable based on the current freeboard. The Turnbull TSF water level in Chart 2 shows that the pond level was increasing throughout the reporting year.



Note: Elevations presented in Elk Valley Elevation Datum.

Chart 2: Turnbull Tailings Storage Facility Pond Water Elevation for 1 September 2019 to 27 July 2020

Observed Performance

As of 27 July 2020, the TSF pond was at elev. 1,656.3 m, which results in a freeboard of 24.7 m below the low point in the bedrock around the pit on the west side of the facility.

5.6.3 Tailings Migration and Seepage

Design Basis

A water quality model prepared for permitting (Golder 2012) predicted that the maximum potential water quality impacts to the potable wells and the Fording River would occur at the ultimate configuration of tailings in the Turnbull TSF.

Westward seepage flow could develop between the TSF and potable well field when the tailings pond elevation exceeds approximately 1,674 m (Mine Grid elevation). However, the estimated small volume of seepage that will report to the water supply wells in the future is not expected to significantly affect the existing water supply's water quality (Golder 2012).

Potential impacts to Fording River could occur where the tailings pond elevation exceeds that of the nearby Fording River elevation at about 1,679 m (Mine Grid elevation) immediately west of the potable wells. Potential TSF seepage is expected to have a limited influence on the Fording River water quality during operations (Golder 2012).

The permit conditions require monitoring in place no later than when the tailings level reaches elev. 1,675 m (Ministry of Energy and Mines 2013). The elevation is noted in the permit as 1,675 m above sea level, but the permit data were reported in FRO Mine Grid and will require monitoring in place when the tailings reach elev. 1,674.5 m Elk Valley Elevation Datum.

Seepage of groundwater with dissolved phase constituents is a credible failure mode. Migration of the tailings along bedrock discontinuities is not considered a credible failure mode because the bedrock discontinuities are typically very tight and not sufficiently wide to facilitate transport of tailings sediment from the Turnbull TSF (Golder 2012).

Instrumentation – Water Quality Monitoring

There are two water quality monitoring locations in the vicinity of the Turnbull TSF (CC1 and FR1, Figure 2). There is no requirement to monitor water quality as a result of Turnbull TSF operations. Monitoring at an additional location is required by the permit to be in place no later than when the elevation of tailings reaches elev. 1,675 m above sea level (Ministry of Energy and Mines 2013), which is forecasted to be in about 2028 based on the 2018 tailings deposition assessment (Golder 2018b).

Observed Performance

The volume of tailings and water in the TSF as of September 2020 is low relative to the design capacity. Migration of water through bedrock is a very unlikely failure mode at the current elevation of tailings and water in the pit.

Migration of tailings or seepage through waste rock is not a credible failure mode at the current elevation of tailings and water in the pit.

5.6.4 Release of Tailings and Tailings-Affected Water through Pipeline Failure

Design Basis

The dredged tailings pipeline from the STP facility to the Turnbull TSF is located along spoils northeast of the STP and along a bench of the Turnbull TSF in-pit spoils. The reclaim water pipeline is located along the west side of the Turnbull TSF. A failure of one of these pipelines could release tailings or tailings-affected water.

Observed Performance

This failure mode is managed by routine inspections of the pipeline by the dredging contractor during active dredging. During the 2020 site inspection by the EoR, debris was observed to be collecting between tailings dredging pipeline berm and the spoils over the low wall (Photograph A-5), in an area within the TSF. The debris is to be cleaned out such that the berm could catch ravelling rocks from the waste rock slope above the pipeline (recommended action 2020-01 in Table 14).

5.7 Review of Previous Deficiencies and Non-conformances

The deficiencies and non-conformances that were noted in the 2019 TSFI (Golder 2020b) are outlined in Table 13. The incomplete actions have been brought forward to the 2020 TSFI recommendations (Table 14).

Table 13: Current Status of 2019 Recommended Actions

ID Number	Deficiency or Non-conformance	Recommended Action	Current Status as of March 2021
2016-04	Risk of tailings exiting the facility via wave generated from pit wall and/or spoil failure not quantified.	Undertake numerical assessment for wave generation due to pit wall and/or spoil failures to determine whether the wave would be able to overtop the facility and the tailings and pond elevations at which the facility would be overtopped and reach the Fording River. The assessment should include the likelihood and probability of failure of pit wall and of waves being able to overtop the facility and reach the Fording River.	**In Progress** – results of empirical wave assessment (Phase 1) provided in draft report (Golder 2019) indicated there is a low likelihood of a pit wall failure, and existing controls are in place to monitor the pit wall as part of the operations of the TSF. This recommendation can be closed once the report (Golder 2019) is finalized. See recommendation 2020-03 for additional numerical wave assessment (Phase 2).
2016-07	Update IDF calculation.	Confirm IDF volume for Turnbull TSF.	**Complete** – results provided in Golder (2021a).
2016-09	No dam safety review.	Complete dam safety review within 5 years of 2016 update to Part 10 of the HSRC.	**Planned** – see Table 14 for updated recommendation and timeline.
2017-06	Water quality monitoring at river and at potable wells not completed (future requirement only).	Develop and implement groundwater monitoring program for tailings levels above elevation 1,675 m above sea level (Ministry of Energy and Mines 2013).	**Not required until 2027 based on 2018 deposition planning (Golder 2018b)** – planning of the facility groundwater monitoring program should begin around 2027 for implementation in 2028.
2018-05	No risk assessment completed.	Include the Turnbull TSF in the 2019 annual review of TSF risk assessments.	**Complete** – risk assessments completed as of 29 September 2020 and documented in a draft report.
2018-06	Higher warning trigger levels were set for GPS units to offset noise in the data.	The TSF Qualified Person or their designate is to conduct monthly review of the GPS data to check for movements or trends of concern that are below the warning triggers that have been adjusted upwards to account for data noise. Update the OMS manual to include the above requirements.	**Complete**
2018-07	Piezometer trigger levels in OMS manual do not reflect the most recent recommendations from pit stability assessment (Golder 2020a), and pond elevation trigger levels should be updated to reflect the design bedrock low point elevation. New prisms installed at the northern end of the TSF are not in the OMS manual.	Update the OMS manual with new piezometer trigger levels from (Golder 2020a), pond elevation triggers from Table 6, and new prisms.	**Complete**
2019-01	Rockfall and erosion gullies along the access road to the crest of the highwall.	Maintain the access road as required, so that the GPS and piezometers installed along the highwall crest are accessible. If a proper berm is maintained along the inside of the road, it will assist in containing rockfall and diverting water along the road instead of across the switchbacks to minimize water from entering along the highwall. Add maintenance of access road to the OMS manual.	**Complete** – access road maintenance added to OMS manual. No erosion issues noted during 2020 pit wall inspection.
2019-02	No inundation study completed.	Perform an inundation study for the TSF. Update the population at risk and potential loss of life with results from the inundation study. Review the consequence classification based on the assessment of the population at risk and potential loss of life.	**Incomplete**
2019-03	Undocumented stability hazard and unknown tailings and pond elevations at which current non-credible failure modes become credible.	Perform analyses to identify stability hazard for pit walls and tailings and pond elevations at which the current non-credible failure modes will become credible for the potential hazard of tailings or contaminated water exiting the facility due to debris from a pit wall or spoil failure generating a wave in the TSF.	**Planned for 2021/2022**
2019-04	Monitoring procedures of pit wall inspections not in the OMS manual.	Update the OMS manual to include ongoing monitoring of the pit walls and increased frequency of inspection when equipment and/or personnel are working near the pond in the TSF or close to the face of the walls.	**Complete**
2019-05	Flowmeter on the water pipeline from Turnbull TSF to the STP was damaged.	Repair flowmeter before water transfer begins in 2020.	**Complete**
2019-06	Bathymetric survey of the TSF pond was not done in 2019.	Conduct bathymetric survey of the TSF pond in 2020.	**Complete** – partial bathymetry survey completed in August 2020.
2019-07	Backfill spoil over the footwall forms a low point along the west side of the facility and this is now considered a dam based on the credible failure mode of overtopping due to wave from a significant highwall failure; this assessment was not covered in the design or current OMS manual.	Develop a plan as part of the 2020 annual inspection to address dam safety assessment of this area of the facility.	**Complete** – backfill spoil area inspected in 2020 by EoR

