1951 30th 1981 Anniversary

HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

File No. K4946

June 22, 1981

Indian and Northern Affairs
200 Range Road
Whitehorse, Yukon
Y1A 3V1

Attention: Mr. H.F. McAlpine, P.Eng.

Dear Sir:

RE: Cassiar Asbestos Mine,
Waste Dump and Tailings
Pile Stability

This letter summarizes observations and comments arising from my recent site inspection at the above mine. The site visit was made on June 2, 1981, in the company of Mr. McAlpine. In addition, a review of the latest monitoring data, made available to us courtesy of Golder Associates by means of a letter dated June 8, 1981, has been undertaken.

1.0 CLINTON CREEK WASTE DUMP

1.1 The main and east dump segments (uphill from the access road) exhibit fresh tension cracks (not effaced during the past winter and spring seasons), indicative of a continuing movement. However, the rate of movement may be

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CALGARY DAWSON CREEK EDMONTON FORT McMURRAY LETHBRIDGE MEDICINE HAT PRINCE GEORGE RED DEER SASKATOON VANCOUVER WINNIPEG

decreasing, since some of the cracks are at least partly healed and no major new disturbances are indicated. On the other hand, the District Geologist has reported new open cracks uphill of and behind the uppermost reaches of the dump. Since we have not inspected these features, it is difficult to evaluate whether they are associated with the dump area, or possibly, with ongoing instabilities occuring in the mine pit.

The difficulties associated with the evaluation of the behaviour of the main dump segment are conpounded by the fact that the monitor reflectors which were placed on this dump segment have been stolen or destroyed.

Notwithstanding the lack of direct evidence, it is my opinion that the main dump segment and the eastern portion of the dump have not achieved an equilibrium condition.

1.2 The downslope dump segment (adjacent to the creek channel) exhibits fresh cracks and apparent vertical displacements along some previously documented fissures. The movements are most apparent along the existing access road.

Despite a relatively low spring runoff, the banks of the creek channel show fresh sloughing and erosion scars (Photo 1).

The monitors located along creek closures confirm that continuing movement of this dump segment into the creek channel is occuring (Table 1). The movement is seasonally related, being greater in the summer and somewhat slower during the winter season. The last set of readings shows that the rate of horizontal movement during the 1980 - 1981 winter was essentially the same as that during the 1979 - 1980 winter, ranging from 1.5 to 3.3 feet per year. Consequently, it can be speculated that during this summer season, the movement will increase to about the same rate as experienced in 1980, i.e. to 1.7 to 5 feet per year.

The vertical component of the movement, monitored since the summer of 1980, confirms that the total actual displacement is somewhat higher (measured in the true direction of the movement) than the above values.

It is concluded that the entire waste dump is unstable, that the movement will likely continue, and that the instability is adversely affecting the geometry of the creek channel. However, a sudden and catastrophic movement is not anticipated.

1.3 Initial dump failure. An old post card (Photo 2) obtained during the site visit and showing the initial stage of the dumping operation, illustrates several aspects which are of interest when evaluating the dump failure. These, in my view, are:

- angle of repose of the waste material is greater than the shearing resistance of foundation materials,
- the dump failed due to the failure of its foundation, both on the slope and in the valley bottom,
- the movement resulted in a net decrease of shearing resistance (along the slip planes) from its original peak to residual strength value,
- the stabilization of the dump, if left to natural processes, will likely take a very long time while the factor of safety against sloughing would be unlikely to significantly exceed the value of unity,
- the sloughing experienced during the initial stages of the dumping operation provided an early warning of possible problems resulting from uncontrolled dumping of waste material into this area.

1.4 The creek channel between the lake outlet and the downstream point of the dump area, is unstable. Observations made during the last summer and recent inspections indicate that the retrogressive erosion is quite strong, and that the stream has a tendency to maintain its channel width by eroding the toe of the north hillside site. Even the bedrock strata are subjected to erosion.

1.5 Structural integrity of weirs controlling the lake outfall is poor. Rock blocks forming the weirs are being undermined (Photo 3) and gradually displaced. This will, eventually, destroy the system.

