Klohn Crippen Berger

British Columbia Ministry of Energy and Mines

2014 Dam Safety Inspection

Good Friday and Jumbo Tailings Storage Facilities
Red Mountain Mine

November 2014
M09970A01

November 28, 2014

British Columbia Ministry of Energy and Mines
1810 Blanshard Street
Victoria, British Columbia
V8W 9N3

Diane Howe, P.Geo.
Deputy Chief Inspector

CC: Heather Narynski, P.Eng
Senior Geotechnical Inspector

Dear Mrs. Howe:

2014 Dam Safety Inspection
Good Friday and Jumbo Tailings Storage Facilities
Red Mountain Mine

We are pleased to submit under cover of this letter our report "Red Mountain Mine, Good Friday and Jumbo Tailings Storage Facilities – 2014 Dam Safety Inspection".

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Chris Gräpel, P.Eng.
Senior Project Engineer

CG:kc

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M09970A01

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2014 Dam Safety Inspection

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Red Mountain Mine

EXECUTIVE SUMMARY

This Summary is provided solely for purposes of overview. Any party who relies on this report must read the full report. The Summary omits a number of details, any one of which could be crucial to the proper application of this report.

This report presents our Dam Safety Inspection of the Red Mountain Mine, Good Friday and Jumbo Tailings Storage Facilities (TSF) on November 11, 2014. The review was carried out in accordance with the 'Guidelines for Annual Dam Safety Inspection Reports' (BCMEM, 2013) in compliance with the MEM Chief Inspector's Orders of August 18, 2014.

The Red Mountain Mine operated in the Kootenay region of south eastern British Columbia from 1966 to 1972. The mine site is located approximately 4 km northwest of Rossland, BC.

The Good Friday TSF is a side valley slope impoundment approximately 200 m long (north-south) and 180 m wide (east-west). The TSF dam has a maximum height of 20 m. The crest elevation of the TSF dam is 1286 m. The TSF impoundment was created by one embankment dam consisting of two limbs, the West Limb (on the western and northern portion of the facility) and the South Limb (on the southern half of the facility). The crest of the dam is approximately 430 m long. The dam appears to have been raised at least once.

The Jumbo TSF is created by an embankment approximately 125 m long and 28 m high constructed across the Little Sheep Creek valley. The crest elevation of the TSF dam is 1296 m. The TSF impoundment is approximately 350 m long (north-south). The dam appears to have been raised by 1 m to 2 m during operation along the upstream third of the crest width. Little Sheep Creek was diverted beneath the TSF via a 600 mm diameter corrugated metal pipe (CMP) that passed from the head of the impoundment to the downstream toe of the dam.

A summary of KCB's findings are presented as follows:

General

- There has been no construction undertaken on the Red Mountain site TSFs in 2014 and none since 2004 during the final details of the reclamation construction work;
- There are no documented Operational, Maintenance or Surveillance (OMS) activities undertaken on the Red Mountain TSFs since 2004 when the last inspection was conducted;
- Instrumentation readings and water quality sampling and testing have not been conducted since 2004;
- The Good Friday and Jumbo TSFs have been assigned the Classification of Low according to the Canadian Dam Association – Dam Safety Guidelines (CDA Guidelines, 1994). However, the Earthquake Design Ground Motion (EDGM) and Inflow Design Flood were selected at the upper end of the range of return periods suggested at that time for the Low Classification which were the same as the lower limits for the High Classification;

- A Dam Safety Review was recommended for 2011 and not conducted. A Dam Safety Review is recommended for 2015;
- The site was snow covered at the time of KCB's 2014 inspection;
- The contact information in the OMS Manual needs to be updated; and
- The OMS Manual provided to KCB is dated 2005 and is believed to be the original version. KCB knows of no other revisions of this document. It includes an Emergency Preparedness and Response Plan.

Good Friday TSF

- A small surficial slope instability is present on the natural slope adjacent to the spillway channel beyond the downstream toe. This instability is minor and does not appear to have the potential to block the spillway;
- Trees and shrubs are growing in the spillway channel beyond the downstream toe of the dam;
- Seepage on natural ground beyond the downstream toe of the South Limb of the dam is present just above the reclaimed borrow area. Previous seepage collection work is present in this area with rock filled drainage ditches being present; and
- The v-notch weirs below the West Limb of the dam are clogged with organic debris.

Jumbo TSF

- There is a 0.3 m depression in the surface of the reclaimed tailings above the former Little Sheep Creek diversion culvert that failed in 1999 and deposited tailings at the toe of the dam. Red silt at a seepage discharge zone was noted at the toe of the TSF dam in the stilling basin near the former outlet of the Little Sheep Creek diversion culvert;
- A rockfall of about 5 m^3 has occurred with rock debris located adjacent to the spillway channel near the crest of the TSF dam; and
- The rip rap Sediment Control weir downstream of the stilling basin has been damaged by discharge flows with a channel being eroded through the weir.

On the basis of our review of the performance to date of the Good Friday and Jumbo TSFs, review of available data and our observations of the condition of the dams at the time of our inspection, we conclude the following:

- The snow cover at the time of inspection hindered assessment of the physical state of the dams and reclaimed tailings surfaces. From what KCB could observe, the TSF dam structures appear to be in good condition, with the exception of potential tailings release at the Jumbo TSF;
- There may still be periodic loss of tailings via the Little Sheep Creek CMP, which should be investigated;

- The current state of stability of the dams cannot be assessed due to an absence of piezometer data;
- There is no data to assess if the quality of water being released from the site meets discharge requirements; and
- The lack of annual inspections and instrumentation readings since 2004 makes dam safety assessment difficult.

As a result of these aspects, KCB cannot state that the dams of Good Friday and Jumbo Tailings Storage Facilities reviewed as part of this report are safe or that they are in compliance with design requirements. Additional assessments are required to verify the dams are safe.

A table summarizing recommended action items is provided in Section 11 of the report.

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1 INTRODUCTION

1.1 General

Klohn Crippen Berger Ltd. (KCB) was engaged by the British Columbia Ministry of Energy and Mines (BCMEM) to complete the 2014 Dam Safety Inspection (DSI) of the reclaimed Good Friday and Jumbo Tailings Storage Facilities (TSF) dam structures at the closed Red Mountain open pit molybdenum mine site. This DSI was requested as a result of the BCMEM Chief Inspector's Orders dated August 18, 2014.

The mine site is located approximately 4 km northwest of Rossland, BC at 49° 05' N, 117° 49' W. A site location plan and site plans for the Good Friday and Jumbo impoundments are presented in Appendix I. KCB is not the Engineer of Record for the design of the original facilities; however, Klohn Crippen, a predecessor of KCB, designed all of the reclamation and closure works.

This report was prepared to comply with the BCMEM requirements specified in the "Guidelines for Annual Dam Safety Inspection Reports" included in Appendix II.

This report is solely based on KCB's observations of the condition of the two TSF dams on the day of inspection.

1.2 Disclaimer

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of the BCMEM (Client) for the specific application to the 2014 Dam Safety Inspection. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally - accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

2 FACILITY DESCRIPTION

2.1 General

The Red Mountain Mine operated in the Kootenay region of southeastern British Columbia from 1966 to 1972. The general area of Red Mountain had been the site of historic mining back to the early 1900s. There are two TSFs located at this site, the Good Friday TSF and the Jumbo TSF.

The area surrounding the Red Mountain Mine site is densely forested with denser stands of forest being located near the valley bottom near the TSFs. Since closure of the mine site, the area surrounding the TSFs has become an extensive ski resort area with ski runs located on the adjacent Red Mountain and Granite Mountain. The ski lodge is located approximately 800 m to the northeast of the Good Friday TSF. A ski run is located approximately 100 m to the north of the Jumbo TSF.

2.2 Background Information

The following reports were reviewed by KCB during this assignment:

- Klohn Crippen, 1999a. As-Built Report for Slope Remediation at the Good Friday Tailings Impoundment. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 1999b. Red Mountain Mine Sinkhole Remediation – Event Report. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2000a. Jumbo Creek Diversion – As-Built Report. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2000b. Red Mountain Mine, Annual Inspection. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2000c. Red Mountain Mine, Tailings Impoundment Data Report – Draft. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2001a. Red Mountain Mine, 2000 Construction Report. Report submitted to Inco Technical Services Ltd. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2001b. Red Mountain Mine, Design of Physical Stabilization Works for Tailings Storage Facilities. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2001c. Red Mountain Mine, Tailings Impoundment Aquatic Chemistry Report. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2002. Red Mountain Mine, 2001 Construction - Final Report. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2003a. Red Mountain Mine, 2002 Construction Record and Annual Inspection – Final Report. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2004. Red Mountain Mine, 2003 Construction Record, Aquatic Chemistry and Annual Inspection Report. Report submitted to Inco Technical Services Ltd.;

- Various, 1999 – 2004. Miscellaneous correspondence between BCMEM, Klohn Crippen and Inco Technical Services Ltd.;
- Klohn Crippen, 2005a. Red Mountain Mine, 2004 Construction Record, Aquatic Chemistry and Annual Inspection Report. Report submitted to Inco Technical Services Ltd.;
- Klohn Crippen, 2005b. Red Mountain Mine – Jumbo and Good Friday Tailings Storage Facilities, Operation, Maintenance and Surveillance Manual (OMS Manual) MEM Version. Document submitted to BCMEM; and
- Thurber Engineering Ltd., 2005. OMS Manual Reviews. Reviews conducted on various mines (Gibraltar, Brenda, Equity Silver and Red Mountain). Reviews submitted to BCMEM.

2.3 Construction History

Two tailings impoundments, the Good Friday and Jumbo TSFs, were constructed in the mid-1960s and late-1960s respectively.

