2017 Dam Safety Inspection, Placid Tailings Storage Facility

Bull River Mine, Bull River, BC

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Project No.:643035

Prepared For:
Purcell Basin Minerals Inc.

SNC · LAVALIN

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Executive Summary

The Bull River Mine maintains a Tailings Storage Facility (TSF) which is the subject of this annual dam safety inspection. The TSF was constructed in 1970 to 1971 and was reclaimed approximately 4 to 5 years later. The facility is understood to have a low consequence classification.

Based on inspections in 2014, 2016 and 2017, the reclaimed TSF is in good condition and appears to be stable. Some groundwater is likely present in a perched condition within portions of the tailings but its nature is unknown due to the absence of instrumentation in the reclaimed facility. Seepage was not encountered; nor did the dam structure exhibit signs of instability. Surface water is managed by diverting through pipes and ditches around the TSF to the west and east sides into natural gullies. Upgrading work in 2015 was conducted to direct some surface water on the TSF to the north under a haul road in a culvert, into the mine's primary settling pond. The only surface water to contact the TSF is a portion of the precipitation falling directly within its footprint, and it is observed by mine staff to consistently infiltrate into the soil cover and tailings with minimal areas of ephemeral standing water. The water balance is favorable in the long term; the TSF soils are porous and appear to be naturally under-drained, percolating close to vertically downward.

A gully in the reclaimed TSF in a portion of the dam had encountered periodic erosion events prior to 2014. In response to our 2014 report, some slope re-dressing and gully channel cross-berm work was completed by Purcell Basin Minerals.

Design documents and correspondence submitted by engineers during construction were reviewed. A CAD file with topographic was provided in 2016, as an as-built drawing for the TSF.

This TSF does not appear to meet the definition of a major impoundment as defined in the Health, Safety and Reclamation Code for Mines in British Columbia; the definition can be interpreted as being intended for materials stored in a slurry or liquid state. However, the TSF configuration meets the definitions for a major dam and a major dump. An Operation, Maintenance and Surveillance Manual is likely required for this TSF but SNC-Lavalin did not receive a copy if one exists. Recommendations for operations, maintenance and surveillance have been provided in this report. An Emergency Preparedness Plan is not required for this particular TSF due to its low consequence classification.

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1 Introduction

Purcell Basin Minerals Inc. (PBM) retained SNC-Lavalin to perform Engineer of Record services and conduct a dam safety inspection of the legacy Placid tailings storage facility (TSF) at the Bull River Mine near Bull River, B.C. The Dam Safety Inspection (DSI) is to be conducted in accordance with the Ministry of Energy and Mines' Guidelines for Annual Dam Safety Inspection Reports, dated August 2013.

SNC-Lavalin's author performed a DSI in October to November, 2014, gaining familiarity with the site at that time. In 2016, SNC-Lavalin performed site visits and inspections on September 15, 2016 and November 22, 2016. For 2017, SNC-Lavalin performed another site inspection on October 17, 2017. The purpose of the visual inspections was to provide a qualitative evaluation of the TSF condition.

The scope of the work is to:

1. Gather and review available relevant background and historical information;
2. Interview mine staff regarding the history and operation of the TSF;
3. Visually examine and photograph the facility;
4. Inspect changes in conditions and operations and repairs since the last inspection; and,
5. Analyze the TSF and document our observations and any resulting recommendations in a report prepared in accordance with the Ministry of Energy and Mines' 2013 Guidelines for Annual Dam Safety Inspection Reports.

Part 10 of the HSRC requires that the Engineer of Record (EOR) have professional responsibility for assuring that a tailings storage facility or dam has been designed and constructed in accordance with the applicable guidelines, standards and regulations. The EOR is required to inform the Mine Manager of any safety issues that could compromise the integrity of the facility, and shall also provide a consequence classification. Further the HSRC requires an Operations, Maintenance and Surveillance (OMS) Manual to be completed by a qualified person prior to operation. Bull River Mine's Placid TSF is not operating and so an OMS manual is not required; however, safe caretaking of the facility will need to be addressed in a site-specific listing of recommended OMS procedures.

SNC-Lavalin performed a detailed background review of the Placid TSF design drawings, construction records (although limited availability) and Mines Inspector records in its 2014 DSI and reporting. Much of the TSF background information was recorded in our November 24, 2014 report and 2016 DSI report, which should be read in conjunction with this 2017 DSI report. Some of the text in this report is repeated from the previous reports, while other portions of the 2014 report are not reproduced in this present report.

2 Background and Site Description

2.1 Bull River Mine

PBM maintains its Bull River Mine on mountain slopes north of the Bull River at the location shown on Figure 1, 30 km east of Cranbrook, British Columba. The site is accessed by the Wardner-Fort Steele Road and the Bull River Road. The mine is presently under care and maintenance and has operated in the past under previous owners.

According to Snowden (2013), the site contains a mill, assay laboratory, shops, offices, underground facilities and infrastructure, two open pits, various dumps, the Placid TSF and associated electricity supply and mining facilities. One of the open pits has been backfilled and the other pit, north of the TSF, is being used as a settling pond.

The mine was first developed in approximately 1968 by Placid Oil. First called the Dalton Mine and the Bull River Mine, design and construction of the TSF and other facilities took place in 1970 and 1971, with production of copper, silver and gold beginning in October 1971 from the open pits. Pit production ceased in approximately summer 1974 and underground exploration and development was attempted soon after; Placid Oil encountered difficulties in initial tunnelling. The TSF was reportedly reclaimed at about this time. Placid Oil sold the property and assets in 1976.