IDF = inflow design flood; HSRC = Health, Safety and Reclamation Code; TSF = tailings storage facility; OMS = operation, maintenance, and surveillance; n/a = not applicable; STP = South Tailings Pond; EoR = Engineer of Record; FRO = Fording River Operations.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary of Activities

Activities completed during the reporting period were as follows:

- A total of 1,648,701 dry metric tonnes of tailings was dredged from the STP to the Turnbull TSF between 18 April and 16 October 2020.
- Tailings were deposited from the low point outlet location during the 2020 dredging season.
- An inspection of the pit wall stability from September 2020 is provided in Golder (2021b).
- The electrical shed for the pumping infrastructure was raised from elev. 1,656 m to elev. 1,680 m in July 2020. However, the pumps remained on the surface of the pond.
- A bathymetry survey was conducted in August 2020. Only partial results were obtained from the survey due to technical difficulties with the drone. A complete survey should be carried out before end of year (recommended action 2020-02).
- The flowmeter on the permanent reclaim water pipeline was repaired and it started measuring flow on 7 April 2020.
- Inflow of water to the Turnbull TSF from the Eagle 4 SRF well began in August 2020. A water balance analysis (Golder 2020c) was undertaken as part of the Eagle 4 SRF project to evaluate the impact of discharge from Eagle 4 SRF on the TSF's storage volume and freeboard.
- An updated IDF assessment was completed for the Turnbull TSF (Golder 2021a).
- Twelve new prisms were installed along the north end of the TSF in November 2019. The first reading of the new prisms was in May 2020.
- A risk assessment was completed as of 29 September 2020 and has been documented in a draft report.

6.2 Summary of Climate and Water Balance

The climate data during the reporting period indicate the annual precipitation received at the local FRO weather stations was lower than the long-term annual average.

6.3 Summary of Performance and Changes

The Turnbull TSF was observed to be in good condition at the time of the 2020 site inspection.

6.4 Consequence Classification

The Turnbull TSF remains a High consequence structure, following Section 3.4 from the HSRC Guidance Document (Ministry of Energy and Mines 2016b).

6.5 Current Deficiencies and Non-conformances

Table 14 summarizes the 2020 TSFI recommended actions for the Turnbull TSF.

Table 14: 2020 Inspection Recommended Actions for the Turnbull Tailings Storage Facility

ID Number	Deficiency or Non-conformance	Applicable Regulation or Guideline	Recommended Action	Priority Level	Recommended Timing for the Action
2016-04	Risk of tailings exiting the facility via wave generated from pit wall and/or spoil failure not quantified.	Permit condition (Ministry of Energy and Mines 2013) HSRC 2017 §10.1.11	Finalize draft report (Golder 2019) on empirical wave assessment (Phase 1).	2	Q2 2021
2016-09	No dam safety review.	HSRC 2017 §10.5.4	Complete dam safety review within 5 years of 2016 update to Part 10 of the HSRC.	3	2021
2017-06	Water quality monitoring at river and at potable wells not completed (future requirement only).	Permit condition (Ministry of Energy and Mines 2013)	Develop and implement groundwater monitoring program for tailings levels above elevation 1,675 m above sea level (Ministry of Energy and Mines 2013).	3	Based on 2018 deposition planning, planning of the facility groundwater monitoring program should begin around 2027 for implementation in 2028.
2019-02	No inundation study completed.	HSRC §10.1.11	Perform an inundation study for the TSF. If Phase 2 numerical assessment of wave run-up study is to be carried out (recommended action 2020-03), perform the inundation study after results from the Phase 2 assessment is available. Update the population at risk and potential loss of life with results from the inundation study. Review the consequence classification based on the assessment of the population at risk and potential loss of life.	2	2021/2022
2019-03	Undocumented stability hazard and unknown tailings and pond elevations at which current non-credible failure modes become credible	HSRC Guidance Document §4.4.1	Perform analyses to identify stability hazard for pit walls and tailings and pond elevations at which the current non-credible failure modes will become credible for the potential hazard of tailings or contaminated water exiting the facility due to debris from a pit wall or spoil failure generating a wave in the TSF.	3	2021/2022
2020-01	Debris collecting behind berm above tailings dredge pipeline.	n/a	Remove debris collecting behind berm above tailings dredge pipeline.	3	Q2 2021
2020-02	A bathymetry survey of TSF's pond volume and storage capacity has not been updated since 2018.	OMS Manual § 4.3	FRO should collect a complete bathymetry data set before end of 2021, then review results from the survey and update the TSF's underwater beach slopes, pond volume, storage capacity, and estimate in situ tailings deposit density with results from the survey.	2	Q3 2021
2020-03	Uncertainty in assessment for wave generated from pit wall failure resulting in a wave that could run up and overtop the TSF low point.	Permit condition (Ministry of Energy and Mines 2013) HSRC 2017 §10.1.11	If included in recommendations of the empirical wave assessment (Phase 1, from recommended action 2016-04), carry out Phase 2 numerical assessment to further assess the potential wall failure slide impact velocity and model the wave runup height.	2	Q2 2021
2020-04	OMS manual needs updating	HSRC 2017 §10.5.2	Items for the next annual update of the OMS manual should include: a) IDF volume (Golder 2021) b) updated maximum operating pond level and QPOs from Section 2.4 of this report c) addition of new QPO for piezometer GTF17-08 (03) d) frequency of bathymetry survey could be changed to once a year (currently twice a year) e) description of deviations between design basis in 2012 (Golder 2012) and current operating conditions (from Section 2.2.4 of this report)	4	2021