The Good Friday TSF is a side valley slope impoundment approximately 200 m long (north-south) and 180 m wide (east-west). The surface elevation of the TSF is 1286m. The TSF impoundment was created by one embankment dam consisting of two limbs, the West Limb (on the western and northern portion of the facility) and the South Limb (on the southern half of the facility). The crest of the dam is approximately 430 m long. The dam appears to have been raised at least once. The South Limb dam is a compacted till embankment covered with coarse rock fill with a maximum embankment height of 20 m. It appears the South Limb was raised using downstream construction techniques. The West Limb appears to be a compacted till starter dam covered with coarse rock fill. However, it appears the West Limb was raised using the upstream method of construction and at the north end appears to be initially constructed as a sand tailings dyke (Klohn Crippen, 2001). The maximum height of the West Limb is approximately 10 m. The Engineer of Record for the initial design and construction of the Good Friday TSF is unclear. An initial proposed design of the Good Friday TSF was obtained by Klohn Crippen in 1999 from Fluor (successor to Wright Engineers).

The Jumbo TSF is created by an embankment approximately 125 m long and 28 m high constructed across the Little Sheep Creek valley. The surface elevation of the TSF is 1295 m. The TSF impoundment is approximately 350 m long (north-south). Jumbo Dam is a rockfill structure with upstream fine and coarse filters and a basal blanket drain. The crest width varies between 10 and 15 m due to uneven grading of the downstream crest and slope. The dam appears to have been raised by 1 to 2 m during operation along the upstream third of the crest width. Little Sheep Creek was diverted beneath the tailings impoundment via a 600 mm diameter corrugated metal pipe (CMP) that passed from the head of the impoundment to the downstream toe of the dam. Pond water decant structures and conduits were installed within the tailings impoundment to drain ponded water from the impoundment during operation. The Engineer of Record for the initial design and construction of the Jumbo TSF appears to be Kilborn Engineering Ltd.

2.4 Reclamation of Good Friday and Jumbo TSFs

Attention was re-focused on the abandoned site in 1997 when BCMEM became aware of an overtopping incident on the West Limb portion of the Good Friday dam. Additionally, in June 1999 the diversion CMP beneath the Jumbo impoundment failed, resulting in a sinkhole being formed on the impoundment surface and tailings being transported through the CMP to the downstream toe of the dam. As a result of these incidents, INCO Technical Services Ltd., acting as an agent for the BCMEM undertook a number of reclamation works aimed at addressing the long term physical stability of the abandoned impoundments. Klohn Crippen provided engineering design services for the reclamation works.

Design and construction work continued until November 2004 and included the following general activities:

- Constructing armoured drainage channels on both tailings impoundments to drain water off the surface with 1 m of freeboard between the crest of the dam and the maximum water level in the spillway channel;
- Constructing rip rap armoured spillway channels to convey impoundment surface water flow down abutments of the respective dams and beyond the downstream toe area of both dams;
- Capping the surface of both tailings impoundments and establishing vegetation to resist wind and water erosion;
- Constructing a rockfill buttress/toe berm to stabilize the natural slope below the downstream toe of the West Limb of the Good Friday dam;
- Grouting a portion of the Little Sheep Creek diversion CMP beneath the Jumbo tailings impoundment;
- Removing decant structures and grout backfilling all associated conduits in both tailings impoundments;
- Installing subsurface drains to improve groundwater management (downstream toe drains at Good Friday, including slope drains installed to improve drainage of the natural slope adjacent to the spillway and a counterfort drain at Jumbo along the downstream toe);
- Landscaping and re-vegetating borrow areas at each tailings impoundment area after completion of reclamation work; and
- Installing monitoring wells at each impoundment to measure depth to water table and also water sampling for chemical testing. Additionally, a seepage collection pipe (Seep #16) was installed and v-notch weirs were established in two places (Seep #17 and Seep #18) downslope of the Good Friday impoundment to measure flow rate and for water sampling for chemical testing. The instrumentation locations are shown in the Figures included in Appendix I for the Good Friday and Jumbo impoundments.

The two TSFs were ranked as Low Classification structures (Klohn Crippen, 2001b) according to the 1999 Canadian Dam Association – Dam Safety Guidelines (CDA Guidelines, 1999) during the design phase of the reclamation activities. This Classification was prepared on the basis of no anticipated loss of life and moderate environmental/economic damage. However, the selection of 1:1,000 design events places the structures at the upper end of the Low Classification range which was the lower end of the High Classification range according to the CDA Guidelines (CDA, 1999). The CDA Guidelines were updated in 2007. There has been no update to the Classification of either TSF since 2001.

The design criteria for the reclamation work included constructing the reclamation works to resist the 1:1,000 year Earthquake Design Ground Motion (EDGM) and Inflow Design Flood (IDF) events. The establishment of design criteria for the reclamation of both TSFs is presented in Klohn Crippen 2001b and is summarized in the OMS Manual (Klohn Crippen, 2005b).

2.5 Construction in 2014

There was no construction in 2014. The last recorded construction activity at the Red Mountain site was in 2004 and consisted of final details related to the reclamation of the two TSFs.

3 OPERATION, MAINTENANCE AND SURVEILLANCE AND EMERGENCY PREPAREDNESS ACTIVITIES

There have been no documented operational, maintenance and surveillance (OMS) activities undertaken on either of the TSFs since the reclamation work was completed in 2004. There are no facilities at either TSF that require operation. The OMS Manual (Klohn Crippen, 2005b) presents a list of the recommended annual OMS tasks. It does not appear that any of these tasks have been completed since 2004.

An Emergency Preparedness Response plan has been prepared as part of the OMS Manual.

KCB noted that the contact information (e.g. names, companies, phone numbers) presented in the OMS Manual, including the Emergency Preparedness Response section, should be updated.

4 CLIMATE DATA REVIEW

Monthly temperature and rainfall data near Red Mountain Mine was recorded at two Environment Canada climate stations located approximately 3 km away over two separate periods:

- Rossland City Yard station (No. 1146870) recorded weather data between 1905 and1962 and 1990-2000; and
- Rossland MacLean station (No. 1146874) recorded weather data between 1963 and 1990.

Daily temperature and rainfall data was recorded at Warfield RCS station (No. 1148705) between 2001 and 2014.

Snowpack measurements are taken at the three stations listed above and are generally recorded monthly from October to May. It is important to note that during KCB's November 11, 2014 site visit, there was approximately 5 cm of snowfall the night of November 10 but this was not recorded by Environment Canada at station No. 1148705.

Only maximum daily temperatures were recorded between January and March 2014 at station No. 1148705 with maximum, minimum and average daily temperatures recorded between March and November.

Observations for January through August 2014 are as follows:

- The average daily maximum and minimum temperatures in 2014 were higher than the average monthly maximum and minimum monthly temperatures recorded between 1900 and 2000. The 2014 daily average max temperatures ranged between 0° C and 8° C above the historic normals. The 2014 daily average min temperatures ranged between 1° C and 4° C above the historic normals.
- At the time of this report, no snowfall or rainfall data was recorded in 2014 at Environment Canada climate stations neighboring Red Mountain Mine.

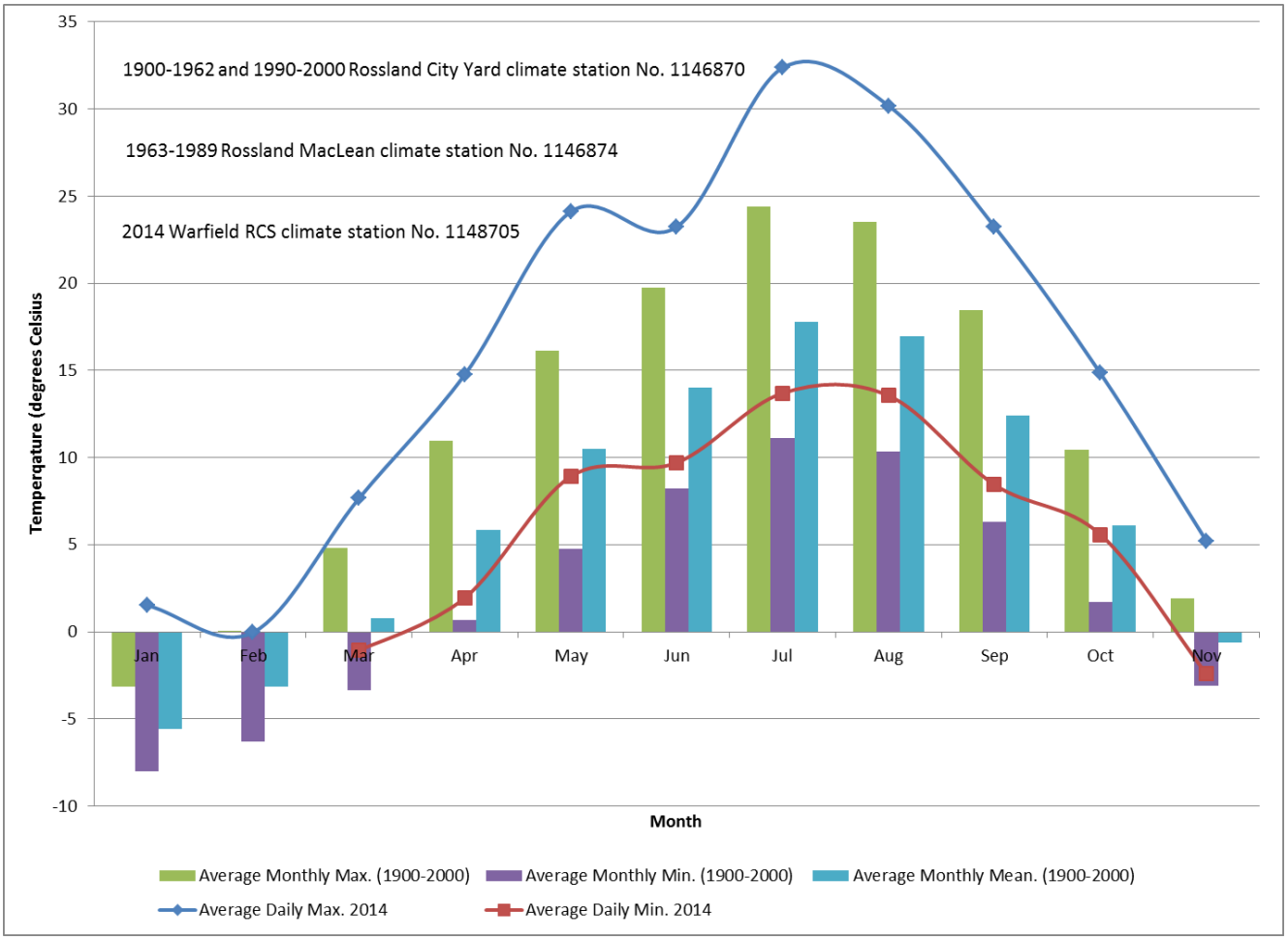


Figure 4.1 Average Monthly Temperatures (2014 versus 100 Year Normals)

5 WATER MANAGEMENT

The design of the surface water management diversion channels and spillways for the Good Friday and Jumbo TSFs is intended to provide a long term, low maintenance surface water drainage system to prevent the erosion of tailings and to convey surface water flows off of the TSF. Except for during the IDF, the reclamation design was prepared to avoid ponding of water on the surface of either TSF. The surface drainage measures are in place partly to limit ponding of water and associated infiltration causing increased phreatic surface within the tailings.

