Klohn Crippen Berger

Cheni Mine

Lawyers Tailings Storage Facility

2014 Dam Safety Inspection

November 2014
M09969A01

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:

Lawyers Tailings Storage Facility
2014 Dam Safety Inspection

We are pleased to submit under cover of this letter our report titled “Cheni Mine, Lawyers Creek Tailings Storage Facility – 2014 Dam Safety Inspection”.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Chris Gräpel, P.Eng.
Senior Project Engineer

CG:kd

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Cheni Mine

Lawyers Tailings Storage Facility

2014 Dam Safety Inspection

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 Cheni Mine, Lawyers Tailings Storage Facility (TSF) on October 30, 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 Inspectors Orders of August 18, 2014.

The Cheni Mine is located in the Toodoggone region of northern British Columbia. The mine operated from 1989 to late 1992.

The Lawyers TSF dam was designed to be a homogeneous embankment section with a horizontal drain below the downstream shell. The Stage 1 embankment was constructed in 1987 and 1988 with subsequent raises conducted in 1990 and 1992. The dam had a maximum height of approximately 20 m prior to reclamation. The mid points of the north and south limb were approximately 12 to 15 m high. The TSF was reclaimed in 1996.

A summary of KCB's findings is as follows:

- The site was snow covered at the time of inspection.
- The TSF does not have a Classification according to the Canadian Dam Association – Dam Safety Guidelines (CDA, 2007 and 2013). The TSF has not had a Dam Safety Review.
- There have been no documented operational, maintenance or surveillance (OMS) or construction activities undertaken on the TSF since the 1996 reclamation work and the 1996 Annual Review were completed. However, observed site conditions at the emergency spillway indicate that earthworks were conducted after 1996.
- The TSF surface water drainage system appears to be inadequate for hydrologic conditions experienced to date since reclamation work was completed. Minor erosion of the TSF dam downstream slope is occurring near the right abutment where surface water overtops the crest of the dam. Significant erosion (gully about 1.0 m deep) has occurred at the spillway channel and extends from the toe to the downstream crest of the dam
- A Dam Safety Review should be conducted during which the Classification of the TSF should be assessed.
- Assess dam safety under updated IDF and EDGM conditions associated with the selected Classification.
- There appears to be no OMS Manual or Emergency Preparedness and Response Plan in place.

On the basis of our site visit and review of available information we conclude the following:

- The snow cover at the time of inspection hindered assessment of the physical state of the dams and reclaimed tailings surface. From what KCB could observe, the dam appeared to be in good condition, with the exception of spillway erosion near the left abutment and rill erosion from crest overtopping near the right abutment.
- There is no piezometric data to indicate whether the dam has adequate stability.

- There is no data to assess if the quality of water being released from the site meets discharge requirements.
- The lack of annual inspections since 1996 makes dam safety assessment difficult.

As a result of these aspects, KCB cannot state that the dam is safe or that it is in compliance with design requirements. Additional assessments are required to verify dam safety.

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

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

List of Tables

List of Appendices

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 Lawyers Mine Tailings Storage Facility (TSF) dam structures at the closed Cheni underground gold/silver mine. The DSI was requested in response to the Chief Inspector's Orders dated August 18. 2014.

The mine site is located approximately 280 km north of Smithers, BC at 57° 20' N, 127° 10'W. The old access road is no longer in service.

A site location plan, a satellite image from Google Earth and a site plan (Klohn Leonoff, 1989) are presented in Appendix I. Klohn Leonoff, a predecessor to KCB, designed the original tailings dam and was on site in 1988 during construction. Klohn Leonoff also designed the dam raise of 1991. Piteau Associates Engineering Ltd. (Piteau) designed the closure and reclamation work.

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

This report is based solely on KCB's observations of the condition of the Lawyers TSF dam 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 endeavored 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 Cheni Mine is located in the Toodoggone region of northern British Columbia. The mine operated from 1989 to late 1992. The Lawyers TSF is located over a 0.7 km length of the west bank of Attorney Creek, a north flowing tributary to the Toodoggone River, at approximately El. 1360 m. The north limit of the TSF is located approximately 3.4 km south of Toodoggone Creek. The surrounding topography rises steeply to peaks of about 1800 m elevation. The area surrounding the TSF has dense stands of forest near the valley bottom with upper unforested alpine slopes. The mine site is located in a hanging mountain valley at approximate El. 1600 m.

The Lawyers TSF was reclaimed in 1996 after the Cheni Mine closed.

2.2 Background Information

The following reports, which were submitted to Cheni Gold Mines Inc, were reviewed during this assignment:

Klohn Leonoff reports:

- 1987. Tailings Dam Design Report, Lawyers Creek Project.
- 1989. Lawyers Creek Project, Tailings Dam Stage 1 As - Built Construction Report.
- 1990. Raising of Tailings Dam for Year 1990.

Piteau Associates Engineering Ltd. reports:

- 1992. Lawyers Mine, Tailings Disposal Facility, 1991 Annual Review.
- 1994. Lawyers Mine, 1993/94 Tailings Review.
- 1994. Closure and Reclamation Plan for the Lawyers Mine Tailings Impoundment.
- 1995. Lawyers Mine, Tailings Impoundment 1994/1995 Annual Review.
- 1997. Lawyers Mine Tailings Impoundment, 1995/1996 Annual Review.

Piteau Komex Environmental reports:

- 1996. Lawyers Mine Tailings Impoundment ARD Assessment.

2.3 Construction History

The Lawyers TSF dam is an earthfill structure as shown in the Stage I plan on Drawing D-4003 and section on Drawing D-4004, in Appendix I. The Stage I was constructed in 1987 and 1988. The dam consists of a north limb and a south limb meeting at an angle of approximately 120 degrees. The dam alignment follows the topographic highs and lows to maximize tailings storage volume as much as practicable. The east limit of the TSF was initially located 20 m from a meander bend of Attorney's

Creek. However, the creek was realigned during construction to shift the creek approximately 100 m away from the dam toe.

The TSF was designed to operate as a closed system with a low permeability till foundation. More permeable zones in the till foundation were covered with low permeability glacial till. The dam was constructed with low permeability glacial till.

A summary of TSF construction activities is presented in Table 2.1.

Table 2.1 Summary of TSF Construction Activities

Year	EL. Of Dam Crest (m)	EL. Of Spillway Invert (m)	Comment
1989 – Stage I Construction	1374	1373	Spillway has concrete invert
1990 – Dam Raise	1375	1374	Dam raised as per license requirements
1991	1375	1374.5	2m dam raise designed, poor weather precluded construction. Reclaim pond constructed at edge of natural ground to reduce sediment content of recycled supernatant water sent to the mill.
1992	1375.2 to 1375.4	1374.5	
1994 (no construction)			Annual Review (site visit July 1994) states timber lagging and granular fill in spillway channel still in place. No mention of this in previous reports.
1996	Crest of dam excavated vertically and laterally for recontouring downstream slope of dam. Remaining crest elevation not clearly stated ("at least 1 m of the Stage I core and 1992 raise remains….", Piteau, 1997).	Not clearly stated, but invert is "0.7 to 0.8 m below remnant dam crest.	TSF surface drainage swale not constructed. Elevation of spillway invert not stated nor if the timber lagging and fill placed since 1989 in place or not.

