HARDY ASSOCIATES (1978) LTD.

CASSIAR ASBESTOS CORPORATION MINE
REVIEW OF
WASTE DUMP AND TAILINGS PILE
BEHAVIOURS (1980)

Prepared For

INDIAN AND NORTHERN AFFAIRS,

YUKON WATER BOARD

By

HARDY ASSOCIATES (1978) LTD.

CALGARY ALBERTA

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1.0 INTRODUCTION

Hardy Associates (1978) Ltd. were commissioned by Indian and Northern Affairs, on behalf of the Yukon Water Board, to review and provide a critique of plans and works proposed and built by Cassiar Asbestos Corporation and Cyprus Anvil Mining Corporation. This work was authorized under contract No. Y9WA-20.

Within the framework of this assignment and further to our previous participation in a review of stability conditions of waste and tailings piles at the Cassiar Asbestos Corporation Mine, Mr. H.F. McAlpine, Administrator of Water Licensing, requested Hardy Associates (1978) Ltd. (by letter dated December 10, 1979) to:

(a) review movement monitoring data for both the tailings and waste rock piles,

(b) provide our analysis of this data in report form, and

(c) comment on Clinton and Wolverine Creek channel works which have been undertaken.

Fundamental sources of information for the requested review were:

1. Golder Associates November, 1979 Report on Movement Monitoring Data.

2. Golder Associates November 27, 1979 letter to Cassiar Asbestos Corporation regarding Clinton Creek works and waste and tailings piles movement summaries.

Work undertaken as part of this assignment has included analysis of monitoring data on movements of both waste piles (as to the change of rate, direction and total displacements for specific time periods), quantitive assessment of the recorded movements, qualitative evaluation of the trends relative to future behaviour of the dumps and preparation of this report. The work was undertaken by Mr. M. Stepanek and was reviewed by Dr. J.I. Clark.

2.0 DISCUSSION

The established monitoring system is designed to provide an economical and practical means of achieving adequate, though sparce (especially on the Clinton Creek dump) information on horizontal surface displacements.

Plots of cumulative displacement vs. time and of displacement rates (similar to those compiled by Golder Associates) were used to interpret and evaluate the behaviour of the monitored terrain. These plots are customarily used, in the case of an existing instability, to assess whether the slide is tending to stabilize (i.e. displacement rate decreases) or whether movement is continuing at a consistent or accelerating rate. This interpretation is based on case histories which show that many failures have an orderly decrease or increase in displacement rate as stabilization or failure progresses. There have been, however, slides which exhibited erratic motion with no orderly acceleration of displacement.

Moreover, plots of monitored displacements may be used to evaluate the effect of seasonal conditions on slide behaviour. Insofar as this aspect is concerned, the consultant did not consider seasonal variations. As a result, conclusions drawn on the basis of monitoring data for the 1978-79 winter season (Golder Associates March 1979 submission) may be optimistic.

The accuracy of displacement plots and the degree of confidence in interpreted data depends on the accuracy of the survey. The type of survey equipment used in this case is not known to us. It is known that a 1 second theodolite has a standard reading error of $\pm$ 2.8 s. Distance measurement accuracies of $\pm$ 0.2 in ($\pm$ 5 mm) are possible to achieve using EDM units directly attached to a theodolite. We have assumed that this is the order of precision obtained.

On plots showing cumulative displacement for monitored points on Clinton Creek Mine dumps, the individual readings have been interpolated and movement rates for individual monitoring intervals graphed. This approach, in our opinion, at least partly obscures actual slide behaviour. Displacements over certain monitoring intervals lie within the range of instrument error. Consequently, we favour the interpretation of the cumulative charts in terms of overall trends taken over a few or several monitoring intervals. When the existing monitoring data (in general, for the period of November 1977 to November 1979) is interpreted in terms of displacement trends, seasonal movement variation becomes obvious. Intersections between interpolated trends on charts showing cumulative displacements indicate that the rate change between the winter and summer regimes occurs in late April to late May. Relatively frequent monitoring data is available for this time period in April, May and June, 1977 and 1978.

The determination of the beginning of the winter regime is more difficult since intervals between monitoring in fall and winter are longer (for example September 22, 1978 October 17, 1978 and then February 1, 1979). According to the intersections of interpolated trends, the beginning of the winter regime in 1978-79 was approximately between mid December and mid January.

