

June 26, 2015

Gibraltar Mines Ltd.  
P.O. Box 130  
10251 Gibraltar Mine Road  
McLeese Lake, British Columbia  
V0L 1P0

**Richard Tremblay, MBA, P.Eng.  
General Manager**

Dear Mr. Tremblay:

**Gibraltar MEM Response  
Response to MEM Memorandum Issued February 3, 2015**

## **1 INTRODUCTION**

The Independent Expert Panel<sup>1</sup> (Panel) appointed by Ministry of Energy and Mines, British Columbia (MEM) released their report on Mount Polley tailings dam failure January 30<sup>th</sup>, 2015. After the release of the Expert Panel report, MEM issued a letter on February 3<sup>rd</sup>, 2015 (MEM letter), to all tailings dam owners in British Columbia to undertake a specific risk assessment of their tailing dams and report the results to MEM by June 30<sup>th</sup>, 2015. A copy of the MEM letter is attached in Appendix I.

This report addresses the specific questions raised by the MEM letter, and outlines KCB's assessment of conditions at the three dams forming the Gibraltar Tailings Storage Facility (TSF) relative to these questions, based on a review of available documents to prepare a "summary of knowledge". This assessment has been sealed by a qualified professional engineer and complies with generally-accepted professional practice common to Canada.

The report format is based on the MEM wording and numbering system, as requested by MEM. MEM items are shown in blue italicized text; KCB's response is shown in normal black text.

We consider this assessment to represent the available knowledge of the facility at the time of writing. Operating, inactive, and closed facilities are subject to physical and geochemical changes over time, including ongoing construction activities. It is essential that monitoring and assessment of the facilities continue through regular surveillance, dam safety inspections, dam safety reviews, and other stewardship activities.

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<sup>1</sup> Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach*. January 30.

## 1.1 Assessment Scope

The MEM letter asked that an assessment be undertaken to determine if the dams may be at risk due to the following three conditions:

1. undrained shear failure of silt and clay foundation;
2. water balance adequacy; and
3. filter adequacy.

KCB reviewed available historical information on foundation characterization, design, construction, and operations records for the Gibraltar TSF dams to prepare responses for sub-items listed in the MEM letter. A list of documents reviewed is provided in the References. The responses for the above three items are provided in Sections 3 to 5, respectively, following the numbering system used in the MEM letter.

## 2 OVERVIEW OF THE GIBRALTAR TAILINGS STORAGE FACILITY

The Gibraltar open pit copper mine is located near Williams Lake, in the southern interior of British Columbia. The TSF is located within the East Cuisson Creek valley and is bound by the Cycloned Sand Dam (CSD), North Earthfill Dam (NED) and the East Saddle Dam (ESD). The mine was put into care and maintenance on December 18, 1998, and was purchased by Taseko and re-commenced operations in May 2004.

### 2.1 Cycloned Sand Dam

Construction of the CSD began in 1972 with a 100 ft high starter dam of compacted glacial till across the outlet of the East Cuisson Creek valley. Subsequent dam raises were performed using the centreline method of construction using cycloned tailings sand. The CSD was raised by the modified upstream method in 2006, 2008, 2010, 2011, 2012 and 2013, to El. 3,587 ft and a height of 277 ft. During 2013 and 2014 the downstream slope was regraded to 2.5H:1V (22 degrees). A tailings beach of more than 4,500 ft width is currently maintained between the CSD and the pond.

### 2.2 North Earthfill Dam

The NED is a compacted glacial till embankment, designed as a water retaining structure. Construction of the NED began in 1990, and was raised in 1998, 2006, 2008, 2010, 2011, 2012, and 2013 to minimum elevation 3,583 ft. The raise was constructed with a low permeability glacial till core and an upstream till/tailings sand zone. A tailings beach of more than 1,700 ft width is currently maintained between the NED and the pond. The upstream and downstream slopes are 2.5H:1V.

## 2.3 East Saddle Dam

The ESD confines the eastern side of the tailings pond. The ESD is a compacted glacial till embankment designed as a water retaining structure with a downstream drainage blanket and toe drain. It was initially built in two stages in 1985 and 1986. The dam was raised in 2007 and 2008, and has been raised annually since 2010. In 2014 the dam was raised to minimum crest El. 3,590 ft and a height of approximately 107 ft with further extensions to the drainage blanket and toe drain. The upstream and downstream slopes are 2.5H:1V.

Based on the Long-Term Tailings Deposition Plan (KCB 2013a), the dam will be raised progressively to ultimate crest El. 3,630 ft and a height of 147 ft. The ongoing raises of the ESD will follow the downstream construction method.

