KLOHN LEONOFF
CONSULTING ENGINEERS

Our File: PB 3169 0101

September 6, 1985

Brinco Mining Limited
2000 - 1055 West Hastings Street
Vancouver, British Columbia
V6E 3V3

Mr. Peter C. Jones
Executive Vice-President

Clinton Creek Asbestos Mine
Waste Dump and Tailings Pile
1985 Site Visit

Dear Sirs:

We are pleased to submit six copies of our report on the 1985 site visit to Clinton Creek. The report includes our observations on the waste dump and tailings piles and the results of the 1985 survey of monitoring points. The report recommends final abandonment of the Clinton Creek waste dump and tailings piles.

Yours very truly,

KLOHN LEONOFF LTD.

Peter C. Lighthall, P.Eng.
Project Manager

Encl.

SR/PCL/bl

REPORT ON 1985 SITE VISIT

PROJECT: CLINTON CREEK ASBESTOS MINE
WASTE DUMP AND TAILINGS PILES

LOCATION: CLINTON CREEK, YUKON TERRITORY

CLIENT: BRINCO MINING LTD.
CASSIAR DIVISION

OUR FILE: PB 3169 0101 SEPTEMBER 6, 1985

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LIST OF DRAWINGS

1. INTRODUCTION

This report summarizes the main observations and conclusions made during a site visit to Clinton Creek by Peter Jones of Brinco and Peter Lighthall of Klohn Leonoff Ltd. on June 19, 1985.

2. WASTE DUMP

2.1 GENERAL

The Clinton Creek waste dump was described in Klohn Leonoff's report on Mine Waste Dumps, dated August 16, 1983. The waste dump consists of argillite material placed across the valley of Clinton Creek during the years 1968 to 1978. The dump has blocked the valley to form a large dam that impounds Hudgeon Lake, which has a maximum depth of about 85 ft. The present channel of Clinton Creek occupies the north side of the valley where it has incised a channel bounded by waste dump material to the south and bedrock valley walls to the north. The waste dump is founded on a permafrost foundation and movements of the dump, in the order of a few feet per year, have been ongoing since completion of dumping in 1977. The stream channel is gradually downcutting at the interface between the bedrock on the left (north) bank and the waste dump material on the right bank. Erosion of the right bank occurs as the creep movement of the dump tends to squeeze the channel.

A riprap-ribbed erosion control section, designed by Golder Associates, was constructed in 1981 near the upper end of the channel. During spring runoff in 1982, the flow escaped from the rock-ribbed channel and eroded a new channel into fine-grained soils on the left bank.

Klohn Leonoff recommended remedial works to repair the channel in the following two reports.

1. Report on Mine Waste Dumps issued on August 16, 1983.
2. Report on 1984 Site Visit issued on August 23, 1984.

This remedial work was started in September 1983 and was completed in 1984.

2.2 OBSERVATIONS ON 1985 SITE VISIT

Clinton Creek was carrying a high flow at the time of the site visit and there appeared to be a generally high spring runoff. The flow was considerably higher than observed by the writer during two previous visits in June of 1983 and 1984.

The channel conveying Clinton Creek over the waste dump performed as expected over the past year. The channel protection works near the upstream end, completed by Brinco in 1984, performed well during spring runoff and appear to be successfully protecting the left bank from further erosion. The remaining rock weir at the lower end of the channel protection works also performed well. Photo 1 shows the channel protection works.

Some deepening of the Clinton Creek channel, downstream of the 1984 protection works had occurred through downcutting into the bedrock on the left bank. The ongoing process of oversteepening, toe erosion and slumping of the waste material into the stream continued. However, armouring of the stream bed with large rock fragments from the dump also continued. These large fragments serve to dissipate the energy of the stream and also provide erosion protection. Photos 2 and 3 show typical views of the downstream portion of the waste dump channel.

2.3 MONITORING RESULTS

Results of the June 1985 survey of movement monitoring stations on the waste dump are presented in Appendix II. Seven points on the waste dump were surveyed. Vertical and horizontal movements were determined for each of the seven points. In addition, movements of six channel closure sections were determined. The locations of monitoring stations are shown on Drawing D-1006A from the 1984 report, attached.