HSRC = Health, Safety and Reclamation Code; IDF = Inflow design flood; OMS = operation, maintenance, and surveillance; QPO = quantifiable performance objectives; TSF = tailings storage facility; STP = South Tailings Pond; n/a = not applicable.

Priority Level	Description
1	A high probability or actual 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 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 safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

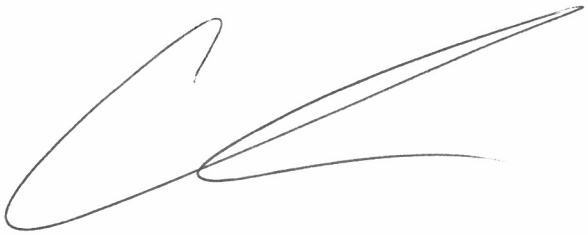
Source: HSRC Guidance Document, Section 4.2 (Ministry of Energy and Mines 2016b).

7.0 CLOSURE

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

We trust that this report meets your present requirements. If you have any questions or additional requirements, please contact the undersigned.

Golder Associates Ltd.



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

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

CYL/JCC/hp/ajh/it

https://golderassociates.sharepoint.com/sites/121039/project files/6 deliverables/issued/2020-221-r-rev0-2000-turnbull tsf dsi report/20136981-2020-221-r-rev0-2000-turnbull tsf dsi fro 08mar_21.docx

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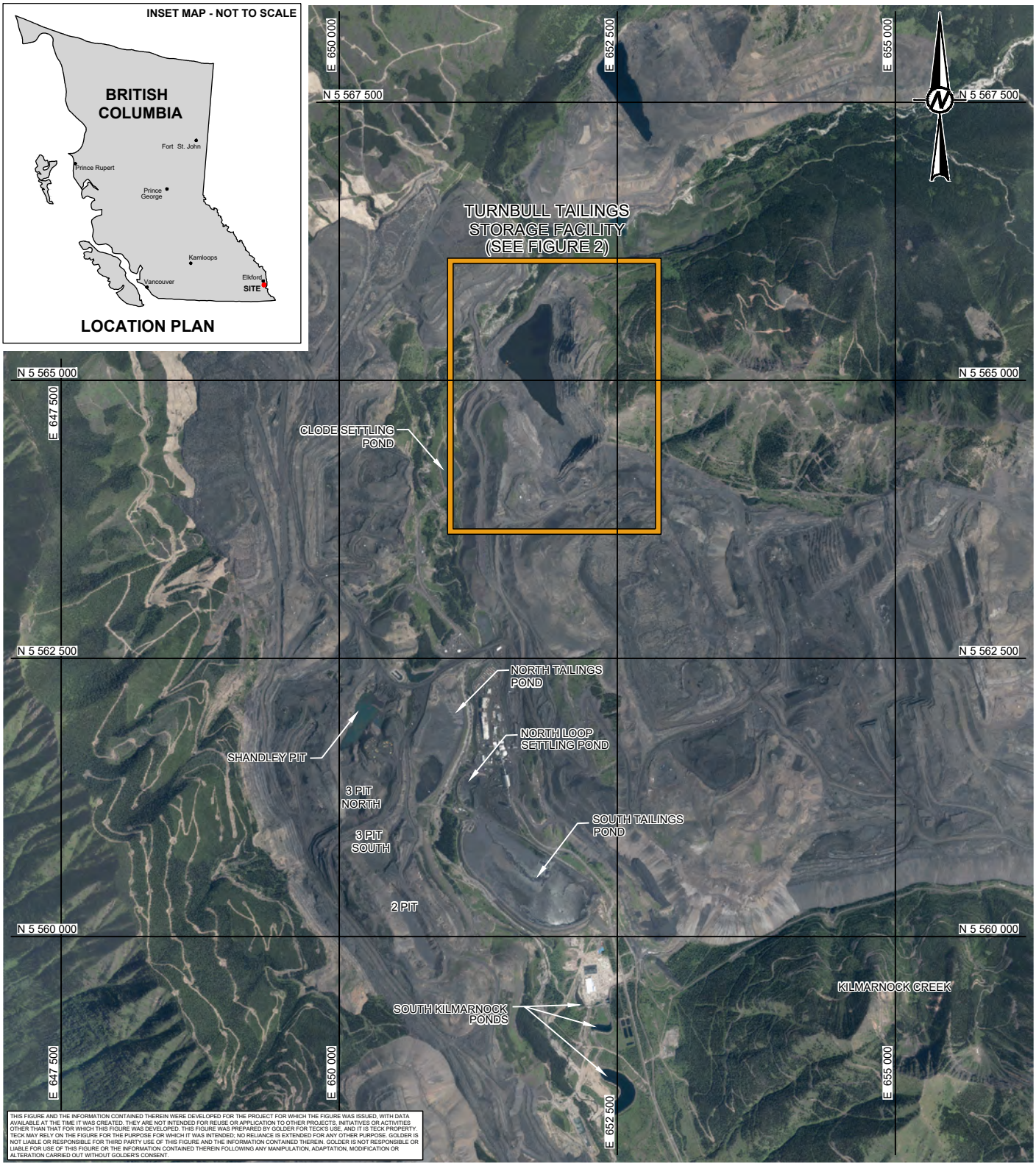
FIGURES



REFERENCE

1. 2020 AERIAL PHOTO AND LIDAR TOPOGRAPHY PROVIDED BY TECK COAL LIMITED, RECEIVED: 01 DECEMBER 2020, DATES FLOWN: 15-26 JULY 2020.

