CURRAGH RESOURCES - FARO MINE

007503

REPORT

ON

1987 SITE VISIT

Prepared For:
NORTHERN AFFAIRS PROGRAM
Whitehorse, Y.T.

July, 1987
G052-4

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

Water Resources Division of Northern Affairs Program authorized, by means of a letter dated June 10, 1987, Mr. M. Stepanek, P. Eng., of Geo-Engineering (M.S.T.) Ltd. to inspect the geotechnical aspects of Curragh Resources mining operations in the Faro area. The site visit has been undertaken on June 17 and 18, 1987 in the company of Mr. H.F. McAlpine, P. Eng. We have reviewed the physical, hydrological and geotechnical aspects of the current operations, namely:

- Fresh Water Reservoir dam,
- Down Valley Tailings scheme, including Rose Creek diversion channel,
- waste dumps (random selected segments),
- North Fork causeway, and
- main pit.

The purpose of the site visit was to examine the surface appearance of these facilities and evaluate, on that basis, their current and probable future performance.

In addition, we have visited the proposed Grum and Vangorda mine areas. The main objective of this reconnaissance was to familiarize ourselves with terrain conditions relative to the planned mining facilities.

During the field reconnaissance, we have received assistance from Mr. Roy Bourke, Mr. Jack Bowers and Mr. Robert McLelane, representing Curragh Resources. Our views and interpretations of the features indicating possibly deficient performance of some of the facilities were discussed, during our site visit, with these company representatives.

2.0 FRESH WATER RESERVOIR

The dam is approximately 410 m long and a maximum 20 m high and was constructed in 1968 using local materials. The design crest width was 6 m and the upstream and downstream side slopes were 2.5H:1V and 2H:1V, respectively. At its highest section, the dam is founded on up to about 11 m of predominantly silty sand and gravel deposits, including glacial outwash and till materials. The abutment sections reportedly rest directly on the biotite-schist bedrock.

A spillway, equipped with stoplogs is located at the northern abutment, and a low level outlet pipe is under the maximum dam section, near the south abutment. The spillway is 30 m wide and consists of a concrete sill with 3.5 m high wing walls. The discharge channel bed is formed by boulder and cobble covered bedrock while its banks are eroded overburden.

The existing dam was constructed as a zoned embankment. It has a core, keyed into the foundation, and upstream seepage control blanket. However, due to the similarity of materials used for the construction, the dam is actually a near homogeneous fill embankment, comprised predominantly of a silty till ("dirty gravel"). The fill is apparently competent and it is expected to have a relatively high shearing strength.

High seepage pressures are indicated for both the existing dam and its foundation. Seepages were recorded along the downstream toe of the dam during the initial filling of the reservoir and a toe support berm was constructed to enhance the dam stability. Seepages downstream from this berm adversely affect the ground bearing capacity due to the uplift.

While the dam and reservoir has been in service for about 20 years, its minimum Factor of Safety against foundation failure is apparently in the range of 1.2 to 1.3. However, localized dam segments could have Factors of Safety lower than those calculated for the foundation failure.

The last complete set of piezometer readings (October, 1985) indicates that the phreatic line below the crest of the dam was approximately 5 m below the water level in the reservoir (BH 85-4) and at the downstream toe 1.8 m above the berm elevation (BH 85-3).

While an office review of dam design and construction documentation was conducted in 1986, no field inspection (except by the mine personnel) has been undertaken until this site visit.

The reservoir was at its full storage level and only one field of stop-logs had been opened on June 18, 1987. Water was flowing over the spillway sill and through the base pipe.

A lift of mine waste (of an unknown thickness) was placed over the crest and coarse rip-rap was dumped over the upstream dam face, probably in 1985 or 1986. The width of the crest ranges from 5 to 7 m.

An almost continuous crack (and locally several subparallel arcuate cracks) traverse the top of the dam (Photo Nos. 1 and 2). In most instances, the crack is located approximately 1.0 to 2.0 m from the upstream dam face. In the middle of the dam (BH 85-4), where the crest is about 5 m wide, the crack reaches a point approximately 4 m away from the upstream edge (Photo 3).

There are localized depressions in the crest. These could have been produced because of an uneven thickness of additionally placed fill, or because of settlement caused by some other types of slope deformations. However, no bulging is visible on either slope of the dam.

