REPORT

November 21, 2014

INDEPENDENT REVIEW OF 2014 DAM SAFETY INSPECTION AND REVIEW REPORT

Trojan Dam Tailings Storage Facility

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Executive Summary

Golder Associates Ltd. (Golder) was engaged by Teck Highland Valley Copper Partnership (HVC) to perform an independent review of the 2014 Dam Safety Inspection and Review report for the Trojan Dam Tailings Storage Facility produced by Klohn Crippen Berger Ltd. (KCB).

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014).

The scope of the review included the following:

- site visit by Mr. Terry Eldridge, P. Eng., on September 16, 2014, as part of a Tailings Review Board meeting at the HVC site, to visually observe the status and condition of the Trojan tailings dam; and
- review of the 2014 Annual Dam Safety Inspection and Review (DSI) report produced by KCB, reference 141107R-Trojan DSI Report, dated November 7, 2014 (KCB 2014).

The findings of Golder's review are as follows:

- The DSI report prepared by KCB addresses the elements required by the BC MEM (2012).
- The dam consequence classifications are appropriate.
- The report provides a comprehensive documentation of the status and performance of the tailings dam.
- The report provides a thorough description of the responses of the instrumentation over time.
- The report provides a list of recommended actions assigning priority and a timeline for implementation. None of the recommendations relate to high priority issues concerning dam safety.

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was engaged by Teck Highland Valley Copper Partnership (HVC) to perform an independent review of the 2014 Annual Dam Safety Inspection and Review (DSI) report produced by Klohn Crippen Berger Ltd. (KCB).

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014). This order states:

> *The mine manager must have the DSI reviewed by an independent qualified third party professional engineer from a firm that has not been associated with the tailings dam. The Independent Third Party Review of the DSI must also include a review of the dam consequence classification.*

The scope of the review included the following:

- site visit by Mr. Terry Eldridge, P. Eng., on September 16, 2014, as part of the Tailings Review Board meeting at the HVC site, to visually observe the status and condition of the Trojan tailings dams; and
- review of the 2014 Annual Dam Safety Inspection and Review (DSI) report produced by KCB, reference 141107R-Trojan DSI Report, dated November 7, 2014 (KCB 2014).

The KCB DSI report includes discussion of the performance of the seepage collection pond associated with the tailings dam (KCB 2014). As tailings dams are the focus of the BC MEM (2014) order, this independent review is restricted to the Trojan tailings dam.

The independent review is not a Dam Safety Review as defined in the *Dam Safety Review Guidelines* produced by the BC Dam Safety Section (BC MEM 2012), Section 5 of the Canadian Dam Safety Guidelines (CDA 2013) and in the *Professional Practice Guidelines – Legislated Dam Safety Reviews in BC* produced by the Association of Professional Engineers BC (APEGBC 2014).

2.0 BACKGROUND

2.1 Site Description

The Highland Valley Copper Mine, owned and operated by Teck Highland Valley Copper Partnership (HVC) is located near Logan Lake, BC about 45 kilometres south of Kamloops. The Trojan Dam Tailings Storage Facility (TSF) is located to the northeast of the Highland Valley mill site, on the north side of Highway 97C. The TSF comprises the Trojan dam along the south side of the TSF and the Bethlehem No. 1 dam on the east side. The Trojan TSF was constructed along approximately the north half of the No. 1 dam and the Trojan tailings now support the downstream face of this section of the No. 1 dam.

The Trojan dam was constructed from 1973 to 1987. Tailings deposition stopped in 1989 and reclamation of the TSF was started in the early 1990's. Trojan pond now supports a varied aquatic ecosystem including trout.

The Trojan Dam starter dam was a rockfill structure and was raised as an upstream constructed cycloned sand dam. The dam has a nominal crest elevation of 1441.5 m, giving a nominal height of 71 m.

A spillway was constructed in the right abutment of the dam in 1996 and controls the water level in the impoundment. The invert of the spillway is at elevation 1435.5 m.

2.2 Engineer of Record

Design of the Trojan TSF was carried out by Gepac Consultants Ltd. in 1973. Klohn Leonoff Limited, a predecessor to KCB took over the design in 1981. KCB is now the Engineer of Record for the Trojan Dam.

The preparation of this report by Golder does not impact the Engineer of Record role held by KCB.

3.0 INDEPENDENT REVIEW OF DAM SAFETY INSPECTION REPORT

3.1 Compliance with Ministry of Energy and Mines Requirements

The requirements for DSIs are presented in *Guidelines For Annual Dam Safety Inspection Reports* (BC MEM 2012). Table 1 summarizes the compliance or otherwise of the KCB DSI report with the BC MEM requirements.