## 2.4 Step-Back Embankment

Construction of the SBE started at the south abutment in June 2013. The SBE is constructed of cycloned underflow tailings at an upstream offset along the CSD and NED. Once tied into the north abutment at design elevation, the SBE will become the flood control structure for the pond. The embankment is shaped to design slopes of 4% near the NED and to 10% near the CSD by dozers and is currently under construction to crest El. 3,600 ft. The toe of the SBE is set back 500 ft from the crest of the CSD, and 200 ft to 300 ft from the NED.

## 3 CYCLONED SAND DAM

### 3.1 Task 1 - Review of Foundation Conditions Undrained shear failure of silt and clay foundations

- a. *Including a determination with respect to whether or not similar foundation conditions exist below the dams on your site*

No, similar foundation conditions do not exist beneath the CSD. A glaciolacustrine silt layer was found (RKL 1971a), but is much deeper and stiffer than the upper glaciolacustrine unit found at Mount Polley (IEEIRP 2015).

Site investigations comprised of boreholes, test pits, excavation mapping, and laboratory testing show the CSD foundation is dense glacial till composed of sandy silt with trace to some gravel, and is interlayered with water bearing sands and hard laminated sandy silt (glaciolacustrine layer) (KCB 2013a, KC 1996, RKL 1971a, RKL 1970).

- b. *Whether or not sufficient site investigation (boreholes, etc.) has been completed to have confidence in this determination*

The original design assumed a massive dense glacial till foundation and investigations comprised mainly of test pits, were considered appropriate (RKL 1971a). In light of recent findings at Mount Polley (IEEIRP 2015) and recent experience by KCB at other mine sites, thin glaciolacustrine layers

may exist within dense till deposits, and could control the stability of the embankment if present, continuous and widespread.

The presence of continuous and widespread glaciolacustrine layers at the CSD is considered very unlikely based on the existing site investigation data (KCB 2013a, KC 1996, RKL 1971a, RKL 1970). However, the presence of these layers cannot be completely ruled out in the absence of drill holes penetrating to bedrock. Therefore deeper investigations are underway, to be completed by the fall of 2015, to determine if glaciolacustrine layers are present at depth within the dense glacial till foundation.

*c. If present, whether or not the dam design properly accounts for these materials*

Stability analyses have confirmed the CSD dam is stable even if a continuous and widespread weak glaciolacustrine layer was present beneath the dam. Depending on the extent of the layer, stability may be marginally below the design safety factor, and therefore further investigations are required. Resloping of the dam in 2013 and 2014 improved stability by between 5% and 15%. If investigations identify a weak glaciolacustrine layer at depth, static and seismic stability will be re-evaluated.

*d. If any gaps have been identified, a plan and schedule for additional sub-surface investigation*

A site investigation program is underway to explore ground conditions at depth, to be completed by the fall of 2015.

### **3.2 Task 2 - Water Balance Adequacy (applies to CSD, NED and ESD)**

*a. Including the total volume of surplus mine site water (if any) stored in the tailings storage facility*

The TSF contains approximately 62 Mm<sup>3</sup> of supernatant water based on the May 2015 bathymetry data. Gibraltar has indicated that the operation requires approximately 25 Mm<sup>3</sup> of water to operate the mill. The TSF stores about 37 Mm<sup>3</sup> of excess water.

*b. The volume of surplus mine water that has been added to the facility over each of the past five years*

Mine water inflows and outflows to the TSF from 2010 to 2014, tracked using flow meters, are summarized in Table 3.1.

**Table 3.1 Mine Water Inflows and Outflows to the TSF (2010-2014)**

| Year         | Inflows<br>(million US gallons)            | Outflows<br>(million US gallons)             | Net Flows<br>(million US gallons) |
|--------------|--|--|-----------------------------------|
|              | Mine Surface Water and<br>Pit Water to TSF | TSF Water Removed by<br>Pumping to Open Pits | Mine Water to TSF                 |
| 2010         | 452  | 688  | -236                              |
| 2011         | 684  | 671  | 13                                |
| 2012         | 838  | 214  | 624                               |
| 2013         | 913  | 0  | 913                               |
| 2014         | 1,845                                      | 0  | 1,845                             |
| <b>Total</b> | <b>4,732</b>                               | <b>1,573</b>                                 | <b>3,159</b>                      |