Extensive seepages exist along the toe of the downstream face of the dam. In the middle section of the dam and towards its south abutment, wet spots and growth of willows up to a line about 2 m above the ground surface indicate seepage discharges at these locations. Standpipe

BH 85-2 measured 1.8 m pressure head above the surface of the toe support berm (Photo 4).

The ground immediately downstream from the toe berm is saturated and heavy seepage discharges exist throughout this area (Photo 5). The soil is in a loose (or in the case of localized cohesive materials in a soft) state of consistency, confirming existence of high pore pressures.

The existence of extensive cracks in the crest of the dam indicates an unstable upstream slope. The extent of the instability is believed to be serious, especially with respect to known high pore pressure conditions in the dam and its foundation. Therefore, it is recommended that you consider the following actions:

- Request that the owner undertakes an evaluation of the stability of the dam.

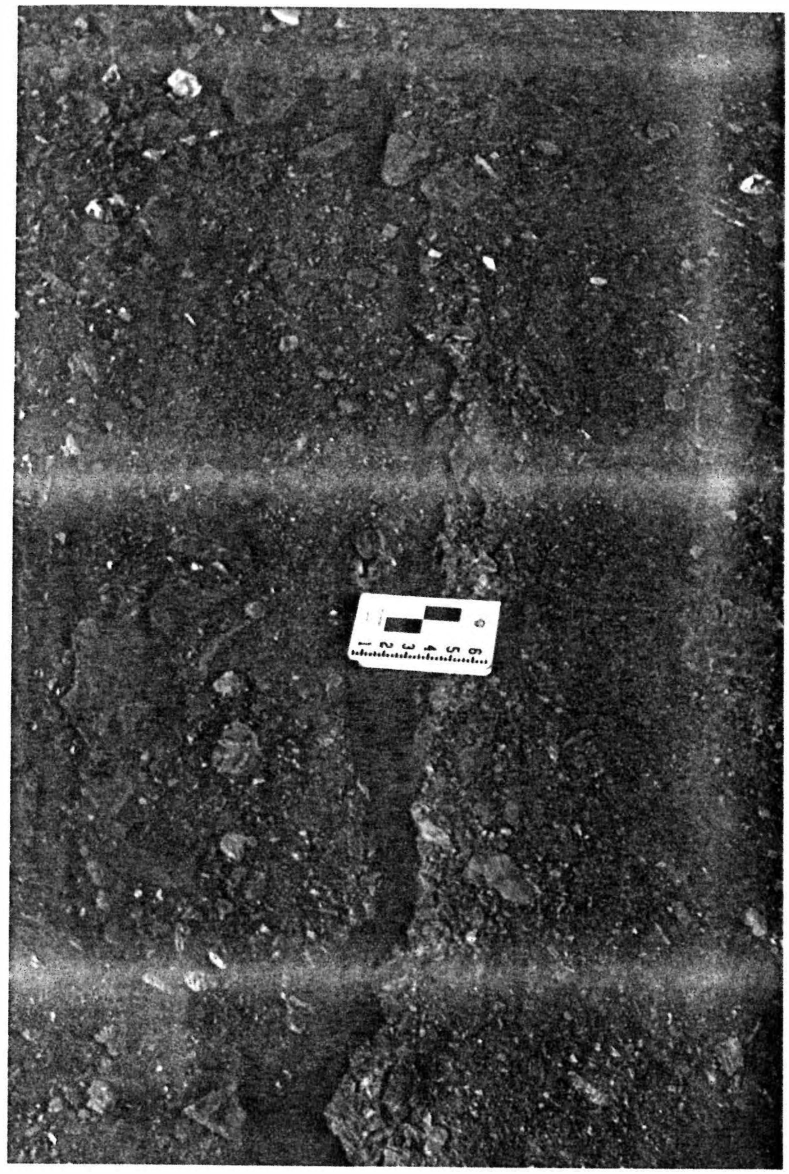
- When evaluating the stability of the dam and its segments, a realistic but most adverse combination of site and reservoir conditions should be considered.

- Request that the owner establishes a schedule of inspections and monitoring (including seepage pressures).

- Depending upon the results of the review, establish operation guidelines for the reservoir and, if necessary, request modifications of the structure to ensure a satisfactory Factor of Safety against foundation or dam failure.