The following details on the design of water management for both TSFs have been summarized based on information presented in the report "Design of Physical Stabilization Works for Tailings Storage Facilities" and the OMS Manual (Klohn Crippen, 2001b and 2005b). In both cases, the diversion channel and grading of the reclaimed tailings surface is sufficient to permit no long term ponding of water. However, during the IDF, short term ponding of water would occur on the reclaimed tailings surfaces during a brief period at the time of peak flow but would drain into the diversion channel after the peak flow period had passed (Klohn Crippen, 2001b).

An IDF with a 1:1,000 year return period was used in the design of the diversion channels, spillway and rip rap armouring for both TSFs. In both cases, the freeboard between the maximum routed water level in the diversion channel and spillway and dam crest is 1.0 m. The tailings surface at each TSF was reclaimed through placement of capping fill and seeding the reclaimed surface to promote development of grass cover.

The water management infrastructure in place at the Good Friday and Jumbo TSFs is described as follows for each TSF:

Good Friday

- A diversion channel is located at the toe of the natural slope above the TSF. The channel is armoured with rip rap with a granular filter below the rip rap to minimize the potential for tailings to be eroded through voids in the rip rap.
- A swale was included to divert surface water drainage from the TSF surface near the former decant structure locations into the diversion channel.
- At peak water elevation during the IDF, there is 1.6 m of freeboard from the crest of the dam, well in excess of the 1 m required (Klohn Crippen, 2001b).
- An armoured spillway channel and a training berm was included to convey surface water flows from the tailings surface to a channel discharging into the forest and ultimately to Little Sheep Creek. The rip rap armouring in the spillway channel is underlain by a granular filter to minimize erosion of the tailings through rip rap voids. The training berm is in place to minimize the potential for spillway discharge flowing along the downstream toe of the dam.

Jumbo

- A diversion channel is in place to the right of the TSF surface to convey Little Sheep Creek flows across the TSF. The channel is armoured with rip rap with a granular filter below the rip rap to minimize the potential for tailings to be eroded through voids in the rip rap.
- At peak water elevation during the IDF, there is 1.7 m of freeboard from the crest of the dam, well in excess of the 1 m required (Klohn Crippen, 2001b).
- Rip rap armoured guide berms are in place at the head of the Jumbo TSF to direct surface water flows into the diversion channel.
- The rip rap armoured spillway channel along the downstream toe of the dam along the right abutment has been mostly constructed on bedrock approximately 10 m downstream of the toe of the dam. However, it was identified (Klohn Crippen, 2001b) that significant repairs might be required after the IDF event.
- A stilling basin has been constructed at the downstream toe to dissipate energy from water flow down the steep spillway channel. The design of the stilling basin and rip rap armoured discharge channel is such that significant repairs could be required following the IDF. However, these facilities are sufficiently far removed from the dam structure that the dam integrity will not be affected.

6 SITE OBSERVATIONS

6.1 General

The site inspection for the DSI for the Good Friday and Jumbo TSFs was conducted by Mr. Chris Gräpel, P.Eng. on November 11, 2014. Site access was on foot via the access road to the south end of the site from Hwy 3B. During the inspection the weather was -10° C, clear with light wind. The TSF was covered with approximately 5 cm of snow at the time of inspection. In general, the snow cover obscured the surface of the two TSFs. As a result, only general comments can be made about the state of the TSFs observed during KCB's inspection.

The inspection was conducted in the following order:

Good Friday TSF

- Toe of natural slope below downstream toe of the West and South Limbs of the TSF dam along south access road, including instrumentation at Seep sites #16, #17 and #18;
- Downstream toe of Good Friday Dam, West Limb and South Limb;
- Crest of Good Friday Dam, South Limb to West Limb;
- Surface of reclaimed tailings, including former decant structure locations and reclaimed side hill pile of tailings to north of TSF;
- Drainage channel from start of channel to spillway;
- Spillway control section at Good Friday Dam crest and channel down to natural ground and beyond downstream toe of dam; and
- Reclaimed borrow area downstream of South Limb of Good Friday Dam.

Jumbo TSF

- Crest of Jumbo Dam;
- Drainage channel from spillway to head of TSF adjacent to ski hill;
- Reclaimed tailings surface, including locations of former decant structures and general area of 1999 sinkhole;
- Downstream slope of Jumbo dam along right abutment, including counterfort drain location and spillway channel to downstream toe and then up left abutment; and
- Spillway stilling basin and channel leading to sediment control weir.

The write up in the following sections for the inspections of each TSF will start with the dam structure, followed by the spillway, the reclaimed tailings surface and, in the case of Good Friday TSF, areas downslope of the TSF dam.

The OMS Manual (Klohn Crippen, 2005b) was referenced throughout the inspection of the two TSFs. Summary sheets included in the OMS Manual for the inspection of each TSF have been completed and are presented in Appendix III.

6.2 Good Friday TSF

Key observations made by KCB during the site inspection are presented as follows with photo references. Photographs referenced in this section are included in Appendix IV.

TSF Dam

- The downstream slope of the dam consists of a rockfill slope with rockfill particles up to approximately 1.0 m in size. Seepage was visible in the downstream toe area of the West Limb near the right abutment as well as in the northern portions of the downstream toe ditch. The toe access road along the West Limb toe to the southwest corner of the South Limb is becoming overgrown with willows/alders. The rockfill buttress/toe berm repair of the natural slope below the South Limb of the dam appears to be in good condition with no obvious deformations. The downstream slope does not appear to have changed from what is shown in figures included in Appendix I. Deciduous and coniferous trees are growing sporadically on the downstream face of the dam (Photos 1 through 9).
- The crest is relatively even and straight. The upstream crest – tailings transition appears to be defined by the transition from the rockfill crest to the grassed reclaimed tailings surface. Deciduous and coniferous trees are growing sporadically on the crest of the dam (Photos 10 through 15).

Drainage Channel and Spillway

- The drainage channel on the reclaimed tailings surface appears to be in good condition. Some seepage from the slope above the TSF was flowing through the drainage channel in the southern half of the channel (Photos 16 through 19). Evidence of high water marks were not observed during the inspection due to snow cover.
- The spillway on the left abutment of the TSF dam appears to be in good condition. Evidence of high water marks was not observed during the inspection. However, willows/alders and small coniferous trees were noted to be growing in the spillway channel beyond the downstream toe of the dam which would impede water flow through the channel. There appears to be a small instability of a natural slope beyond what is believed to be the downstream limit of the slope drain system constructed as part of the reclamation works. This instability does not appear to pose a risk of blocking the spillway channel (Photos 20 through 22).

Reclaimed Tailings Surface

- The reclaimed side hill tailings pile on the north slope above the north portion of the Good Friday impoundment appears to be in good condition (Photo 23).

- The reclaimed tailings surface appears to be well vegetated. Ground surface cover appears to be well established in the few areas visible through snow cover. Additionally, there is a grove of deciduous and coniferous trees growing on the reclaimed tailings surface with small deciduous and coniferous trees scattered across the remainder of the reclaimed tailings surface. The reclaimed tailings surface is gently undulating, most likely due to settlement of the tailings under the additional load of the tailings cap and possibly due to landscaping earth works. The markings for the former decant locations appear to have been destroyed since 2004 and could not be located. However, the general area of the former decant locations is generally level with no obvious surface depressions (Photos 24 through 26).

Reclaimed Borrow Area and Slope Downstream of TSF Dam

- The reclaimed borrow area downstream of the South Limb of the dam appears to be well vegetated with grass cover. A seepage and/or drainage collection swale was observed at the southwest corner of the South Limb of the TSF dam. Some seepage was observed at the base of this channel through the snow cover approximately 10 m beyond the downstream toe of the dam. Additional seepage was observed approximately 15 to 20 m beyond the downstream toe of the dam that drained towards a cobble and boulder filled drainage ditch that appears to have been constructed to collect seepage. The collected seepage was captured by a drainage ditch that extended down to the creek channel draining from the spillway. Water was ponded up to depths of 0.15 m in this location (Photos 27 through 29).

Natural Slope Downslope of TSF Dam

- The natural slope below the West limb of the TSF dam was viewed from the south access road. Cracking of the access road surface below the rockfill buttress/toe berm that was observed in 2002 could not be seen due to snow cover on the road surface.
- The south access road downslope of the Good Friday TSF appears to have been constructed using a side hill cut and fill method of construction. As a result, the cut slope below the TSF dam appears to have caused or exacerbated some surficial shallow instability as indicated by trees with bent trunks (Photo 30).
- The seepage collection pipe (Seep #16) was located. The flow rate discharging from the pipe was measured by recording the time it took to fill a 21 l pail that had been left at the pipe location. However, seepage was exiting above the pipe in two locations. As such, it is unclear if changes to the subsurface seepage paths since 2004 have occurred, resulting in this pipe not collecting the same amount of seepage as previously recorded (Photo 31).
- The v-notch weirs were located and found to be completely clogged with partially frozen leaves and twigs. The debris was cleaned out about 100 mm upstream of the weir and the height of water passing through the v-notch weir was recorded. The water flowing through the weir was clear several minutes after the weir was cleared of debris (Photos 32 and 33).