Stage I dam was constructed to El. 1374.0 m in 1987/1988. The Stage II dam raise design concept presented in Klohn Leonoff's 1990 design report was not constructed. Stage II dam was raised to El. 1375 m (alternate design) in 1991. An as-built report was not prepared for the Stage II dam raise. Piteau (1991) prepared a summary of Stage II construction activities based on discussions with Cheni and Klohn Leonoff. In 1992, near the end of the mine life, the dam crest was raised again with a 0.2 to 0.4 m centreline "crown" to permit final deposition of tailings associated with milling of a small amount of ore.

The TSF dam had a maximum height of approximately 20 m prior to reclamation. The mid points of the north and south limb were approximately 12 to 15 m high.

The Stage I spillway is located at the left abutment as shown on Drawings D-4003 and D-4006, in Appendix I. The steep upper section was rip rap lined. The lower section was unlined. A concrete sill was provided in the dam crest area at El. 1373 m, 1 m below dam crest level. The Stage I spillway channel was constructed with a 2.0 m invert width and 2H: 1V side slopes.

The spillway invert was raised by 1.0 m to El. 1374.0 m in 1990 and by another 0.5 m to EL. 1374.5 m in 1991. Observations made by Piteau during the 1994 Annual Review indicate the spillway invert was raised using timber lagging and granular fill. The spillway remained in this configuration at EL. 1374.5 m until the TSF was closed and reclaimed in 1996.

Approximately 447,000 m^3 of settled tailings (Piteau, 1997) were deposited in the TSF up until January 1996. The tailings were deposited as a beach with a supernatant reclaim water pond located in the central and northern portions of the TSF. The reclaim pond was constructed in 1991 through placement of a rockfill filter berm that created a central water collection pond adjacent to the natural slope at the west limit of the TSF.

An acid rock drainage assessment (Piteau Komex, 1996) concluded that low pyrite concentrations in the upper 0.5 to 1.0 m of tailings in the TSF "do not represent a significant ARD threat". Additionally, they concluded the risk of significant ARD impact was "very slight".

2.4 Reclamation of TSF

Piteau, (1994) designed the TSF closure works based on requirements of the MEMPR (1992) Health, Safety and Reclamation Code for Mines in British Columbia. The TSF was not classified according to the Canadian Dam Association – Dam Safety Guidelines (CDA Guidelines, 1994) during the reclamation design process. During the reclamation design, the reclaimed TSF dam was confirmed to have adequate stability to resist the Maximum Credible Earthquake (MCE) which was estimated to have a peak ground acceleration (PGA) of 0.1g (Piteau, 1994); the same as used by Klohn Leonoff, (1987) for the Stage I dam design. However, an Inflow Design Flood (IDF) event was not defined for the design of surface water drainage measures.

The TSF reclamation design included regrading the spillway to its Stage I invert elevation (El. 1373 m, approximately 2.2 to 2.4 m below the final dam crest elevation (EL. 1375.2 m to 1375.4 m). A drainage channel on the surface of the capped tailings was to be constructed to have a gradient less

than 2% across the entire TSF surface from near the right abutment to the spillway near the left abutment. An Inflow Design Flood event does not appear to have been used in the design of the drainage swale. It appears that the design basis for the drainage swale was to set spillway invert elevation at the crest of the TSF dam to be the lowest point on the reclaimed tailings surface with grading conducted to achieve positive drainage to the swale. The drainage swale was to have a gentle gradient to minimize potential for erosion of the reclaimed TSF surface. The drainage measures were designed to minimize ponding of water and associated infiltration into the capped tailings.

Regrading of the tailings surface also included infilling the water reclaim pond. The design report (Piteau, 1994) indicated that the reclaim pond backfilling should be conducted in a way that minimizes settlement that affects drainage via the swale. Piteau (1994) identified mixing backfill materials with tailings and soft saturated materials as a way to backfill the reclaim pond and minimize post reclamation settlement. According to the reclamation design report, a standpipe piezometer was to be installed at this location.

The tailings were capped with glacial till and the dam was subsequently contoured and landscaped during the 1996 reclamation works. Wet weather conditions and poor traffic ability of the tailings created challenges and delays for the reclamation earthworks.

Based on the background information provided to KCB by BCMEM, the reclaimed TSF was inspected once after completion of the reclamation activities. The last inspection conducted by Piteau in 1996 (Piteau, 1997) indicates that the spillway invert was located approximately 0.7 to 0.8 m below the remnant dam crest (elevation unknown). Piteau stated that the spillway invert was the lowest elevation on the reclaimed TSF impoundment surface. Piteau further noted that there was no drainage swale in place to drain the tailings surface. An additional observation made by Piteau in their 1996 inspection report (Piteau, 1997) was that some seepage was observed on the slope face near the right abutment. The seepage was believed to be due to finer layers in the tailings deposit causing a perched water table behind and within the TSF dam.

It is unknown if the Emergency Spillway was revised at all during the 1996 reclamation work.

Piteau (1997) concluded that the stability of the TSF dam did not need to be verified because the phreatic surface within the TSF was up to 5 m lower than during tailings deposition and because the downstream slopes had been flattened during reclamation work. Records of previous slope stability analyses by Piteau were not available for review during this DSI.

2.5 Construction in 2014

There was no construction in 2014. The last recorded construction activity at the Lawyers TSF site was in 1997 and consisted of reclamation and closure construction work. However, there appears to have been additional construction since reclamation (date unknown) based on observations made during KCB's site inspection described in Section 6.

3 OPERATIONAL, MAINTENANCE AND SURVEILLANCE AND EMERGENCY PREPAREDNESS ACTIVITIES

There have been no documented operational, maintenance or surveillance (OMS) activities undertaken on the TSF since the reclamation work was completed in 1996 and the 1996 Annual Review completed (Piteau, 1997).

It is understood that neither an OMS Manual nor Emergency Preparedness Plan (EPP) has been prepared for the Lawyers TSF.

4 CLIMATE DATA

Climate data is not being collected at the Lawyers TSF. The nearest Environment Canada climate station with 2014 daily readings is located at Dease Lake, BC, approximately 210 km away. A climate data review has not been conducted by KCB due to the remoteness of the site and the lack of site specific data.