- Institute a system of formal annual inspections and reporting with the objective to assess the dam and reservoir conditions from year to year.

Photos 1 and 2: Cracks encountered on the crest of the dam are fresh, up to 10 cm wide and mostly sub-parallel with the upstream face.



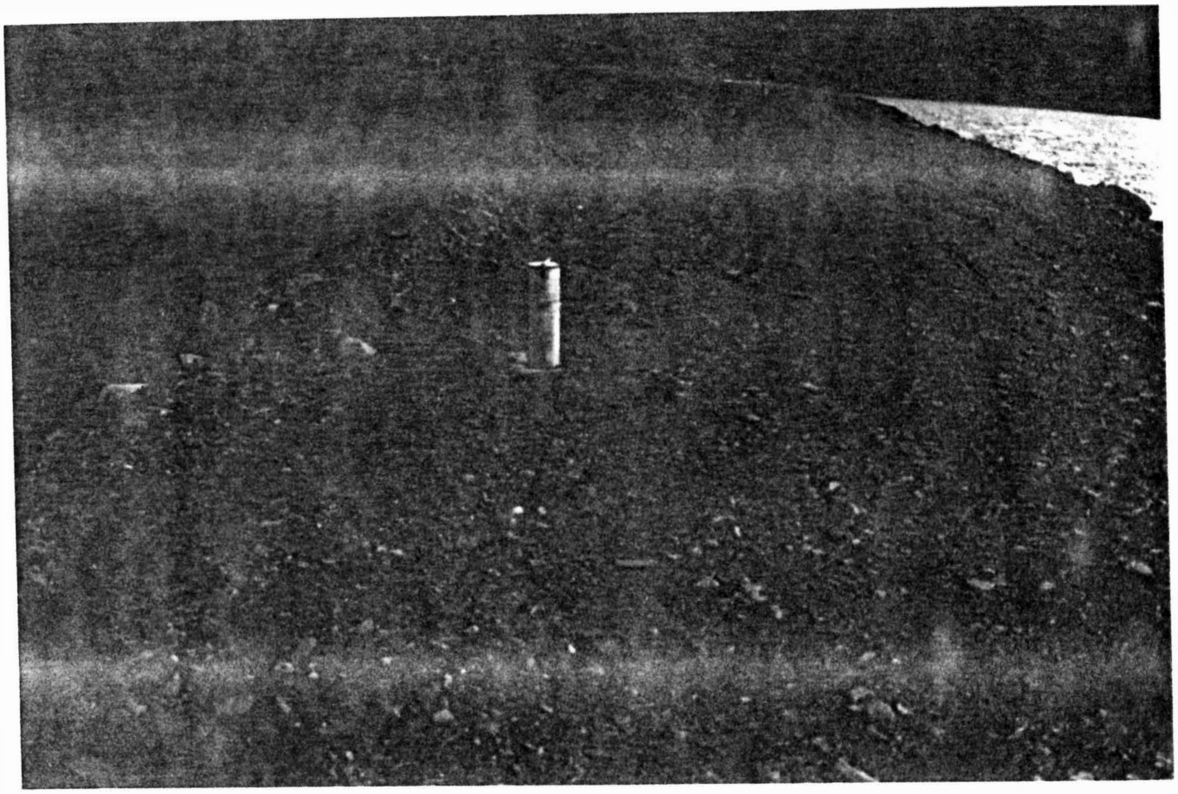


Photo 3: An arcuate crack is only 2 m away from the downstream edge of the the crest in the centre of the dam (at test hole BH 85-4).

Photo 4: Standpipe BH 85-2 measured 1.8 m pressure head above the toe berm. Note the seepage surfacing at the toe.

