Peter Lighthall, P.Eng
Consulting Geotechnical Engineer

Dankoe Mine

Report on 2014 Dam Safety Inspection of Tailings Storage Facility

Report prepared for
439813 BC Ltd.

December 4, 2014

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Consulting Geotechnical Engineer

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439813 BC Ltd.
1503-555 Jervis Street
Vancouver BC V6E 4N1

Attention: Mark Aplas

Dankoe Mine Tailings Disposal Facility
2014 Dam Safety Inspection

Dear Mr. Aplas

I am pleased to submit under cover of this letter the 2014 Dam Safety Inspection for the Dankoe Mine Tailings Disposal Facility.

Yours truly,

Peter C. Lighthall, P.Eng.
Consulting Geotechnical Engineer

3755 North Naramata Road
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EXECUTIVE SUMMARY

This report presents a Dam Safety Inspection (DSI) of the Dankoe Mine Tailings Storage Facility (TSF) made on November 20, 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.

Dankoe Mine TSF is located in the Similkameen Valley, about 10km south of Keremeos, BC. The TSF was formed by an upstream-constructed embankment, using coarse talus material to construct berms which were placed over the beach of spigoted tailings. The dam is about 1300 ft. (400m) in length, with a maximum height of about 100 ft. (30m). The Dankoe mill and TSF have been shut down since 1989.

The Dankoe TSF was found to be essentially unchanged since operations ceased in 1989. The dam has remained stable. Piezometers installed in the tailings beach upstream of the dam crest are all dry, indicating that the tailings deposit is fully drained by the underlying pervious alluvial fan materials. The tailings surface is dry and there is no indication that any significant amount of water ever ponds on the tailings surface.

Recommendations from the DSI are the following:

- The consequence classification of the dam is recommended as LOW. In spite of the dam being alongside Highway 3, there appears to be no viable mode of failure that would impact the highway, threaten public safety or have the potential for any cultural or environmental losses.
- Reclamation of the TSF should be completed, as a major step toward application to remove the facility from MEM's inventory of tailings dams. Remaining reclamation activities include removal of all the tailings piping from the TSF, completing placement of growth medium over the tailings surface, and grading the site to direct potential surface water flow away from the tailings surface. The reclamation work should be undertaken in consultation with the writer or other qualified tailings engineer.
- The requirement for annual dam safety inspections should be relaxed to every five years. The dam has remained incident-free without the benefit of dam safety inspections for the past 25 years so there would be little value in ongoing annual inspections.

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1 INTRODUCTION

This report presents the 2014 Dam Safety Inspection (DSI) for the Dankoe Mine tailings storage facility (TSF), in response to a request from the owner, Mr. Mark Aplas of 439813 BC Ltd.

Dankoe Mine was an underground silver mine, located on the eastern slope of the Similkameen Valley, about 8 km south of Cawston, BC, as shown on the Location Plan, Appendix I. Dankoe operated a 450 T/day mill and deposited tailings into its tailings storage facility (TSF) located alongside Highway 3.