5 WATER MANAGEMENT

Review of the last available inspection report for the reclaimed TSF (Piteau, 1997) indicates that the Emergency Spillway was not revised as per the design during the closure works, nor was the drainage swale constructed across the top of the capped tailings to drain water to the spillway. Piteau indicated that this condition could result in overtopping of the dam during high run off periods and erosion of the downstream slope. Additional monitoring in subsequent years was recommended to identify if overtopping and associated erosion started to occur. There is no current or as-built reclamation topography for the TSF available for KCB's review. It is not currently possible to assess water management for the Lawyers TSF.

A topographical survey of the TSF should be conducted. Site specific climate data should be collected. Available climate data from surrounding stations should be reviewed and compiled with site specific climate data so an IDF can be estimated. The performance of the TSF during the IDF should be assessed.

6 SITE OBSERVATIONS

6.1 General

The DSI site inspection was conducted by Mr. Chris Gräpel, P.Eng. on October 30, 2014. Site access was via a helicopter contracted from Canadian Helicopters in Smithers, BC. Mr. Gräpel was accompanied by the pilot during the inspection. During the inspection the weather was 1° C, overcast with light wind. The TSF was covered with approximately 10 cm of snow at the time of inspection. The snow cover obscured the entire surface of the TSF. As a result, only general comments can be made about the physical state of the Lawyers TSF. Photographs from the site inspection are included in Appendix III.

The site inspection started with a helicopter fly over of the various elements of the TSF. Selected photos from the initial helicopter reconnaissance of the dam, spillway and tailings surface are presented in Photos 1 through 9.

Upon landing, the site inspection was conducted in the following order:

- crest of south limb of dam;
- surface of reclaimed tailings, including depression in approximate location of former supernatant pond;
- drainage swale to spillway;
- spillway control section at dam crest and channel down to natural ground;
- crest of north limb of dam;
- toe and slopes of north limb of dam;
- former channel of Attorney Creek to confluence with realigned creek; and
- downstream toe and slope of south limb of dam.

The write up for the inspection in the following sections will start with the dam structure, followed by the spillway and the tailings surface.

6.2 TSF Dam

Key observations made by KCB during the site inspection are as follows with photo references.

South Limb of TSF Dam

- The crest is relatively even and straight with some minor rutting. The upstream crest – tailings transition is not well defined and the downstream crest does not have a sharp change in slope angle due to reclamation work. Vegetation cover appears to be minimal. Two erosion rills (0.4 m wide, 0.2 m deep) were noted approximately 50 m from the right abutment through the snow cover to extend from the downstream crest to approximately 1/3 embankment height above the downstream toe. The

drainage causing this erosion is believed to be due to surface water discharging off of a local high area of the reclaimed tailings surface (Photos 10 through 13).

- The downstream slope of the dam is relatively even with sparse vegetation cover extending above the snow cover. There is a clear line at approximate 1/2 embankment height below which the density and height of vegetation above snow level appears to be greater than the upper half of the slope. This may indicate the extent of landscaping earthworks conducted during the 1996 reclamation work or other details relating to revegetation efforts (Photos 13 through 16).
- The seepage previously observed on the dam slope near the right abutment (Piteau, 1997) was not observed by KCB due to the snow cover.
- The slopes of the dam are generally as indicated in the plan view of reclamation design (Piteau, 1997) included in Appendix I.
- There is seepage daylighting beyond the downstream toe of the dam near the elbow of the two limbs. There are two locations in this general area which have seepage occurring. There is surface water sheet flow over a 5 m wide section and also a pond of water (Photo 17). This general area is believed to be the Seep-1 site identified in the last available inspection report (Piteau, 1997) and indicated on the plan of reclamation work included in Appendix I.
- The second seepage point identified by Piteau (1997), Seep-2, was not located due to snow cover. The Piteau drawing "Plan of Tailings Impoundment" included in Appendix I indicates it is located to the north of the elbow of the two limbs of the TSF dam.

North Limb of TSF Dam

- The crest is relatively even and straight with some minor rutting. Due to reclamation work, the upstream crest/tailings transition is not well defined and the downstream crest does not have a sharp change in angle. Vegetation cover appears to be minimal (Photos 18 and 19).
- The slopes of the dam are generally as indicated in the Piteau Figure 1 included in Appendix I.
- The downstream slope of the dam appears to be even with sparse vegetation cover extending above the snow cover. The downstream toe was difficult to identify on the ground, partially due to snow cover but also due to the reclamation landscaping. The density and height of vegetation above snow level provided some guidance on finding the downstream toe. The vegetation appeared, in places, to be denser beyond the toe than on the slopes. (Photos 19 and 20).

6.3 Spillway

Key observations made by KCB during the site inspection of the spillway channel are presented as follows with photo references:

- The spillway channel is located near the left abutment at the crest of the dam. The dam is approximately 4 to 6 m high at this location. The downstream toe of the dam at this location was difficult to locate due to the snow cover and the reclamation landscaping.
- The spillway inlet section at the dam crest has an invert that is approximately 1.2 m below dam crest elevation. The channel bottom is approximately 3 m wide and the side slopes are approximately 3H: 1V. Snow cover in the spillway channel was approximately 0.3 m deep. The geometry of the spillway is

different than what was described in the last available inspection report for this site (Piteau, 1997) and as summarized in Section 2.4.

- The spillway channel at the crest of the dam appears to be armoured with rip rap but snow cover precluded an accurate description of the rip rap. The limited particles seen were a maximum size of 0.2 to 0.3 m in diameter (Photo 21).
- An eroded channel is present on the downstream slope from spillway discharge. The erosion channel extends from the downstream crest channel to beyond the apparent toe area and into natural ground by at least 20 m. The erosion channel is approximately 1.0 m deep and between 1 and 3 m wide (Photo 22 and 23).

6.4 Reclaimed Surface of Tailings

Key observations made by KCB during the site inspection of the reclaimed tailings inspection are presented as follows with photo references:

- In general, the tailings surface has a greater density of vegetation than the dam crest or slopes.
- The reclaimed tailings surface is covered with small generally parallel ridges approximately 0.3 to 0.5 m high. The ridges are believed to be due to settlement of the tailings surface after placement of the cover or possible landscaping features.
- Standpipe piezometers referred to in the 1996 Annual Inspection report (Piteau, 1997) were not observed on the surface of the reclaimed tailings. They either have been broken off near ground surface with time or were installed with low stick up heights that we buried by snow.
- There is a depression in the middle of the reclaimed tailings surface. This area appears to correspond to the former location of the supernatant pond just before mine closing. However, the extent of the depression exceeds the estimated size of the supernatant pond presented on the Piteau drawing “Plan of Tailings Impoundment” included in Appendix I. The greater size might be due to increased compressibility of tailings close to the former supernatant pond location. Cat tails and other hydrophilic or aquatic vegetation were noted around the edge of the depression which indicates that water can pond on the reclaimed tailings surface for a prolonged period of time during warmer months.
- The density of vegetation increases closer towards the middle of the reclaimed area (Photos 24, 25 and 26).
- There is a drainage swale from the depression was partially filled with snow. The width and depth of the swale varies between the depression outlet and the spillway section on the dam crest. The swale appears to be little more than a shallow, narrow trench (approximate dimensions estimated through snow cover of 0.2 m deep and 0.5 m wide) at the “outlet” of the central depression and increases in width and depth to match the spillway section at the dam crest.
- A hand level was used to estimate that the centre of the depression is approximately 1.4 m below the dam crest level at the elbow between the two limbs. Furthermore, the invert level of the swale appears to be 0.4 m above the centre of the depression. As a result, it appears that the drainage swale can maintain a freeboard of approximately 1.0 between the maximum pond level in the depression and the dam crest. This visual survey should be confirmed with a more detailed topographic survey.