Table 1: Compliance of Dam Safety Inspection Report with British Columbia Ministry of Energy and Mines Dam Safety Inspection Requirements

Requirement	Included	Comment
Executive Summary Classification of the dam(s) in terms of Consequence of Failure in accordance with Table 2-1 of the CDA Dam Safety Guidelines (2013). a. Significant changes in instrumentation and/or visual monitoring records. b. Significant changes to dam stability and/or surface water control. c. 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. d. 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. e. Scheduled date for the next formal Dam Safety Review in accordance with Table 5-1 of the CDA Dam Safety Guidelines (2013). 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.	 ✓ ✓ ✓ ✓ ✓ ✓	 Very High Dec 2013 Dec 2013 2018
Summary of past years' construction (if any) with a description of any problems and stabilization	✓	No tailings deposition since 1989. Maintenance of downstream slope near right abutment
Plan and representative cross-sections	✓	
Site photographs	✓	
Review of climate data	✓	
Water balance review	✓	
Freeboard and storage availability (in excess of the design flood)	✓	
Water discharge system, volumes, and quality	✓	Water quality reported by HVC
Seepage occurrence and water quality	✓	Water quality reported by HVC
Surface water control and surface erosion	✓	
Instrumentation review including: (a) Phreatic surfaces and piezometric data (b) Settlement (c) Lateral movement	 ✓ ✓ ✓	

3.2 Dam Consequence Classification

Tailings dams in British Columbia are regulated under the Health, Safety and Reclamation Code for Mines in British Columbia 2008, which references Canadian Dam Association (CDA) Dam Safety Guidelines (CDA 2013).

Consequence categories are based on the incremental losses that a failure of the dam might inflict on downstream or upstream areas, or at the dam location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. The classification assigned to a dam is the highest rank determined among the loss categories.

Table 2 presents the dam classification criteria by CDA (2013).

Table 2: Dam Classification in Terms of Consequences of Failure

Dam Class	Population at Risk[a]	Incremental Losses		
		Loss of Life[b]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short term loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transport routes.
High	Permanent	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent	100 or fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: CDA (2013).

a) Definition for population at risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

b) Implications for loss of life:

Unspecified – The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

A dam break and flood inundation study was carried out by AMEC for the Trojan Dam TSF (AMEC 2014). The results of this study were reviewed in order to define the dam consequence classification for the Trojan tailings dam. On this basis, the dam classification is as shown in Table 3.

Table 3: Dam Consequence Classification – Golder Interpretation

Dam	Population at Risk	Incremental Losses			Dam Consequence Classification
		Loss of Life	Environmental and Cultural Values	Infrastructure and Economics	
Trojan	Public - Temporary Only	Unspecified	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	Temporary closure of Highway 97C. High economic losses affecting infrastructure, public transport, and commercial facilities.	High
	HVC Employees - Permanent	10 or fewer – Workers in Valley Pit will not be concentrated in the flow path and can move to higher ground within the pit	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	Temporary shutdown of Valley Pit and HVC milling operations Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).	Very High

KCB have assigned a dam consequence classification of Very High to the Trojan tailings dam. The dam consequence classification typically influences the selection of the design earthquake, design flood event and the frequency for Dam Safety Reviews. KCB reviewed the dam design in 1996 based on a consequence classification of High. KCB have recommended that the design be reviewed considering the updated consequence classification. KCB recommends that a Dam Safety Review be performed every five years, consistent with the CDA recommendations for Very High consequence dams.

4.0 FINDINGS AND RECOMMENDATIONS

4.1 General Findings

The general findings of Golder's review are as follows:

- The DSI report prepared by KCB addresses the elements required by the BC MEM (2012).
- The dam consequence classifications are appropriate.
- The report provides a comprehensive documentation of the status and performance of the tailings dams.
- The report provides a thorough description of the responses of the instrumentation over time.
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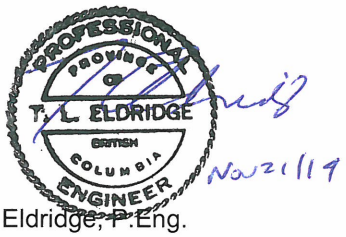
5.0 REPORT CLOSURE

We trust that this Independent Review of the 2014 Annual Dam Safety Inspection and Review Report of the Trojan Dam Tailings Storage Facility meets your requirements. Please contact the undersigned if you require additional information regarding this review.

GOLDER ASSOCIATES LTD.



Nov 21/14

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Principal, Senior Engineer

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