A survey of horizontal displacements is usually considered sufficient for evaluation of simple cases where geotechnical conditions are reasonably well known and predictable. In this case, uncertainties regarding existing thermal and groundwater regimes along failure zones (or planes) and a lack of information about major slide features (position and distribution of slip planes) make a reliable evaluation of slide behaviour difficult and predictions dubious. Moreover, recorded displacement rates and possible environment hazards are additional reasons to upgrade the existing monitoring system in both areas.

3.0 CLINTON CREEK WASTE DUMP

Monuments located within the dump proper show that individual dump segments move, in general, in the direction of the nearest dump slope. The main portion of the dump, located within the former Clinton Creek valley bottom, is apparently spreading; its west segment is moving towards Hudgeon Lake and the lake outlet (monuments 22A and 21A) and its north east lobe is trending into the creek channel and downstream (monuments 68 and 19). Pairs of stations monitoring creek closure have not been surveyed to determine their movement directions.

Interpretation of horizontal movement rates in terms of their overall trends for one "winter" and two "summer" periods indicate seasonal changes in movement rate for all monuments. The first summer period extends from late May, 1978 to early January, 1979, the winter period ended in mid May, 1979 and the second summer interval ended at the time of the latest monitoring, i.e. November 10, 1979. Seasonal changes in the rate of closure of the creek are more erratic than those of dump monuments. The summer regime for closure movements appears to begin in late April which could be associated with creek flow during the spring break-up. Our interpretation of movement rates (based on data measured from submitted graphs) is summarized in Table 1.

TABLE 1

Monument No.	Regimes: Summer 78	Winter 78-79	Summer 79
	Rate of Movement (ft/yr)		
a) main dump segment:			
22A	7.1	4.4	6.0
21A	5.3	3.4	4.9
20A	5.0	1.5	4.5
68	4.5	3.2	4.9
b) uppermost dump segment:			
23	4.5	3.7	destroyed
c) east flank: 19	2.3	1.6	2.3
d) creek closures:			
F	no record	3.1	4.5
G	no record	3.4	4.5
A	4.1	2.1	4.5
B	3.2	1.7	4.5

C	2.8	1.3	destroyed
D	2.2	1.3	destroyed
E	1.9	1.2	1.8

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.

Our interpretation of monitoring data suggests the following conclusions regarding dump behaviour:

(a) The entire dump is unstable and the degree of activity (rate of movement) varies seasonally.

(b) Existing information is insufficient to determine the cause of the seasonal variation. However, seasonal changes of thermal and/or groundwater regimes likely influence dump behaviour.

(c) Movement rates, compared on a seasonal basis, indicate only minor slowing of sliding activity on the west dump segment; the movement rate of other dump segments does not exhibit any significant variation between the 1978 and 1979 summer seasons. It is not expected that the dump will achieve equilibrium in the near future.

(d) Dump movement apparently adversely affects the geometry of the creek channel (closure) which, in turn, may result in damage to existing closure stations.

The above conclusions may be modified if information on the slide geometry (probably involving interacting slide segments), subgrade, and groundwater conditions (including thermal regime) is updated.

The Clinton Creek works are intended to minimize erosion of the slide material forming the creek channel and to reduce localized sloughing of material forming the toe of the sliding dump. This, in turn, would increase the stability of slide toe area, and possibly retard the movement of some dump segments. Providing that the dump reaches an equilibrium condition, erosion control would contribute to the overall stability of the dump.

Insofar as the effectiveness of installed structures on erosion is concerned, this should be evaluated on-site by visual inspections prior to and following high flow events.

The effect of channel walls on the overall dump stability is questionable in the light of available monitoring data. It appears that existing slide driving forces exceed the rather localized stabilization effect of the channel works which have been undertaken.

4.0 WOLVERINE CREEK TAILINGS PILE

Monuments located within the 1974 recontoured failure lobe and the north segment of the pile (recontoured in 1978) show significantly different rates of movement for each pile segment, though the movement direction is relatively uniform - into Wolverine Creek valley. The overall dump configuration apparently produces an arching effect and allows same degree of independent behaviour of the south and north lobes of the tailings pile.

Horizontal movement rates document the favourable effect of the recontouring works. They indicate different summer and winter regimes, similar to those of the Clinton Creek dump with the exception of a few monuments located within the south pile lobe and upper slope of the north lobe. A short monitoring period in 1978 on stations located within the north lobe produced less evidence as to seasonal changes of movement rates (i.e. it leaves more room for interpretation) than in cases where a longer monitoring period is available.