In the 1980's through until 2009, exploration occurred. In 1996 underground development began. In 2005 the Ministry of Energy and Mines granted a permit (# M33) for production of up to 75,000 tonnes per year; however tailings disposal on surface was not included in the permitted activities or disturbance areas. More detailed information can be found in Snowden's 2013 technical report.

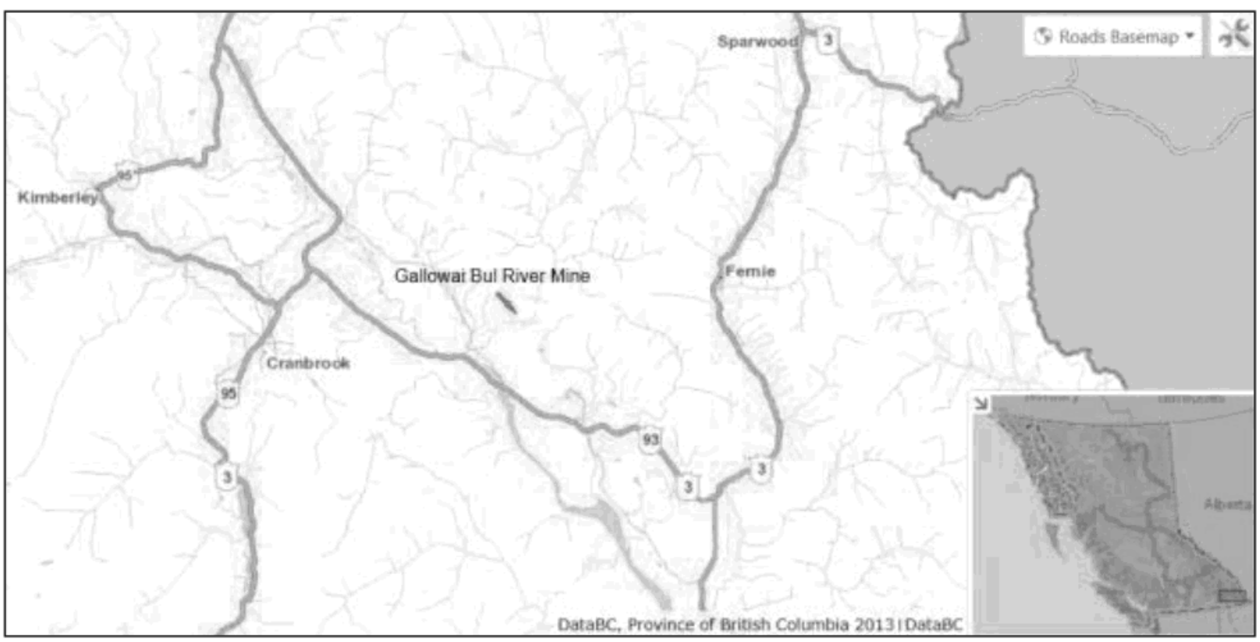

Figure 1: Site Location (Map source: iMapBC website, Province of British Columbia)

2.2 Physiography

The mine site is located on gentle to moderate slopes at the base of Bull Mountain, on a bench above the Bull River, which flows east to west in the site vicinity in a canyon approximately 700 m south of the TSF, approximately 135 m lower in elevation. Burntbridge Creek flows down the mountain from headwaters at the peak and through the property to the west of the TSF and into the Bull River. Earlier in the mine life, Burntbridge Creek was diverted to the west. Its old channel is located on the west side of the Placid TSF and is used for pumping discharge from the old pit, which is used as a settling pond for surface water ditches and water pumped from underground workings.

The site is vegetated with various grasses in disturbed areas, which are grazed by cattle and wild ungulates. Trees are dominantly interior douglas firs in the TSF vicinity, with aspens and larches in gully bottoms outside the TSF to the west and east. Site and mine property features are depicted in Figure 2.