7 INSTRUMENTATION MONITORING

The instrumentation at the Lawyers TSF consists of standpipe piezometers located at the downstream toe of the embankment. These instruments have not been read since 1996. The standpipe that was to be installed near the reclaim pond during the reclamation work and the other standpipe piezometers read by Piteau in 1996 (Piteau, 1997) were not located during KCB's 2014 site visit. The standpipe piezometers should be located and read during the next annual inspection.

8 WATER QUALITY SAMPLING AND TESTING

Water quality samples have not been taken from the standpipe piezometers since 1996. There is no current water quality data for the seepage from the TSF.

9 PREVIOUS RECOMMENDATIONS

The following recommendations were made in the last available inspection report for the Lawyers TSF (Piteau, 1997):

- A 300mm thick layer of granular fill should be placed over seepage zones noted near the right abutment of the TSF dam.
- Ponding on the impoundment surface, and signs of erosion on the embankment crest should be visually monitored over the next few years (i.e. starting in 1997), to identify whether the tailings surface grade towards the spillway is adequate. The surface grade towards the emergency spillway may not be adequate to control ponding on the impoundment below a level which would allow water to overtop the re-contoured embankment crest.
- The scope of water sampling for testing should be reduced to permit all water sampling and inspection activities to be conducted in one day when access to site becomes limited to helicopter transport.

10 CONCLUSIONS

In general, the TSF dam crest and slopes are even and there is no sign of significant deformations through the snow cover. The limited observations that were made of seepage during KCB's site inspection indicates that the seepage from the TSF is primarily occurring beneath the dam. Seepage zones located on the dam slope in 1996 (Piteau, 1997) were not observed. However, the presence of snow cover during KCB's October 30, 2014 inspection precludes any detailed comments on the current structural condition of the TSF dam. As such, a follow up inspection should be conducted in the spring of 2015 after the snow has melted.

The Classification of the Lawyers TSF dam is currently undefined in the background information reviewed by KCB. The Classification of the dam should be assessed during a Dam Safety Review to be conducted in 2015. Once the Classification has been established, the performance of the TSF during IDF and design earthquake conditions should be assessed.

It currently appears that there is approximately 1 meter of freeboard between the estimated pond level and crest of the reclaimed TSF dam during normal conditions. It is expected that either the dam will overtop or the spillway will continue to be eroded, with possible loss of tailings especially during the IDF. Furthermore, the EDGM used in the reclamation design may no longer be adequate.

There appears to be no OMS Manual or Emergency Preparedness Plan in place for the Lawyers TSF. Additionally, it appears the TSF dam has not been inspected, standpipe piezometers have not been read and water samples not taken for testing since 1996. An OMS Manual should be prepared for the TSF facility. Given the remoteness of the site, the practicality of applying an Emergency Preparedness and Response Plan needs to be assessed further.

The TSF surface water drainage system is inadequate for rainfall and snow melt conditions experienced to date. Additionally, the settlement of the tailings has resulted in the drainage swale and spillway channel not being the lowest point on the TSF surface. As a result, water currently ponding on the surface increases the amount of water that infiltrates into the capped tailings. Surface water flow is overtopping the dam near the right abutment and creating erosion rills which will get larger with time.

The armouring for the spillway channel has failed and erosion of the downstream slope and dam crest is occurring, which can be expected to get worse with time and eventually start eroding tailings. The grading and drainage of the TSF surface will require updating to accommodate the IDF appropriate for the Classification of the TSF.

The observation that a drainage swale exists on the reclaimed tailings surface and that the spillway channel was 1.2 m deep at the time of KCB's inspection indicates that either additional earthworks was conducted after 1996 to address concerns raised in Piteau's inspection report for the 1996 Annual Review (Piteau, 1997) or the changes in spillway and swale geometry are due to erosion of the tailings surface and crest of the dam by surface water flow. The snow cover present at the time of KCB's inspection hindered any assessment of this difference between the conditions observed by KCB in 2014 and the conditions observed by Piteau in 1996.

On the basis of our 2014 site visit and review of available information, we conclude the following:

- the snow cover at the time of inspection hindered assessment of the physical state of the dams and reclaimed tailings surface. From what KCB could observe the dam appear to be in good condition, with the exception of spillway erosion near the left abutment and rill erosion from crest overtopping near the right abutment;
- the current state of stability of the dam 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 since 1996 makes dam safety assessment difficult.

As a result of these aspects, KCB cannot state that the dam at the Lawyers Tailings Storage Facility reviewed as part of this report is safe or that it is in compliance with design requirements. Additional assessments are required to verify that the dam is safe.

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.

A summary of KCB's recommendations for deficiencies noted in the 2014 DSI are presented in Table 11.1.

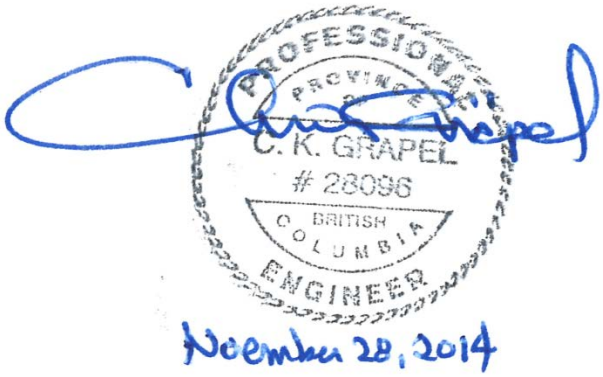
Table 11.1 Summary of Action Items

Recommendation # and Year	Action	Priority	Recommended Completion Date	Status
1 (Piteau, 1997)	Place a 300mm thick layer of granular fill over seepage zones noted near the right abutment of the TSF dam. (The need for this work should be assessed during the next inspection.)	-	August 2015, if required.	Requires additional inspection in 2015
3 (Piteau, 1997)	Reduce water sampling program to permit completion of water sampling and TSF inspection in one day with helicopter access. (The appropriateness of this recommendation depends on review of the next group of water quality test results.)	3	September, 2015	
4 (KCB, 2014)	Resume annual inspections. A follow up inspection after the snow clears in 2015 is recommended due to snow cover at time of the 2014 inspection. Annual inspection should include inspecting the TSF, collecting water samples for water quality testing and reading water levels in piezometers that can be located.	2	Re-start in June, 2015	Spring 2015 inspection required to verify site conditions described herein due to snow cover at time of the 2014 inspection
5 (KCB, 2014)	Obtain current topography of the dam and TSF	2	July, 2015	
6 (KCB, 2014)	Construct short term repairs of spillway	2	August, 2015	
7 (KCB, 2014)	Assess capacity of current TSF drainage system	2	August, 2015	
8 (KCB, 2014)	Conduct a Dam Safety Review. Including: ▪ Failure consequence Classification ▪ Assess the IDF ▪ Determine the design earthquake EDGM ▪ Assess capacity of current TSF drainage system ▪ Check static and seismic stability	2	December, 2015	
9 (KCB, 2014)	Design TSF drainage system upgrade.	2	December 2015	
10 (KCB, 2014)	Prepare OMS Manual and assess if an Emergency Preparedness and Response Plan is required.	2	December 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