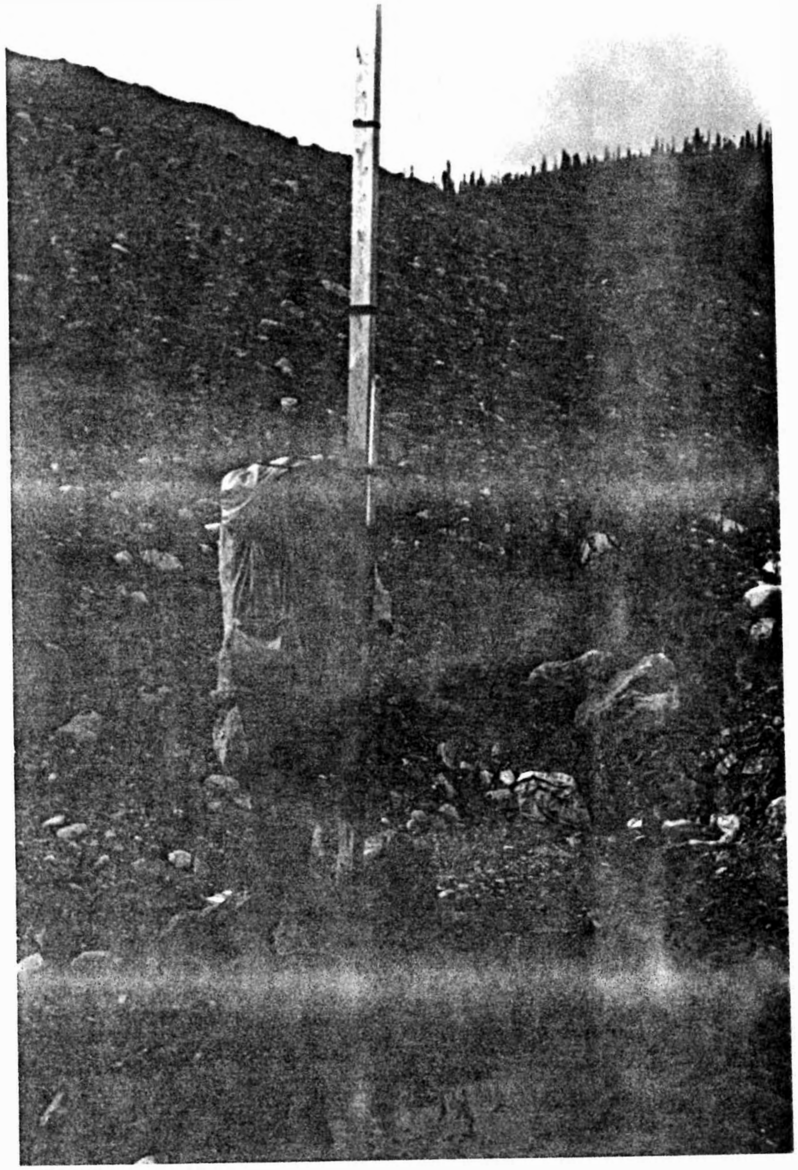
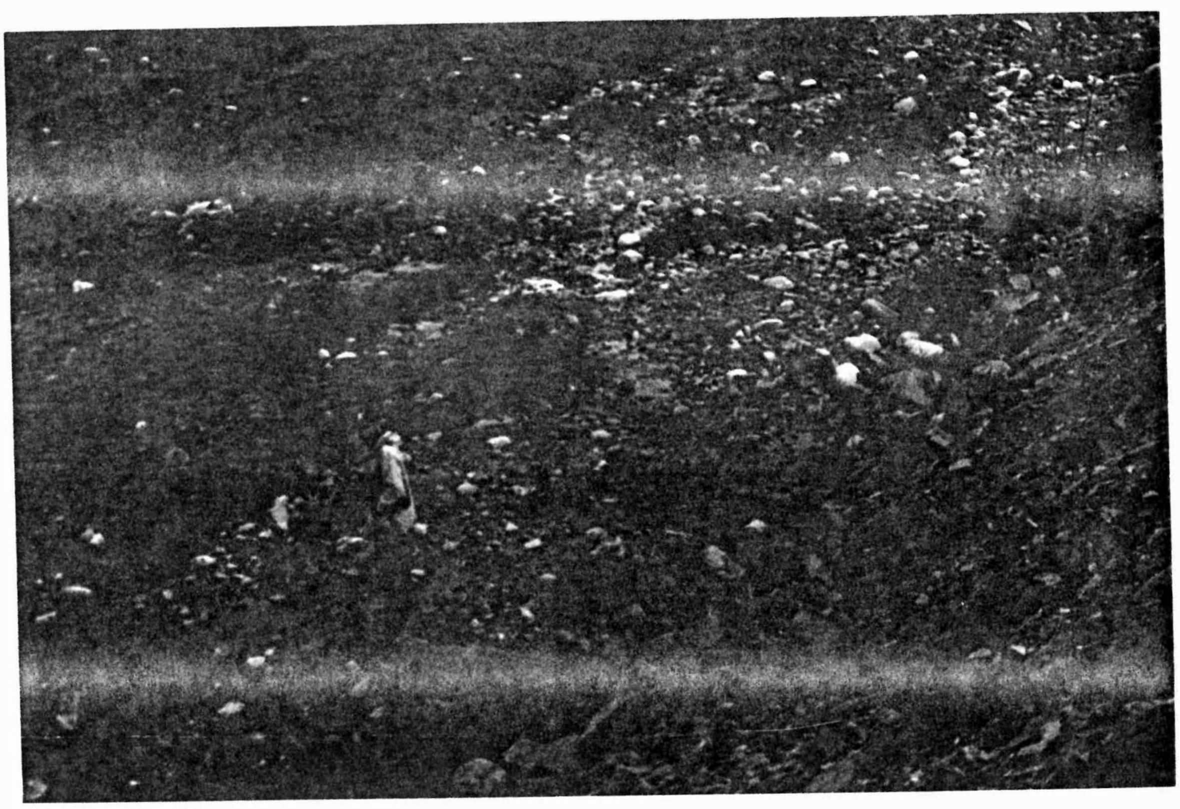