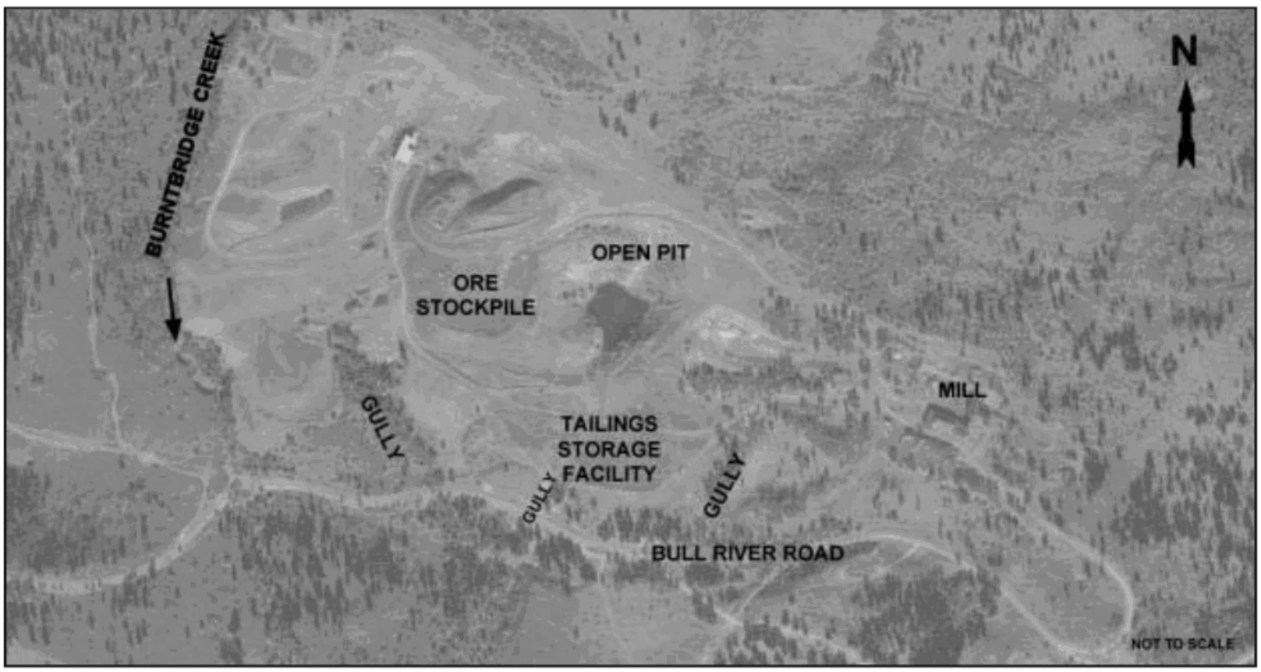

Figure 2: Bull River Mine Layout

2.3 Geology

The upper slopes of the mine site have generally thin soil cover over faulted bedrock of the Aldridge Formation comprising turbidites, siltstones, and argillites (Snowden, 2013). Diorite and gabbro sills have intruded the Aldridge Formation rocks. The ore of the Bull River Mine is found in an area with abundant veins of quartz and carbonates which also contain sulphide minerals.

The surficial geology comprises glacial till and colluvium in upper slopes of the mine site. Lower slopes are underlain by thick glaciofluvial sand and gravel deposits, up to 200 m thick (Snowden, 2013 and Lotic, 2015 a and b). The bedrock surface dips very steeply down to the south under the mine site, notably under the TSF.

2.4 Climate

Environment Canada monitors a weather station at the Cranbrook Airport weather station, located 31 km to the west-northwest. Information in this paragraph is derived from the averages reported between 1971 and 2000. The mean annual temperature is 5.7^{0} C with warm summers (high temperature of 25^{0} C in July/August) and cold winters with minimum daily average temperatures of -11.8^{0} C in January. Average annual precipitation at the airport is 383 mm (water equivalent) with 53 mm in June (the wettest month) and 18 mm in October (the driest month). Generally February through April is also relatively dry. December and January snowfall average 36 and 33 cm, respectively, along with approximately 4 to 7 mm of rainfall. More site specific information can be found in the water balance assessment (Lotic, 2015b).

Precipitation can vary substantially by location in the Cranbrook and Bull River vicinity, with higher amounts occurring near the mountains on the west and east sides of the Rocky Mountain Trench.

2.5 Tailings Storage Facility

2.5.1 Design Review

Golder Brawner Associates Ltd. (Golder Brawner) performed geotechnical investigations and made subsequent recommendations and analyses in 1970 that informed tailings storage facility design and construction specifications produced by Wright Engineers Ltd. (Wright). The constructed TSF is located east of Burntbridge Creek, upslope of the Bull River Road. According to design drawings, its crest elevation was 3,025 feet (922 m) with a design freeboard of 3 feet. It was 12.3 acres in area with an estimated storage capacity of 500,000 m^3 impounded by 360,000 m^3 of dam embankment material. The dam crest length is approximately 540 m and has at least three bends linking straight crest segments. The crest width was specified as 20 feet (6 m). The proposed tailings dam slope angles were 2H:1V for the upstream and downstream faces. Due to undulating pre-construction topography and relic drainage gullies in the TSF footprint, the dam embankment height ranged from nearly zero at the west and east abutments where it tied into existing terrain sloping upward, to approximately 30 m height over a partial gully fill on the east side.

Based on a review of the historical reports, borehole and test pit logs and related correspondence, the tailings dam foundation soils comprised compact to dense glaciofluvial sand and gravel with cobbles and a trace of silt. At the north end of the impoundment, closer to the open pit, the surficial soils were glacial till rather than glaciofluvial sands and gravels. Golder Brawner concluded the dam foundation materials and pond floor area were pervious and predicted the facility would leak water excessively unless it was fitted with an impermeable liner comprising a PVC membrane, soil and drainage layer liner, or asphaltic concrete (asphalt). Later correspondence omitted the soil and drainage liner option and listed a sprayed asphalt method instead. An asphaltic concrete liner was ultimately selected in the correspondence as the preferred option. However, several years later M.G. Sveinson, Mill Superintendent wrote that the tailings pond was lined with Dupont Fabrene “C”.

The embankment was to be constructed of glacial till derived from stripping and site grading at the open pits and mill site. Laboratory tests from 1970 indicate the till was composed generally of gravelly silty sand with some variation of those components in the samples. Atterberg Limits results reported in the documents indicate the material behaved as nearly non-plastic to low plastic silt (ML). Optimum moisture content for compaction was 8 % on two samples subject to Standard Proctor moisture-density tests, and the natural water content of samples was below this level. Golder Brawner concluded the glacial till was relatively impermeable and competent once compacted and was suitable for dam construction.

Golder Brawner performed a consolidated undrained triaxial shear test on laboratory-compacted samples of the till, and reported and used an internal friction angle of 32^{o} and zero cohesion. In later correspondence (December 1970), they noted that these strength values may be conservative and that a higher friction angle on as-constructed embankment fill was likely present because constructed fill densities were somewhat higher than those used in laboratory compacted specimens. Additionally, the engineer stated that a small amount of cohesion was likely present which would increase stability conditions notably.