- c. *Any plans that are in place or that are under development to release surplus mine water to the environment*
- ♦ Gibraltar is currently permitted to release 190 L/s annually to the Fraser River between April 11 and November 11.
  - ♦ Gibraltar requested a permit amendment to increase the annual discharge to the Fraser River from 190 L/s to 285 L/s between April 11 and November 11.
- d. *Recommended beach width(s), and the ability of the mine to maintain these widths*
- ♦ Gibraltar has indicated that they can maintain the minimum required beach widths with the continuation of controls currently in place.
  - ♦ Design beach width during operating conditions for the CSD, the NED, and the SBE is 1,500 ft.
  - ♦ Existing minimum beach width as of May 2015:
    - CSD: approx. 4,500 ft; and
    - NED: approx. 1,700 ft;
  - ♦ The flat upstream SBE design slope of 5% (20H:1V) will promote a wide beach.
- e. *The ability of the TSF embankments to undergo deformation without the release of water (i.e. the adequacy of the recommended beach width)*
- ♦ Since the CSD and NED are at their ultimate elevation, static loading of the CSD and NED due to dam raising is complete and the main source of potential additional deformation for the CSD and NED is seismic loading. The calculated seismic deformations (horizontal and vertical) for the CSD and NED can be accommodated by the approximately minimum 13 ft of freeboard (incl. flood storage) and minimum 1,700 ft pond set-back as of May 2015. As identified in Section 3.1, if investigations currently underway locate weak

glaciolacustrine layers, the potential for seismic loading to trigger undrained behaviour in the foundation should be investigated, including potential deformations.

*f. Provisions and contingencies that are in place to account for wet years*

- ◆ The TSF is designed to store the 30 day PMF (about 14 Mm<sup>3</sup>). Required flood storage was available as of the end of the 2015 freshet, but the pond is near the maximum normal operating level which, if surpassed, would encroach on the flood storage and freeboard. Gibraltar is discharging as allowed by permit to maintain the pond below the maximum normal operating level.
- ◆ Gibraltar can transfer approximately 20,000 USGPM to Granite Pit via the reclaim water system if required during an emergency.

### **3.3 Task 3 - Filter Adequacy**

*a. Including the beach width and filter specifications necessary to prevent potential piping*

The gradation of the CSD cycloned sand (RKL 1971b) is adequate to meet filter compatibility between cycloned sand and the foundation soils, and between the upstream tailings and the cycloned sand, based on US Army Corps of Engineers (USACE 2004) criteria.

The beach width is currently at least 4,500 ft between the pond and the crest of the CSD (KCB 2015a).

The CSD was constructed with finger drains beneath the downstream shell of the dam. The finger drains have been filling with cycloned sand since 1985. The current dam design does not rely on the finger drains for stability and the OMS manual provides direction to cap the ends of the finger drains, as required, with filter sand and gravel to halt any migration of sand that reports to the drain outlet. Therefore the performance of the finger drains is not considered to affect dam safety and is not identified as a gap.

*b. Whether or not the filter has been constructed in accordance with the design*

The as-built gradations of the cycloned sand and the sand and gravel filter are in accordance with design.

*c. If any gaps have been identified, a plan and schedule for addressing these issues*

No gaps have been identified in this review.

## 4 NORTH EARTHFILL DAM

### 4.1 Task 1 - Review of Foundation Conditions “Undrained shear failure of silt and clay foundations”

- a. *Including a determination with respect to whether or not similar foundation conditions exist below the dams on your site*

No, similar foundation conditions do not exist beneath the NED. A clay layer was found (KCB 2013a), but it did not have a laminated structure and was much stiffer than the upper glaciolacustrine unit found at Mount Polley (IEEIRP 2015).

- ♦ Two site investigations comprised of test pits, excavation mapping, and laboratory testing show the NED foundation is dense glacial till (KC 1997, KL 1990).
- ♦ Drilling intersected very stiff to hard clay with trace to some sand and gravel, interpreted to be glacial till (KCB 2013a).

- b. *Whether or not sufficient site investigation (boreholes, etc.) has been completed to have confidence in this determination*

The original design assumed a massive dense glacial till foundation and investigations comprised mainly of test pits were considered appropriate (KC 1997, KL 1990). In light of recent findings at Mount Polley (IEEIRP 2015) and recent experience by KCB at other mine sites, thin glaciolacustrine layers may exist within dense till, and could control the stability of the embankment if continuous, widespread, and at shallow depth.

The presence of continuous and widespread glaciolacustrine layers is considered very unlikely based on the existing site investigation data (KCB 2013a, KC 1997, KL 1990).

- c. *If present, whether or not the dam design properly accounts for these materials*

Stability analyses confirm the NED has adequate stability even assuming the presence of a weak glaciolacustrine layer located immediately below the known depth of dense till.