Photo 5: Heavy seepage along the toe berm.



3.0 DOWN VALLEY TAILINGS SCHEME

This facility, constructed in 1981, consists of a Rose Creek Diversion channel, tailings pond formed by an Intermediate Dam and a retention pond formed by the Cross Valley Dam (Figure 1). The original tailings ponds are located immediately upstream from the new facility.

The tailings have been discharged into the new pond since June 1986, when Curragh Resources resumed the milling operations. It appears that tailings were occasionally discharged into the original pond as well. The total volume of tailings deposited in 1986 into the pond was 5.8×10^6 m^3 and water 3.3×10^6 m^3. It is estimated that volume of water discharged from the facility was 7.6×10^6 m^3.

A geotechnical monitoring of the Diversion Channel, Intermediate Dam and Cross Valley Dam was initiated in December 1981. A report dated March, 1987, prepared by Golder Associates, summarizes the results of this program until the end of 1986.

In the Curragh Resources 1986 report of water use, the company accepted maintenance measures recommended by their geotechnical consultant and planned to undertake the following work this year:

1 o repair a portion of the disturbed thermal liner to assess the effectiveness of such work,

2 o repair the channel and dyke disturbed by access to the quarry,

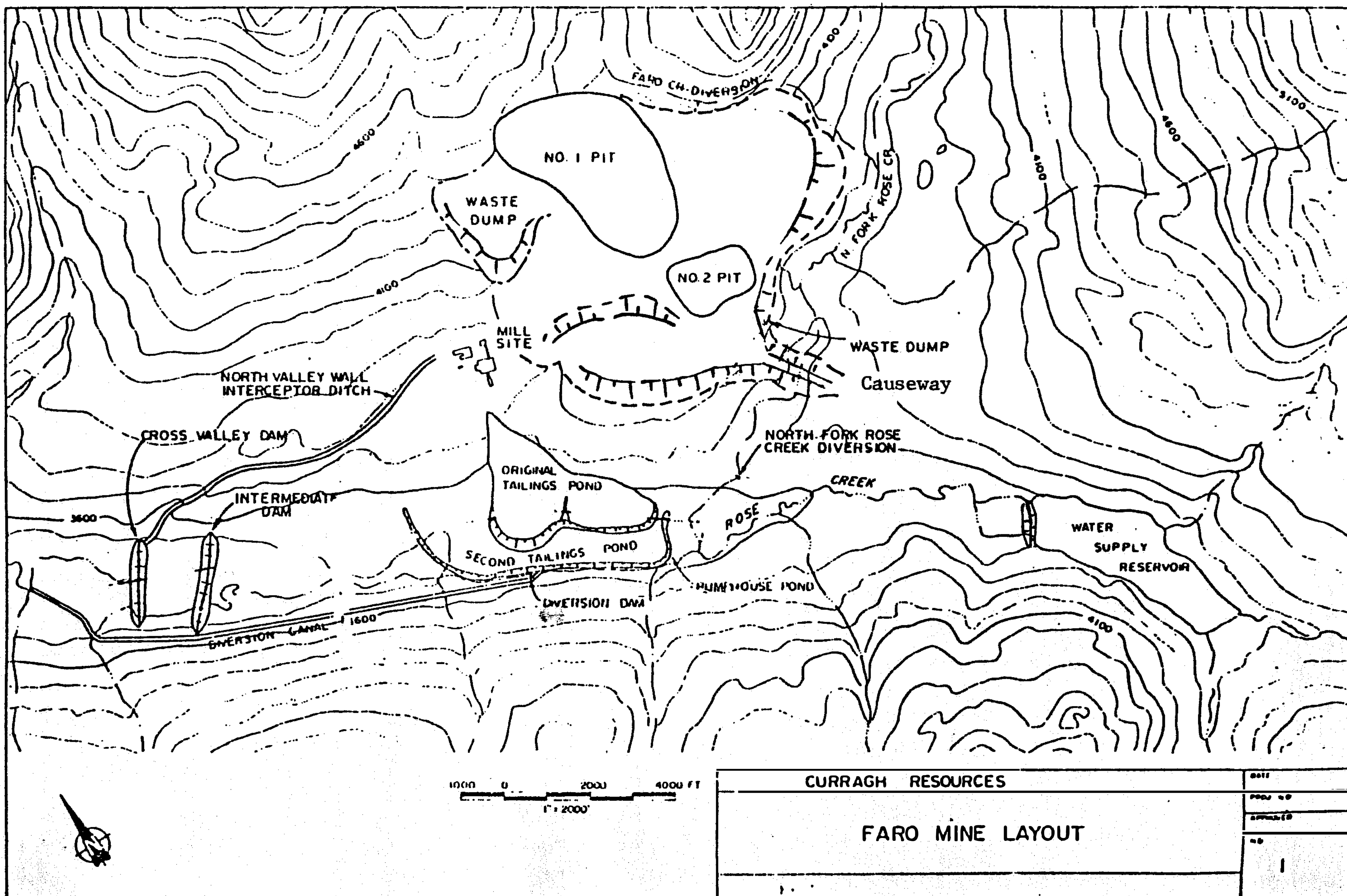
3 o install a sedimentation benchmark for the canal and initiate a sediment survey,

4 o place rip-rap in the drop weir canal section,

5 o repair all dams, weirs and spillways as necessary,