The rates of horizontal movement of five of the seven waste dump monitor points and all of the channel closure sections decreased from the rates measured in June 1984. The other two waste dump monitor points showed slight increases in the rate of horizontal movement. Horizontal movement rates, for the period from June 1984 to June 1985 ranged from 1.0 ft/yr to 1.8 ft/yr.

The rates of vertical movement of all seven waste dump monitor points decreased over the rates measured in June 1984.

The survey of the Clinton Creek waste dump channel profile could not be done because of the high streamflow at the time. This work should be done, if possible, during summer 1985.

3. WOLVERINE CREEK TAILINGS PILES

3.1 GENERAL

The Wolverine Creek tailings piles were formed by depositing approximately 10 to 12 million tons of dry, mainly serpentine material from the Clinton Creek millsite over the western slope of Wolverine Creek valley. The south tailings lobe was placed in the years 1968 to 1974, when a failure of the tailings pile occurred and a segment of the pile moved downslope and blocked Wolverine Creek, creating a small lake in the valley bottom. After the failure tailings deposition was relocated northward and tailings were placed in the north lobe from 1974 until mine closure in 1978. A rock-lined channel was installed in 1978 to convey Wolverine Creek over the failed portion of the south lobe. Survey monitors were installed on the tailings piles to monitor downslope movements. Portions of the tailings on the north and south lobes were excavated in 1978 in an attempt to stabilize the tailings piles, in accordance with recommendations by Golder Associates. Movements of the tailings piles have continued in spite of the stabilization measures. A further description of the tailings piles were presented in Klohn Leonoff "Report on Wolverine Creek Tailings Piles", January 16, 1984.

3.2 OBSERVATIONS ON 1985 SITE VISIT

The north lobe of the tailings pile continued large movements on the lower part of the slope. Photo 4 shows the movement of the north lobe into the lake formed by the south lobe. As the photo shows, the previously steep face at the toe flattened considerably as the pile moved into the lake. With this flattened toe, the potential for rapid failure of the north lobe appears to be reduced.

The toe of the south lobe continued to upthrust slightly and to squeeze Wolverine Creek against the left bank. However, an adequate channel remains intact to carry the stream across the south tailings lobe. Some minor erosion of the tailings is occurring at the toe. Photo 5 shows the channel at the toe of the south lobe.

3.3 MONITORING RESULTS

Results of June 1985 survey observations of monitoring points on the tailings piles are included in Appendix II. The trends shown by these movement observations are as follows:

1. On the north lobe, the rates of horizontal movement of five of the thirteen points surveyed decreased from the rates observed in June 1984. Six points showed some increase in rate of movement and one (650-2, which was not recorded in 1984) showed a decrease from the rate reported for June 1983. The maximum rate of movement was at point 350-3A, near the toe of the north lobe, which showed a movement rate of 75 ft/yr since June 1984. This is a significant reduction in the rate of movement for this same point of over 100 ft/yr between June 1983 and June 1984. (This was also the maximum rate of movement measured in June 1984.)

2. The rate of horizontal movement of five of the six points surveyed on the south lobe increased over the rates for previous years. One point 80-9 showed a slight decrease in the rate of movement.

Drawing D-1004B shows monitoring point locations and rates of movement from June 1984 to June 1985.

3.4 RECENT STUDIES

Subsequent to the 1984 site visit, three separate studies have been carried out with respect to this deposit. The results of those studies were presented as follows:

1. Flow capabilities of the erosion resistant channel on the downstream side of the south lobe, in a letter dated February 28, 1985.

2. Stability evaluation of the north lobe covered in a second letter dated February 28, 1985.

3. Sediment transport analysis of Wolverine Creek, Clinton Creek and the Forty Mile River including the channel across the tailings site in a report dated April 23, 1985.

The first study indicated that the channel would probably serve for a number of years, provided that flow does not bypass the channel due to deflection by the moving tailings lobes. However, the channel does have a limited capacity relative to a major, long return period, flood.

The second study indicated that the north lobe will continue to move and eventually close the valley bottom upstream of the present channel. At that time, an equilibrium state of erosion and continued movement will develop similar to that occurring at the south lobe. Steps may have to be taken when that occurs to prevent significant rerouting of the creek, particularly should it tend to interfere with the existing rock-lined channel across the south lobe. There will be some increased erosion resulting in more sand being transported through the riprapped channel and into the streams beyond.