The till borrow was to be placed on a scarified and recompacted, stripped surface. It was to be placed in 8-inch maximum thickness lifts measured before compaction (10 inches in final construction specifications), at 98 % of its Standard Proctor maximum dry density. Within 15 feet of the upstream face of the embankment, stones greater than 6 inches diameter were to be removed (8 inches diameter was stipulated in final construction specifications).

Where foundation soils could have low hydraulic conductivity, a drain filter blanket under the dam's downstream toe was detailed on the drawings. Based on a review of correspondence, it appears Golder Brawner advised that the filter drain would only be selectively required in the eastern approximately 120 m of the proposed dam as well as two small locations within the western approximately 100 m of the dam. The drain material was specified as 3-inch minus, well graded sand and gravel with less than 5 % fines. It was to be constructed 3 feet thick vertically and 30 feet wide in the design drawings (minimum 50 feet wide drain shown in the initial soils report). Letters written during embankment construction included supporting drawings that noted the drains would have varying 10 to 30 foot widths.

One spillway culvert (12-inch diameter) at each of the west and east terminus points of the dam crest were included on the drawings to direct excess supernatant water down into gullies situated on either side of the TSF. Reclaim pumphouse and piping facilities were also shown on the drawings.

2.5.2 Construction

Some construction related information is available in letters written by Golder Brawner discussing observations and recommendations arising from site visits during construction. No as-built drawings were discovered by PBM.

In November 1970, Golder Brawner submitted a letter describing site observations made on October 15 and 16, 1970. Where natural foundation soils were granular and relatively free-draining, the drain filter under the embankment downstream toe was allowed to be omitted. Silty subgrade areas observed during the site visit were recommended to be topped with a filter, and a site plan was produced, showing the areas that did require a toe drain.

During embankment construction, Golder Brawner reported that fill was being placed in lifts not exceeding 6 inches in thickness and that boulders were being removed. Based on measured fill densities and moisture contents, compared to the laboratory Standard Proctor moisture-density curves, Golder Brawner allowed a one or two percentage point reduction from the minimum 98 % of Standard Proctor maximum dry density, depending on whether samples were +/- 1% or +/- 2 % of the optimum moisture content. The letter alluded to potential construction challenges related to working with some ambient temperatures below freezing.

2.5.3 Operation and Reclamation

The TSF was operated for approximately four to five years. Sveinson's report indicated that the Dupont synthetic liner was torn by fill weight and wind and patched several times in early operation before being covered with fine overburden. Placid Oil reported that on April 15, 1976 following ten days of unusually warm weather, high runoff led to overtopping and a washout on the south dam of the TSF, transporting approximately 3,000 yd^3 of sand and gravel onto the Bull River Road. Approximately 4 acres of the TSF surface was disturbed and the area was recontoured. Surface ditches were diverted away from the TSF and seeding and fertilizing were conducted.

There were no records available relating to planning or execution of the reclamation of the TSF. It was reclaimed in approximately 1976. Presently, the ground surface of the former tailings pond is grassy and contains a soil cover. It is sloped approximately 2 % down to the north, into the mountain. A gully was left in place from the 1976 washout, in the south embankment, west of its center. The abutment area spillway culverts and reclaim facilities are no longer present.

According to PBM staff, five test pits were excavated in the TSF in August 2014 in order to assess the tailings material for studying cement powder addition to future tailings from the mill which may be generated should production re-commence. We understand the test pits revealed approximately 1 to 1.5 m of a surficial soil cover containing some organics, overlying tailings consisting of alternating coarse and fine sand layers. Moisture content of tailings sand samples were in the order of 10 %.

2.5.4 Dam Safety Inspections

PBM could not locate records from previous dam safety inspections. However, a Ministry of Energy and Mines inspection and Order by a Geotechnical Mines Inspector was documented, along with the mine manager's response. The Ministry inspection report noted that tailings were covered, re-vegetated and dry. The dam toe was reported as dry with no evidence of seepage or vegetation types that grow in moist areas. The west and east downstream dam faces were assessed as stable with no significant erosion. The report noted that a drainage swale was cut down through the dam just west of its middle. The report noted that erosion had occurred in 1992 and that a previous Order by a Mines Inspector (presumably conducted in 2000) for site re-vegetation had not resulted successful vegetation reestablishment. The Order required a plan and cross sections to be submitted along with a design for permanent water diversions, spillway design and erosion protection, to be constructed by November 30, 2000.

On September 29, 2000 the mine manager responded in a letter that some waste rock had been placed in part of the gully and noted that surface water from the TSF could not report to the gully due to topography around the gully head, with ground surface sloped away to the north. The permanent water diversion system was reported to comprise ditches and pipes that convey surface water around the TSF and/or to the former open pit and its pump system.

In fall 2014, and again in fall 2016, SNC-Lavalin completed a DSI as noted above. The DSI inspections found no items of significant concern, but recommended some repairs and pullback of oversteepened slopes in the south gully which was formed from the 1976 washout, and was the subject of the Ministry's inspection Order in 2000.

2.5.5 Dam Consequence Classification

As a result of the 2014 DSI and a third party review of SNC-Lavalin's DSI by Groundtech Engineering, the Placid TSF has a low consequence classification.

3 Methodology

A visual inspection of the TSF and surrounding area was conducted by Jeremy Zandbergen of SNC-Lavalin on October 17, 2017. PBM personnel provided a site tour in the morning, giving verbal background information.