Our interpretation of movement rates (based on data presented on submitted graphs) is summarized in Table II.

TABLE II

Monument No.	Regimes:	Rate of Movement (ft/yr) Summer 78	Winter 78-79	Summer 79
South lobe (1974 failure zone)				
24 (upper slope)		0.7	0.7	1.3
24A		3.6 (from July)	5.1	6.3
24B		5.5	4.7	7.6
24D		9.1 (Sept-Nov)	3.8	6.9
25B		7.3 (from Sept)	3.7	6.5
25C (toe area)		6.9	2.6	5.4

North lobe (recontoured in 1978)			
24 (upper slope)	6.5 (till Nov.9)	1.6	1.1
26A (upper slope)	5.7 (till Nov.9)	1.6	1.1
350-1A	18.9	11.5	14.8
350-2A	23.1	11.6	16.6
350-3A	33.7	13.3	17.3
500-1	28.6	11.6	17.3
500-2	21.6	11.0	15.4
650-1	31.6	12.2	15.5
650-2	21.6	10.4	16.4

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

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

Our interpretation of monitoring data suggests the following conclusions regarding behaviour.

(a) The entire pile is unstable, the rate of its movement varies seasonally and the regime of the south lobe differs significantly from the north pile segment.

(b) Existing information is insufficient to determine the cause of the seasonal variation. Seasonal changes of thermal and groundwater conditions appear to be the main factors causing the seasonal variation.

(c) The south lobe is apparently experiencing mass re-adjustment; the movement of the lower portion of the slide slowed down in 1979 while the upper slide segment showed an increase in movement rates relative to those monitored in 1978. This may indicate that the upper slope segment requires more toe support than currently rendered by the slide toe. These trends indicate that the south lobe involves several slip segments interacting and influencing each other. If this assumption is correct, then movement rates of the toe area may increase in the future.

(d) Recontouring of the north pile lobe, which was undertaken in 1978, slowed down the movement rates to 50 to 75 percent of those recorded prior to slope modification. However, last year movement rates were still within the range which can be classified as relatively rapid. Consequently, there is still a likelihood that the tailings pile may reach Wolverine creek upstream of the rehabilitated channel.

The movement of the lower slope should produce re-adjustment of the upper slope segment. This re-adjustment will likely have a significant vertical component, so far not monitored.

As in the case of the Clinton creek dump, more detailed information on slide geometry, subgrade, groundwater and thermal conditions may modify the above conclusions which are based solely on available monitoring data.

On the basis of Dr. J.I. Clark's field inspection (undertaken on October 20, 1979) the Wolverine Creek rehabilitation measures appear to be performing satisfactorily.

5.0 RECOMMENDATIONS

The following recommendations are presented for consideration by the Yukon Water Board on the basis of monitoring data reviewed to date:

1) That the mining company be requested to continue monitoring of stations installed on both dumps.

2) That the mining company be requested to produce a plan upgrading the existing monitoring system on both dumps. This plan should consider monitoring of vertical displacements at selected locations, monitoring of water pressures along active slide faces at selected locations and a review of the thermal regime. Consideration should be given to the scheduling of such installations in order to ensure including the period when changes in the above regimes most likely occur.

3) That the mining company be requested to produce plans outlining main slide features of both dumps. Such plans may be compiled on the basis of low level air photos.

4) That the mining company be requested, in cooperation with the Yukon Water Board, to inspect the performance of channel rehabilitation works at both streams, preferably following spring break-up. Remedial measures alleviating discovered deficiencies or possible improvements of existing installations should then be suggested.

5) That the mining company be requested to present a contingency plan for diversion of Wolverine Creek in the event that the tailings pile reaches its channel upstream of the rehabilitated stream segment.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF ALBERTA
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Respectfully submitted,