6 o construct a tower to allow spiggotting of the tailings upstream from the Intermediate Dam,

7 o repair No. 6 weir and install a weir at X23.


FARO CH. DIVERSION
NO. 1 PIT
WASTE DUMP
NO. 2 PIT
N. FORK ROSE CR.
MILL SITE
WASTE DUMP
Causeway
NORTH VALLEY WALL INTERCEPTOR DITCH
CROSS VALLEY DAM
NORTH FORK ROSE CREEK DIVERSION
ORIGINAL TAILINGS POND
INTERMEDIATE DAM
ROSE
CREEK
WATER SUPPLY RESERVOIR
SECOND TAILINGS POND
PUMPHOUSE POND
DIVERSION DAM
DIVERSION CANAL
3600
4100
1000 0 2000 4000 FT
1" = 2000'
CURRAGH RESOURCES
FARO MINE LAYOUT
1

None of these actions were initiated prior to June 18, 1987.

We were not involved in any inspection since the facility was completed. The main objective of our visit was to examine the surface appearance of key structures and to evaluate their performance relative to the design objectives.

At the time of the site visit, the flow in the Diversion Channel was above the average summer flow. Water from the tailings pond was continuously decanted into the retention pond. Water level in the retention pond was kept below the elevation of the crest of the decant spillway by syphoning.

3.1 ORIGINAL TAILINGS PONDS

We did not observe any significant deformations on the slopes and crests of the original tailings ponds.

There is a significant volume of seepage discharged into the old diversion canal and along the shore of the new tailings pond. Some of the seepage could originate from the Rose Creek channel. Mr. Gilchrist (Golder Associates) reports a possible increased quantity since 1985.