The third study indicated that Wolverine Creek and upper Clinton Creek have a limited sand transporting capability relative to lower Clinton

Creek and the Forty Mile River, and that any sand that can be delivered by Wolverine Creek will not cause sand deposition in the lower streams. Fine and coarse gravel sizes on the other hand, will all be deposited in lower Wolverine and upper Clinton Creeks and will not be carried beyond a point about 1 to 2 miles downstream of the confluence between Wolverine and Clinton Creeks.

One major conclusion that can be drawn from a review of these three studies is that, even if Wolverine Creek should escape its present channel and start rapidly downcutting through the lobes of the tailings pile; or the lobes start moving faster thus increasing the sand available for erosion, there is a finite limit to how much will actually reach lower Clinton Creek or the Forty Mile River in any given year. This limit is probably less than two million cubic metres per year, which is well below the sand transporting capabilities of lower Clinton Creek, and would go practically unnoticed in the Forty Mile River.

4. FINAL ABANDONMENT

The performance of both the waste dump and tailings pile continued as expected over the past year. The waste dump erosion protection work installed in 1984 performed well, while the process of downcutting and channel armouring continues downstream. The south tailings lobe continues to move at a moderate rate. The north tailings lobe is not accelerating. There does not appear to be any further reasonable measures possible prior to final abandonment, with the exception that the culverts should be removed from the waste dump channel inlet prior to abandonment. As discussed in Klohn Leonoff's report on sediment transport, the expected ongoing erosion following abandonment of the site will result in some limited deposition of coarse material in Clinton Creek downstream of the confluence with Wolverine Creek, but most of Clinton Creek downstream to the Forty Mile River will be

essentially unaffected. Photo 6 shows an aerial view of the mouth of Clinton Creek at the Forty Mile River.

KLOHN LEONOFF LTD.

Steve Rice.

Steve Rice, P.Eng.
Project Engineer

for Peter C. Lighthall, P.Eng.
Project Manager

SR/PCL/tp

APPENDIX I

PHOTOGRAPHS

PHOTO 1: Waste Dump channel inlet area looking upstream to channel protection works and inlet culverts.

PHOTO 2: Waste Dump channel looking upstream. Erosion protection works in distance.

PHOTO 3: Waste Dump channel further downstream.

PHOTO 4: North lobe of tailing pile at toe of slope. Toe is now well into lake and slope is flattening.

PHOTO 5: Channel at toe of south lobe of tailings pile with inlet to lined channel in distance.

PHOTO 6: Mouth of Clinton Creek at 40 Mile River.

APPENDIX II

MONITORING DATA

TABLE 1

MINE WASTE DUMPS

Station	Coordinates & Elevation June 19, 1985	Rates of Movement (ft/yr)							
		Horizontal				Vertical			
		June 83	Sept 83	June 84	June 85	June 83	Sept 83	June 84	June 85
20A	N 110774.37 E 106809.03 1470.59	2.61	0.65	1.78	1.28	-0.66	-0.89	-1.43	-0.07
21A	N 110842.51 E 106346.49 1474.85	2.36	0.72	1.53	1.70	-0.92	0.00	-1.40	-0.30
22A	N 110829.00 E 106107.17 1471.67	2.82	0.27	2.09	1.72	-1.28	-0.20	-2.04	-1.09
68	N 110951.08 E 107088.64 1436.22	2.69	3.17	-	1.58	-1.25	-1.06	-0.72	-0.07
81-1	N 110207.60 E 106549.54 1501.12	2.15	2.28	1.29	1.79	-0.78	-0.58	-1.68	-0.31
81-2	N 110767.77 E 106661.05 1463.57	2.57	1.91	1.72	1.54	-0.47	-3.72	-0.26	-0.21
19	N 110492.27 E 107817.12 1322.02	-	1.39	-	1.19	-	-0.59	-0.76	-0.31