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.

0 1,000 2,000
1:50,000 METRES

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

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	A. VAN ENGELEN
PREPARED	A. KIM
REVIEWED	C. LEE
APPROVED	J. CUNNING

PROJECT
TURNBULL TAILINGS STORAGE FACILITY
2020 ANNUAL INSPECTION REPORT

TITLE
FORDING RIVER OPERATIONS PLAN

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20136981	2000/2007/2020-221	0	1

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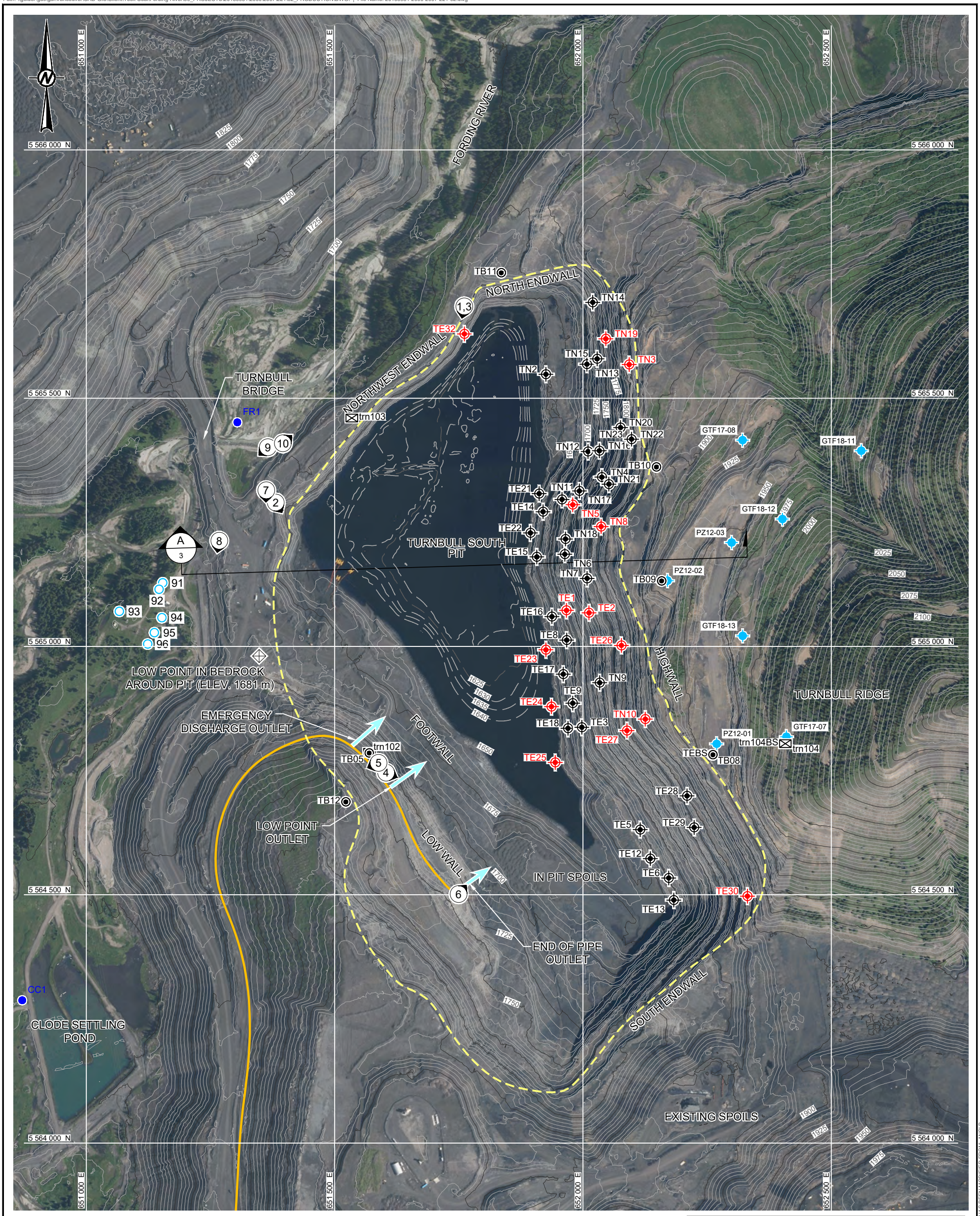
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

0 25 mm



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.

LEGEND

- TOPOGRAPHIC CONTOURS
- BATHYMETRY CONTOURS (SEE REFERENCE 8)
- DREDGE LINE
- TURNBULL SOUTH PIT LIMIT
- PIEZOMETER LOCATION
- POTABLE WELL LOCATION
- WATER QUALITY MONITORING LOCATION
- GPS MONITORING LOCATION
- ACTIVE PRISM LOCATION
- INACTIVE PRISM LOCATION
- 2020 PHOTOGRAPH LOCATION
- PRISM SURVEY STATION LOCATION
- LOW POINT IN BEDROCK AROUND PIT

REFERENCES

1. 2020 AERIAL PHOTO AND LIDAR TOPOGRAPHY PROVIDED BY TECK COAL LIMITED, RECEIVED: 01 DECEMBER 2020, DATES FLOWN: 15-26 JULY 2020.
2. GPS LOCATIONS FROM FRO'S GEOEXPLORER PROGRAM. ACCESSED 18 OCTOBER 2019.
3. POTABLE WELL LOCATIONS PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS IN 2010.
4. WATER QUALITY STATION LOCATIONS PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS ON 17 OCTOBER 2019.
5. 2012 PIEZOMETER LOCATIONS PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS IN 2012.
6. BEDROCK LOW POINT PROVIDED BY FRO. 2018B. TURNBULL TSF NORTHWEST ENDWALL GPR SURVEY RESULTS FOR BEDROCK DELINEATION. DRAFT RECEIVED 12 DECEMBER 2018.
7. 2017 PIEZOMETER LOCATIONS PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS IN 2017.
8. GOLDER. 2018c. 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.
9. PRISM LOCATIONS WERE PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS ON 19 OCTOBER 2020.