REFERENCES

British Columbia Ministry of Energy and Mines, 2013. Guidelines for Annual Dam Safety Inspection Reports.

British Columbia Ministry of Energy, Mines and Petroleum Resources, 1992. Health, Safety and Reclamation Code for Mines in British Columbia.

Canadian Dam Association, 2007 and 2013. Dam Safety Guidelines

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Klohn Leonoff, 1989. Lawyers Creek Project, Tailings Dam Stage 1 As - Built Construction Report.

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Piteau Komex Environmental, 1996. Lawyers Mine Tailings Impoundment ARD Assessment.

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Piteau Associates Engineering Ltd., 1992. Lawyers Mine, Tailings Disposal Facility, 1991 Annual Review.

APPENDIX I

Figures

0 500
KILOMETRES

SCALE

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: LAWYERS CREEK TAILINGS POND

TITLE: LOCATION PLAN

CLIENT: WRIGHT ENGINEERS LIMITED

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — JOHN BRUCE

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
JULY 24, 1987	PB3546-02	A - 2001	

APPROVED

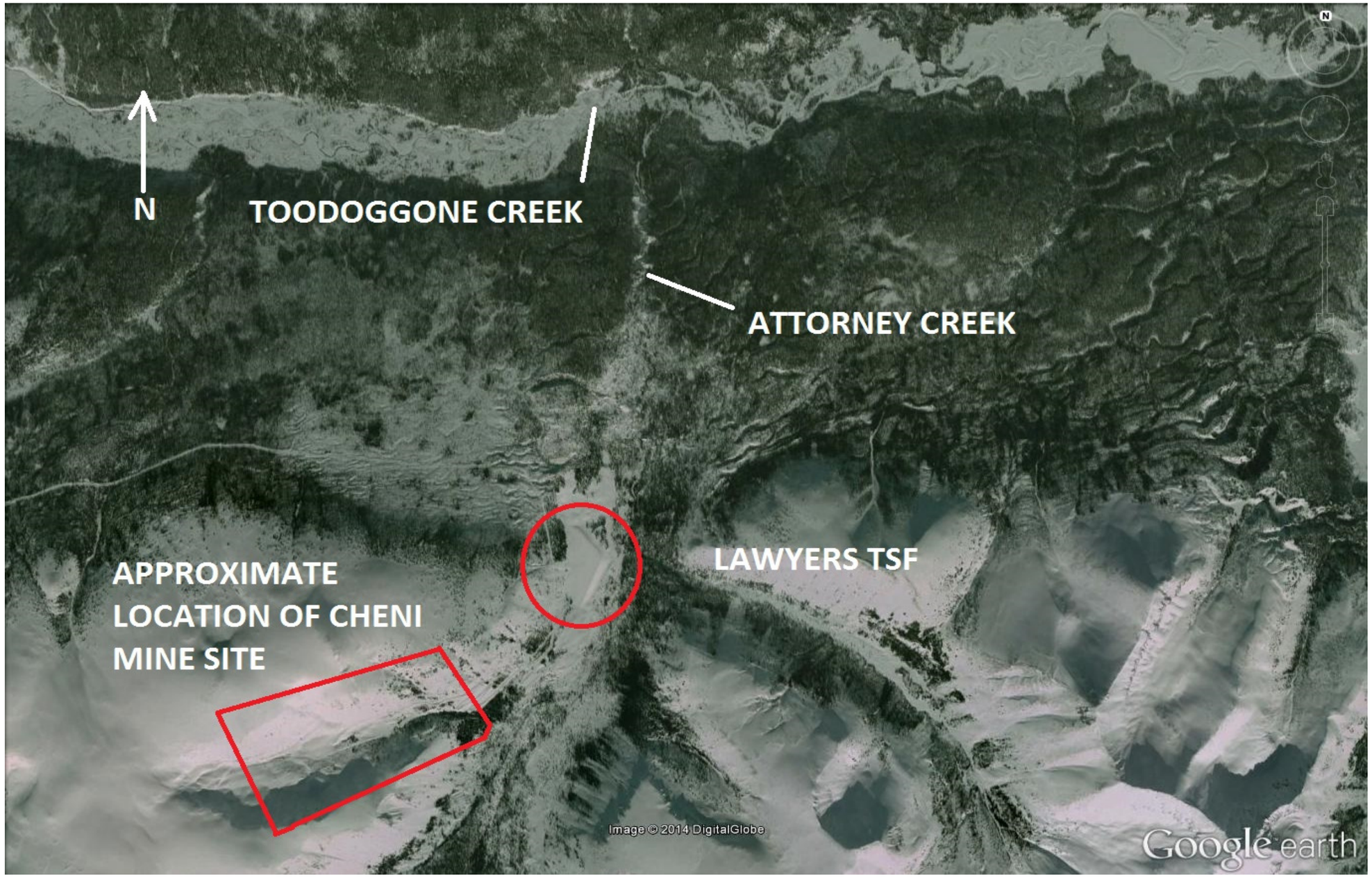


Image taken from Google Earth 2014, image dated 2007

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED November 2014

Client: BRITISH COLUMBIA MINISTRY OF MINES AND ENERGY

Klohn Crippen Berger

PROJECT: Cheni Mine 2014 DSI

TITLE: Site Plan, Cheni Mine Site and Lawyers Tailings Storage Facility (TSF)

PROJECT No.: M09969A01

FIG. No.: FIGURE 1

BORROW AREA 'C'
(GENERAL FILL)
NOT DEVELOPED IN STAGE I CONSTRUCTION

BORROW AREA 'B'
(SOME DEPLETED SECTIONS)

CREEK DIVERSION

REMAINING PORTION OF BORROW AREA 'E'

DEPLETED PORTION OF BORROW AREA 'E'

ATTORNEY CREEK

DEPLETED PORTION OF GLACIAL TILL FILL MATERIAL IN BORROW AREA 'A'

ORIGINAL DEFINED LIMITS OF BORROW AREA 'A'

