APPENDIX XII

Excerpts from

Dam Safety Assessment, Mount Nansen Tailings Facility near Carmacks, YT

EBA Engineering Consultants Ltd
May 2002

Table 1: Mount Nansen Tailings Facility Design Criteria and As-built Information[1]

Component	General	Details
Main Dam (Dam 1)	Seismic Review at Closure; 1 L/sec seepage after freezeback; can accommodate 0.6 m of crest settlement and complete thawing of foundation.	Sand fill, 2.5:1 U/S, 3.5:1 D/S; 6 m crest width, crest 1151.5 m, 20 m U/S berm at 1141 m, U/S GCL, 18.5 m maximum height, minimum 300 mm of gravel surfacing on U/S and D/S slopes and 500 mm on Crest, 50 m wide tailings beach.
Downstream Toe Berm (Dam 1)	Emergency Toe Berm constructed in July/August 1997 to control piping activity at toe of dam. Field designed by EBA and constructed in stages by mine operator without full geotechnical supervision.	4:1 slope with 7 m wide crest at 1141 m. Layered construction including: sand bedding (0.1 to 0.8 m), non-woven geotextile, clean placer gravel (0.3 m to 0.6 m), and rockfill and/or ripped residual soil shell for remainder. Cut off trench and drain installed at toe of berm.
Original Seepage Control Dam (Dam 2)	Designed to intercept seepage from Dam 1 with anchored GCL in permanently frozen ground.	Sand fill, design 3.5:1 U/S & D/S, 5 m crest width, 1130 m crest, U/S GCL; 300 mm gravel surfacing ; Actual 3.3:1 U/S, 3.1:1 D/S, 7 m crest width, 300 mm gravel surfacing U/S, 1 m average thickness gravel surfacing D/S.
Rebuilt Seepage Control Dyke (Dam 2)	Original seepage control dyke replaced with new construction in November 2000. New dyke includes PVC arctic grade liner keyed into permafrost trench. Sand bentonite seal within trench and thermosyphon system to control refreeze permafrost in key trench.	Sand fill with surfacing gravel cover; 2.5:1 U/S and D/S; crest elevation of 1131 m; seepage control using PVC liner keyed into permafrost in a sand bentonite filled trench. Refreezing of key trench promoted by horizontal thermosyphons. Maximum height 4 m.
Instrumentation for Dams 1 and 2	Instrumentation for Dam 1 and 2 was installed in 1995 and 1996. Most of this original instrumentation was destroyed and/or malfunctioned by 1997. Additional instrumentation was installed for Dam 1 in 1998 and 1999. New instrumentation for Dam 2 was installed in 2001.	Dam 1: nine thermistor suites with a total 53 measurement beads; five piezometers suites with a total of 15 pneumatic piezometers; 43 settlement/displacement points (including 9 well casings); and one standpipe. Dam 2: three thermistor suites each with 16 thermistor beads and three 50 mm sampling wells.
Permanent Diversion	20 year peak flow at 6.4 m^3/s and 1.4 m flow depth.	3 m wide invert, 1.4 m depth, 0.1% grade, 300 mm grade liner, upstream elevation 1151.5 m, horizontal distance 360 m, crosses Dam 1 centreline at 1151.0 m.
Emergency Spillway	200 year peak flow, 3.7 m^3/s for 0.1% gradient section (flow depth 0.8 m) and 6.4 m^3/s for 10% grade section (flow depth 0.4 m)	1149.7 m intake, 5 m invert, 1.1 m depth at 0.1% from -55 m to +50 m D/S of Dam 1 centreline, 0.8 m depth at 10% +50 to +340 m D/S of Dam 1 centreline; erosion protection: 300 mm of surfacing gravel within 0.1% section; filter cloth and 750 mm surfacing gravel or placer gravel within 10% section.
Reservoir	240 000 m^3 original design capacity at Elev 1149.7 m prior to reservoir enlargement by excavation for borrow, actual maximum tailings elevation 1148.7 m.	Trees and shrubs mostly removed, haul roads left inplace, access road on north side and causeway to reclaim pump, upstream borrow areas increased capacity.
Water Licence	QZ94-004, Indian and Northern Affairs Canada	Licence expired December 31, 2001.
Design Document	Tailings Impoundment Final Design Report, Klohn-Crippen Consultants Ltd., August 1995	

[1] Table updated and amended from Klohn-Crippen Construction Report , December 1996

Based on the results of stability analyses, it is therefore concluded that

- The factor of safety of the critical dam section varies from 1.52 to 1.61 under current observed level of phreatic surface (groundwater level within the dam). This range of factor of safety is considered adequate under static conditions for dam stability.
- The factor of safety under the high level of phreatic surface could decrease to 1.36 and is considered inadequate for dam stability under permanent condition. The groundwater level at the toe berm is critical to the dam stability.
- The perspective of dam stability for the 5-year window (to 2005) can be viewed as similar or the same as for the current condition. Moreover, the worse case phreatic level scenario (slope breakout at Elev. 1135 m) was considered for the 2005 condition and was found to decrease the factor of safety from 1.34 to 1.23.
- Under the design seismic condition (MDE event), the risk of the dam failure along the liquefied foundation soil is considered to be high. The post liquefaction static factor of safety was calculated to be about 0.70 indicating an unstable slope condition.

The above conclusions with regard to the stability of the dam do not address any potential safety issues associated with piping due to excessive underground water seepage. Moreover, they are based on assumed soil strength parameters. Actual parameters are likely to vary above or below those used in this assessment, although the range of values for the native sand is supported by empirical correlations to cone penetration resistance[2]. It should also be noted that the analysis using the "slope break out" phreatic case does not account for any seasonal refreezing of the thawed foundation soils. The seasonal refreezing of the thawed soils is expected to produce the breakout seepage that has been observed near the south abutment, it is also expected to strengthen the otherwise "thawed" foundation soil zone of the dam. As always in limit equilibrium analyses, the factor of safety has some undefined level of uncertainty.

2 "Interpretation of Piezocone Test Data for Geotechnical Design", Soil Mechanics Series Nos. 157 & 158, University of British Columbia, September 1995.