Field conditions were suitable for performing a visual inspection. Weather conditions were sunny; ground conditions were nearly dry, although light rain showers had fallen during the previous days. The Cranbrook area experienced some six times the mean monthly precipitation for the month of October 2016. November 2016 was also significantly wetter than average and entire winter to spring 2016-2017 experienced high snowfall/precipitation. As a result many landslides and flooding events occurred in the Cranbrook area in spring 2017, with high groundwater levels that caused many flooded basements as well as flows in ephemeral creek draws which normally never experience surficial flow, even during spring snowmelt.

The Bull River Mine site was photographed during the inspections and selected photographs are included in this report below.

SNC-Lavalin reviewed original design and construction reports for the TSF, along with recent reports provided by PBM related to restart studies in hydrology and hydrogeology and water balance. These documents are listed in the References in Section 8 below.

4 Observations

General comments and visual observations of the integrity of the TSF, slope stability, cracks, seepage and erosion are documented in the following sections of this report. Site observations are supported by the photographs. Recommendations for maintenance or remedial work (if any) are assigned priorities as follows:

High priority: Immediate action should be taken to maintain/restore the integrity of the dam or the TSF system. No high priority recommendations are presented in this report.

Medium priority: Action should be taken but not necessarily immediately. Maintenance is recommended within the next year or two.

Low priority: Housekeeping issues or cosmetic repairs are recommended but not critical to maintain the TSF integrity. While an action may be low priority, it may yet be important to undertake regularly rather than deferred.

4.1 General Layout

Overall, the TSF is situated on relatively gentle to moderate pre-construction slopes above a steep-faced natural glaciofluvial terrace north of the Bull River Road. A second, flat to gentle terrace extends south from the road toward the escarpments above the Bull River. The overall TSF is pictured in Photographs 1 and 2.

The old open pit is now being used to manage sediment as a primary settling pond. It is approximately 15 m lower in elevation than the TSF ground surface at its north side.

Contour data from 1996 is shown in Figure 3 below, taken from a CAD file of topographic data having 2 m contour intervals. Key site features are labeled on the figure.

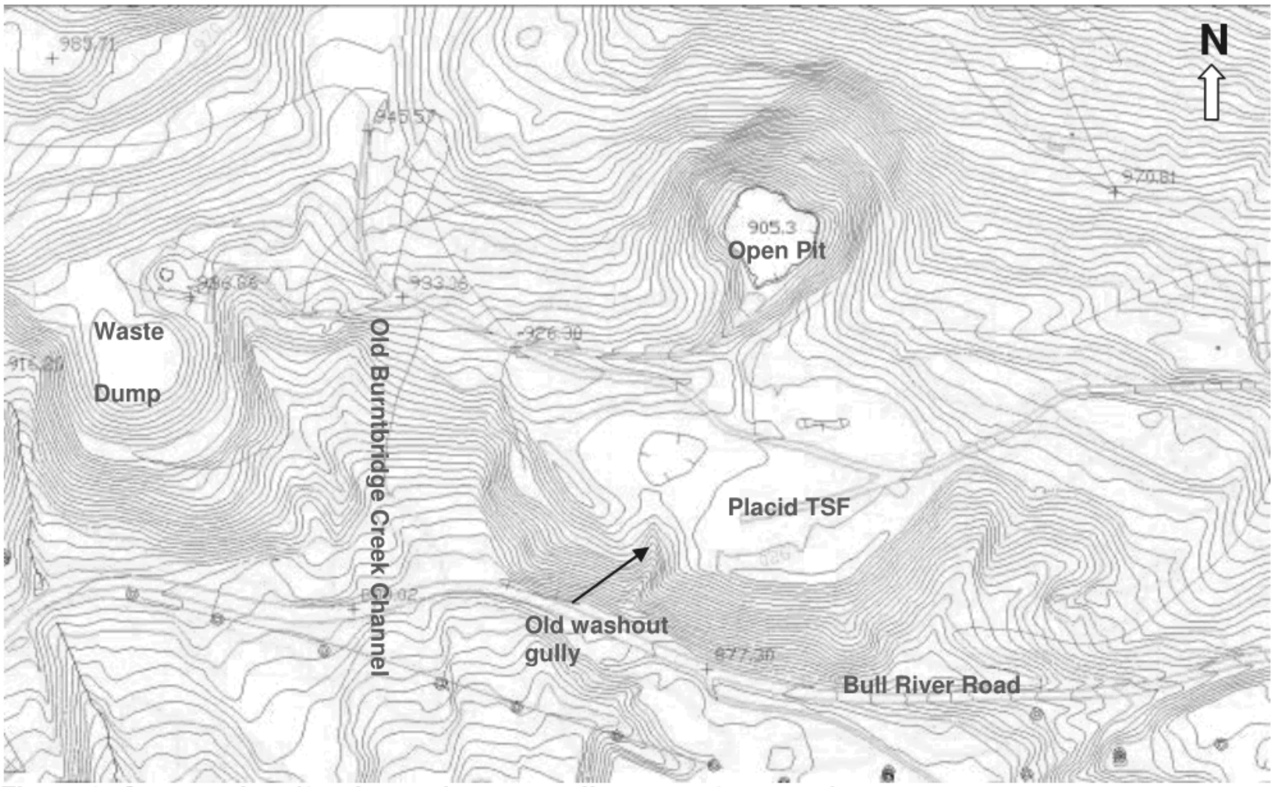

Figure 3: Contour data (2 m interval, magenta lines are 10 m apart).