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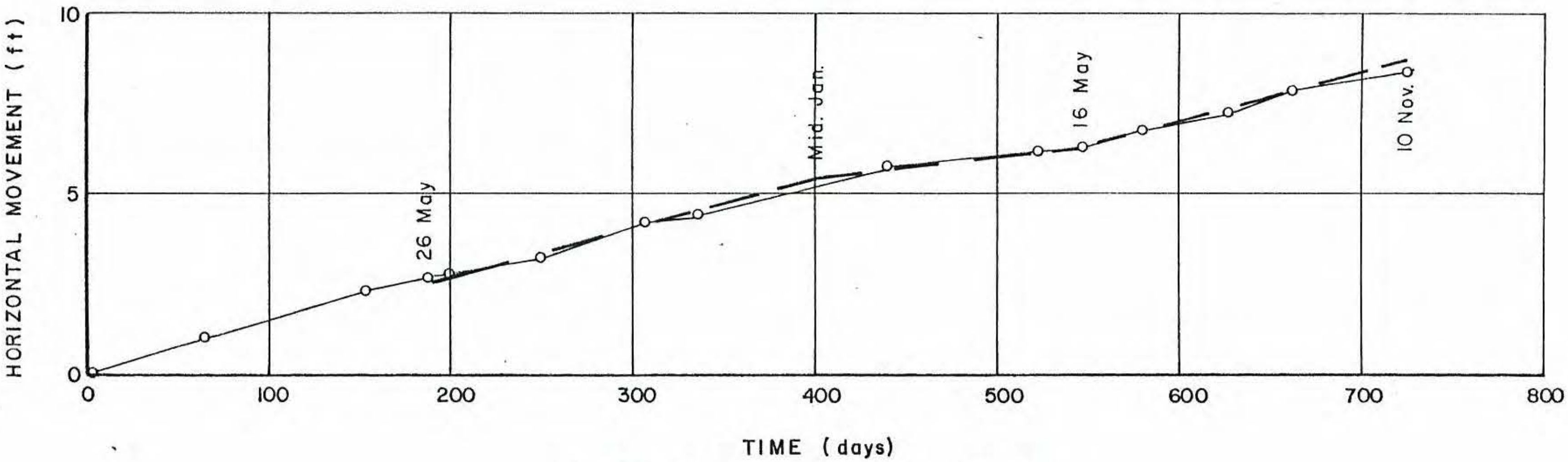
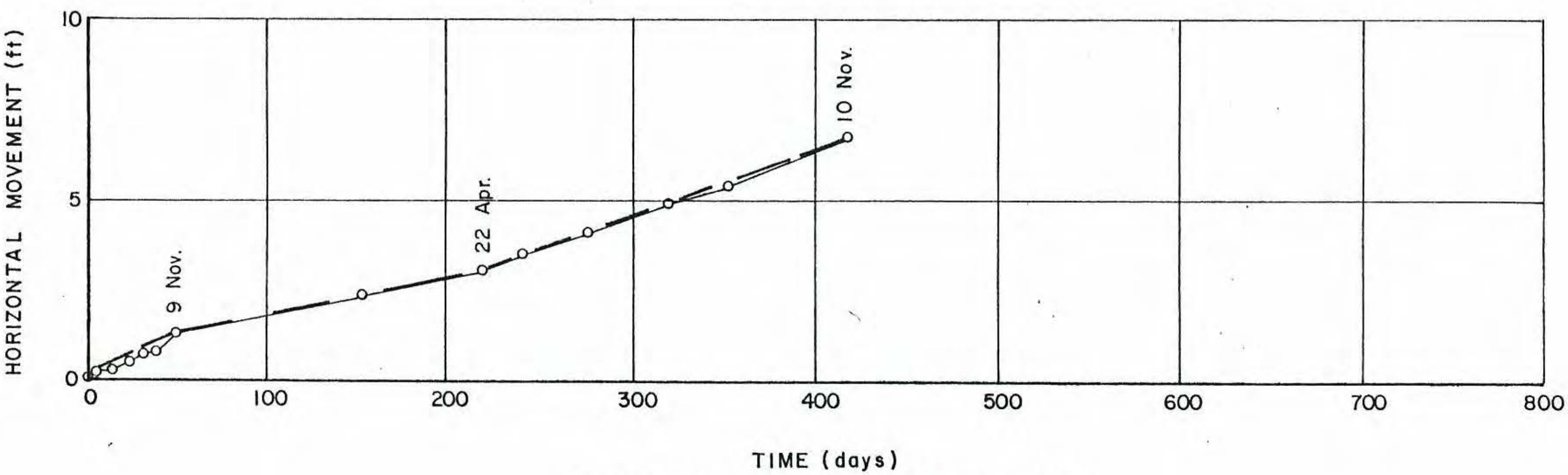
Per: for M. Stepanek, M.Sc.,P.Eng.

PROFESSIONAL ENGINEER ALBERTA
M. STEPANEK

Calgary, Alberta.
February 4, 1980
Project No. K4946



WASTE DUMP - MONITOR No. 20A



TAILINGS PILE - MONITOR No. 24 D

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