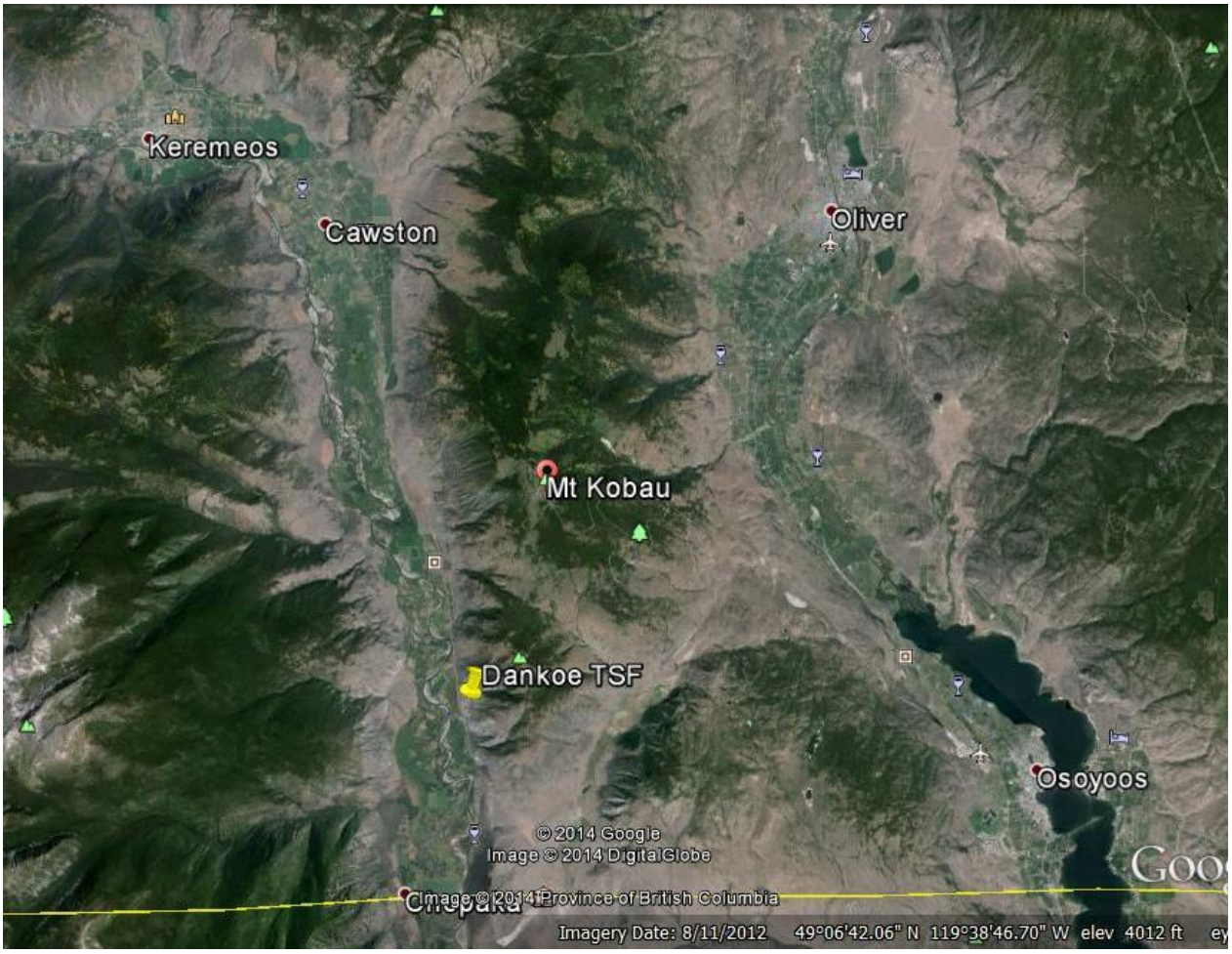


Figure 1. Location plan

Klohn Leonoff Consulting Engineers provided periodic geotechnical engineering services for the Dankoe TSF over its operating life. The most recent dam safety and design review reports were the following:

- 1983, Dankoe Mines Tailings Disposal System, Geotechnical Review Report
- 1989, Dankoe Mines Tailings Disposal System, Report on Geotechnical Review

- 1990, Design Review of Dankoe Mine Tailings Dam

The writer was a member of the Klohn Leonoff team that prepared the above reports and is well familiar with the site.

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

The report is presented using primarily Imperial units, for consistency with past reports and drawings.

2 FACILITY DESCRIPTION

The Dankoe tailings dam was formed by a series of rockfill dykes used to raise the TSF by upstream construction. The dam is about 1300 ft. in length, with a maximum height of about 100 ft. The crest elevation of the dam is between 1380 and 1382 ft. Tailings were spigoted along the crest of the dam to form a beach of coarse tailings, to provide support for successive placement of rockfill dykes for dam raising. The dam slopes are nominally 2.5 horizontal : 1 vertical. Views of the TSF are shown on photographs in Appendix III.

The tailings dam and TSF are aligned essentially north-south, situated parallel to Highway 3, with the toe of the dam within about 100 ft. of Highway 3. Figure 2 below shows the TSF.