- d. *If any gaps have been identified, a plan and schedule for additional sub-surface investigation*

No gaps have been identified in this review.

### 4.2 Task 3 - Filter Adequacy

- a. *Including the beach width and filter specifications necessary to prevent potential piping*

The NED embankment and drain designs meet the filter criteria outlined in US Army Corps of Engineers (USACE 2004), and are adequate to meet filter compatibility between the fine grained dam fill and the sand and gravel drainage blanket, and between the sand and gravel drainage blanket and the coarse sand and gravel toe drains.

- ♦ The NED is a homogenous earthfill dam constructed of glacial till (borrow), with a sand and gravel drainage blanket and toe drains in required areas.
  - ♦ Where the phreatic surface has been observed to be above the toe of the dam, inverted filters composed of sand and gravel have been constructed on the downstream face of the dam.
  - ♦ The NED currently has a 1,700 ft wide beach. The Step-Back Embankment is under construction and will further widen the beach.
  - ♦ The NED was originally designed as a water retaining structure, and does not require a beach.
- b. *Whether or not the filter has been constructed in accordance with the design*
- ♦ The as-built gradations of the fine-grained dam fill and the sand and gravel filter are in accordance with design.
- c. *If any gaps have been identified, a plan and schedule for addressing these issues*
- No gaps have been identified in this review.

## 5 EAST SADDLE DAM

### 5.1 Task 1 - Review of Foundation Conditions “Undrained shear failure of silt and clay foundations”

- a. *Including a determination with respect to whether or not similar foundation conditions exist below the dams on your site*

No, similar foundation conditions do not exist beneath the ESD.

- ♦ Site investigations comprised of boreholes, test pits, excavation mapping, and laboratory testing show the ESD foundation to be sandy clay till with trace to some gravel (glacial till), low plastic, moist, massive, typically firm to stiff, overlying bedrock (KCB 2015b, 2015c, 2015d, 2013a, 2013b, 2010, 2008, KC 1998).
- b. *Whether or not sufficient site investigation (boreholes, etc.) has been completed to have confidence in this determination*

The site investigations adequately characterize the foundation of the ESD.

- ♦ Boreholes and test pits at the ESD provide good spatial coverage and full depth to bedrock.
- ♦ Investigations provide several methods of characterizing the foundation soils, including continuous core, penetration resistance through SPT, laboratory index testing, and surface exposure mapping.



*c. If present, whether or not the dam design properly accounts for these materials*

Weak glaciolacustrine sediments were not found beneath the ESD. Future raises of the ESD will require additional site investigations of foundation materials in areas that become incorporated into the dam footprint.

*d. If any gaps have been identified, a plan and schedule for additional sub-surface investigation*

- ◆ No gaps have been identified in this review.

## **5.2 Task 3 - Filter Adequacy**

*a. Including the beach width and filter specifications necessary to prevent potential piping*

The ESD embankment and drain designs satisfy the filter requirements outlined in US Army Corps of Engineers (USACE 2004). The ESD is designed as a water retaining structure, and does not require a beach.

- ◆ The ESD is a homogenous earthfill dam constructed of glacial till, with a sand and gravel drainage blanket and a high capacity toe drain encased in the drainage blanket at the valley bottom.
- ◆ Grain size specifications are adequate to meet filter compatibility between the fine grained dam fill and the drainage blanket, and between the drainage blanket and the toe drain.

*b. Whether or not the filter has been constructed in accordance with the design*

- ◆ Annual construction reports indicate acceptable material gradations.

*c. If any gaps have been identified, a plan and schedule for addressing these issues*

- ◆ No gaps have been identified in this review.

## 6 GAPS IN DATA AND ANALYSES

| GAP  | SCHEDULE TO ADDRESS  |
|--|--|
| Data on ground conditions below 10 m depth on flanks of CSD foundation | A site investigation program is underway, to be completed by the fall of 2015. |

## 7 CLOSING

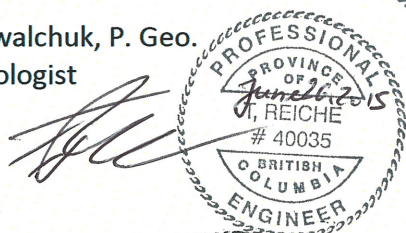
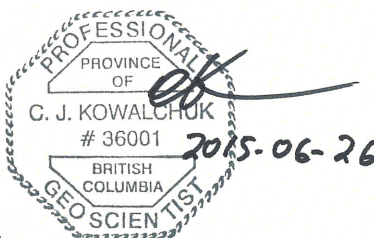
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Yours truly,

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## **APPENDIX I**

### **MEM Memorandum Issued February 3, 2015**

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February 3, 2015

To: Richard Tremblay, Mine Manager - Gibraltar-Gibraltar Mines Ltd.