3.2 ROSE CREEK DIVERSION

The diversion channel performs as designed and its overall apperance is good (Photo 6). The main deficiencies and deformations we have identified are similar to those detailed in 1986 Golder's report. These, in brief, include:

- Minor depressions within the crest of the canal dyke, for example, upstream of borrow pit "I." These are likely associated with local settlement.

- The ramp to the rock quarry cut through the rip-rap layer, filter and into the low permeable liner. This ramp weakened the dyke and destroyed the pilot channel at this location.

- Gulling of the backslope thermal liner at tributary drainages.

- Aggradation of gravel at canal junctions with major drainage courses, such as Goodall and Cornish Creeks. This may, in time, result in blockages of the pilot channel and outflanking of erosion control works.

- Seepage discharges and ponding of water along or below the toe of the canal dyke, such as documented by Photo Nos. 7 and 9. This could adversely affect the stability of the dyke. Presently, the most critical situation is in the area adjacent to borrow pit "I" where a fresh mudflow (Photo 8) is retrogressing towards the dyke. Cracks, quite fresh and up to 10 mm wide, cut across the dyke toe area at this location. The volume of seepage is considerably larger than that experienced during the early stages of the canal operation.

- Localized sloughing of waste piles, possibly due to continuing thaw of deposited materials and subgrade.

- Drop weir sections show localized dislocation of boulders, and in a few instances disturbance of the sidewall rip-rap (Photo 10).

- Channel erosion and aggradation downstream from the last weir (Photo 11).

The inspection confirms that ongoing maintenance is required if the diversion channel integrity is to be ensured. Main concerns at the present are:

- stability of the canal dyke,
- stability of the drop weir sections,
- stability of the creek channel immediately downstream from the diversion outfall, and
- sediment transport.

We believe that the maintenance works the company is planning for this year will enhance the performance of the canal. It appears, however, that the stability conditions of the terrain in the vicinity of former borrow pit 'I" have deteriorated. It is recommended that in addition to the already planned works, the following actions be considered:

- improvement of drainage and stability conditions in the borrow pit "I" area,

- regular (at least monthly during the warm season) visual monitoring of cracks and stability aspects of this area,

- development of stabilization measures should a retrogressive failure be indicated, and

- draining of the water ponded along the toe of the canal dyke at other locations as well.