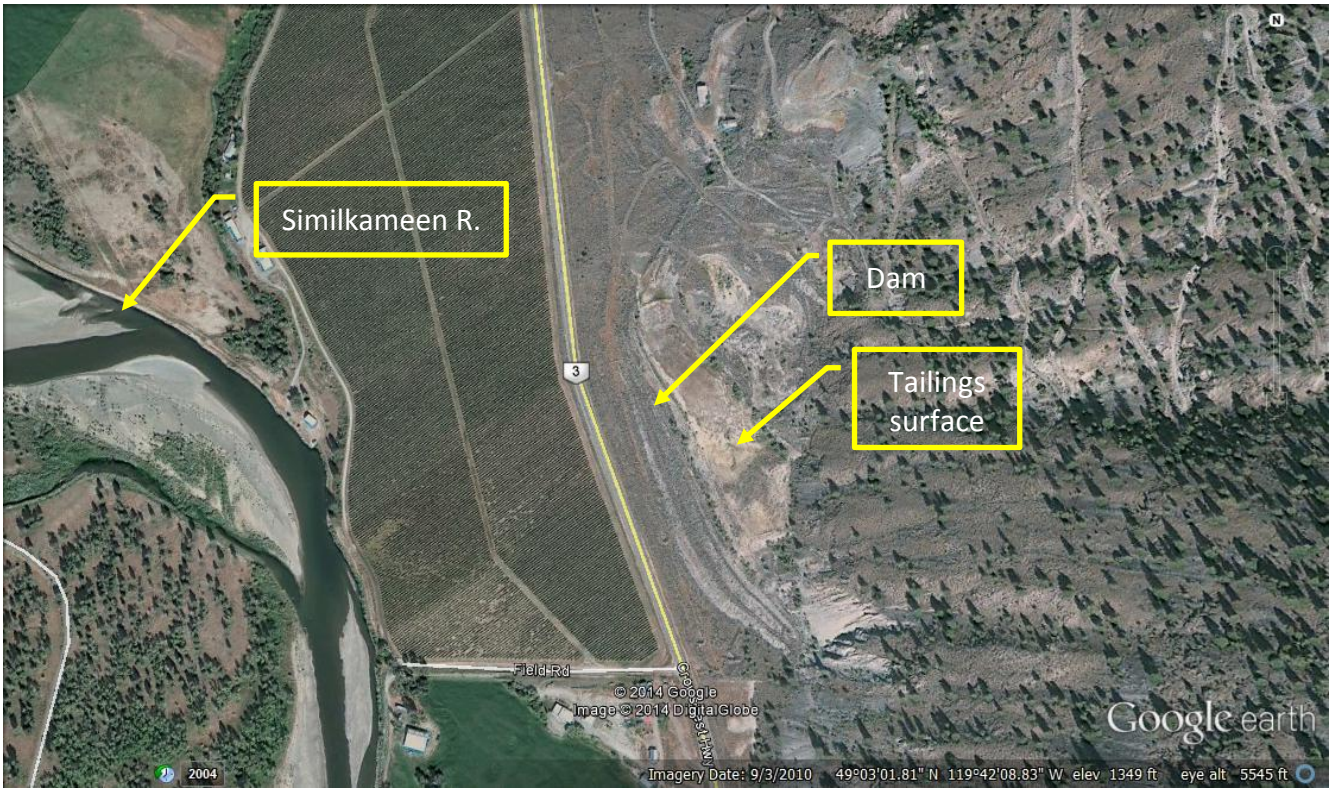


Figure 2. Photo of Tailings Dam and TSF

The Dankoe mill began operation in about 1967, with ore fed from the mine which was located high up on the mountain slopes above the mill and TSF site. Mining at Dankoe ceased in the early 1980's. During the latter years of the 1980's the mill was used sporadically for custom milling. The mill last operated in late 1989. In November 1989, the District Inspector of the Ministry of Energy, Mines and Petroleum Resources (MEMPR) pointed out that the TSF was full to its permitted capacity, and listed a number of items that needed to be addressed to fulfil requirements for approval for continued use of the TSF. Accordingly, Klohn Leonoff prepared the 1990 Design Review report. The 1990 study included a program of geotechnical drilling and piezometer installations, updated survey of the dam and TSF, stability analyses, and design of future raising of the dam. Klohn Leonoff drawings D-3001

and D-3002 showing the dam plan with piezometer locations and sections through the piezometer locations are included in Appendix II. The study concluded that the dam was stable, and that it could be raised 22 ft. to provide storage for an additional 250,000 tons of tailings. MEMPR granted the permit approval, but there has been no further use of the TSF since milling ceased in late 1989. The facility has remained essentially unchanged for the past 25 years.

There have been no formal dam safety inspections since 1990. The mine owners periodically submitted internal inspection letters, the most recent by the current property owner, 439813 BC Ltd., in 2011.

The Dankoe tailings dam is founded on an alluvial fan deposit at the base of a steep mountainside. The fan deposit consists of coarse sand and gravel, with some silt. Klohn Leonoff (1990) describes clean, highly pervious gravels encountered at a depth of 50 ft. below the fan deposit, probably deposited by the Similkameen River. The fan deposit and underlying gravels form a dense, free-draining foundation beneath the TSF. The south abutment of the dam and the back of the tailings pond contact a talus deposit that contains fine to coarse rock, even more pervious than the underlying fan and gravels.

3 2014 SITE INSPECTION

Peter Lighthall, P.Eng., accompanied by Mr. Mark Aplas of 439813 BC Ltd., visited the Dankoe site on November 20, 2014 for a site inspection. During the site inspection, all standpipe piezometers were sounded to determine water levels. Key observations of the site inspection were as follows:

- The TSF appears to be essentially undisturbed since tailings disposal operations were suspended in 1989. Tailings delivery lines remained in place along the crest of the dam.
- All standpipe piezometers (total 9) were found to be intact, most with caps in place. All piezometers were found to be dry to their tip elevations.
- Approximately the northerly half of the tailings surface has been covered with gravelly soil as a growth medium and is developing natural vegetation of grasses and sagebrush. Tailings remain exposed on the southern part of the TSF and have sparse growth. There is no evidence of any wind erosion or dusting from the tailings surface.
- The rockfill berm forming the dam crest remains intact. The freeboard between the tailings surface and the top of the berm was estimated at 4 to 5 ft. At the south portion of the embankment, the berm is lower, with about 3 ft. of freeboard.
- The tailings surface was completely dry, and there was no indication that there has been any ponded water in recent years.
- The downstream slope, comprised of coarse talus material, appears stable with no signs of any deformation. There is considerable growth of sagebrush, grasses and some trees on the slope.
- No seepage was observed.
- There was no indication of oxidation or geochemical weathering.