TABLE 2

WASTE DUMP CHANNEL CLOSURES

Station	Rate of Horizontal Closure (ft/yr)					Rate of Vertical Movement (ft/yr)				
	Nov 81	June 82	June 83	June 84	June 85	Nov 81	June 82	June 83	June 84	June 85
A	2.82	2.15	1.99	1.63	1.10	0.00	-0.08	0.00	-0.66	+0.15
B	1.61	1.54	1.56	0.91	destroyed	-0.02	-0.07	-0.31	-0.14	destroyed
E	0.65	1.14	0.92	destroyed		0.00	+0.06	+0.29	destroyed	
F	2.61	1.99	1.89	1.21	1.17	-0.02	-0.16	-0.09	-0.32	+0.02
G	3.22	2.53	2.27	1.64	1.55	-0.03	+0.01	+0.30	+0.12	-0.12
J				1.17	1.01				+0.23	-0.36
K				1.99	1.37				+0.14	-0.05
L				1.76	1.41				-0.10	+0.09

TABLE 3

WOLVERINE TAILINGS PILE
NORTH LOBE

Station	Coordinates & Elevation June 19, 1985	Rates of Movement (ft/yr) Horizontal June 83	Horizontal June 84	Horizontal June 85	Vertical June 83	Vertical June 84	Vertical June 85
26	N 114491.00 E 108226.41 1891.61	3.61	0.27	1.55	-0.32	-0.67	+0.31
80-2	N 114320.94 E 108441.49 1818.71	6.50	0.40	1.41	-0.23	-0.17	-0.06
26 A	N 114483.01 E 108413.80 1836.33	0.62	0.17	0.84	-0.36	-1.42	-0.09
80-1	N 114708.13 E 108419.83 1832.38	0.77	0.69	0.84	-0.67	-0.63	-0.15
80-4	N 114020.37 E 108855.62 1666.32	1.96	1.05	0.36	-0.61	-0.54	-0.39
80-5	N 114173.64 E 108948.86 1602.68	32.64	8.35	5.84	-32.18	-9.39	-6.25
500-1	N 114506.07 E 108914.78 1600.66	57.14	33.33	34.06	-24.52	-15.39	-7.72
650-1	N 114709.99 E 108877.18 1624.57	50.26	18.63	14.10	-16.53	-5.69	-3.78

TABLE 3
(continued)

WOLVERINE TAILINGS PILE
NORTH LOBE

Station	Coordinates & Elevation June 19, 1985	Rates of Movement (ft/yr)					
		Horizontal			Vertical		
		June 83	June 84	June 85	June 83	June 84	June 85
350-1A	N 114352.51 E 109170.89 1533.58	55.99	91.48	65.27	-19.85	-34.05	-24.72
500-2	N 114499.43 E 109245.78 1502.97	74.37	58.47	58.60	-27.28	-29.31	-25.86
350-2A	No reading		91.95	71.55	-	-37.57	-24.54
650-2 (80-6)	N 114698.52 E 109227.43 1497.65	88.62	-	68.86	-42.99	-	-31.48
80-7	N 114503.53 E 109409.74 1442.94	103.27	59.88	55.95	-42.96	-24.75	-23.01
50-3A	N 114400.74 E 109447.38 1429.83	109.93	108.69	75.12	-44.06	-29.03	-32.53

TABLE 4

WOLVERINE TAILINGS PILE
SOUTH LOBE

Station	Coordinates & Elevation June 19, 1985	Rates of Movement (ft/yr)					
		Horizontal			Vertical		
		June 83	June 84	June 85	June 83	June 84	June 85
24	No reading	-	1.85	-	-	-1.14	-
24A	N 113454.60 E 109001.79 1591.85	16.39	19.18	20.09	-5.77	-6.83	-7.44
24B	N 113474.82 E 109192.55 1527.11	15.02	17.92	19.31	-5.14	-6.01	-6.92
24D	N 113553.82 E 109523.51 1418.24	10.87	-	11.76	-3.79	-	-3.84
25B	No reading	10.44	12.38	-	-2.36	-2.26	-
25C	N 113753.08 E 109818.71 1357.28	3.43	6.72	7.25	+2.64	+2.69	+3.15
80-9	N 113370.32 E 109792.98 1344.24	2.72	3.43	3.02	+0.87	+1.41	+1.45