In addition, the channel bottom downstream of the last weir is unprotected and the change in the flow velocity in this area (Photo 4) has already damaged the downstream-most weir. This will, unless mitigated, accelerate retro-gressive erosion and adversely affect the stability of upstream weirs.

It has been brought to our attention that Cassiar Asbestos Corporation Ltd. plans to reconstruct the weirs. The plans prepared by Golder Associates are considered adequate insofar as armouring of this creek segment is concerned; however, narrowing of the stream channel to the original design width is also considered. While the design width may be sufficient to convey the flows, I do not favour the proposed channel narrowing. It is my opinion that the channel banks, due to the existing armouring, have achieved a certain degree of stability which could be destroyed by the proposed construction works. Since the flow velocity and erosion potential in the narrower channel will be increased, it appears prudent to maintain the existing channel width and to reconstruct and improve the weir system using additional rip-rap material.

When selecting the rock for rip-rap and weir construction, attention should be paid to the rock durability. Most local rock types exhibit relatively rapid deterioration.

2.0 WOLVERINE CREEK TAILINGS PILE

The visual inspection of both south and north tailing pile lobes revealed a number of fresh cracks and scarps, indicative of continuing and possibly accelerating movement of key components of the pile (Photos 5 to 7 inclusive). The toe of the south lobe, forming the bank of the creek channel upstream of the weir system, exhibits extensive deformation, manifested by cracks parallel and perpendicular to the stream (Photos 7 and 8). It is apparent that this area is experiencing both horizontal and vertical movements.

Considerably greater deformations are discernible on the north lobe of the tailings pile. Numerous wide open cracks and almost vertical and relatively high scarps exist throughout the north lobe of the pile. Some of the benches, cut into the pile in 1978 with the intent of arresting the movement, are intersected by numerous cracks and scarps. The toe area of the north slope is bulged and the material apparently overrides the natural ground. The results of field inspections undertaken in 1980 and recently lead to the conclusion that the movement is accelerating.

The monitoring results, summarized in the following paragraphs, confirm the visual observations made.

2.1 The south lobe, according to monitoring data compiled in Table 2, experienced about the same rate of horizontal displacement during the summer of 1980 and winter season of 1980 - 1981. Indeed, there is very little difference between summer 1979 and summer 1980 movement rates, which ranged from 0.9 to 9.4 feet per year for individual monitoring stations. Horizontal displacement during the 1980 - 1981 winter ranged from 0.5 to 9.3 feet per year and the vertical component was in the range of 0.6 to 3.5 feet per year. Upward movements were recorded at monitors 25C and 80-9 located within the toe area of the south lobe.

The results of the visual inspection, together with the record of past movement, suggest the following conclusions:

- the south lobe is experiencing mass re-adjustment which may continue for a long time,
- the deformations are not decreasing; conversely, they become greater in the toe area and could in time, restrict the creek channel,
- the movement rates remain, in general, the same; however, movements with certain slope segments are exxhibiting tendency to accelerate. The movement rates are not indicative of a sudden and catastrophic slope movement.

2.2 The monitoring data compiled for the north lobe (Table 2) indicate a significant increase in slide activity during the 1980 - 1981 season. The rate of horizontal displacement during the 1980 summer and winter seasons ranged from 0.4 to 31.3 and 0.6 to 39.1 feet per year, respectively. This is in accordance with the maximum horizontal displacements of 17.3 and 18.0 feet per year recorded for 1979 summer and winter seasons. Vertical movements reached maximums of 17.8 and 18.2 feet per year during the summer and winter 1980 seasons, respectively.

The differences in movement rate indicate that the north lobe is not moving as a single mass but that individiual lobe segments move somewhat independently while interacting and influencing each other.

The recontouring undertaken in 1978 did not arrest the movements and the anticipated increase in factor of safety against sloughing for this dump segment has not been achieved. Indeed, the factor of safety for this dump segment is likely less than unity.