0 125 250
1:7,500 METRES

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

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	A. VAN ENGELEN
PREPARED	A. KIM
REVIEWED	C. LEE
APPROVED	J. CUNNING

PROJECT
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2020 ANNUAL INSPECTION REPORT

TITLE
PHOTOGRAPH LOCATIONS

PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20136981	2000/2007/2020-221	0	2

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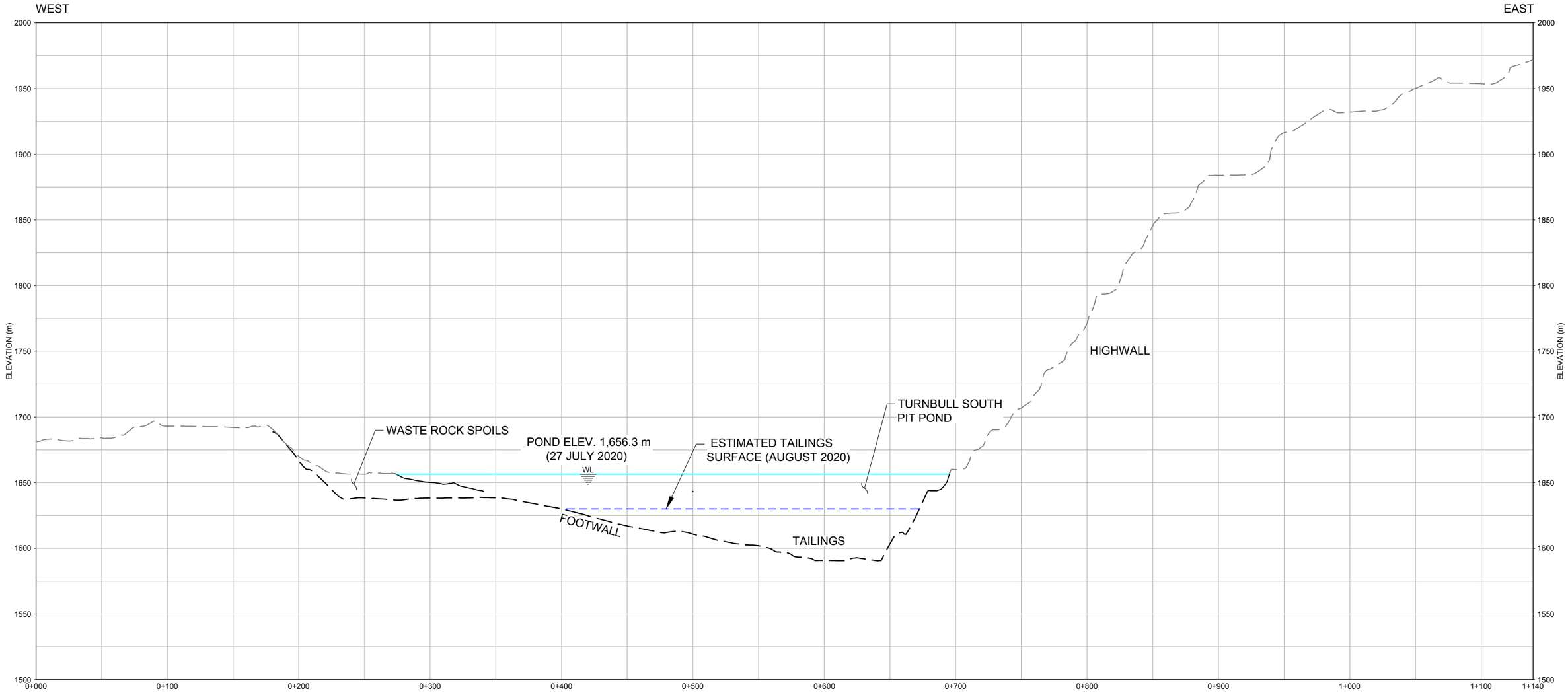


SCALE 1:3,000 m

A-2 TURNBULL SOUTH PIT - CROSS-SECTION

LEGEND

- 2020 AS-BUILT GROUND SURFACE (SEE REFERENCE 1)
- 2018 GROUND SURFACE (SEE REFERENCE 2)
- ESTIMATED 2020 TAILINGS (SEE REFERENCE 4)
- TURNBULL SOUTH PIT AS-BUILT (SEE REFERENCE 5)
- CURRENT WATER LEVEL (SEE REFERENCE 3)

NOTE

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS ARE REFERENCED TO ELK VALLEY ELEVATION DATUM.

REFERENCES

1. 2020 GROUND SURFACE FROM LiDAR TOPOGRAPHY PROVIDED BY TECK COAL LIMITED, RECEIVED: 01 DECEMBER, 2020, DATES FLOWN: 15-26 JULY 2020.
2. 2018 TOPOGRAPHY PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS. FLOWN ON 15 TO 16 JULY 2018.
3. 2020 WATER LEVEL PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS. ON 16 SEPTEMBER 2020.
4. AUGUST 2020 TAILINGS SURFACE ESTIMATED FROM AUGUST 2020 BATHYMETRY SURVEY PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS ON 20 AUGUST 2020.
5. AS-BUILT TURNBULL SOUTH PIT SHELL CREATED USING 3D FACES PROVIDED BY TECK COAL LIMITED, FORDING RIVER OPERATIONS. RECEIVED: 11 APRIL 2018.