4.2 Embankment and Surface

The TSF consists of a relatively flat surfaced fill that has been reclaimed and slopes gently to the north, into the mountain slope. As observed in the field, and corroborated by examination of the as-built contour data in Figure 3, the TSF surface slopes north to the open pit. It also slopes in westward and eastward to a point located just north of the old washout gully. Surfaces mostly slope to the open pit. The washout gully captures water only that falls within its confines, and the ground surface north of its headwall is graded down to the north toward the pit.

Some site observations are as follows:

- Natural slopes south of the TSF embankment were variable, approximately 28º to 31º down to the Bull River Road and the terrain was forested with interior douglas fir trees.
- The slopes and TSF crest appeared to be stable and no evidence of seepage or cracking or bulging was evident.
- In 2015, PBM conducted some grading activity to pull back some sloughing and oversteepened side slopes in the old washout gully sidewalls (see Photograph 3 and Photograph 4). Further, the ground surface of the TSF was modified slightly so as to ensure that the only surface water entering the gully would be direct precipitation within its confines.
- In 2015, culverts were upgraded at the north central area of the TSF, and ditches enhanced, to direct any surface water on the TSF under the haul road and into a ditch flowing to the open pit / primary settling pond (see Photograph 5).

- Surface water is managed to convey water to the old open pit (Photographs 1, 2, 5 through 8).
- The downstream face of the TSF was variably sloped from 26º to 31º. In general it was sloped flatter than 29º below the horizontal and vegetated in grasses with dry conditions (see Photograph 9).

Photograph 1: View to east from the waste dump in fall 2016. The primary settling pond / open pit is visible at the left edge. A haul road transects the TSF near the center of the photograph. The south (right) edge of the TSF crest has a depression hosting the old washout gully. The TSF surface slopes north (left) to the settling pond, with ditches and a culvert under the haul road.

Photograph 2: View to the south from a road above the open pit / settling pond in fall 2016. The TSF is in the center background, and the Bull River canyon is located in the background beyond the TSF. Ditches draining to the settling pond are visible, and the pond is pumped daily to the southwest in pipes to old Burntbridge Creek. The old washout gully is visible just above (south) the settling pond in the photograph, beyond the haul road.

Photograph 3: View south down the old washout gully to the Bull River Road from the TSF crest. Dam soils consist of silty sands with gravels and cobbles. The side slopes were repaired and recontoured in 2015. Cross berms were installed. The TSF surface, behind the photographer, was shaped and ditched to shed water in the opposite direction from this gully, north toward the settling pond. No changes were observed compared to 2016.

Photograph 4: View to the south to the Bull River Road, showing the lower end and deposition zone from the old washout gully. The gully was stabilized in 2015 and TSF surfaces were modified to ensure surface water, if any, would flow north away from the crest of this gully.

Photograph 5: View to east at the haul road through the TSF. The foreground ditch and culverts were constructed in 2015 to ensure any surface water would flow north to the primary settling pond in the old open pit, situated left of this photograph.

Photograph 6: View to northeast to terrain on the north fringe of the TSF, with the old open pit at the left edge of the photograph. The soils are relatively porous, and terrain graded toward the pit or to ditches flowing to the open pit situated just beyond the white pickup truck.

Photograph 7: View to the northwest from the TSF south crest toward the haul road to the ore stockpile. Burntbridge Creek flows from the mountain basin in the upper right background.

Photograph 8: Panoramic view to the north across the TSF from its south crest, showing the old open pit in the center, and the haul road aligned east-west across the Placid TSF.

Photograph 9: View to the east along the south TSF crest, wtih the Bull River Road in the lower right background. The embankment's downstream face appeared to be free from signs of instability and erosion along its perimeter.

4.3 Groundwater

The TSF has a soil cover overlying tailings sands and may have a plastic liner on its floor and part of the upstream face of the dam which could restrict the flow of groundwater out the floor and under the dam. Old correspondences from the TSF operations phase indicate the liner may have been damaged and be leaking. The dam was apparently constructed of compacted glacial till, borrowed from overburden stripping at the open pits and mill site. The compacted till would have been relatively impermeable, and the dam's downstream face was dry in all upper and middle elevations. Two localized and small zones of higher moisture content at ground surface were observed on the southern downstream face in 2014, at the estimated elevation of the dam foundation. Slopes below these zones in natural terrain did not exhibit seepage or wet conditions, and soils consisted of natural glaciofluvial granular sediments.

Groundwater may be present in the tailings, thinly perched atop a plastic liner where it is intact. Groundwater is likely leaking downward below the old TSF floor. Lotic Environmental (2015 a and b) has also assumed vertical percolation of groundwater through overburden in this area. A second potential flow path for groundwater out of the TSF soils is provided where the south gully through the old dam exists, below the dam foundation elevation. It provides a lateral dewatering route to allow potential lowering of the phreatic surface to nearly 25 m below the original dam crest elevation. No monitoring wells are installed; so the presence of groundwater and its flow velocity and direction are unknown.