The movement trends have an accelerating tendency, and are classified as relatively rapid. While a sudden and catastrophic failure of the entire north lobe remains unlikely, the possibility of a downslope segment of the lobe moving suddenly down and reaching the Wolverine Creek area upstream of the rehabilitated channel cannot, in my view, be discounted.

Even if a sudden failure of the toe of the north slope does not occur, the likelihood that the tailings pile will eventually reach the valley bottom is, in my view, high.

2.3 Visual inspection of the Wolverine Creek spillway system showed that most of the weirs and embankment armouring are performing satisfactorily. However, since the outfall (i.e. the area immediately downstream of the last weir), is unprotected, retrogressive erosion is occuring and the structural integrity of the last three weirs is poor (Photos 9 and 10). It would be prudent to undertake the following repair works:

- installation of a rip-rap apron downstream of the last weir,
- rehabilitation of the damaged weirs.

3.0 RECOMMENDATION

The following recommendation is presented for consideration by the Yukon Water Board, on the basis of presently available data:

> That the mining company be requested to revise its position regarding courses of action which may be necessary to ensure the long term integrity of both drainage courses relative to possible future behaviour of both dumps.

Respectfully submitted,

HARDY ASSOCIATES (1978) LTD.

M. Stepanek, M.Sc., P.Eng.

MS:pm

CLINTON CREEK WASTE DUMP

TABLE I

Rate of Movement (ft/yr)

Monument No.	Regimes: Summer 78	Winter 78-79	Summer 79	Winter 79-80	Summer 80 H*	Summer 80 V**	Winter 80-81 H	Winter 80-81 V
a) Main dump segment:								
22A	7.1	4.4	6.0	4.5	3.0		destroyed	
21A	5.3	3.4	4.9	3.7	3.5		destroyed	
20A	5.0	1.5	4.5	4.0	3.0		destroyed	
68	4.5	3.2	4.9	3.8	3.8		destroyed	
b) Uppermost dump segment:								
23	4.5	3.7	destroyed					
c) East Flank:								
19	2.3	1.6	2.3	2.2	2.0		destroyed	
d) Creek closures:								
F	no record	3.1	4.5	2.7	3.5	0.7	2.7	0.5
G	no record	3.4	4.5	3.5	3.5	0.3	3.3	0.1
A	4.1	2.1	4.5	2.9	5.1	0.1	3.0	0.3
B	3.2	1.7	4.5	2.0	2.3	1.0	2.3	0.5
C	2.8	1.3	destroyed					
D	2.2	1.3	destroyed					
E	1.9	1.2	1.8	1.5	1.7	0.1	1.5	0.2

* H = horizontal rate of movement

** V = vertical rate of movement

NOTES: Data are organized from the upstream (west) side of the dump sequentially towards the east side. Directions of movement for creek closure monuments have not been surveyed; movements are measured across the channel between monuments located on either bank. Since movement of the northeast segment of the dump has a downstream trend, actual displacements of monitors A to E inclusive may be greater than those tabulated.

WOLVERINE CREEK TAILINGS PILE

TABLE II

Rate of Movement (ft/yr)