4 TAILINGS DAM STABILITY

Klohn Leonoff (1990) carried out stability analyses of the Dankoe tailings dam, both for its then current crest elevation and for a 22 ft. raise. The stability analyses applied conservative piezometric water elevations, based on operating conditions. The analyses determined that the dams had adequate factors of safety, under both static and earthquake conditions. The analysis is shown on their Drawing D-3006 in Appendix II.

The present crest elevation and dam geometry are unchanged from that analyzed by Klohn Leonoff, and piezometric elevations are lower, as evidenced by all piezometers being dry. Hence, it can be concluded that the dam remains stable.

5 CLIMATE DATA

The Environment Canada website was used to provide the summary in Table 1.1 below of precipitation data from the Keremeos weather station, about 10km north of the Dankoe site. As can be seen from the data, the site is in a dry area, with average annual precipitation of 325.5 mm (12.8 in.). The extreme recorded daily rainfall was 45.8mm, or 1.8 in. This value for extreme daily rainfall is consistent with Klohn Crippen, 1990, which selected a value of 2 in. for a 200-year, 24 hour rainfall.

Table 5-1 Keremeos Precipitation data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	10.5	13.0	18.2	21.8	33.8	39.5	29.7	24.8	14.6	18.6	22.5	9.6	256.6
Snowfall (cm)	21	10	1	0	0	0	0	0	0	0	9	27	69
Precipitation (mm)	31.8	22.8	19.5	21.8	33.8	39.5	29.7	24.8	14.6	19.0	31.8	36.5	325.4
Extreme Daily Rainfall (mm)	15.0	19.1	17.5	19.6	**45.8**	29.0	31.0	24.8	18.6	22.4	31.5	15.7	
Extreme Daily Snowfall (cm)	26	**37**	23	0	0	0	0	0	0	8	18	31	
Extreme Daily Precipitation (mm)	26.0	36.8	22.9	19.6	**45.8**	29.0	31.0	24.8	18.6	22.4	31.5	31.0	

6 FLOOD STORAGE

The TSF lies below a steep mountain slope, partly on an alluvial fan and partly on a talus deposit. The catchment area was estimated by Klohn Leonoff (1990) to be 65.7 ha. They calculated the rainfall from a 24 hour, 200-year return period rainfall event of 2 in. (50mm), to be 26,000m^3. They assumed total runoff after seepage in the catchment to be 22,000 m^3, which would result in a flood depth in the TSF of 3 ft., and recommended that a total freeboard of 5 ft. be maintained above the tailings surface to provide flood freeboard.

It is uncertain how the net runoff amount was calculated. Anecdotal evidence (personal communication from Mark Aplas) suggests that no surface water has ever been observed reaching the TSF, since all runoff enters the coarse alluvial and talus deposits upslope of the TSF. This observation is confirmed by the absence of any evidence of high water marks in the TSF.

Based on the site evidence, it is likely that even under design maximum precipitation conditions there will be at most a small runoff amount reaching the TSF surface. The current freeboard of 4 to 5 ft. will be ample to avoid overtopping the main embankment.

The southern portion of the dam crest is lower over a length of about 30 ft., with a freeboard above the tailings surface of about 3 ft. In the unlikely event of a large water accumulation in the pond, this low area would form a spillway. It is adjacent to the talus slope at the south end of the pond. There is an excavated depression below the toe of the slope in this area which would serve as an infiltration basin for any water flowing over the spillway.

7 DAM CLASSIFICATION

The TSF classification has been evaluated according to the 2013 CDA Dam Safety Guidelines and the 2014 CDA Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams. The CDA classification guidelines are summarized in Table 7.1.

Table 7-1 Dam Classification

Dam class	Population at risk	Incremental losses		
		Loss of life	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 services.
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 transportation 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 transportation, 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)

No dam classification has been previously assigned to the Dankoe TSF. In reviewing the potential incremental losses of a dam failure, the potential for failure and the resulting inundation need to be considered. The Dankoe TSF has remained stable for 25 years. In reviewing dam stability and flood

considerations, there appear to be no viable modes of failure that would result in any loss of tailings or water. Even though the toe of the dam is within 100 ft. of Highway 3, a well-traveled highway, there is no potential for inundation of the highway given the proven stability of the embankment. Likewise, there appear to be little potential for environmental or cultural losses. It is concluded that a dam classification of LOW is appropriate for the Dankoe TSF as long as it remains in a non-operational mode. There is little likelihood that the TSF will ever again be operational.

8 CONCLUSIONS AND RECOMMENDATIONS

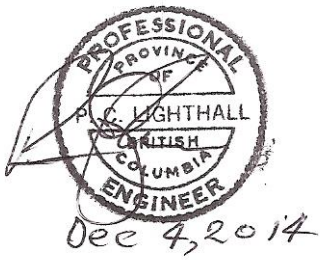
The Dankoe TSF was found to be essentially unchanged since operations ceased in 1989. The dam has remained stable. Piezometers installed in the tailings beach upstream of the dam crest are all dry, indicating that the tailings deposit is fully drained by the underlying pervious alluvial fan materials. The tailings surface is dry and there is no indication that any significant amount of water ever ponds on the tailings surface.