6.3 Jumbo TSF

Key observations made by KCB during the site inspection are presented as follows with photo references. Photographs referenced in this section are included in Appendix IV.

TSF Dam

- The crest is uneven and sloped in a downstream direction. Additionally, the downstream crest is uneven, most likely from uneven fill placement or end dumping of fill on the downstream slope of the dam during original construction. There is a berm constructed on the upstream crest of the dam which appears to have been part of the post construction dam raise described in Section 2.3. Deciduous and coniferous trees and shrubs are growing sporadically on the crest of the dam. The spillway is located in native ground at the right abutment and downstream toe area (Photos 34 through 36).
- There is an access road along the downstream toe of the dam along the right abutment between the dam and the spillway channel. A counterfort drain was constructed here during the reclamation work. No seepage was observed through the snow cover. Small deciduous and coniferous trees (3 m tall or less) are present at the downstream toe of the dam (Photos 37 and 38).
- The downstream slope of the dam is exposed rockfill of variable gradation (maximum size varies from 0.3 m to 1.0 m). The slope is uneven, likely from construction practices during original construction of the dam which may have included end dumping rock fill downslope from the crest. The downstream slope does not appear to have changed from what is shown in figures included in Appendix I (Photos 39 through 43).
- There is a deposit of loose, soft red silt with trace to some fine sand on the upstream portion of the spillway stilling basin. Dark grey silt is located at an appropriate depth of 10 cm. Clear seepage can be seen entering the stilling basin from the upstream side as well as vertically from the base of the stilling basin. The silt is actively being deposited in this location as it is burying vegetation growing in the stilling basin at this area is being buried by silt. This is the approximate outlet location of the 600 mm CMP that diverted Little Sheep Creek flows beneath the Jumbo TSF. The base of the stilling basin is covered with silt except at the outlet where rip rap particles are exposed on the bottom of the basin (Photos 44 through 47).

Drainage Channel and Spillway

- The guide berms to direct surface water flow into the drainage channel at the head of the TSF (north end of TSF) are in good condition and appear to be functioning as intended (Photo 48).
- Willows and alders are growing on the channel side slopes. Limited grassy vegetation was growing in occasional locations in the middle of the drainage channel. Flowing water in the drainage channel was approximately 10 cm deep. Evidence of high water marks on vegetation growing at the edge of the channel indicates previous high water about 10 cm above current levels (Photos 49 through 51).

- The spillway on the right abutment appears to be in good condition. Evidence of high water marks were not observed during the inspection. However, willows/alders and very small coniferous trees are growing on the side slopes of the channel at the spillway crest. Small trees and shrubs are also growing on the channel side slopes along the downstream toe to the spillway stilling basin. There is a rock fall of about 5 m^3 on the right bank of the spillway channel where it was excavated into a bedrock slope at the right abutment of the dam. The debris from this fall has collected on the bench above the channel with no other material accumulating in the spillway channel (Photos 52 through 53).
- The sediment control berm located across the channel downstream of the spillway stilling basin appears to have experienced movement of rip rap. The berm is not clearly defined and it appears a channel is being eroded through the rip rap berm. This does not appear to be a significant problem that will affect the reclamation work completed in 2004. (Photo 54).

Reclaimed Tailings Surface

- The reclaimed tailings surface appears to be well vegetated based on density of vegetation above snow level. Ground surface cover appears to be well established in the few areas visible through snow cover. Additionally, there are small deciduous and coniferous trees scattered across the remainder of the reclaimed tailings surface. The reclaimed tailings surface is gently undulating, most likely due to settlement of the tailings under the additional load of the tailings cap and possibly due to landscaping earth works.
- There appears to be a 0.3m deep depression in the general area of the 1999 sinkhole where the 600 mm CMP failed and caused tailings to be transported beneath the dam through the CMP to the dam toe. There is a drainage swale leading to the diversion channel from this area. The general area of the former decant location is generally level with no obvious surface depressions (Photos 55 and 56).
- The markings for the former decant location appear to have been destroyed since 2004 and could not be located.
- There is no evidence of water ponding over large areas on the reclaimed tailings surface. Isolated small patches of ice under 3 m diameter were noted through the snow cover.

7 INSTRUMENTATION MONITORING

The instrumentation at both the Good Friday TSF and Jumbo TSF has not been read since 2004.

KCB recorded the following measurements for the Seep sites (#16, #17 and #18) near the Good Friday TSF during our site inspection:

- Seep #16 (seepage collection pipe) – 9 minutes to fill 21 l pail
- Seep #17 (upper v-notch weir) – 4.5 cm height of water
- Seep #18 (lower v-notch weir) – 1.9 cm height of water

These readings were compared to trigger levels presented on the Routine Inspection sheets from the OMS Manual (Klohn Crippen, 2005b) included in Appendix III. These recorded levels and seepage rates are below the trigger levels.

Seepage is occurring around the seepage collection pipe at Seep #16 which could indicate that historical flows that were concentrated into the pipe are now diffused over a wider area. As a result, the seepage rate recorded at this site may not be reliably compared to previous readings. The v-notch weir readings could be affected by the freezing conditions and generally clogged upstream area at the time the readings were taken. The organic debris upstream of the v-notch weirs should be removed during the next site visit.

8 WATER QUALITY SAMPLING/TESTING

A surface water monitoring program for surface water sampling in various locations along Little Sheep Creek was presented in the OMS Manual (Klohn Crippen, 2005b).

- Site #11, upstream of Jumbo TSF;
- Site #13, downstream of the Jumbo TSF below the stilling basin;
- Site #15, 50 m downstream from culvert under access road southwest of Good Friday TSF; and
- 10 km downstream of Red Mountain Mine site.

Additionally, sampling was also required at the following seepage sites:

- #16 –m drainage pipe;
- #17-Upper v-notch weir; and
- #18-lower v-notch weir.

Sampling from piezometers was not required in the water sampling program discussed in the OMS Manual (Klohn Crippen, 2005b).

Water quality sampling and testing has not been taken from any of the water sampling locations identified in the OMS Manual since 2004.

9 PREVIOUS RECOMMENDATIONS

The only recommendation made in the last available inspection report for the 2004 inspection (Klohn Crippen, 2005a) for the Good Friday and Jumbo TSFs was that ongoing monitoring at Red Mountain should include annual geotechnical inspection, measurement of piezometric levels and seepage flows and surface water quality monitoring in Little Sheep Creek. Details on the extent of monitoring required are presented in the OMS Manual (Klohn Crippen, 2005b).

Additionally, a Dam Safety Review of both structures was recommended in the OMS Manual for 2011.

10 CONCLUSIONS

In general, the Good Friday and Jumbo TSF dams appear to be in good condition, with the exception of the seepage and deposit of silt at the downstream toe of Jumbo Dam. However, the snow cover was sufficient to obscure the slopes and toe area of the Good Friday TSF, especially in the West Limb area. The degree of snow cover on the crest and slopes of Jumbo Dam was less due to the orientation and location of the TSF that results in it getting more sunlight during the day. However, the snow cover obscured the downstream toe area. As such, a follow up inspection should be conducted in the spring of 2015 after the snow has melted.

Annual inspections, instrumentation reading and water quality sampling and testing have not been conducted since 2004. These activities should resume in 2015, following OMS requirements. The required schedule of these activities can be re-assessed after comparison of 2015 data to historical data before 2004. Additionally, the OMS Manual and Emergency Preparedness and Response Plan are out of date and should be updated.

Piezometer water levels in the two TSFs were described in Klohn Crippen's 2004 inspection report to be at or below historical levels. Review of the historical data in the 2004 inspection report (Klohn Crippen, 2005a) indicates a reduction in water levels in 2004 compared to earlier data. The trigger levels for additional action after review of water level data have been established based on the maximum historical reading for each piezometer. The significance of the trigger levels with regard to the stability of the TSF should be reviewed and presented in the revised version of the OMS Manual.

A Dam Safety Review was recommended for both TSFs for 2011 in the OMS Manual (Klohn Crippen, 2005b). This was not completed and should be completed in 2015. The Classification of the Good Friday and Jumbo TSFs should be re-assessed and the stability of the dams and discharge capacity of the diversion channels and spillways be checked using the IDF and EDGM appropriate for the Classification.

The only visible indication of slope instability in the vicinity of the two TSFs was observed downstream of the Good Friday spillway. It appears to be shallow in nature and currently does not appear to have the potential to block the spillway. It also appears to be located just outside of the area formerly treated with subsurface drains to collect groundwater seepage from the natural slope. This area should be assessed during the next inspection.

Trees and shrubs were noted to be growing within the lower portion of the spillway channel at Good Friday TSF. The presence of trees and shrubs will reduce the discharge capacity of the channels. In the case of the Good Friday TSF, this could result in water either exceeding the minimum freeboard requirement or overtopping the diversion berm and spilling water along the downstream toe of the dam or into the reclaimed borrow area during the IDF. In the case of the Jumbo TSF, continued growth of trees and shrubs in the diversion channel could result in overtopping of the channel and short term ponding on the TSF surface. Trees and shrubs in the diversion and spillway channels at both TSFs should be cut close to the channel base and the roots left in place. Vegetation removal from the diversion and spillway channels will be required on a regular basis indefinitely.

Seepage was noted along the downstream toe of the South Limb of the Good Friday TSF dam. This seepage does not appear to be a dam safety issue but could result in erosion in the reclaimed borrow area. The seepage should be assessed during the next inspection and the need for a rockfill drainage trench extension to capture the seepage should be considered.

The v-notch weirs are clogged with organic debris (leaves and twigs) As a result of the clogging, the ability of the v-notch weirs to be useful in identifying a developing dam safety incident may be impaired. The area behind the v-notch weirs should be cleared to permit correct readings of seepage flow rates in these locations.