Monument No.	Regimes: Summer 78	Winter 78-79	Summer 79	Winter 79-80	Summer 80 H*	Summer 80 V**	Winter 80-81 H	Winter 80-81 V
South lobe (1974 failure zone)								
24 (upper slope)	0.7	0.7	1.3	0	0.9	1.0	0.5	0.6
24A	3.6 (from July)	5.1	6.3	7.5	7.2	3.4	5.6	3.4
24B	5.5	4.7	7.6	7.5	9.4	3.3	9.3	3.5
24D	9.1 (Sept-Nov)	3.8	6.9	6.5	7.7	2.8	6.9	2.3
25B	7.3 (from Sept)	3.7	6.5	3.8	7.3	2.1	6.7	1.5
25C (toe area)	6.9	2.6	5.4	4.0	4.5	2.0 ↑	3.8	2.1 ↑
80-9					1.3	1.2 ↑	1.2	0.6 ↑
North lobe (recontoured in 1978)								
26 (upper slope)	6.5 (till Nov.9)	1.6	1.1	0.5	1.7	0.6	1.2	0.2
26A (upper slope)	5.7 (till Nov.9)	1.6	1.1	0.4	1.3	0.3	-	0.5
350-1A	18.9	11.5	14.8	15.0	25.5	12.8	30.6	11.5
350-2A	23.1	11.6	16.6	17.5	29.5	10.3	36.9	11.9
350-3A	33.7	13.3	17.3	18.0	31.3	12.7	39.1	10.8
500-1	28.6	11.6	17.3	16.0	29.6	15.4	30.1	18.2
500-2	21.6	11.0	15.4	16.5	30.7	8.6	35.5	10.1
650-1	31.6	12.2	15.5	14.5	26.3	17.8	28.9	18.0
650-2	21.6	10.4	16.4	16.0	29.0	-	-	-
80-1	-	-	-	-	0.5	0.9	1.2	0.3
80-2	-	-	-	-	0.4	0.2	1.2	0.4
80-4	-	-	-	-	0.6	0.7	0.6	0.6
80-7	-	-	-	-	34.3	13.1	38.8	15.4

* H = horizontal rate of movement

** V = vertical rate of movement

↑ = upward movement

NOTES: Monitoring of 350 station series commenced Oct. 21, 1978

Monitoring of 500 station series commenced Oct. 3 or 13, 1978

Monitoring of 80 station series commenced Nov., 1980.

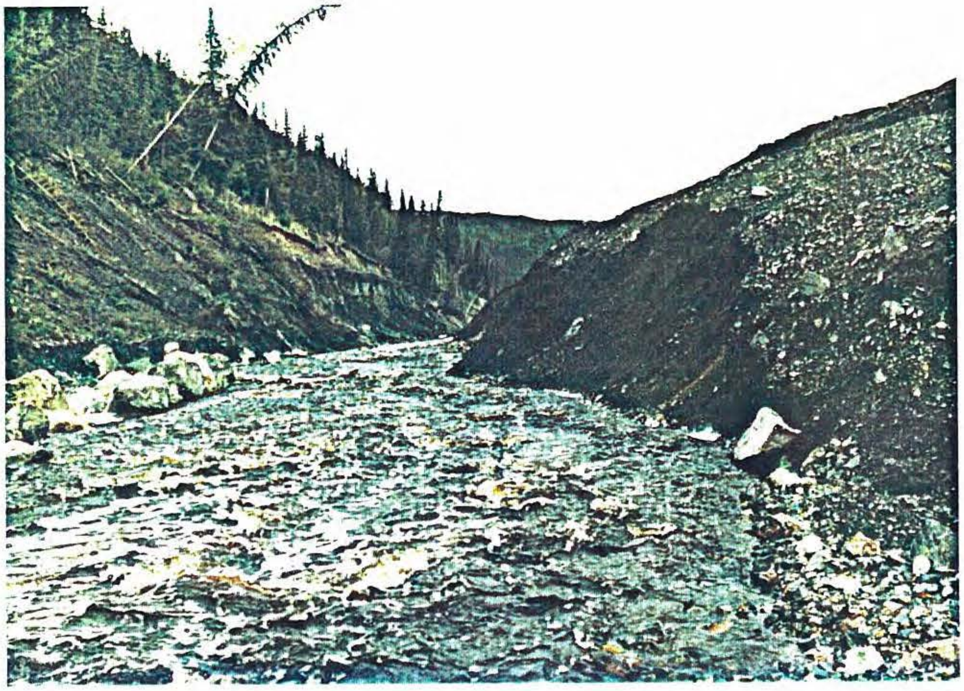

PHOTO 1 - Clinton Creek downstream of closures, note undercutting of both banks.