SEPTIC FIELD

REMAINING PORTION OF GLACIAL TILL FILL

EXCAVATED DITCH

TOE DITCH

TOE DITCH

BARGE ROAD

ACCESS ROAD

EMERGENCY TAILINGS SPILLAGE DITCH

RUNOFF DITCH

SPILLWAY
NON ARMOURED SECTION
(SEE DWG. B-4006 FOR DETAILS)

SPILLWAY
ARMOURED SECTION

RUNOFF DIVERSION DITCH

APPROX. LOCATION OF EMERGENCY TAILINGS DISCHARGE / RUNOFF CONTROL STRUCTURE

TO STURDEE AIRSTRIP

TO MILLSITE

DH 87-01(P)

DH 87-02(P) DESTROYED

DH 87-04(P)

DH 87-05(P)

DH 87-06PA

DH 87-07PA

DH 87-08

D1 D2 D3 D4 D5

S1 S2 S3 S4 S5 S6

STA 4+00 STA 3+00 STA 2+00 STA 1+00 STA 0+00

E 12400 E 12200 E 12000 E 11800 E 11600

N 10,800 N 10,600 N 10,400 N 10,200 N 10,000 N 9,800 N 11,000

1340 1350 1360 1370 1380 1390 1400 1410 1420 1430 1440 1450 1460 1470 1480 1490 1500 1510 1520 1550

LEGEND

- Blanket seal constructed of glacial till fill material
- Blanket seal constructed of a combination of glacial till fill material, silty sand and gravel & silty organic material
- ⊙S1 Shallow wells for interception trench
- ⊕D1 Deep wells for interception trench
- ✦ Borehole, location surveyed
- ⌖ Borehole, location estimated
- Interception trench

NOTES

1. Contours are shown in metres
2. For limits of borrow area 'D', see drawing B-2002 in Klohn Leonoff Ltd Tailings Dam Report dated July 1987
3. Station numbers along dam centreline represent the system used by Cheni surveyors for Stage I construction
4. Omitted details on the drawing include tailings pipeline and reclaim water pipeline
5. Contours shown within the tailings reservoir represent the final conditions after Stage I construction
6. Suffix PA denotes piezometer installed in borehole by Piteau Associates Ltd. (1987) eg. DH 87-07 (PA)
7. Suffix (P) denotes piezometer installed in borehole by Klohn Leonoff Ltd. (1987) eg. DH 87-04 P

TO BE READ WITH KLOHN LEONOFF REPORT DATED JAN. 27, 1989

SCALE: 50m 0 50 100 150m

REV.	DATE	REVISION

DESIGN	DRAWN	DATE	SCALES
D.D	D.T.	NOV. 1988	1:2000

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

CLIENT: CHENI GOLD MINES INC.

PROJECT: LAWYERS CREEK TAILINGS POND

TITLE: STAGE I CONSTRUCTION AS-BUILT PLAN

DATE OF ISSUE: JAN. 27, 1989
APPROVED:

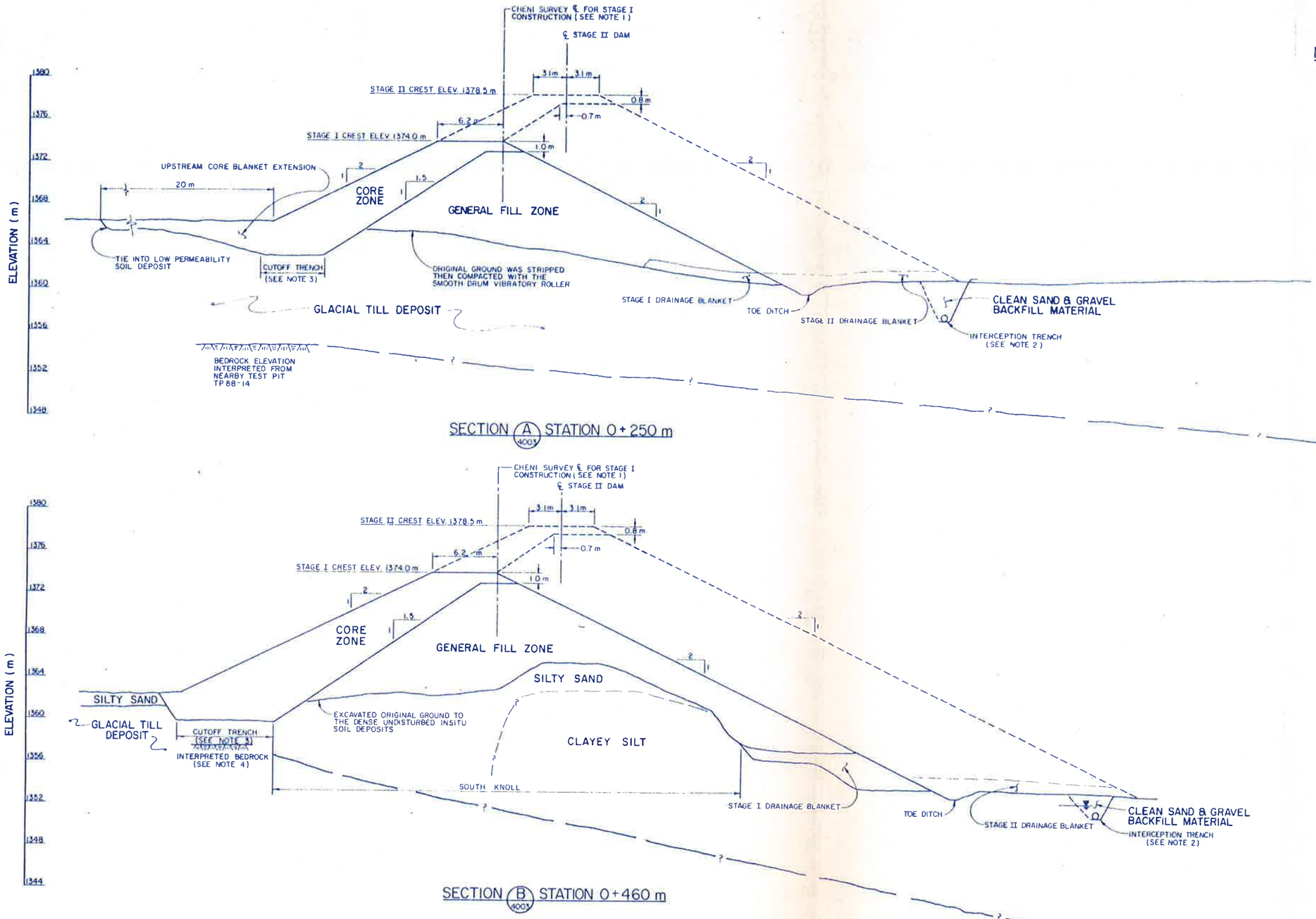
PROJECT No. PB 3546-04

DWG. No. D-4003

REV.