LIST OF DRAWINGS

D-1004B	-	PLAN OF WOLVERINE CREEK TAILINGS PILES
D-1006A	-	PLAN AND LONGITUDINAL PROFILE OF WASTE DUMP CHANNEL

1 2 3

D C

105 000 E 106 000 E 107 000 E 108 000 E

115 000 N 114 000 N

1750 1800 1850 1900 1950

N

A 1005

B 1005

STACKER CONVEYORS

MILLSITE

4 5 6

109 000 E

110 000 E

111 000 E

LOCATION OF LATERAL SLIP PLANE

ESTIMATED POSITION OF TOE - 1985

TAILINGS EXCAVATED 1978

TAILINGS PILE

TAILINGS EXCAVATED 1978

CHANNEL BEING SQUEEZED BY TAILINGS PILE

A 1005

B 1005

80-1 0.8

650-1 14.1

650-2 68.9

26A 0.8

1.6

500-1 34.1

500-2 58.6

80-7 56.0

350-3A 75.1

350-1A 65.3

350-2A —

80-2 1.4

80-5 5.8

80-4 0.4

25C 7.3

24D 11.8

25B —

24 —

24A 20.1

24B 19.3

80-9 3.0

1750

1700

1650

1600

1550

1500

113 000 N

B

112 000 N

A

1900

1850

1800

1750

1700

1650

1600

1550

1500

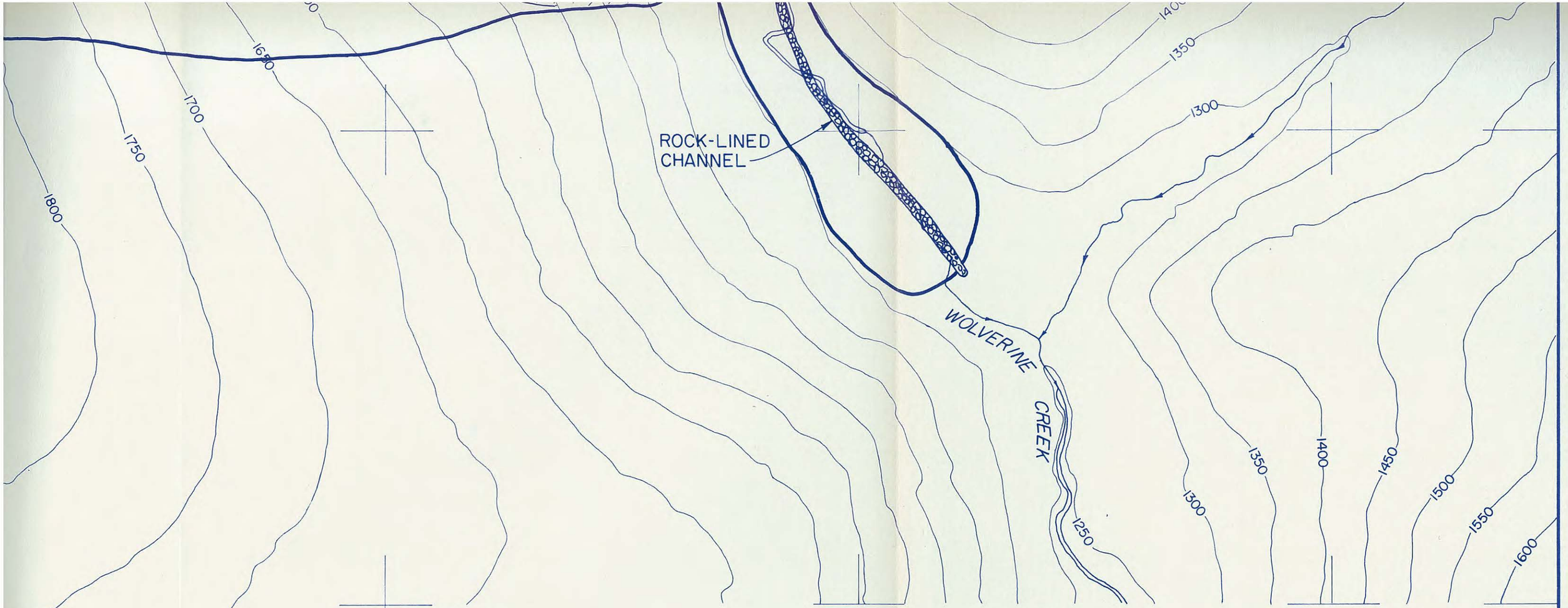
1450

1400

1350

1300

NCI - 603



LEGEND

24 ⊙ 1.9 Monitoring Point (Rate of horizontal movement - ft/yr June 1984 to June 1985)

NOTE

TOPOGRAPHY TRACED FROM CASSIAR ASBESTOS CORPORATION LIMITED SHEET No. 223, COMPILED IN 1965 BY McELHANNEY AIR SURVEYS LTD.