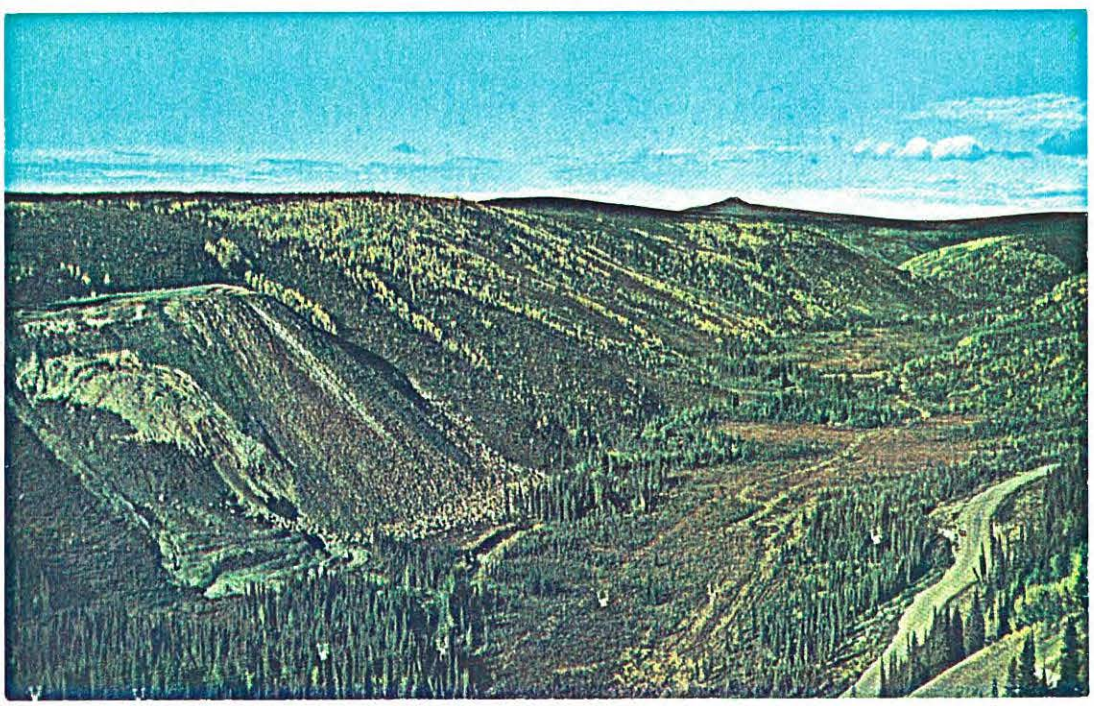

PHOTO 2 - Post Card showing an initial dump stage, note the instability of left dump portion.