0 50 100
1:3,000 METRES

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

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-03
DESIGNED	A. VAN ENGELEN
PREPARED	A. KIM
REVIEWED	C. LEE
APPROVED	J. CUNNING

PROJECT
TURNBULL TAILINGS STORAGE FACILITY
2020 ANNUAL INSPECTION REPORT

TITLE
CROSS-SECTION A

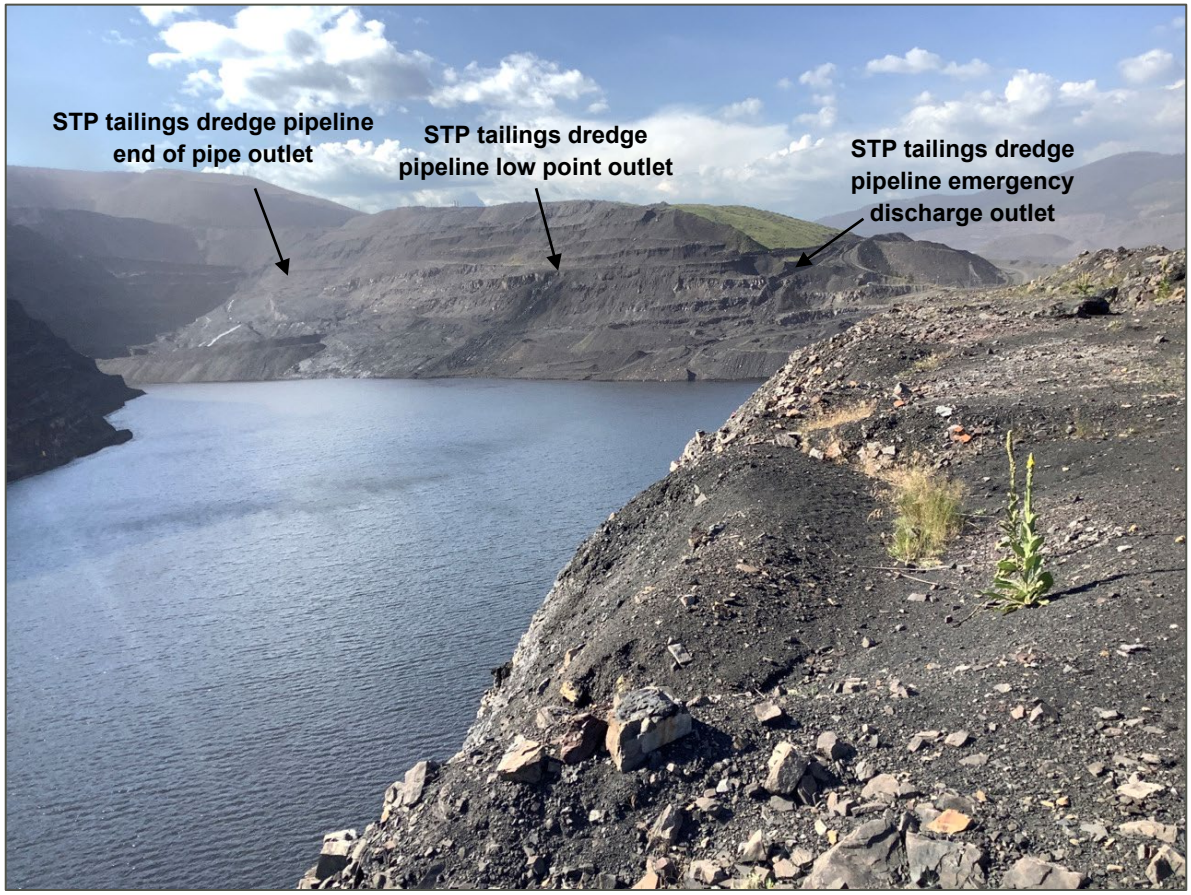
PROJECT NO.	PHASE/TASK/DOC	REV.	FIGURE
20136981	2000/2007/2020-221	0	3

APPENDIX A

Site Photographs

2020 Annual Dam Safety Inspection for Turnbull Tailings Storage Facility

PHOTOGRAPH A-1 **19 August 2020**



Turnbull TSF overview from north endwall, looking southwest.