REV.	DATE	REVISION DETAILS
B	Aug 85	Monitor points plotted to 1985 coordinates. Movement rates revised. Position of toe revised.
A	July 84	Monitor points plotted to 1984 coordinates. Movement rates revised. Position ot toe revised.

TO BE READ WITH KLOHN LEONOFF REPORT DATED SEPT. 6, 1985

SCALE: 200 0 200 400 ft.

DESIGN	DRAWN	DATE	SCALES
P.C.L.	F.C.	DEC. 1983	1" = 200'

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

CLIENT: BRINCO MINING LIMITED
CASSIAR DIVISION

PROJECT: CLINTON CREEK MINE RECLAMATION

TITLE: PLAN OF WOLVERINE CREEK TAILINGS PILES

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
JAN. 26, 1984	PB 3169-01	D-1004	B

APPROVED

1 2 3

D

C

111500N

111000N

110500N

105000E 1055000E 106000E 106500E 107000E 107500E

N

A/1

B.C.

J-J F-F K-K G-G

J F K G

CLINTON CREEK ROAD

ORIGINAL VALLEY SLOPE

A-A B-B

A B

83-1

19

TOE OF ORIGINAL VALLEY SLOPE

HUDGEON LAKE

68

22A 21A 81-2 20A

WASTE DUMP

TOE OF ORIGINAL VALLEY SLOPE

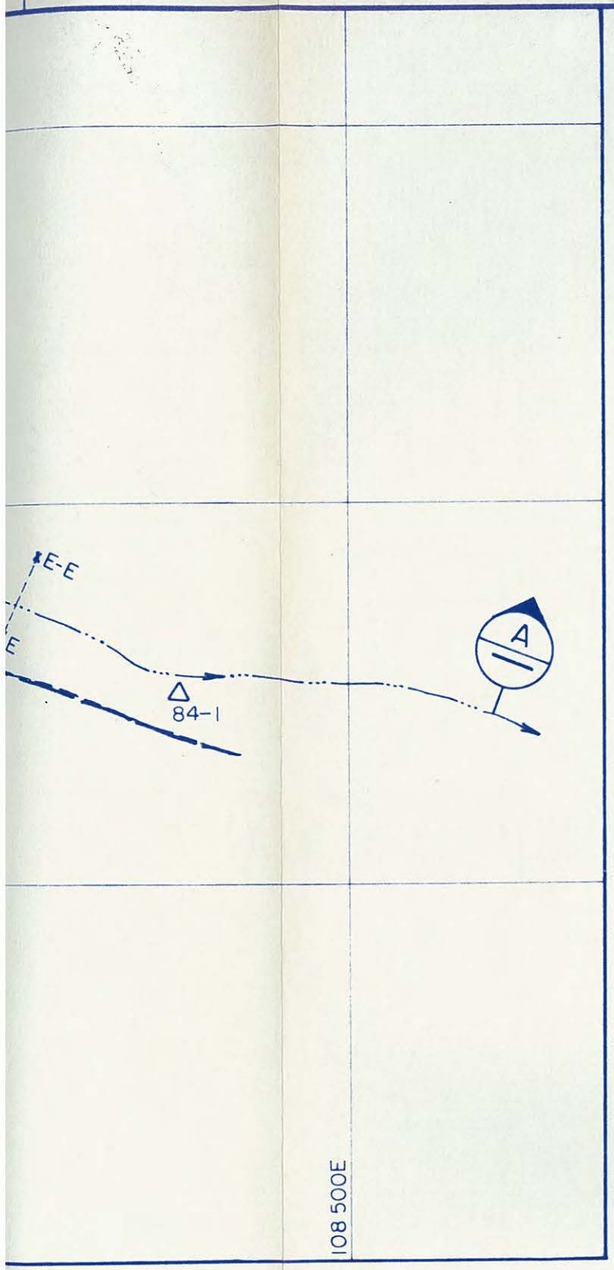
81-1

PLAN

200FT. 0 400FT.