Recommendations from the DSI are the following:

- The consequence classification of the dam is recommended as LOW. In spite of the dam being alongside Highway 3, there appears to be no viable mode of failure that would impact the highway, threaten public safety or have the potential for any cultural or environmental losses.
- Reclamation of the TSF should be completed, as a major step toward application to remove the facility from MEM's inventory of tailings dams. Remaining reclamation activities include removal of all the tailings piping from the TSF, completing placement of growth medium over the tailings surface, and grading the site to direct potential surface water flow away from the tailings surface. The reclamation work should be undertaken in consultation with the writer or other qualified tailings engineer.
- The requirement for annual dam safety inspections should be relaxed to every five years. The dam has remained incident-free without the benefit of dam safety inspections for the past 25 years so there would be little value in ongoing annual inspections.

9 CLOSING

Thank you for the opportunity to undertake this dam safety inspection of the Dankoe Mine tailings storage facility. I would be pleased to provide any additional information or clarification you may require.



Peter C. Lighthall, P.Eng.
Consulting Geotechnical 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

Klohn Leonoff, 1983. Geotechnical Review Report, Dankoe Mines Tailings Disposal System. Report prepared for Dankoe Mines Ltd., April 19, 1983.

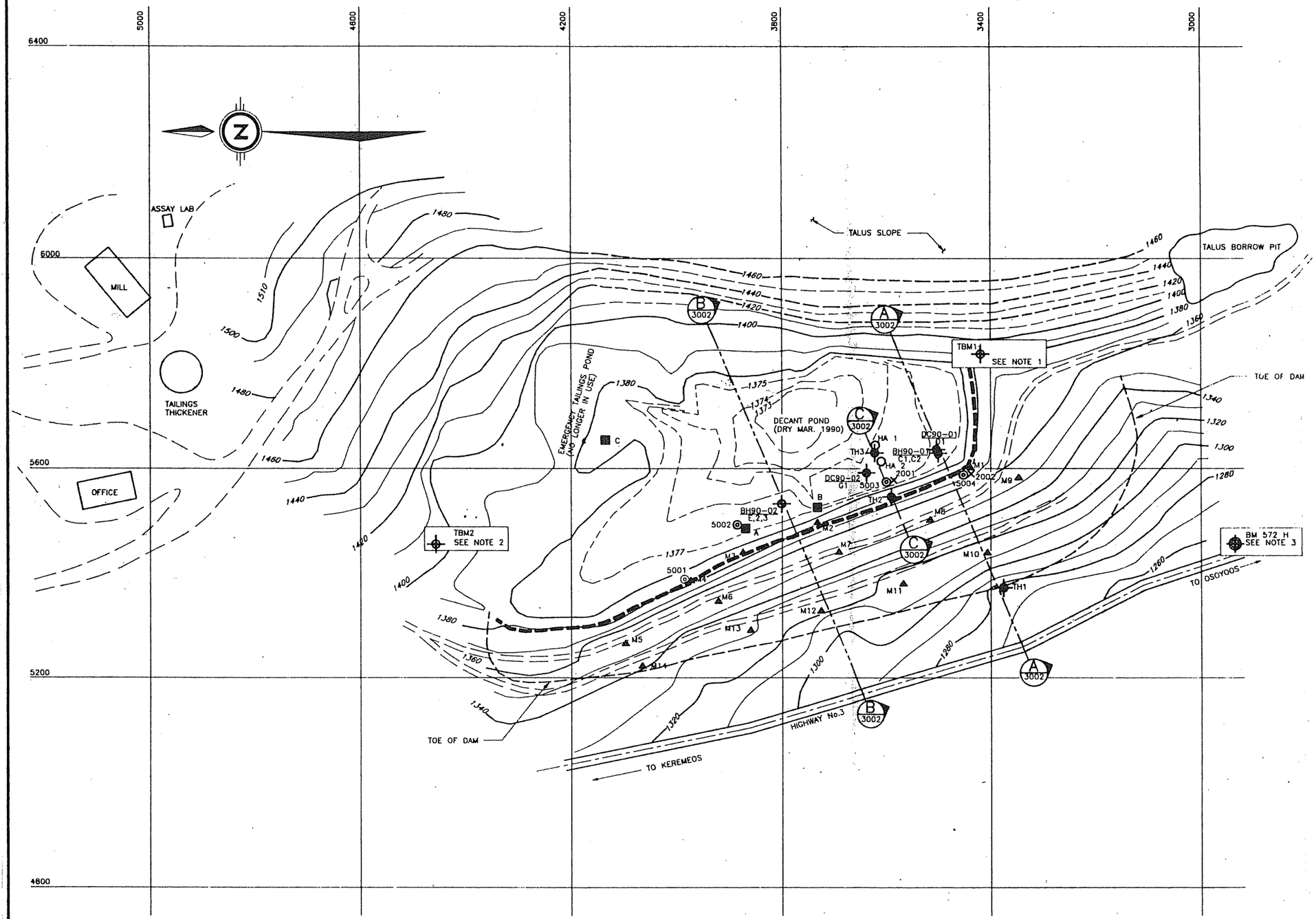
Klohn Leonoff, 1989. Geotechnical Review of Tailings Dam, Dankoe Mine. Report prepared for Skylark Resources Ltd., September 28, 1989.