The presence of seepage and a deposit of silty material at the downstream toe of Jumbo Dam in the stilling basin appears to indicate a possible re-initiation of tailings transport to the downstream toe of the dam via the 600 mm diameter CMP that used to convey the Little Sheep Creek diversion flows. The presence of a depression on the TSF surface approximately above the former diversion CMP further supports this conclusion. The seepage at this location appears to be clear which indicates that continuous erosion of fines is not occurring. However, there is vegetation that has been buried by the silt build up which indicates that silt transport to the toe of the dam may be occurring in episodes. The duration of material deposition in the stilling basin is unknown but it was not identified in the 2004 inspection report (Klohn Crippen 2005a). The source of the silt deposit at the toe of Jumbo Dam should be assessed as soon as possible and remedial work carried out, if required.

The deposit of rockfall debris at the right bank of the Jumbo TSF spillway at the crest of the dam should be removed. Additionally, the stability of the rock slope should be assessed and, if required, mitigation measures put in place (e.g. scaling, rock bolting of slope, catch berms to stop debris from entering channel) to minimize the potential for rock falls entering the spillway channel.

The Sedimentation Berm at the end of the armoured discharge channel appears to have become damaged with rip rap being dislodged and eroded. The OMS Manual (Klohn Crippen, 2005b) indicated that this berm was designed to resist a 1:200 year event and its state should be inspected annually. The rip rap appears to have been shifted by water flow, possibly due to undersized rip rap being used or not being properly keyed into the creek bed. The need for this berm is unclear and should be assessed. If it is required, it should be repaired to withstand the 1:200 year event. It seems more appropriate to do in-stream remedial work and key the rip rap into the base of the creek rather than have a raised berm which will likely experience continued erosion.

On the basis of our review of the performance to date of the Good Friday and Jumbo TSFs, review of available data and our observations of the condition of the dams, we conclude the following:

- The snow cover at the time of inspection hindered assessment of the physical state of the dams and reclaimed tailings surfaces. From what KCB could observe, the TSF dam structures appear to be in good condition, with the exception of potential tailings release at the Jumbo TSF.
- There may still be periodic loss of tailings via the Little Sheep Creek CMP, which should be investigated.

- The current state of stability of the dams cannot be assessed due to an absence of piezometer data.
- There is no data to assess if the quality of water being released from the site meets discharge requirements.
- The lack of annual inspections and instrumentation readings since 2004 makes dam safety assessment difficult.

As a result of these aspects, KCB cannot state that the dams of the Good Friday and Jumbo Tailings Storage Facilities reviewed as part of this report are safe or that they are in compliance with design requirements. Additional assessments are required to verify the dams are safe.

A Table summarizing recommended action items is provided in Section 11 of the report.

11 LIST OF ACTION ITEMS

Below is an updated list of recommended action items which are prioritized as follows:

- **Priority #1**:
  These are items with high probability of immediate danger to life, health or the environment.
- **Priority #2**:
  These are items that could lead to injury or environmental impact or, are considered a repetitive aspect that demonstrates a breakdown of operating procedures.
- **Priority #3**:
  These are single occurrence items that alone are unlikely to result in dam safety issues.

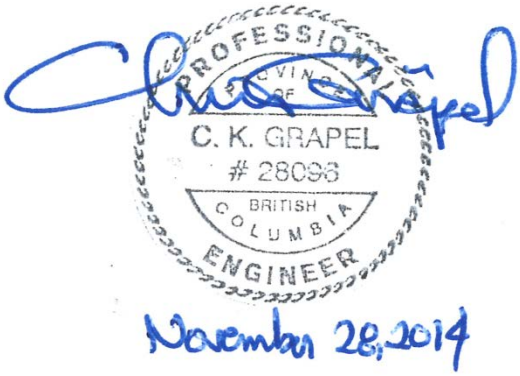
Table 11.1 Summary of Action Items

Recommendation # and Year	Action	Priority	Recommended Completion Date	Status
1 (KC 2005b KCB 2014)	Conduct annual inspections. A follow up inspection after the snow clears in 2015 is recommended due to snow cover at time of the 2014 inspection.	2	April 2015	
2 (KC 2005b KCB 2014)	Complete a Dam Safety Review. The Classification should be reviewed and safety assessed under IDF and EDGM conditions.	2	December 2015	
3 (KCB 2014)	Update the OMS Manual and Emergency Preparedness and Response Plan, including adding detail on meaning of weir and piezometer trigger levels.	3	December 2015	
4 (KCB 2014)	Resume monitoring instrumentation and water quality according to OMS Manual.	2	Start by early 2015	
5 (2014)	Assess the natural slope instability adjacent to Good Friday Spillway during annual inspections and assess if slope repair is required.	3	April 2015	
6 (2014)	Clear trees and shrubs growing in Good Friday spillway channel, as per OMS Manual. Leave roots in place, dispose of cuttings outside of TSF.	2	September 2015	
7 (2014)	Assess seepage beyond downstream toe of Good Friday South Limb of Dam and determine if additional drainage and rip rap armouring is needed.	3	April 2015	
8 (2014)	Clear organic material from V-notch weirs below West Limb of Good Friday dam.	2	April 2015	
9 (2014)	Assess if the red material at toe of dam is tailings. Note the depression in tailings surface above former Little Sheep Creek Diversion CMP and silt deposit in Stilling basin of Jumbo spillway at toe of dam.	2	June 2015	
10 (2014)	Remove rockfall debris adjacent to spillway at dam crest and assess stability of rock slope.	2	September 2015	
11 (2014)	Assess need for sediment control weir. If required, assess if weir repair or in-stream remedial work to key rip rap into creek bed is more appropriate..	3	September 2015	

12 CLOSING

Please contact the undersigned should you have any questions or comments regarding this report.

KLOHN CRIPPEN BERGER LTD.



Chris Gräpel, P.Eng.
Senior Project Engineer

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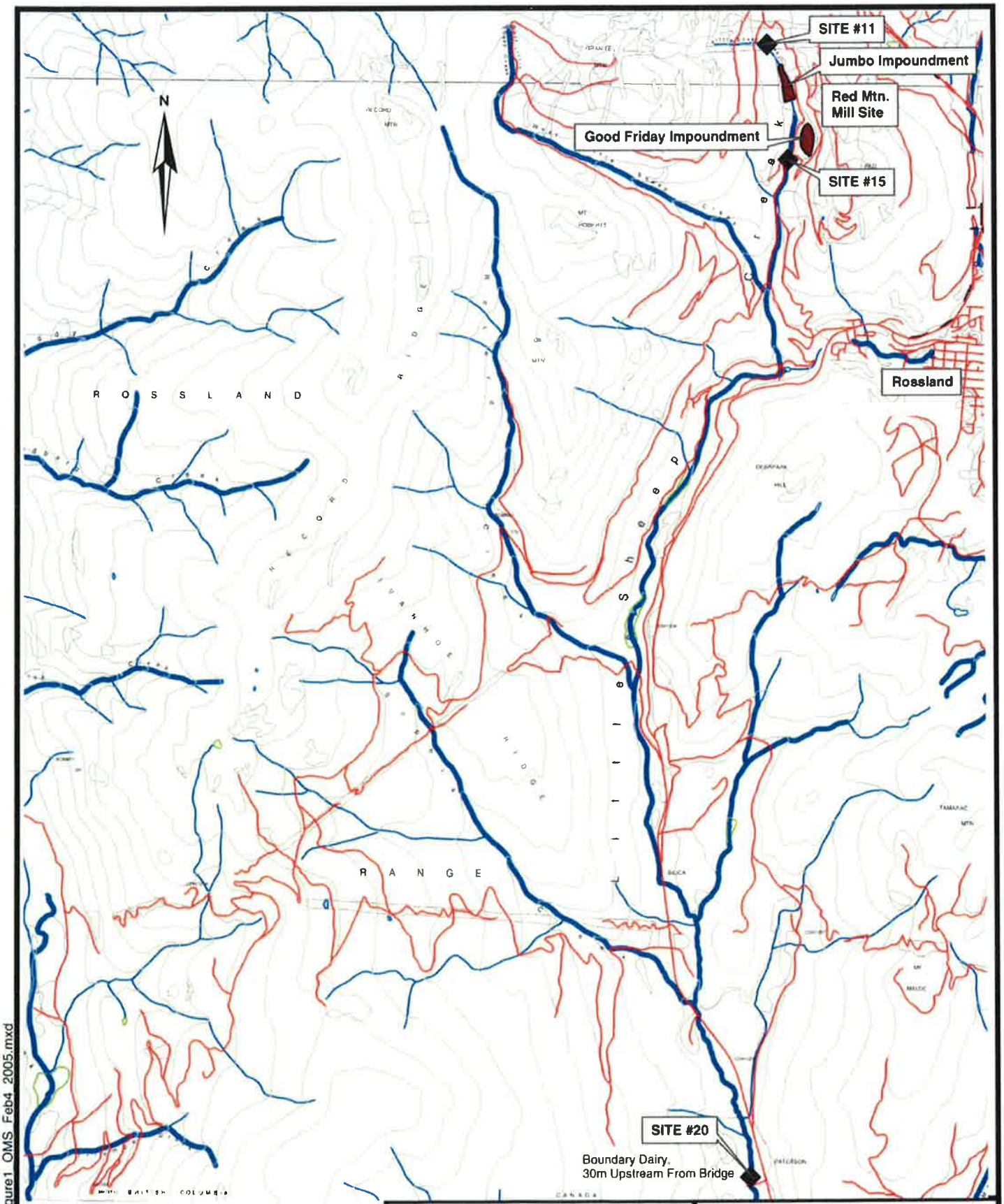
Thurber Engineering Ltd., 2005. OMS Manual Reviews. Reviews conducted on various mines (Gibraltar, Brenda, Equity Silver and Red Mountain). Reviews submitted to BCMEM