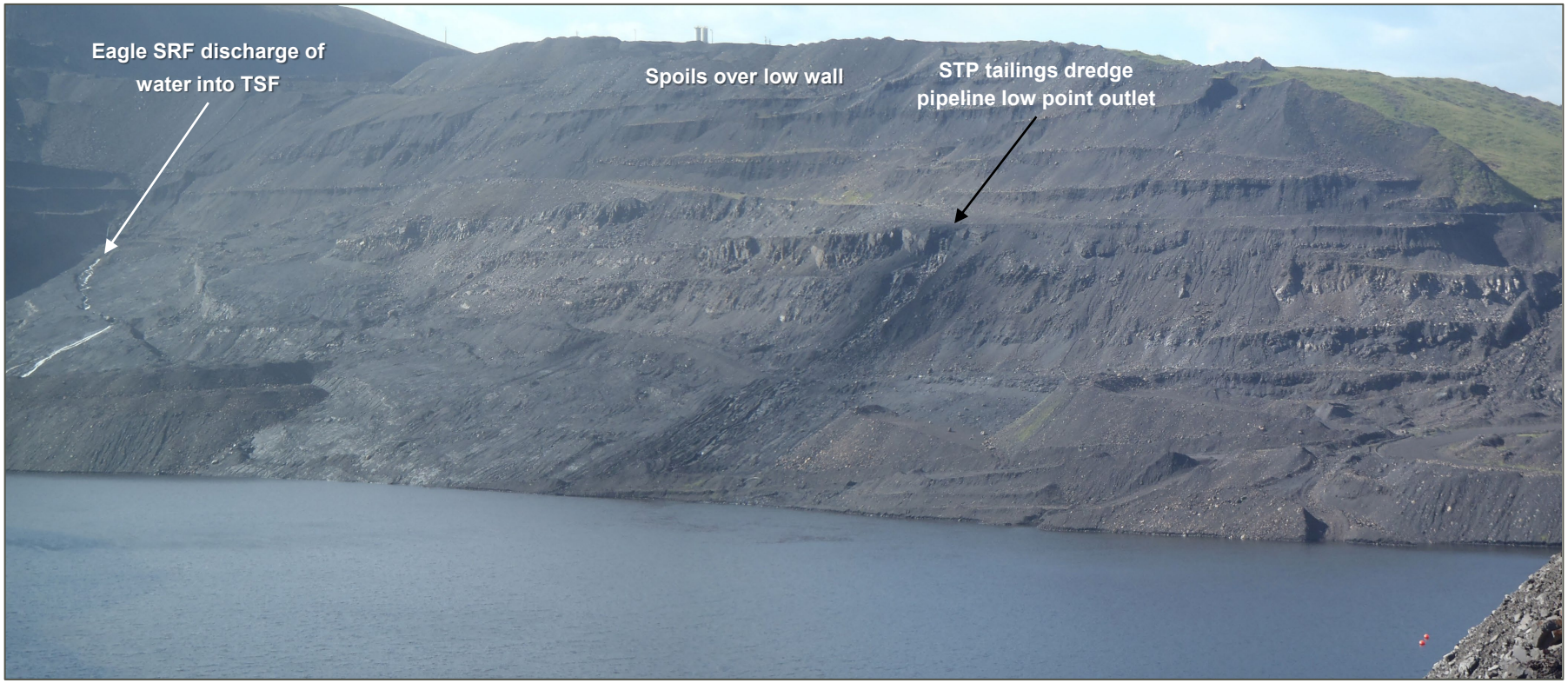
PHOTOGRAPH A-2

19 August 2020

Turnbull TSF Pond, reclaim water intakes and pipelines, looking southeast.

PHOTOGRAPH A-3

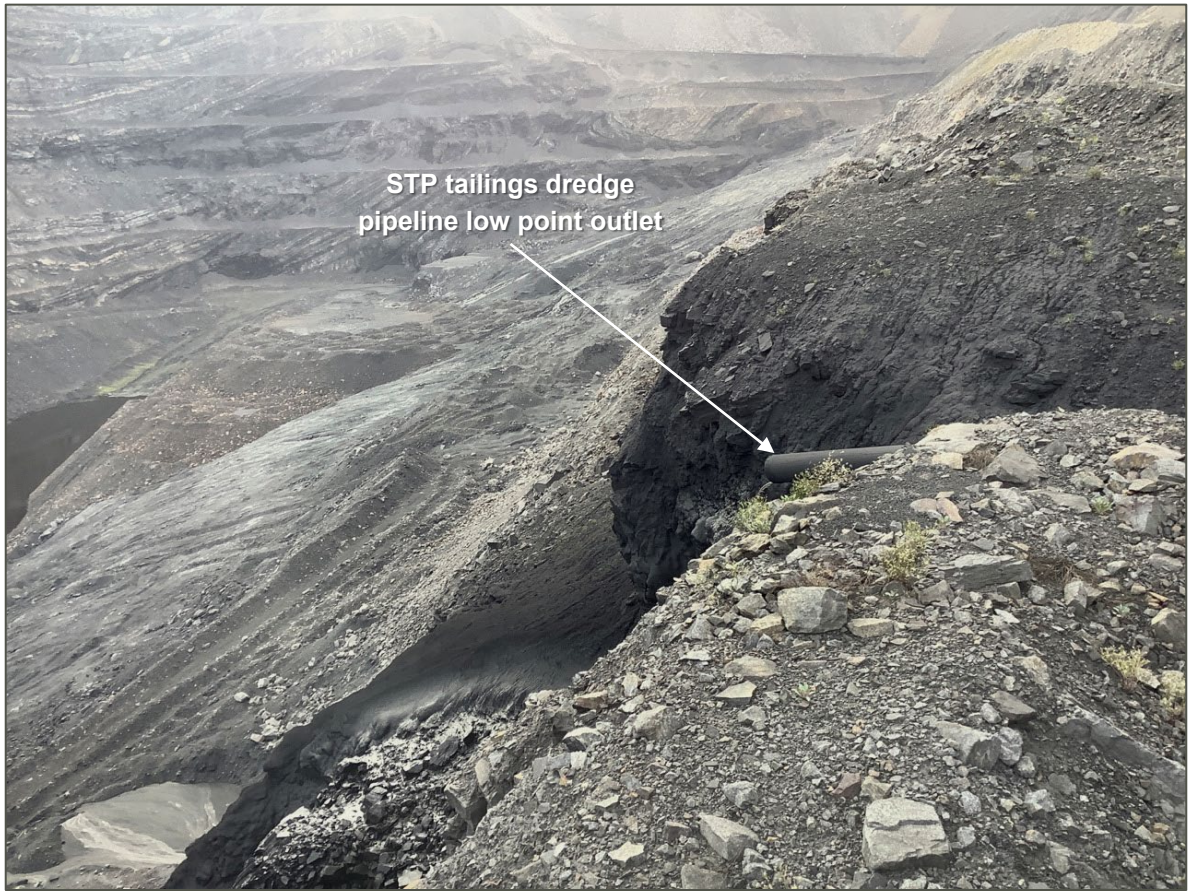
19 August 2020



Turnbull TSF Eagle Saturated Rockfill (SRF) pipeline discharge into Turnbull TSF, looking south.

PHOTOGRAPH A-4

19 August 2020

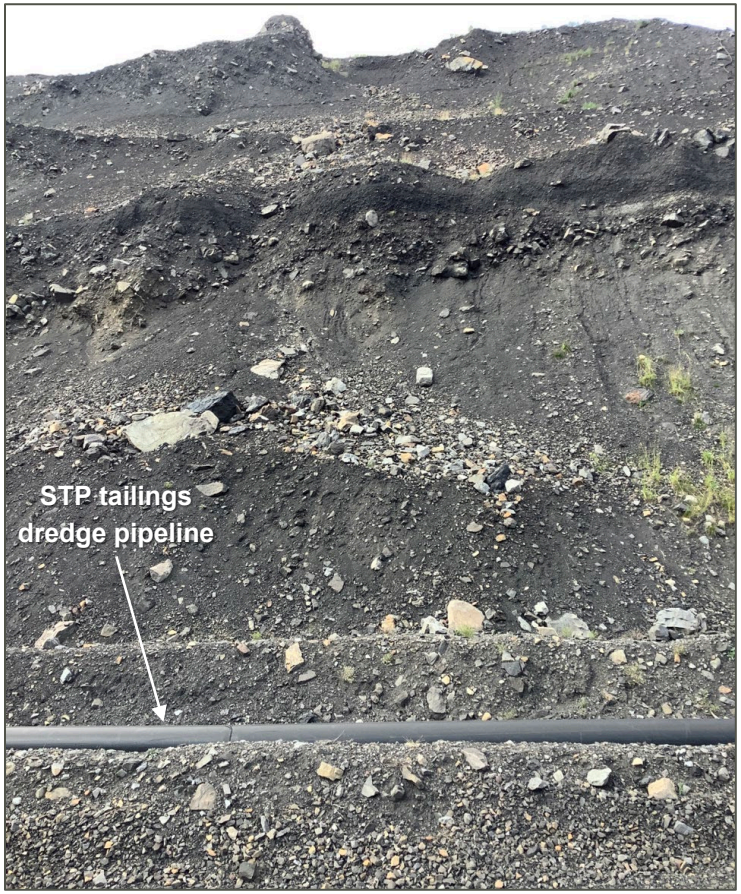


Tailings dredge pipeline low point outlet, looking southeast (STP dredge was not running at time of site visit).