Klohn Leonoff, 1990. Design Review of Dankoe Mine Tailings Dam. Report prepared for Dankoe Mines Ltd., May 11, 1990.

439813 BC Ltd., 2011. Annual Dam Safety Inspection Report - 2010. Letter report to BC Ministry of Energy and Mines, March 31, 2011.

APPENDIX I

Figures



LEGEND

HA 1	HAND AUGER HOLE (1970)
5001	PIEZOMETER INSTALLATION (1970)
2001	PENETRATION TEST (1970)
	CREST OF DAM (MAR. 1990)
	LOCAL ROADS
TH1	TEST HOLE No. 1(1980)
A	PIEZOMETER A (1983)
DC90-01 / D1	DYNAMIC CONE HOLE 90-01(1990) CONTAINING PIEZOMETER D1
BH90-02 / E1,E2,E3	BOREHOLE 90-01(1990) CONTAINING PIEZOMETERS E1,E2,E3
TBM1	TEMPORARY BENCHMARK (SEE NOTES 1 & 2) (1990)
BM 572 H	BENCHMARK (SEE NOTE 3) (1990)
M1	SETTLEMENT MONUMENT NO.1(1990)

NOTES.

1. TBM1 3421.24 N 5818.81 E ELEV. 1391.46 ft
2. TBM2 4456.77 N 5453.13 E ELEV. 1405.80 ft
3. BM 572H 2940.00 N 5452.00 E ELEV. 1257.396 ft
4. CONTOURS ARE SHOWN IN 10' INTERVALS, EXCEPT WHERE INDICATED ON TAILINGS SURFACE.
5. POSITIONS OF 1970, 1980 EXPLORATION HOLES ARE ESTIMATED.
6. LOCATION OF MILL BUILDINGS AND LOCAL ROADS ARE APPROXIMATE

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — R. G. TOOMBS

TO BE READ WITH KLOHN LEONOFF REPORT DATED MAY 11,1990

SCALE: 80 0 200ft

REV.	DATE	REVISION DETAILS

DESIGN | DRAWN CYW/CY | DATE | SCALE: AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