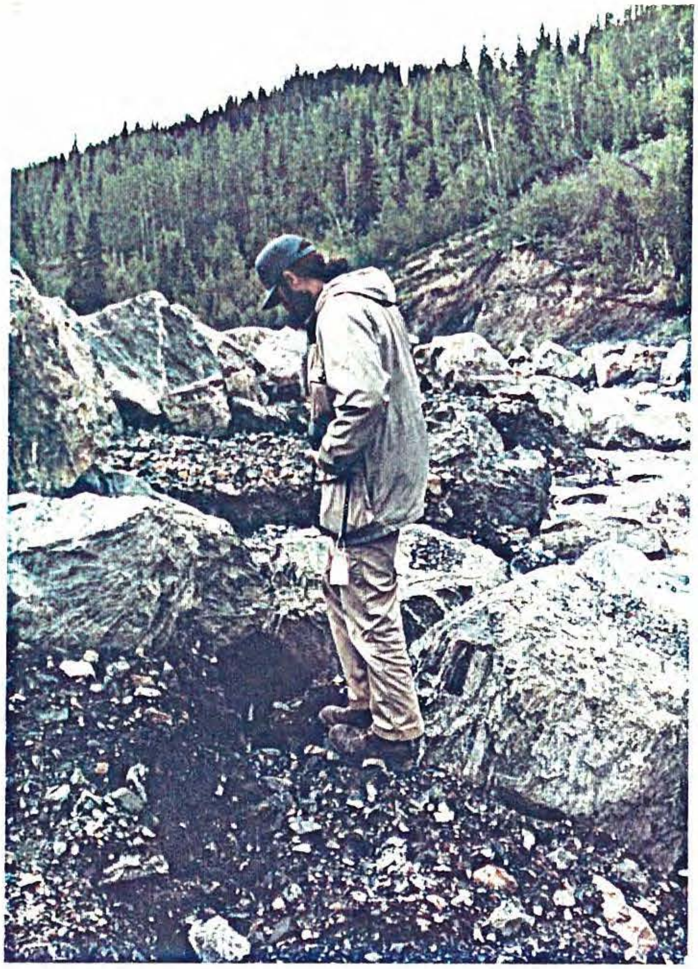

PHOTO 3 - Undermined and unstable rock blocks forming weir closures.

PHOTO 4 - Continuing deterioration of weirs at the closure outfall.

PHOTO 5 - General view of Wolverine Creek south lobe tailings pile.

PHOTO 6 - North lobe of the tailings pile, note slide cracks and scarps.

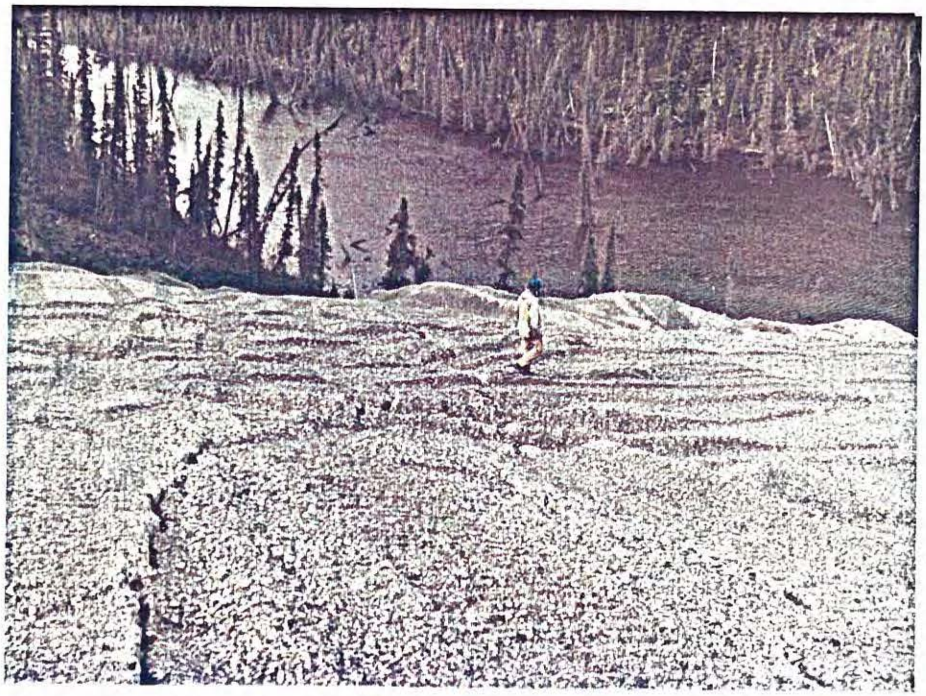

PHOTO 7 - Downslope segment of south lobe exhibiting open slide cracks.