APPENDIX I

Figures



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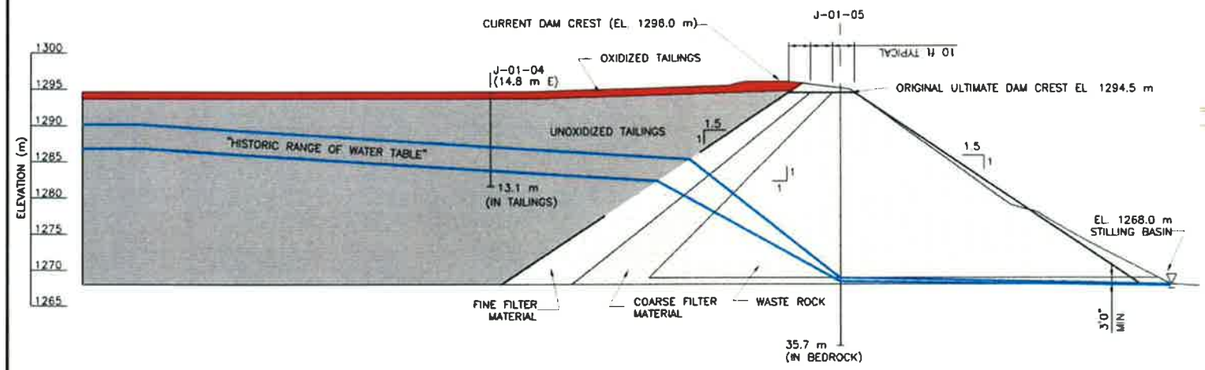
KLOHN CRIPPEN

MINISTRY OF ENERGY AND MINES

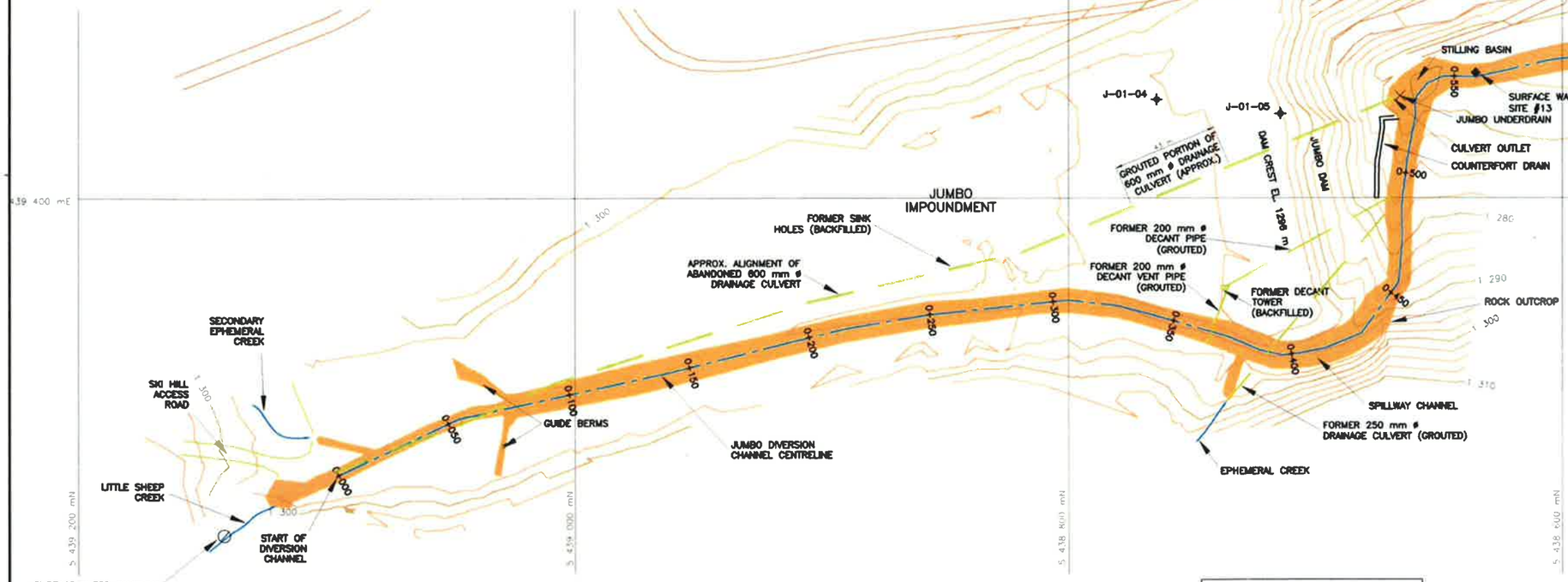
RED MOUNTAIN TAILINGS FACILITY
OPERATION, MAINTENANCE AND
SURVEILLANCE MANUAL

Site Location and Water
Sampling Location Plan

FEB 4, 2005	M08564A14	Figure 1



TYPICAL SECTION
SCALE B



PLAN
SCALE A

LEGEND:

- CHANNEL CENTERLINE
- MAN MADE FEATURES
- CONTOUR MINOR
- CONTOUR MAJOR INDEX
- FOOTPRINT OF DRAINAGE CHANNEL
- ROADS AND SKID TRAILS
- GF-99-8B PIEZOMETER
- MAIN DRAINAGES
- FINGER DRAINS
- BI-ANNUAL SEEP OR SURFACE WATER SAMPLING LOCATION
- ANNUAL SURFACE WATER SAMPLING LOCATION
- SURVEY MONUMENT

SCALE B: 0 15 m

SCALE A: 0 40 m

NOTES:

1. EXTENTS OF INDICATED WORK ARE APPROXIMATE.
2. TYPICAL SECTION TAKEN FROM KILBORN DRG. 279-100-4 DATED NOV. 22, 1971, INCLUDED IN KLOHN CRIPPEN REPORT DATED JAN. 6, 2000.
3. SURVEY INFORMATION PROVIDED BY SEL SURVEY AND DESIGN (MAY, 2004)

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED FEB, 2005

CLIENT: MINISTRY OF ENERGY AND MINES

KLOHN CRIPPEN

PROJECT: RED MOUNTAIN TAILINGS FACILITY
OPERATION, MAINTENANCE AND SURVEILLANCE MANUAL

TITLE: JUMBO IMPOUNDMENT
GENERAL ARRANGEMENT AND
SAMPLE LOCATION PLAN

PROJECT No: M08564A14

FIG No: 2

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Date: 24/2/2005
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Xrefs: C4spnl.ctb

LEGEND:

- CHANNEL CENTERLINE
- MAN MADE FEATURES
- CONTOUR MINOR
- CONTOUR MAJOR INDEX
- FOOTPRINT OF DRAINAGE CHANNEL
- ROADS AND SKID TRAILS
- GF-99-8B — PIEZOMETER
- MAIN DRAINAGES
- FINGER DRAINS
- BI-ANNUAL SEEP OR SURFACE WATER SAMPLING LOCATION
- ANNUAL SURFACE WATER SAMPLING LOCATION
- SURVEY MONUMENT

NOTES:

1. EXTENTS OF INDICATED WORK ARE APPROXIMATE.
2. DECANT PIPE LOCATIONS ARE APPROXIMATE FROM WRIGHT ENGINEERS DWG 460 730 202. A COPY OF THIS DRAWING WAS INCLUDED IN THE GOOD FRIDAY DAM SLOPE REMEDIATION REPORT PREPARED BY KLOHN CRIPPEN, JANUARY 1999.
3. SURVEY INFORMATION PROVIDED BY SEL SURVEY AND DESIGN, (MAY, 2004).

UTM NAD 83 COORDINATES:
N 5438650.384
E 439653.920
EL. 1316.418 m

MILL SITE
UNDERGROUND FUEL STORAGE TANK
GOOD FRIDAY SURFACE WATER COLLECTION CHANNEL CENTER LINE
FORMER DECANT TOWERS (BACKFILLED)
FORMER DECANT LINES (GROUTED) SEE NOTE 2
SWALE
HARD TILL OUTCROP
GOOD FRIDAY SPILLWAY
GOOD FRIDAY IMPOUNDMENT
WEST LIMB EXTENSION
TRAINING BERM
DAM CREST EL. 1286 m
DOWNSTREAM SWALE
SOUTH LIMB
OLD SLIDE AREA
WEST LIMB
WEST LIMB TOE DRAIN
SITE #16 SEEP FLOW MEASUREMENT AND SAMPLING SITE
ACCESS ROAD
STILLING BASIN
JUMBO UNDERDRAIN
SURFACE WATER SAMPLING SITE #13
COUNTERFORT DRAIN
JUMBO IMPOUNDMENT
JUMBO DAM
SITE #17 UPPER WEIR SEEP SAMPLING SITE
WEST BERM
SITE #18 LOWER WEIR SEEP SAMPLING SITE
LITTLE SHEEP CREEK
SEDIMENT WEIR
SURFACE WATER SAMPLING SITE #15

GF-99-1A, GF-99-1B, GF00-03, GF-99-8B, GF-99-8A, GF-99-6A, GF-99-6B, GF-99-3A, GF-99-3B, GF00-04B, GF00-02, J-01-04, J-01-05

439 600 mE, 439 400 mE, 5 438 600 mN, 5 438 800 mN

PLAN

SCALE : 0 40 m

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED FEB, 2005

CLIENT: MINISTRY OF ENERGY AND MINES

KLOHN CRIPPEN

PROJECT: RED MOUNTAIN TAILINGS FACILITY
OPERATION, MAINTENANCE, AND SURVEILLANCE MANUAL

TITLE: GOOD FRIDAY IMPOUNDMENT
GENERAL ARRANGEMENT AND
SAMPLE LOCATION PLAN

PROJECT No: M08564A14

FIG. No: 3

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Xrefs: 04qpal(oct)

APPENDIX II

Guidelines for Annual Dam Safety Inspections

Ministry of Energy & Mines

GUIDELINES FOR ANNUAL DAM SAFETY INSPECTION REPORTS

Reference:

Health, Safety and Reclamation Code for Mines in British Columbia (Code) Section 10.5.3: *The manager shall submit an annual dam safety inspection report prepared by a professional engineer on the operation, maintenance and surveillance of the tailings and water management facilities and associated dams to the chief inspector.*

This Code reference applies to every operating and closed mine in BC.

The report shall provide the following information:

1. Executive Summary

   (a) Classification of the dam(s) in terms of Consequence of Failure in accordance with Table 2-1 of the CDA Dam Safety Guidelines (2007).

   (b) Significant changes in instrumentation and/or visual monitoring records.

   (c) Significant changes to dam stability and/or surface water control.