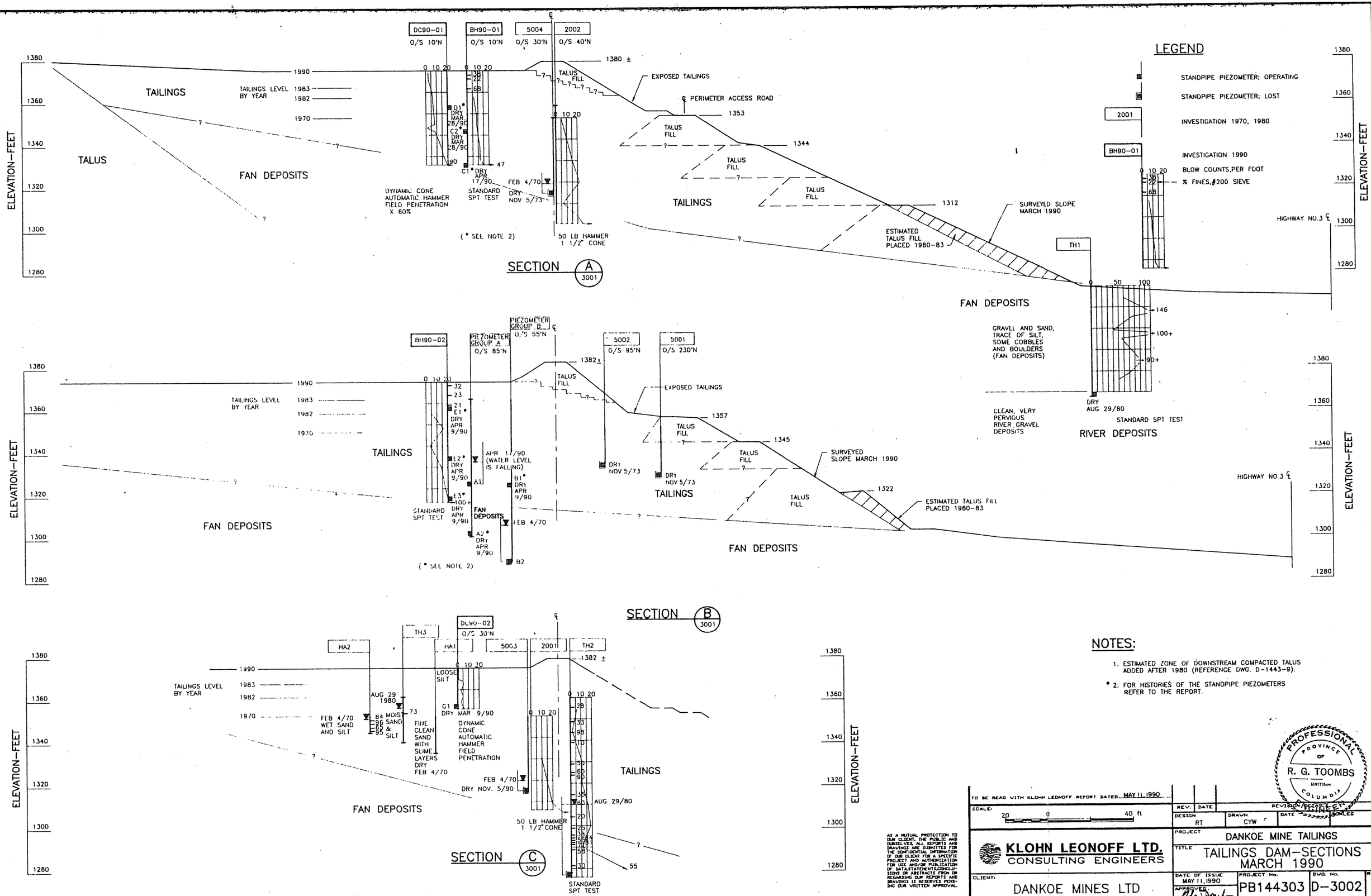
PROJECT: DANKOE MINE TAILINGS

TITLE: TAILINGS DAM — PLAN MARCH 1990

CLIENT: DANKOE MINES LIMITED

DATE OF ISSUE: MAY 11, 1990 | PROJECT No.: PB144303 | DWG. No.: D-3001 | REV.

APPROVED



NOTES:

1. ESTIMATED ZONE OF DOWNSTREAM COMPACTED TALUS ADDED AFTER 1980 (REFERENCE DWG. D-1443-9).
2. * FOR HISTORIES OF THE STANDPIPE PIEZOMETERS REFER TO THE REPORT.

TO BE READ WITH KLOHN LEONOFF REPORT DATED MAY 11, 1990

SCALE: 20 0 40 ft

REV.	DATE	REVISION

DESIGN RT | DRAWN CYW | DATE | CHECKED

PROJECT: DANKOE MINE TAILINGS

TITLE: TAILINGS DAM-SECTIONS MARCH 1990

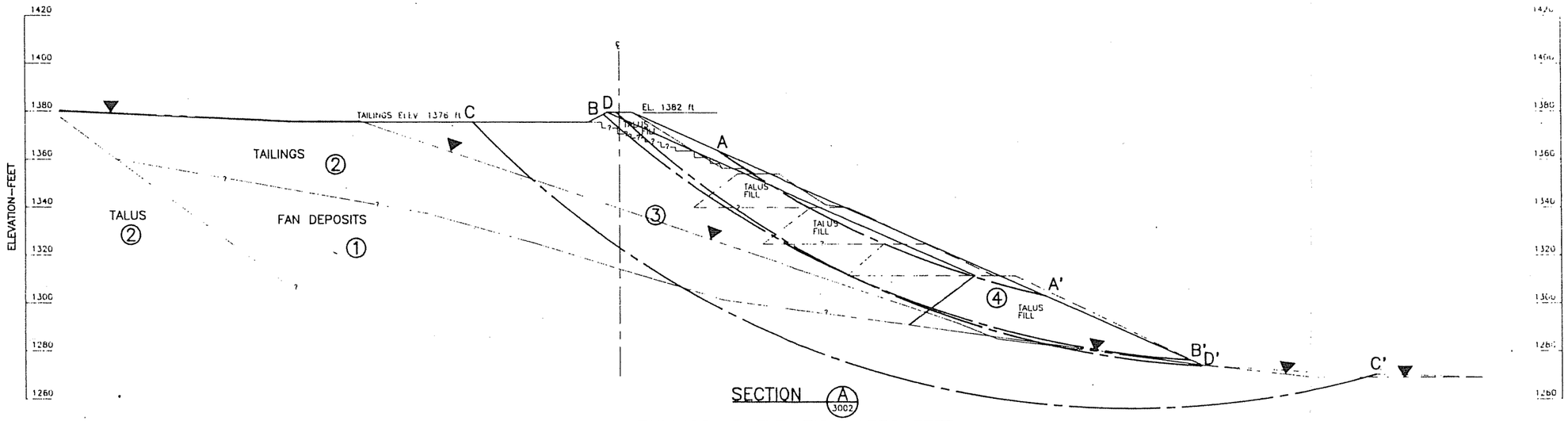
KLOHN LEONOFF LTD. CONSULTING ENGINEERS

CLIENT: DANKOE MINES LTD

DATE OF ISSUE MAY 11, 1990 | PROJECT No. PB144303 | DWG. No. D-3002 | REV.