JDS Energy and Mining Inc. and Tetratech and Lotic Environmental (Lotic) performed work for PBM in 2015 related to the proposed restart of the Bull River Mine. Excerpts of JDS' Bull River Mine Restart Project report were provided to SNC-Lavalin by PBM in 2016, and the Lotic Environmental reports were provided in 2017. JDS reported that the mine's high density of drill holes, underground workings and bedrock faults result in a highly connected system where infiltrating precipitation in the overburden percolates quickly to the mine sumps which are then dewatered. Rain events are quickly transmitted to the underground pumping system, where pumping rates ramp up soon after precipitation to dewater the mine. Lotic (2015a) noted that the a significant amount of water from the overburden vertically transmits in to the mine sumps and pumped out. The connection from surface to the underground is rapid, with pumping required within days of rainfall events. Much of the surface water infiltration originates from the Burntbridge Creek channel area. Lotic (2015a) estimated that approximately 1,985 m^3 of surface water infiltrates down each month on average through the Placid TSF. This water likely percolates nearly vertically, as suggested by JDS and Lotic, as no visual evidence of seepage out of the sideslopes of the TSF or the terrain between the TSF and the Bull River Road was found, and vegetation preferring high soil moisture content was not observed.

4.4 Surface Water

The TSF comprises an outer dam in a semi-circular configuration between two natural gullies. The eastern gully was partially infilled by the dam on its western face, and the north side of the TSF was bounded by natural slopes up to the north along the mountain toward the old open pit. An impoundment within these bounds was filled with tailings and soils during reclamation. At reclamation, a soil cover placement and recontouring is understood to have taken place. Nearly all the surface water to infiltrate the TSF originates from precipitation falling directly on its footprint. Ditches direct water from the haul road and from terrain north of the TSF back north to the primary settling pond/old open pit as shown in the above figures and photographs.

Pumps and pipes convey the pond's water southward to the haul road where it is sleeved through a culvert, then turning west and down to discharge in the old Burntbridge Creek gully west of the TSF.

According to PBM the pit / sedimentation pond level does not rise significantly, and pump house structures at the pond edge do not become flooded. Pump water is composed mostly of groundwater entering the underground workings, by volume. PBM reports that the only time any visible surface water flow is observed in the ditches near the TSF haul road is small ditch flows occurring during early spring when the ground remains frozen and initial snowmelt occurs. The ditch directs water north to the primary settling pond. In October through November of 2016 the region experienced more than six times the average precipitation for this time of year, and minimal ponding was observed in the ditches, immediately after rainfall, but it did not rise and begin to visibly flow. The following winter and spring were also very wet, and regional groundwater levels rose significantly; however, PBM reported no notable surficial and standing water on the TSF or in the haul road ditch above normal spring snowmelt conditions.

The old washout gully in the south TSF face, shown in various figures and photographs above, was repaired in 2014 to 2015, and the TSF surface shaped so that only direct precipitation on the gully footprint could form any source of surface water inflow.

JDS performed a water balance in 2015, reported elsewhere, indicating the TSF area experiences no surface water inflows from mine infrastructure, and only direct precipitation on the TSF forms any inflow. Lotic (2015c) calculated a water balance using various assumptions for runoff coefficients and other factors, concluding that the total annual runoff from the TSF can statistically range from approximately 9,000 m^3 to 30,000 m^3 (taken from a box and whisker graph). Based on PBM staff anecdotes and visual assessments by SNC-Lavalin, these estimates are significantly higher than actually occurs, and essentially all of the precipitation infiltrates to recharge groundwater with the exception of the brief snowmelt period before the ground thaws. The north ditch which connects to the settling pond appears to be the sole path for surface water runoff in use, while the TSF sideslopes appear to absorb effectively all surface water without runoff. The precipitation is readily managed by the TSF soils by infiltration and the diversion ditches near the TSF prevent surface water run-on.

4.5 Instrumentation

According to PBM staff, no instrumentation such as piezometers, inclinometers or settlement plates/hubs have been installed at this TSF and so results cannot be analyzed. A perched and localized groundwater table likely exists within the tailings; however, it does not appear to have caused instability in the dam and no active seepage appears evident in recent years along the dam’s downstream face or lower natural slopes, save for potential elevated soil moisture in two discrete locations on the south face near the dam foundation elevation.

The dam crest was recontoured so its undulating surface would obscure visually detectable evidence of settlement or slumping. The downstream dam face did not exhibit signs of bulging, slumping or cracking, nor cracking on or near the slope crest.

5 Recommendations

This section repeats the conclusions and recommendations from the 2016 DSI.

The Placid TSF appears to be in good condition overall and has performed satisfactorily over the past 35 to 40 years since it was reclaimed. From a slope stability perspective, the facility appears to remain stable. Surface water diversions around and from the TSF serve to minimize water infiltration to the tailings and reduce the probability of breaches to extremely low levels. Standing water does not accumulate.

At this time, no repair recommendations are considered necessary. PBM should visually monitor the TSF throughout the year, especially during spring snowmelt and after periods of heavy precipitation to ensure that surface water infrastructure is performing adequately and slopes are not showing signs of instability. Annual dam safety inspections and EOR requirements should be conducted in compliance with the HSRC.

Based on an adequate level of performance since closure, the installation of new instruments is not presently recommended.

Since the TSF is not in operation, and has been reclaimed, no quantifiable performance objectives are considered necessary for this particular facility, aside from the need to perform annual DSI work and ensure that visual inspections are completed as described below.

6 Operations Manual, Emergency Preparedness Plan

This TSF does not appear to meet the definition of a major impoundment as defined in the Health, Safety, and Reclamation Code for Mines in British Columbia, which can be interpreted as intended for materials stored in a slurry or liquid state. The exception is whether the facility was once declared a major impoundment by the Chief Inspector. However, it does meet the definitions for a major dam and a major dump. An Operation, Maintenance and Surveillance (OMS) Manual may be required for this TSF. An Emergency Preparedness Plan is not required for this particular TSF due to its apparent low consequence classification.

Should PBM require an OMS manual, the following text should be considered and/or included.