As you know, the Expert Panel that was convened to examine the Mount Polley tailings dam breach has issued a report on their findings. This report has been made public and you may already be familiar with the conclusions of this report. Chief among these was the determination that the failure at Mount Polley was related to the presence of weak glacio-lacustrine soils in the dam foundation. The Panel also indicated that the severity of the consequence of failure was in large part owing to the quantity of stored water and the proximity of this water to the dam embankment (i.e. lack of beach). The Ministry of Energy and Mines (MEM) requires confirmation that the conditions that lead to the incident at Mount Polley are not present at other mines in B.C.

More specifically, you are required to undertake an assessment to determine if the dam(s) associated with your tailings storage facility/facilities may be at risk due to:

1. Undrained shear failure of silt and clay foundations;
  - a. Including a determination with respect to whether or not similar foundation conditions exist below the dams on your site,
  - b. Whether or not sufficient site investigation (drill holes, etc.) has been completed to have confidence in this determination,
  - c. If present, whether or not the dam design properly accounts for these materials, and
  - d. If any gaps have been identified, a plan and schedule for additional sub-surface investigation.
2. Water balance adequacy;
  - a. Including the total volume of surplus mine site water (if any) stored in the tailings storage facility,
  - b. The volume of surplus mine water that has been added to the facility over each of the past five years,
  - c. Any plans that are in place or that are under development to release surplus mine water to the environment,
  - d. Recommended beach width(s), and the ability of the mine to maintain these widths,
  - e. The ability of the TSF embankments to undergo deformation without the release of water (i.e. the adequacy of the recommended beach width),
  - f. Provisions and contingencies that are in place to account for wet years, and
  - g. If any gaps have been identified, a plan and schedule for addressing these issues.

3. Filter adequacy;
  - a. Including the beach width and filter specifications necessary to prevent potential piping,
  - b. Whether or not the filter has been constructed in accordance with the design, and
  - c. If any gaps have been identified, a plan and schedule for addressing these issues.

The Ministry is cognizant of the demands that were placed on your company by the Chief Inspector's Orders of August 18, 2014, and does not wish to place any additional undue burdens on your company. However, the previous Orders were issued before the mechanism of failure was known. Consequently, you are asked to provide a letter of assurance to respond to the items listed above. The letter is to be prepared and sealed by a qualified professional engineer, and is to be submitted to the Chief Inspector of Mines by June 30, 2015. To facilitate MEM's review, you are asked to maintain the above numbering system in your response to each item.

It is envisioned that the above items would best be addressed through a fulsome review of existing information. Where this information has not been compiled, it will be necessary to conduct a review of historical information to determine if any gaps remain in the understanding of the relevant conditions for the tailings storage facility dams on your site. Where appropriate, follow-up actions shall be identified that will be taken to address any opportunities for improvement.

Documents supporting the letter of assurance shall be maintained on-site and shall be made available to any Inspector of Mines upon request.

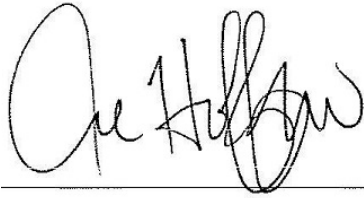
It should be noted that the Panel made a number of additional recommendations in Chapters 9 and 11 of their January 30, 2015 *Report on Mount Polley Tailings Storage Facility Breach*. MEM is in general agreement with all of the recommendations, and will be examining each of them to determine how they can be implemented over the coming weeks and months. You are asked to do the same.

Specifically, in your response, please also provide the following information in order to inform an Action Plan on implementation of other Panel Recommendations:

- Is your mine implementing the "Toward Sustainable Mining" initiative of the Mining Association of Canada? Are there any plans to do so?
- Does your mine have an Independent Tailings Dam Review Board (ITRB) in place? Is one planned?

Thank you for your prompt attention to these matters,

Regards,

A handwritten signature in black ink, appearing to read 'Al Hoffman', written over a horizontal line.

Al Hoffman, P. Eng.  
Chief Inspector of Mines  
Ministry of Energy and Mines

Cc: Diane Howe, Deputy Chief Inspector, Reclamation and Permitting, MEM  
George Warnock, Manager, Geotechnical Engineering, MEM  
Heather Narynski, Sr. Geotechnical Inspector, MEM