APPROVED

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA R. G. TOOMBS



SECTION A (3002)

TAILINGS AT ELEVATION 1376 FEET

SUMMARY OF SOIL PROPERTIES

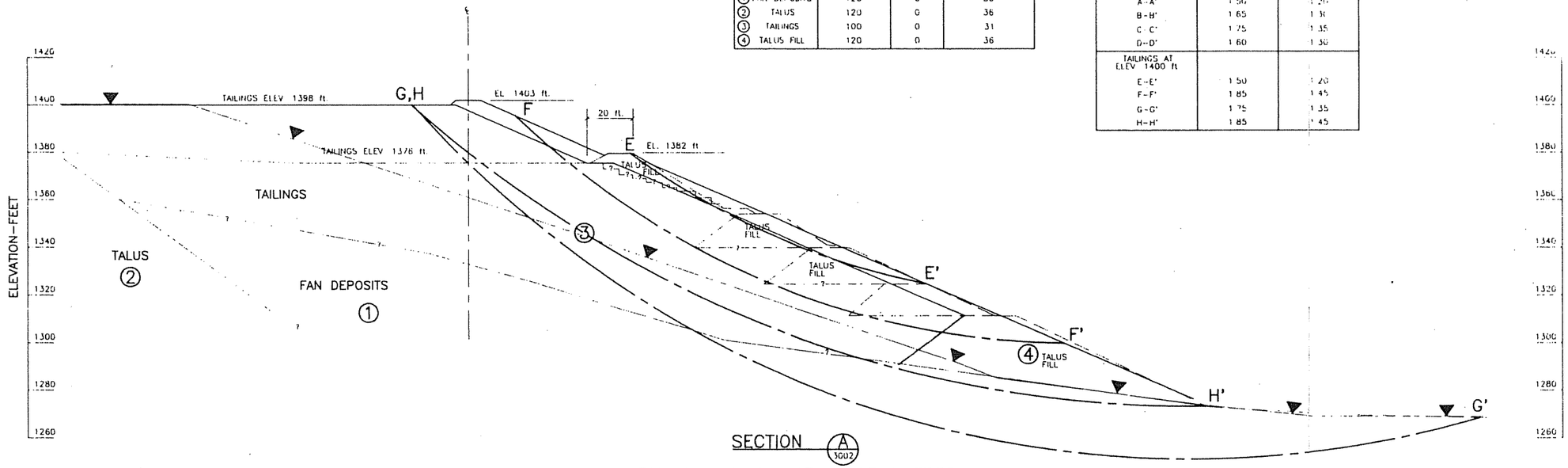
MATERIAL	MOIST DENSITY lbs/ft³	SOIL STRENGTH	
		STATIC & DYNAMIC	
		COHESION lbs./ft²	FRICTION ANGLE degrees
① FAN DEPOSITS	120	0	36
② TALUS	120	0	36
③ TAILINGS	100	0	31
④ TALUS FILL	120	0	36

SUMMARY OF STABILITY ANALYSIS

DESCRIPTION	FACTOR OF SAFETY	
	STATIC	DYNAMIC a=0.09g
TAILINGS AT ELEV 1376 ft		
A-A'	1.50	1.20
B-B'	1.65	1.30
C-C'	1.75	1.35
D-D'	1.60	1.30
TAILINGS AT ELEV 1400 ft		
E-E'	1.50	1.20
F-F'	1.85	1.45
G-G'	1.75	1.35
H-H'	1.85	1.45

NOTES:

1. STABILITY ANALYSES ARE BASED ON BISHOP'S METHOD OF SLICES LIMIT EQUILIBRIUM ANALYSIS



SECTION A (3002)

TAILINGS AT ELEVATION 1398 FEET

TO BE READ WITH KLOHN LEONOFF REPORT DATED MAY 11, 1990

SCALE: 20 ft 0 60 ft

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA R. G. TOOMBS

REV.	DATE	REVISIONS

DESIGN	DRAWN	DATE	SCALES
RT	DT	APR '90	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

PROJECT: DANKOE MINE TAILINGS

TITLE: TAILINGS DAM STABILITY ANALYSIS

CLIENT: DANKOE MINES LTD.

DATE OF ISSUE	PROJECT No	DWG No.	REV
MAY 11, 1990	PB144303	D-3006	

APPROVED

APPENDIX II

Photographs

Photo 1. View of TMF looking south. Similkameen River at top right

Photo 2. Crest of dam looking toward south abutment. Note standpipe piezometer on left

Photo 3. Downstream slope looking north. Highway 3 on left

Photo 4. View toward downstream slope, taken from the shoulder of Highway 3

Photo 5 Panorama of tailings surface, taken from southeast abutment

Photo 6. Tailings surface, taken from south dam crest looking north. Note standpipe piezometers.