   (d) For major impoundments, as defined in Part 10 of the Code, a current Operation, Maintenance and Surveillance (OMS) Manual is required. The annual report shall indicate the latest revision date of the OMS manual.

   (e) For tailings dams classified as High, Very High, or Extreme Consequence, an Emergency Preparedness Plan (EPP) is required. The annual report shall indicate the latest revision date of the EPP document.

   (f) Scheduled date for the next formal Dam Safety Review in accordance with Table 5-1 of the CDA Dam Safety Guidelines (2007). Formal Dam Safety Reviews are required every 5 to 10 years (depending on consequence classification) and differ from annual dam safety inspections. The requirements for Dam Safety Reviews are included in Section 5 of the CDA Dam Safety Guidelines. Dam Safety Reviews may be conducted by the Engineer of Record with third party review, or by an independent third party with involvement of the Engineer of Record.

2. Summary of past years' construction (if any) with a description of any problems and stabilization.

3. Plan and representative cross sections.

4. Site photographs.

5. Review of climate data.

6. Water balance review.

7. Freeboard and storage availability (in excess of the design flood).

8. Water discharge system, volumes, and quality.

9. Seepage occurrence and water quality.

10. Surface water control and surface erosion.

11. Instrumentation review including:

    (a) Phreatic surfaces and piezometric data.

    (b) Settlement.

    (c) Lateral movement.

The report shall be submitted by a qualified geotechnical engineer registered as a Professional Engineer (P.Eng.) in British Columbia. The professional engineer will be deemed the Engineer of Record for the facility unless another engineer is identified within the Dam Safety Inspection report as having this responsibility.

Note, this document modified from the original by George Warnock, P.Eng. (Manager, Geotechnical Engineering) in August 2013. Original prepared by Chris Carr, P.Eng. (former Manager) in February 2002.

APPENDIX III

Routine Inspection and Piezometer Reading Sheet

FAX TRANSMISSION

TO:		**FAX NO:**	(250) 952 0491
CC: (only if unusual results)		**FAX NO:**	(250) 505-5030
FROM:	KCB - Chris Siepel, P.Eng.	**TEL NO:**	
SUBJECT:	**Good Friday Tailings Facility Routine Inspection Report**	**PAGES:**	1

DATE:	November 11, 2014	**TEMPERATURE:**	High -10 °C Low -15 °C
24 HOUR RAINFALL (mm) * **Trigger Level** >55 mm in one day	5cm snow overnight	**WEATHER:**	clear, some wind

TAILINGS SURFACE	**Dry Surface**	**Small Ponds** (< 5 m diameter ponds)	**Medium Sized Ponds** (5-20 m diameter ponds)	**Large Ponds** (> 20 m diameter ponds)
		Few Ponds (1-2 ponds)	**Several Ponds** (2-5 ponds)	**Many Ponds** (>5 ponds)

TOE BERM (SLIDE) AREA	**General**	Stable	Ravelling	Small Slough	Major Slough
	Access Road	No Cracks	Slight Settlement	Small Slough	Major Slough

26.5° "V" NOTCH WEIRS	**Upper Weir** Flow Depth (cm) 4.5cm ***Trigger Level: >10 cm** Flow Depth	**Flow Condition**	**Clean**	**Cloudy**	**Dirty**	**Very Dirty**
		Notes:	Upstream of weir clogged with leaves + twigs			
	Lower Weir Flow Depth (cm) 1.9cm ***Trigger Level: >7 cm** Flow Depth	**Flow Condition**	**Clean**	**Cloudy**	**Dirty**	**Very Dirty**
		Notes:	Upstream of weir clogged with leaves + twigs			

SEEPAGE DRAIN PIPE AT NORTH END (SITE #16) *Trigger Level: <40 seconds	Time to fill 21 L pail 540 (seconds)	**Flow Condition**	**Clean**	**Cloudy**	**Dirty**	**Very Dirty**

PIEZOMETERS (m below Top of Casing) (record to nearest cm) Piezos not read	**GF-99-1A (NE)** *Trigger Level <2.6		**GF-99-1B (SW)** *Trigger Level <2.0		**GF-00-02** *Trigger Level <6.0	
	GF-99-3A (west) *Trigger Level <2.9		**GF-99-3B (east)** *Trigger Level <3.3		**GF-00-03** *Trigger Level <6.3	
	GF-99-6A (west) *Trigger Level <2.0		**GF-99-6B (east)** *Trigger Level <1.8		**GF-00-04B** *Trigger Level <7.4	
	GF-99-8A (south) *Trigger Level <3.2		**GF-99-8B (north)** *Trigger Level <2.4			
Note anything unusual about any of the piezometers (e.g., damaged, cap missing, buried, missing tag, etc.)						

DRAINAGE CHANNEL, SPILLWAY, SPILLWAY OUTLET	**Flow Volume**	**Low** (<25cm average depth in channel)	**Medium** (25-75cm average depth in channel)	**High** (>75cm average depth in channel)
	Flow Clarity	**Clear** (no visible suspended solids)	**Cloudy** (visible suspended solids)	**Dirty** (cannot see channel bottom)
	Slope Instability	**Stable** (no visible instability)	**Marginally Stable** (some minor slumping) 1	**Unstable** (tailings exposed/eroding)
	Debris	**None** (no visible debris)	**Minor** (minor flow channelization from debris)	**Major** (major blockage of flow from debris)
	Vegetation Growth	**None** (no visible organic growth)	**Minor** (some visible algae and grass growth)	**Major** 2 (willows and other woody species)
	Erosion in Borrow Area	**None** (all flow in trees)	**Minor** (some gullying (< 20 cm deep) but self-armouring)	**Major** (Deep gullies, oversteepened slopes cutting back towards dam)

***Trigger Level** – Refer to Red Mountain Tailings Facility Operation, Maintenance and Surveillance (OMS) Manual for procedures to follow if this level is recorded.

1. Natural slope near outlet from spillway has some minor instability, appears to be surficial
2. Channel downstream of spillway has shrubs and trees (butts up to ~0.2m) in channel

FAX TRANSMISSION

TO:		**FAX NO:**	(250) 952 0491
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FROM:	KCB - Chris Gräpel, P.Eng.	**TEL NO:**	
SUBJECT:	**Jumbo Tailings Facility Routine Inspection Report**	**PAGES:**	1

DATE:	November 11, 2014	**TEMPERATURE:**	High -10 °C Low -15 °C
24 HOUR RAINFALL (mm) Trigger Level* >55 mm in one day	5cm snow overnight	**WEATHER:**	clear, some wind

TAILINGS SURFACE	**Dry Surface** Snow covered	**Small Ponds** (<5m diameter ponds)	**Medium Sized Ponds** (5-20m diameter ponds)	**Large Ponds** (>20m diameter ponds)
		Few Ponds (1-2 ponds)	**Several Ponds** (2-5 ponds)	**Many Ponds** (>5 ponds)

PIEZOMETERS (m below Top Of Casing)	**J-01-04** **Trigger Level*** < 8.4 m below TOC		**J-01-05** (in dam) **Trigger Level*** <26.5 m below TOC	
Note anything unusual about any of the piezometers (e.g., damaged, cap missing, buried, missing tag, etc.)	Piezometers not read			

DIVERSION CHANNEL, SPILLWAY INLET, SPILLWAY CHUTE, STILLING BASIN	**Flow Volume**	**Low** (<25cm average depth in channel)	**Medium** (25-75cm average depth in channel)	**High** (>75cm average depth in channel)
	Flow Clarity	**Clear** (no visible suspended solids)	**Cloudy** (visible suspended solids)	**Dirty** (cannot see channel/basin bottom)
	Slope Instability	**Stable** (no visible instability)	**Marginally Stable** (some minor slumping)	**Unstable** (tailings exposed/eroding)
	Debris	**None** (no visible debris)	**Minor** (minor flow channelization from debris)	**Major** (major blockage of flow from debris)
	Iron-rich Algae Growth	**None** (no visible organic growth)	**Minor** (some visible algae growth)	**Major** (abundant iron-rich algae)
JUMBO DAM TOE - SEEPAGE ON ROAD ESCAPING COUNTERFORT DRAIN	**Seepage Volume**	**None** (toe of dam dry)	**Minor** (soil is wet at dam toe)	**Major** (abundant boils)
	Seepage Clarity	**Clear** (no visible sediments)	**Cloudy** (some visible sediments)	**Dirty** (high sediment content)

*** Trigger Level** – Refer to Red Mountain Tailings Facility Operation, Maintenance and Surveillance (OMS) Manual for procedures to follow if this level is recorded.

Seepage into spillway stilling basin is clear but red silt is accumulating in stilling basin. The red silt may be tailings. Seepage appears to be at location of 600 mm CMP for former Little Sheep Creek diversion

Depression (0.3m) noted in vicinity of former sinkhole above failed 600 mm CMP.

APPENDIX IV

Photographs

Photo 1 – Good Friday, right abutment area of West Limb dam. Photo taken facing south. Red arrow indicates seepage area melting thin cover of snow that fell the night before the inspection. Green arrow indicates boulder barricade of toe access road.

Photo 2 – Good Friday, West Limb of dam. Photo taken facing north approximately 100 m from right abutment. Note seepage in drainage ditch at toe of dam and abandoned mine plant buildings on ridge.

Photo 3 – Good Friday, West Limb of dam, downstream toe area. Photo taken facing south approximately 20 m past barricade entrance to toe access road. Natural slope downstream of dam, to left in photo) is heavily treed.

Photo 4 – Good Friday, start of South Limb of dam. Photo taken facing south on downstream toe access road.

Photo 5 – Good Friday, downstream toe area. Rockfill buttress repair of natural slope instability exacerbated by an overtopping event prior to reclamation of tailings facilities. Downstream slope of South Limb of dam located to right of photograph.

Photo 6 – Good Friday, downstream toe area. View looking downslope over rockfill buttress repaired natural slope above main access road from Hwy 3B. Photo taken facing south east.

Photo 7 – Good Friday, downstream toe area. Photo taken facing south along access road from Hwy 3B of rockfill stabilized natural slope below South Limb of dam.