2020 Annual Dam Safety Inspection for Turnbull Tailings Storage Facility

PHOTOGRAPH A-5

19 August 2020



Debris is collecting behind berm for pipeline; this debris should be cleaned out.

Turnbull TSF waste rock benched slope above tailings pipeline on low wall, looking southwest.

PHOTOGRAPH A-6

19 August 2020

Tailings flow from the pipeline low point outlet discharges over in-pit spoils into the pit pond, looking east.

PHOTOGRAPH A-7

19 August 2020

Turnbull TSF backfill spoil and haul road at pit low point area, looking south.

PHOTOGRAPH A-8

19 August 2020

Turnbull TSF view of downstream slope to the low point area waste rock fill and haul road, looking south.

PHOTOGRAPH A-9

19 August 2020

Turnbull TSF view of downstream slope toe to the low point area waste rock fill and haul road fill, looking southwest.

PHOTOGRAPH A-10

19 August 2020

Turnbull TSF view of downstream slope toe to the low point area waste rock fill and haul road, with riprap placed along Fording River, looking northeast.

APPENDIX B

Turnbull Tailings Storage Facility Inspection Report

Client:	**Teck Coal Limited, Fording River Operations**	**By:**	**John Cunning, P.Eng.**
Project:	**20136981 FRO Tailings Facilities 2020 Annual Dam Safety Inspection**	**Date:**	**19 August 2020**
Location:	**Turnbull Tailings Storage Facility**	**Reviewed by:**	**Clara Lee, P.Eng.**

General Information			
Dam Type:	Rockfill (backfill spoil and haul road) over the footwall at low point area of Turnbull Pit		
Weather Conditions:	Sunny	**Temp:**	25°C–30°C

Inspection Item	Observations/Data	Photo	Comments & Other Data
1.0 DAM CREST		7,8	
1.1 Crest Elevation	elev. 1,691 m (2020 LiDAR)		Backfill spoil lower point
1.2 Reservoir Level/ Freeboard	Reservoir level at elev. 1,656,3 m (27 July 2020) 24.7 m freeboard		Turnbull TSF maximum pond is controlled by low point of mined out bedrock at elev. 1,681 m; freeboard reported is measured from the bedrock low point
1.3 Surface Cracking	None		
1.4 Unexpected Settlement	None		
1.5 Lateral Movement	None		
1.6 Other Unusual Conditions	Crest area is haul road and a laydown area for equipment and pumping infrastructure.		
2.0 UPSTREAM SLOPE		7	
2.1 Slope angle	1.33H:1V		Backfill spoils over Turnbull pit footwall
2.2 Signs of Erosion	None		
2.3 Signs of Movement (Deformation)	None		
2.4 Cracks	None		
2.5 Face Liner Condition (if applicable)	Not applicable		

Inspection Item	Observations/Data	Photo	Comments & Other Data
2.6 Other Unusual Conditions	None		
3.0 DOWNSTREAM SLOPE		8, 9, 10	
3.1 Slope Angle	1.33H:1V		
3.2 Signs of Erosion	None		
3.3 Signs of Movement (Deformation)	None		
3.4 Cracks	None		
3.5 Seepage or Wet Areas	None		
3.6 Vegetation Growth	None		
4.0 DOWNSTREAM TOE AREA		9, 10	
4.1 Seepage from Dam	None		
4.2 Signs of Erosion	None		
4.3 Signs of Turbidity in Seepage Water	Not applicable		
4.4 Discoloration/Staining	Not applicable		
4.5 Outlet Operating Problem (if applicable)	Not applicable		
4.6 Other Unusual Conditions	Yes		Fording river located in downstream toe area
5.0 ABUTMENTS			
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	None		
6.0 RESERVOIR			
6.1 Stability of Slopes	good		Monitoring in place
6.2 Distance to Nearest Slide (if applicable)	500 m		Turnbull pit highwall
6.3 Estimate of Slide Volume (if applicable)	7,600,000 m^3		(Golder 2019)

Inspection Item	Observations/Data	Photo	Comments & Other Data
6.4 Floating Debris	None		
6.5 Other Unusual Conditions	None		
7.0 EMERGENCY SPILLWAY/ OUTLET STRUCTURE	None		
8.0 INSTRUMENTATION			
8.1 GPS			6 GPS units installed on the in-pit spoils, the highwall, north end wall, and south end wall of the TBS Pit
8.2 Prisms			30 active prisms and 2 backsights
8.3 Piezometers			Vibrating wire (VW) piezometers at 8 locations within the highwall of the Turnbull TSF
9.0 DOCUMENTATION			
9.1 Operation, Maintenance and Surveillance (OMS) Manual 9.1.1 OMS Manual Exists	Yes		Turnbull Tailings Storage Facility OMS Manual
9.1.2 OMS Manual Reflects Current Dam Conditions	Yes		
9.1.3 Date of Last Revision	27 May 2020		Version 2020-04 (FRO 2020a)
9.2 Emergency Response Plan (ERP) 9.2.1 ERP Exists	Yes		Turnbull TSF included in site tailings facilities ERP. (EP.009.R1) (FRO 2020b)
9.2.2 ERP Reflects Current Conditions	Yes		
9.2.3 Date of Last Revision	25 May 2020		
10. NOTES			
Inspectors:	John Cunning, P.Eng.	**Date:**	19 August 2020

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