1360

HUDGEON LAKE



LEGEND

Δ 20A SURVEY MONUMENT

A x------x A-A CROSS-CHANNEL REFERENCE LINE

NOTES

1. PROFILE IS PLOTTED WITH 5 TIMES VERTICAL EXAGGERATION.

1360

B

A

ELEVATION - FEET

1340

1320

1300

1280

1260

1240

1220

DOWNSTREAM END OF CULVERTS

SEPT. 23, 1983

JUNE

0+000

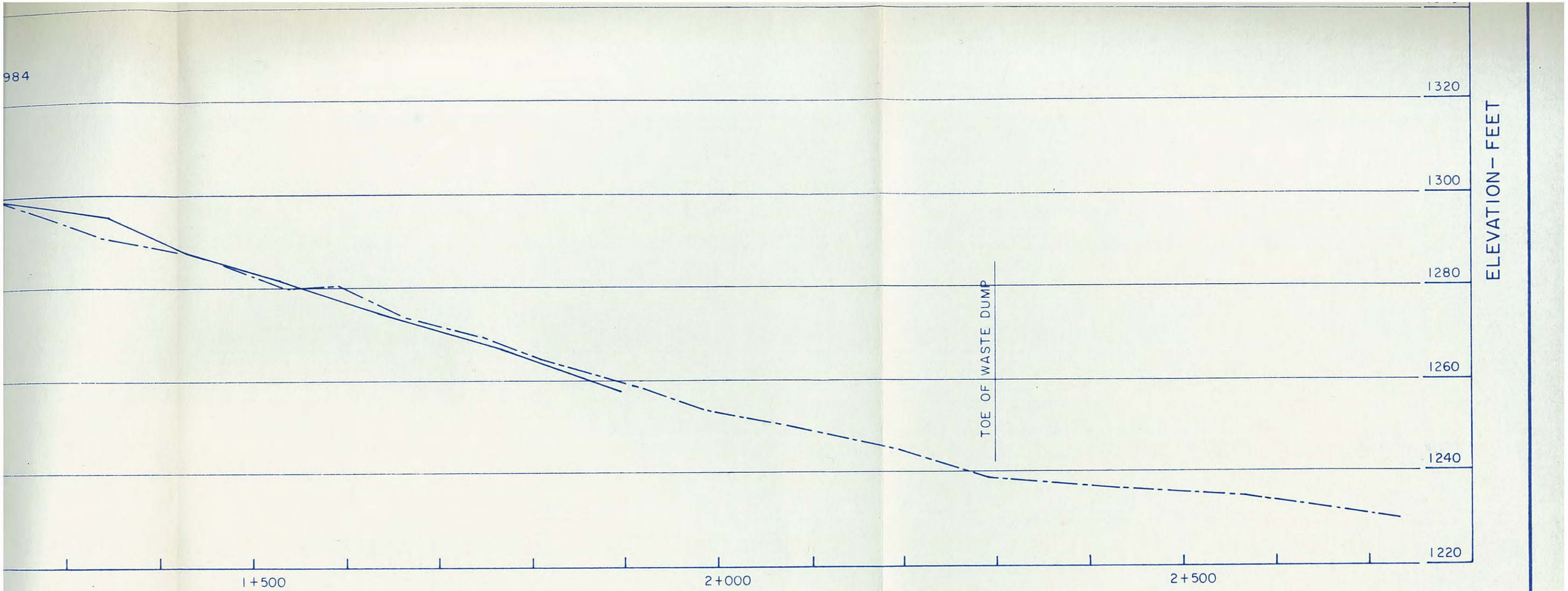
0+500

1+000

SECTION A

100FT. 0 200FT.

NCI - 603



TO BE READ WITH KLOHN LEONOFF REPOPT DATED SEPT. 6, 1985

REV.	DATE	REVISION DETAILS
A	AUG. 1984	ADDED STATIONS TO PROFILE, REVISED CLINTON CREEK PLAN LOCATION ADDED JUNE 15, 1984 PROFILE

SCALE:

DESIGN	DRAWN	DATE	SCALES
P.C.L.	E.D.P.	FEB., 1984	AS SHOWN

KLOHN LEONOFF LTD.
CONSULTING ENGINEERS

CLIENT: BRINCO MINING LIMITED
CASSIAR DIVISION

PROJECT: CLINTON CREEK MINE WASTE DUMP

TITLE: PLAN AND LONGITUDINAL PROFILE OF WASTE DUMP CHANNEL

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
APPROVED	PB 3169-01	D-1006	A