6.1 Operations

The TSF was reclaimed approximately 40 years ago and the Bull River Mine is under care and maintenance at this time. Therefore, no operations phase information is required.

6.2 Maintenance

6.2.1 Objective

The objective of the maintenance program is to maintain the TSF in accordance with all the performance criteria, legislative requirements, PBM company standards, and generally accepted practices.

Maintenance for the TSF consists of using site ditches and culverts to direct surface water to the primary settling pond, and to drain the old washout gully at the south face. Maintenance of the heavy equipment and pumps for this work, and the ditches and culverts, will consist of routine and repair-driven maintenance and will be managed by PBM.

6.2.2 Maintenance Procedures

A preventive maintenance program should be in place for heavy equipment used by PBM at the TSF under the direction of the General Manager. Event-driven maintenance for the heavy equipment would be due to breakdowns or incidents. Event-driven maintenance to the TSF components will be directed by the General Manager under the consultation of the EOR. The actual maintenance program completed will depend on the severity of the issue.

6.2.3 Documentation

Record keeping and documentation of heavy equipment or TSF maintenance is the responsibility of PBM. It involves completion of inspection reports and depending on the severity of the event involves the General Manager and the EOR, if necessary. Documentation of any maintenance completed will be used to access the performance of the infrastructure and determine whether the design, operation, or surveillance of that component must be adjusted.

6.2.4 Reporting

Inspection reports and any other documentation regarding event-driven maintenance for the TSF should be submitted to the General Manager and EOR to determine whether any adjustments to the surveillance are required.

6.3 Surveillance

6.3.1 Objective

Surveillance will include inspection and monitoring of the integrity and safety of the TSF, consistent with regulatory requirements of the facility. Surveillance is composed of routine and event-driven activities.

Key surveillance parameters and procedures must:

- Monitor water management, safety, and environmental performance of the TSF;
- Identify and evaluate unforeseen or unexpected conditions impacting operation, safety, structural integrity, and environmental performance of the facility; and,
- Reporting observations of significant conditions and events for response.

The surveillance program may evolve as the facility or environment changes.

All personnel working at the TSF will be involved in surveillance as a routine part of daily activities, maintaining visual awareness of the facility in the course of their regular and/or routine duties, in addition to surveillance specific inspection, review and oversight.

It is the combination of all the regular inspections assisted by the attention of all site personnel that ensures continued integrity and performance of the facility. The EOR will also inspect the facility.

6.3.2 Responsibility

PBM will designate personnel to conduct routine inspections of the TSF. The General Manager, or his designated replacement is responsible for obtaining the monitoring information and providing it to the EOR upon request. Emergency events will be communicated to the EOR by PBM.

6.3.3 Surveillance Items

Key items to be part of surveillance are linked from identifying and describing potential failure modes of the TSF.

Visual observations of the TSF can indicate potential failure modes such as:

- Surface – cracking, bulging, depressions, sink holes;
- Seepage – new seepage areas, changes in seepage areas;
- Water or tailings flowing down the stack indicating improper grading; and

- A failure or breach of a component of the facility.
- Routine monitoring for ensuring facility performance include:
    - Checking for settlement or holes in embankment crest or benches;
    - Checking for holes on the surface of the TSF indicating possible piping of material to outside; and,
- Recording weather conditions.

These parameters are further described in the following sections.

6.3.4 Surveillance Procedures

The following table summarizes surveillance requirements for the TSF.

Frequency	Location	Personnel	Scope	Deliverable
Quarterly	TSF	Operational staff.	Visually inspect erosion in washout gully down to Bull River Road.	Inspection form containing date/time/personnel/observations, any photographs of significant changes or conditions, recent and current weather.
Quarterly	TSF	Operational staff.	Visually inspect TSF slope faces.	Inspection form containing date/time/personnel/observations, any photographs of significant changes or conditions, recent and current weather.
Quarterly	TSF	Operational staff.	Visually inspect TSF ditches and culverts.	Inspection form containing date/time/personnel/observations, any photographs of significant changes or conditions, recent and current weather.
Annual	TSF	EOR, Operational staff.	Visual DSI visit.	Annual DSI report by EOR.

6.3.5 Documentation

Routine reporting of surveillance results is essential to provide time to make adjustments to existing systems or to initiate mitigation repairs or maintenance changes. Changed conditions observed during surveillance shall be communicated to the General Manager and EOR. Document control is vital to ensuring the ongoing performance of the facility. PBM should provide a centralized location to securely save surveillance records, in an organized fashion.

The following table will need to be included in the OMS plan for record keeping:

Task	Responsible Party	Information Recipient
Quarterly Monitoring Report	To be determined by PBM	General Manager, EOR
Annual DSI Report	EOR	General Manager, Ministry of Energy and Mines

6.3.6 Reporting

Observation of any unusual occurrence should be reported immediately to the General Manager and, depending on the nature of the occurrence, to the EOR. Such occurrences include but are not limited to the following:

- Any seismic event;
- Any high surface water flow event that results in runoff to the old washout gully;
- Settlement, cracks or slumping of the TSF;
- Slope failure of any of the slopes;
- Abnormal seepage from any of the slopes; and,
- Damage to any component of the TSF.

All reports are to be maintained by the General Manager and filed in a suitable format and location for easy access by authorized mine personnel, and for review by government agencies. Documents will be submitted to the Ministry of Energy and Mines in accordance with the HSRC.

7 Closure

We trust that this report meets your requirements. Should you have any questions or comments please contact us.

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2018-03-13

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