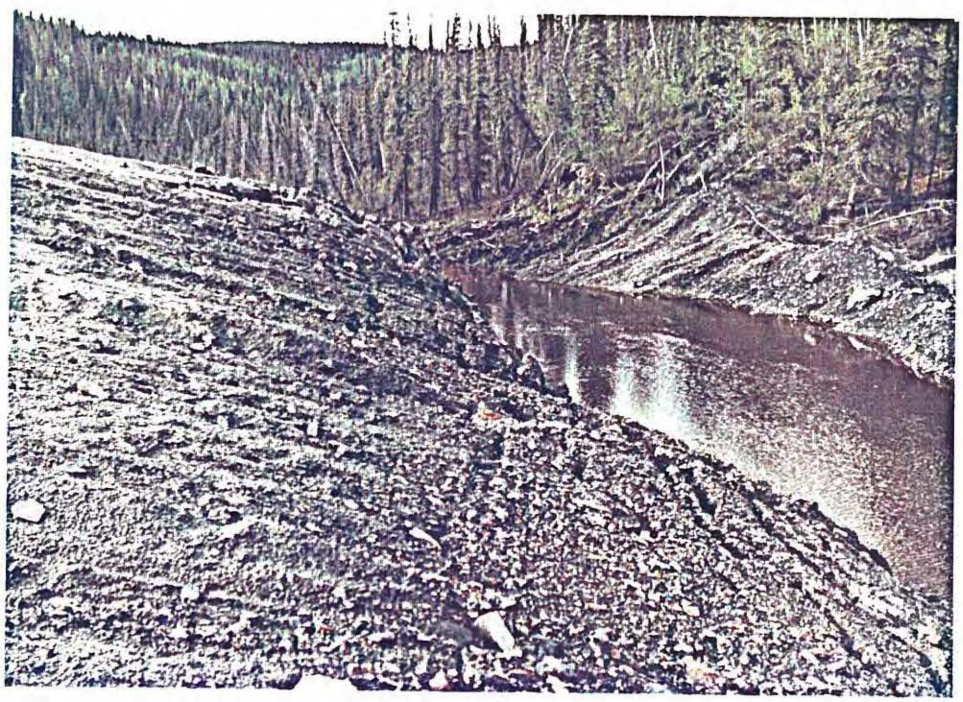

PHOTO 8 - Toe of the south lobe moving upwards and into the creek channel upstream of weir spillway.

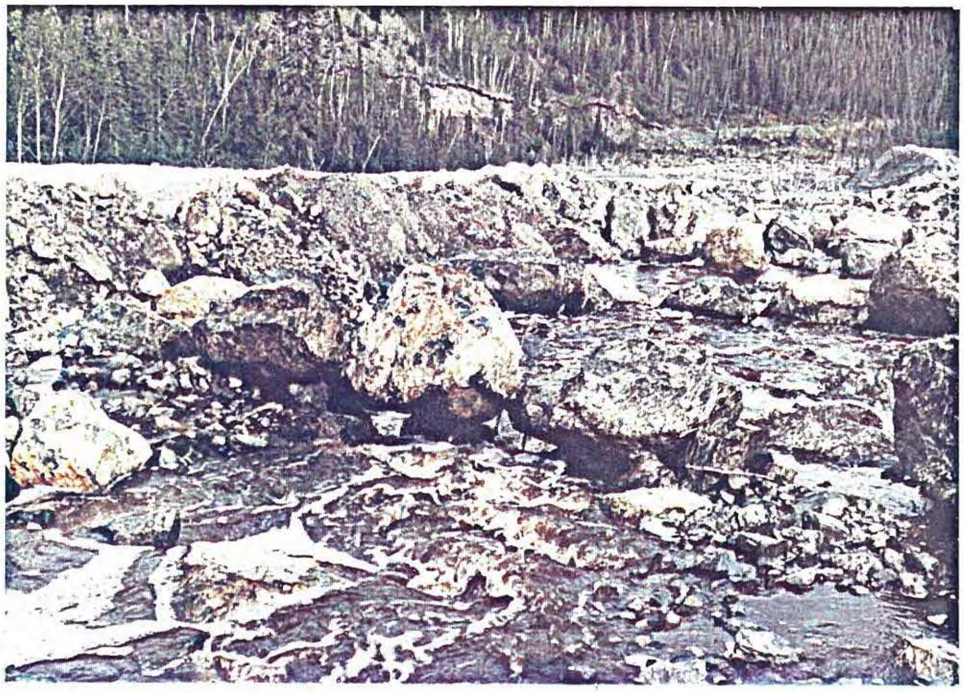

PHOTO 9 - Undermined rock blocks forming a downstream weir.

PHOTO 10 - Weir spillway outfall exhibiting distress due to erosion.