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

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. N. McLEOD



SECTION (A) (4003) STATION 0+250 m

SECTION (B) (4001) STATION 0+460 m

NOTES

1. Cheni Gold Mines Inc. survey centreline for the dam alignment corresponds to the downstream crest of the dam.
2. For details of the interception trench, see drawings D-4007 and D-4008.
3. For details of the soils conditions along the cutoff trench, see drawing D-4006.
4. Bedrock elevation for Section B beneath the cutoff trench was interpreted as the seismic refractor line SL-3 from the Piteau Associates report dated July 1987.
5. Bedrock surface between the known points on this drawing vary in elevation. The exact bedrock surface is not known and is shown on this drawing as a straight line for illustrative purposes only.

WATER LEVEL PROJECTION FROM DEEP WELL D1

TO BE READ WITH KLOHN LEONOFF REPORT DATED JAN. 27, 1989

SCALE: 5m 0 5 10 15m

REV.	DATE	REVISION DETAILS

DESIGN	DRAWN	DATE	SCALES
D.D.	D.T.	NOV. 1988	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

CLIENT: CHENI GOLD MINES INC.

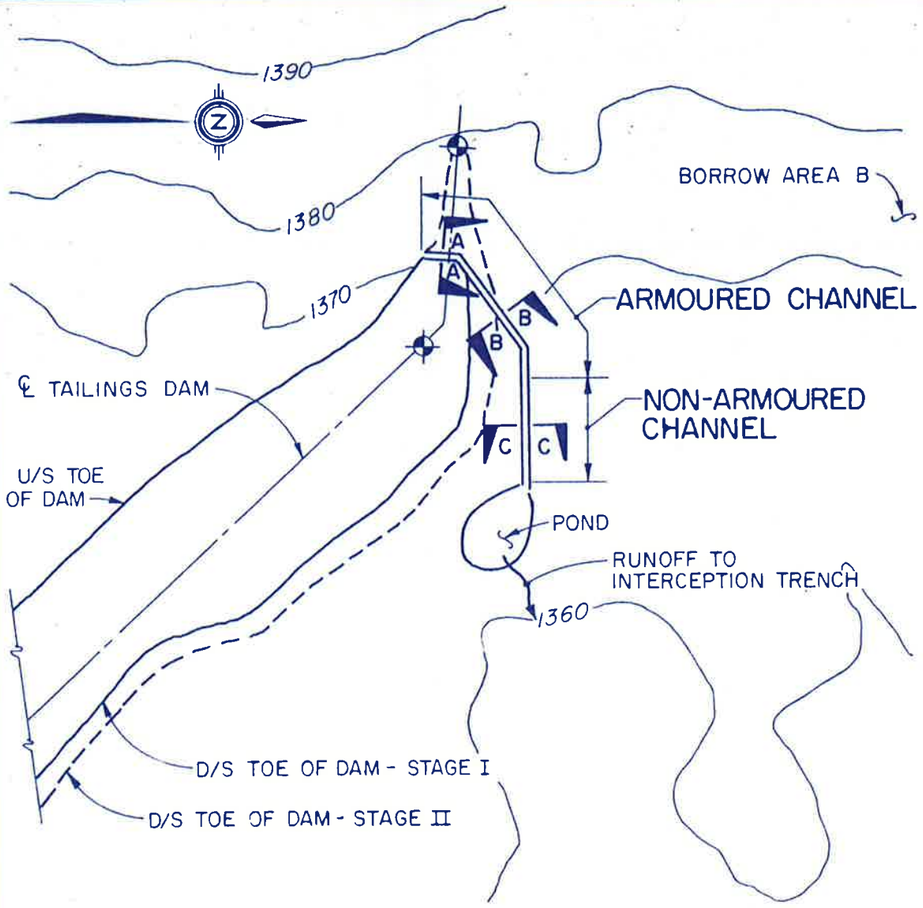
PROJECT: LAWYERS CREEK TAILINGS POND

TITLE: STAGE I CONSTRUCTION AS-BUILT CROSS SECTIONS

DATE OF ISSUE	PROJECT No	DWG. No.	REV
JAN. 27, 1989	PB 3546 04	D-4004	

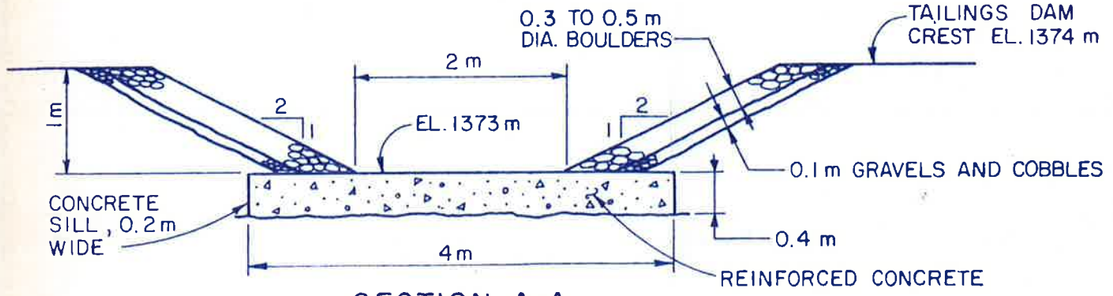
APPROVED

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — H. N. McLEOD



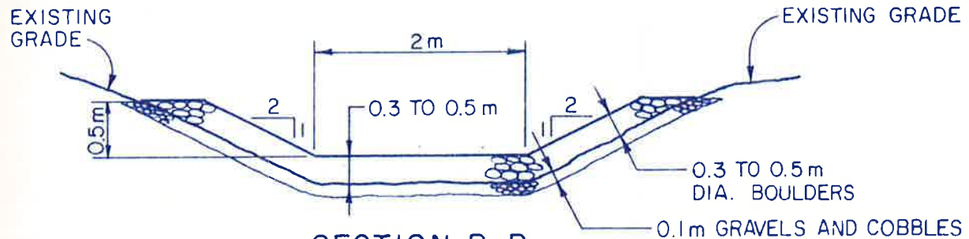
PLAN

SCALE 1:2000 (Approx)



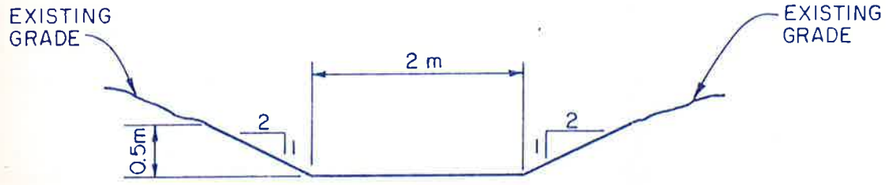
SECTION A-A
SPILLWAY CREST

NTS



SECTION B-B
ARMOURED CHANNEL

NTS



SECTION C-C
NON-ARMOURED CHANNEL

NTS

TO BE READ WITH KLOHN LEONOFF REPORT DATED JAN. 27, 1989

SCALE AS SHOWN

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA N. N. McLEOD

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: LAWYERS CREEK TAILINGS POND			
TITLE: STAGE I CONSTRUCTION AS-BUILT SPILLWAY			
CLIENT: CHENI GOLD MINES INC.	DATE OF ISSUE: JAN. 27, 1989	PROJECT No.: PB 3546 04	DWG. No.: B-4006
	APPROVED:		REV.