Photo 8 – Good Friday, South Limb downstream toe of dam. Photo taken facing east towards spillway channel.

Photo 9 – Good Friday South Limb downstream slope. Photo taken facing north from channel downstream of spillway.

Photo 10 – Good Friday crest of South Limb dam. Photo taken facing north west.

Photo 11 – Good Friday, crest of South Limb of dam. Photo taken facing north towards West Limb of dam.

Photo 12 – Good Friday, crest of South Limb of dam. Photo taken facing south. Note toe access road to right of picture.

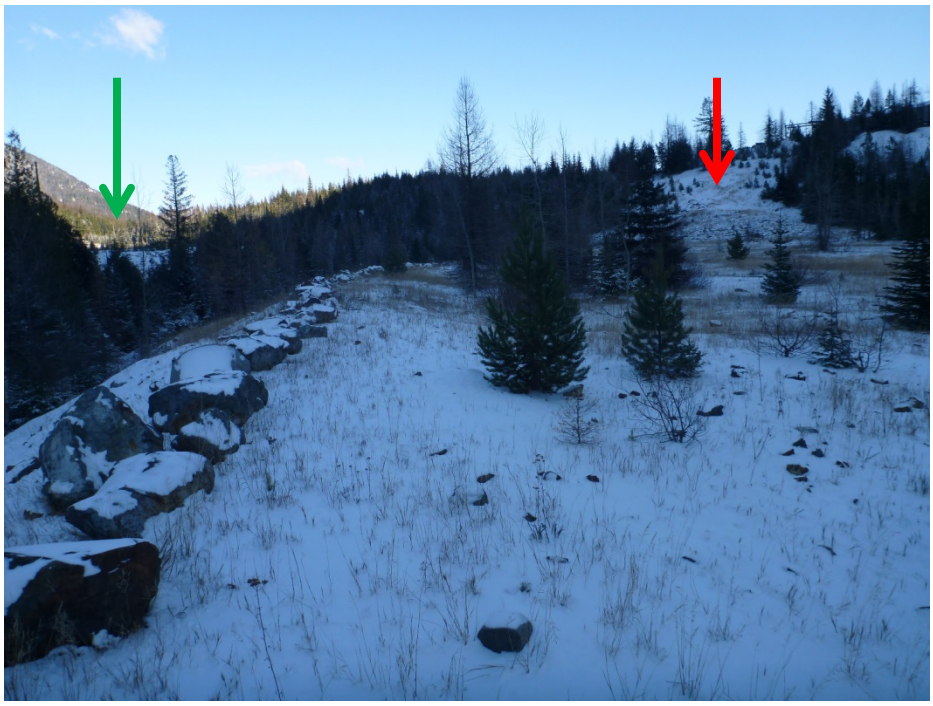

Photo 13 – Good Friday crest of West Limb of dam. Photo taken facing north. Red arrow indicates reclaimed hillside tailings pile. Green arrow indicates location of Jumbo dam.

Photo 14 – Good Friday crest of West Limb of dam. Photo taken facing north - north east facing reclaimed hill side tailings pile.

Photo 15 – Good Friday crest of West Limb of dam. Photo taken at right abutment facing south.

Photo 16 – Good Friday drainage channel on reclaimed tailings surface at toe of slope above impoundment. The north quarter of the channel is shown in this photo. Photo taken facing south east.

Photo 17 – Good Friday drainage channel. Photo taken facing north from approximate mid-point of channel length. Red arrow indicates surficial water flow, believed to be collected seepage from adjacent slope.

Photo 18 – Good Friday drainage channel. Photo taken facing south towards spillway. Red arrow shows approximate start of spillway.

Photo 19 – Good Friday drainage channel and spillway at left abutment. Photo taken facing south east. Transition from drainage channel to spillway is indicated by change in size of channel armouring from gravel and cobbles to rip rap cobbles and boulders.

Photo 20 – Good Friday spillway channel passing over crest of South Limb of dam. Photo taken facing south east.

Photo 21 – Good Friday spillway at left abutment of dam. Photo taken facing north. Note trees growing in spillway channel and rockfill training berms to guide spillway discharge in channel.

Photo 22 – Minor instability of slope near spillway channel. Instability appears to be located downstream of drains installed in this slope during reclamation work (drains not visible through snow).

Photo 23 – Good Friday reclaimed tailings surface. Photo taken facing south from top of reclaimed hill side tailings pile to north of Good Friday impoundment.

Photo 24 – Good Friday reclaimed tailings surface at south end of tailings impoundment. Photo taken facing south. Drainage channel leading to spillway at left abutment of dam is located to left of photo.

Photo 25 – Good Friday reclaimed tailings impoundment surface. Photo taken facing west towards South Limb dam crest.

Photo 26 – Good Friday reclaimed tailings impoundment surface. Photo taken facing north towards abandoned mine plant buildings.

Photo 27 – Good Friday drainage swale from South Limb of dam. Photo taken facing north. A drainage swale with an earthen berm has been constructed to direct seepage from the dam toe through the borrow area. Red arrow shows where seepage was noted at the base of the swale 10 m beyond the downstream toe of the dam.

Photo 28 – Good Friday borrow area downstream of South Limb of Good Friday TSF. Photo taken facing south towards confluence of seepage area with flows from spillway. Red arrow indicates seepage flowing over ground surface towards rip rap lined seepage collection channel.

Photo 29 – Good Friday borrow area. Photo taken facing north west towards Good Friday tailings impoundment from confluence of seepage collection swale with channel downstream of spillway.

Photo 30 – Good Friday West Limb, downslope of downstream toe area. Photo taken facing east from access road from Hwy 3B. Natural slope between access road and downstream toe of West limb shows signs of surficial instability, possibly associated with the cut slope for the road. Red arrow indicates tree with bent trunk associated with slow movements of slope surface.

Photo 31 – Good Friday seepage measurement site 16 for measurement and sampling. Site is located across access road to Jumbo from right abutment of Good Friday dam.

Photo 32 – Good Friday v-notch weir at seepage monitoring and sampling Site 17. Weir has become clogged with leaves and organic matter since initial installation.

Photo 33 – Good Friday v-notch weir at seepage monitoring and sampling Site 18. Weir has become clogged with leaves and organic matter since initial installation.

Photo 34 – Jumbo Dam crest. Photo taken from left abutment at access road. Note boulder barricade preventing vehicle access to dam crest or reclaimed tailings impoundment surface.

Photo 35 – Jumbo Dam crest. Photo taken facing east from crest of spillway channel. A berm is present between the downstream crest of the dam and the upstream tailings impoundment.

Photo 36 – Jumbo crest of dam, right abutment. Photo taken facing west. Spillway for drainage channel on tailings surface is located at left abutment of dam. Note bedrock cut slope behind spillway.

Photo 37 – Jumbo Dam, downstream slope and right abutment. Photo taken facing south east. Spillway is located at right abutment and along downstream toe of dam. Red arrow indicates general location of spillway stilling basin.

Photo 38 – Jumbo Dam downstream slope. Photo taken facing west from mid-point of crest of dam. Red arrow shows location of spillway channel along downstream toe of dam on right abutment.

Photo 39 - Jumbo Dam downstream slope. Photo taken facing east from mid-point of crest of dam.

Photo 40 – Jumbo Dam downstream toe. Photo taken facing south east. Red arrow indicates stilling basin at toe of dam.

Photo 41 – Jumbo Dam downstream slope. Photo taken from access route located at downstream toe of dam at right abutment. Note uneven surface of dam fill on slope face which appears to be due to original grading of dam during initial construction.

Photo 42 – Jumbo Dam left abutment. Photo taken facing north east from downstream toe.

Photo 43 – Jumbo Dam downstream slope. Photo taken facing west from upper left abutment. Note uneven slope surface which is believed to be from original construction of dam.

Photo 44 – Jumbo Spillway stilling basin. Photo taken facing north west. Red arrow indicates location of seepage and associated deposit of red silt with trace to some fine sand (believed to be tailings).

Photo 45 - Jumbo Spillway stilling basin. Photo taken facing south east. Red arrow indicates location of seepage and associated deposit of red silt with some fine sand (believed to be tailings).

Photo 46 - Jumbo Spillway stilling basin. Seepage is entering stilling basin from the bottom and depositing red silt (believed to be tailings) over vegetation that is growing on surface of silt. Red arrow indicates one seepage discharge point. Seepage is clear.

Photo 47 – Jumbo stilling basin outlet and discharge channel. Photo taken facing west. Rip rap is only visible at bottom of stilling basin near outlet.

Photo 48 – Jumbo tailings impoundment near start of diversion channel over reclaimed tailings surface. Photo taken from start of tailings surface, facing south. Note guide berms to direct creek flow into drainage channel.

Photo 49 – Jumbo drainage channel on reclaimed tailings surface. Photo taken facing south approximately one third of channel length from entrance to channel shown in Photo 47.

Photo 50 – Jumbo drainage channel on reclaimed tailings surface. Photo taken facing north approximately two thirds of channel length from entrance to channel shown in Photo 47. Note shrubs and alders/willows growing on channel slopes.

Photo 51 - Jumbo drainage channel entering spillway. Photo taken facing north west at crest of dam near right abutment. Note shrubs and alders/willows growing on channel slopes.

Photo 52 – Jumbo spillway at crest of dam. Photo taken facing west. Red arrow indicates rock fall debris near spillway channel from adjacent bedrock excavation.

Photo 53 – Jumbo spillway channel approximately 20 m upstream of stilling basin. Photo taken facing south east. Note alders/willows growing on and near channel slopes.

Photo 54 – Jumbo discharge channel sediment berm. Photo taken facing south downstream of stilling basin. The rip rap berm is not clearly defined and rip rap appears to have been dislodged with a channel being eroded through the berm.

Photo 55 – Jumbo reclaimed tailings surface. Photo taken facing north. Red arrow indicates depression located near site of 1998 sinkhole where tailings were transported under dam through corrugated metal pipe passing beneath tailings impoundment.

Photo 56 - Jumbo reclaimed tailings surface upstream of Jumbo Dam. Photo taken facing east.