NCI-802-KL

DWG. NUMBER: 1198-005

10200 N
10300 N
10400 N
10500 N
10600 N
10700 N
10800 N
10900 N
11700 E
11800 E
11900 E
12000 E
12100 E

EMERGENCY SPILLWAY (ELEV. 1374.5m)

RECLAIMED SUPERNATANT POND

MAIN POND (MAXIMUM ELEV. 1374.0m, TYP.)

TP95-2 DRY; >4.0 m EL. <1369.8m

TP95-5 ▼1.23 m-bg EL. ~1374.2m

TP95-6 ▼3.35 m-bg EL. ~1370.2m

TP95-3 DRY; >7.4 m-bg EL. <1366.8m

TP95-9 ▼4.35 m-bg EL. ~1369.3 m

TP95-8 DRY; >7.0 m-bg EL. <1365.7m

TP95-11 ▼6.11 m-bg EL. ~1367.9m

TP95-14 ▼6.39 m-bg EL. ~1367.6m

A
A'
B
B'

1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00

3.4H: 1V
2.9H: 1V
2.8H: 1V
3.0H: 1V
3.5H: 1V
3.6H: 1V

APPROX. CREST LOCATION

APPROX. LOCATION OF TOE

SEEP-1
SEEP-2
SEEP-3

DAMP AREA (GRANULAR COVER RECOMMENDED OVER AREAS SUBJECT TO SEEPAGE EROSION)

INTERCEPTOR DITCH

INTERCEPTOR DITCH PUMP HOUSE

TO D-5

D-1
D-2
D-3
D-4
S-3
S-4
S-6
W-1
W-5
ITW-1
ITW-2

LEGEND

- DEEP GROUNDWATER SAMPLING POINT
- SHALLOW GROUNDWATER SAMPLING POINT
- GROUNDWATER SEEP SAMPLING POINT
- TEST PIT SITE WITH STANDPIPE (DRY)
- TEST PIT SITE WITH STANDPIPE (WET)
- WATER SAMPLE TAKEN FROM STANDPIPE

(NOTES BELOW TEST PITS DESCRIBE APPROXIMATE WATER TABLE DEPTH BELOW GROUND SURFACE)

3.4H: 1V SLOPE MEASUREMENT LOCATION

0 20 40 60 80 100m

SCALE 1:2000

NOTES:
1. BASED ON AS-BUILT SECTIONS PROVIDED BY CHENI DATED SEPTEMBER 29, 1991, MODIFIED TO REFLECT EMBANKMENT RECONTOURING COMPLETED IN 1996.
2. DAMP AREA IS APPROXIMATELY LOCATED.

CHENI RESOURCES INC.
LAWYERS MINE

PITEAU ASSOCIATES
GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS
VANCOUVER CALGARY

1995/1996
ANNUAL TAILINGS REVIEW

PLAN OF TAILINGS IMPOUNDMENT

BY: TMC/CV
DATE: JULY 97
APPROVED:
FIG: 1

APPENDIX II

Guidelines for Annual Dam Safety Inspection Reports

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

Photographs

Photo 1 – Aerial oblique view of TSF facing north. Note depression in middle of reclaimed tailings surface.

Photo 2 - Aerial oblique view of TSF facing west. Note former location of Lawyers Creek near toe of TSF and road embankment between realigned Lawyers Creek and toe of TSF. Red arrow indicates seepage pond location (Seep-1 identified by Piteau, 1997) beyond downstream toe of dam at apex between limbs.

Photo 3 – North limb of TSF dam. Photo taken facing south from helicopter. Red arrow indicates location of spillway and channel.

Photo 4 – Drainage swale from former location of supernatant pond. Photo taken facing east from helicopter. Red arrow indicates location of drainage swale.

Photo 5 – View of downstream slope and crest of south limb of TSF dam. Photo taken facing northeast from helicopter.

Photo 6 – View of downstream slope and crest of south limb of TSF dam at apex between south and north limbs. Photo take facing north from helicopter. Note creek located beyond downstream toe of TSF dam.

Photo 7 – Downstream slope at apex of south and north limbs of TSF dam. Photo taken facing northwest from helicopter.

Photo 8 – Downstream slope and crest of north limb of TSF dam. Photo taken facing west from helicopter.

Photo 9 – Erosion at spillway channel extending up downstream slope of TSF dam to crest. Photo taken facing southeast from helicopter. Note caribou foraging on reclaimed tailings surface.

Photo 10 – Crest of south limb of TSF dam. Photo taken facing northeast.

Photo 11 – Downstream slope of south limb of TSF dam near right abutment. Photo taken facing west. One of two erosion rills extending from crest to 1/3 embankment height at this location has been cleared of snow.

Photo 12 – Crest of south limb of TSF dam at approximate mid-point of limb. Photo taken facing northeast.

Photo 13 – Crest and downstream slope of south limb of TSF dam viewed from apex with north limb. Photo taken facing southwest.

Photo 14 – Downstream slope of TSF dam at apex. Note creek of flowing water beyond toe area. Photo facing east.

Photo 15 – Downstream slope of south limb of TSF dam. Photo taken facing southwest.

Photo 16 – Downstream slope of south limb of TSF dam. Photo taken facing southwest.

Photo 17 – Ponded water from seepage at toe of TSF dam. Photo taken facing north. This site is believed to be Seep-1 identified in the last inspection report (Piteau, 1997).

Photo 18 – Crest of north limb of TSF dam. Photo taken facing southeast.

Photo 19 – Crest and downstream slope of north limb of TSF dam. Photo taken facing northwest.

Photo 20 – Downstream slope of north limb of TSF dam. Photo taken facing northwest. Red arrow indicates natural high ground between apex of embankment and left abutment.

Photo 21 – Spillway control section through crest of dam with drainage swale in background. Photo taken facing south.

Photo 22 – Spillway channel erosion at downstream crest of dam. Photo taken facing southeast.

Photo 23 – Spillway channel erosion on downstream slope of TSF dam and on natural ground beyond downstream toe. Photo taken facing northeast.

Photo 24 – Reclaimed tailings surface with depression in background. Photo taken facing southwest. Note density of vegetation is greater on top of reclaimed tailings surface than on dam slopes and crest. Fuel drums are for helicopter operations in the area.

Photo 25 – Reclaimed tailings surface with depression in background. Photo taken facing north.

Photo 26 – Reclaimed tailings surface and depression. Photo taken facing south.