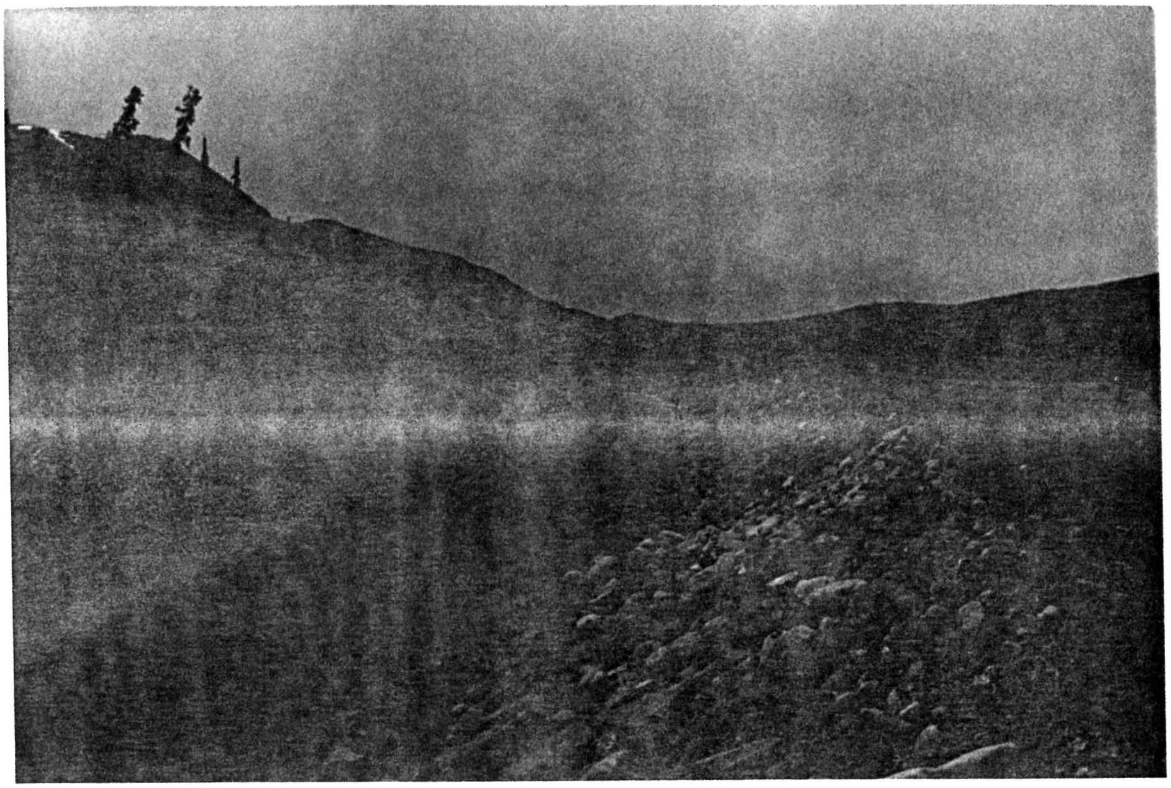


Photo 6: View of the diversion channel looking downstream. Note aggradation of material at a small tributary outfall.

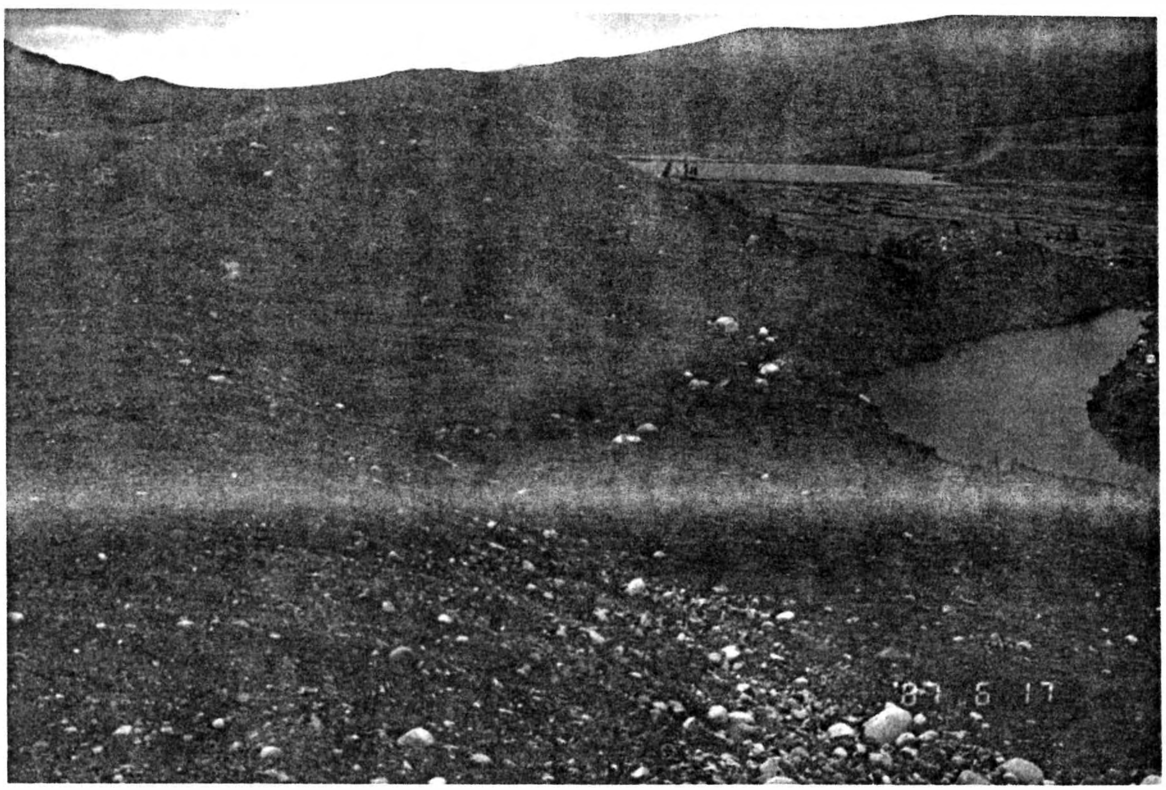


Photo 7: Seepage discharges into borrow pit "I." The borrow pit slopes are unstable. There are fissures and cracks on the face of the dyke and along its toe.

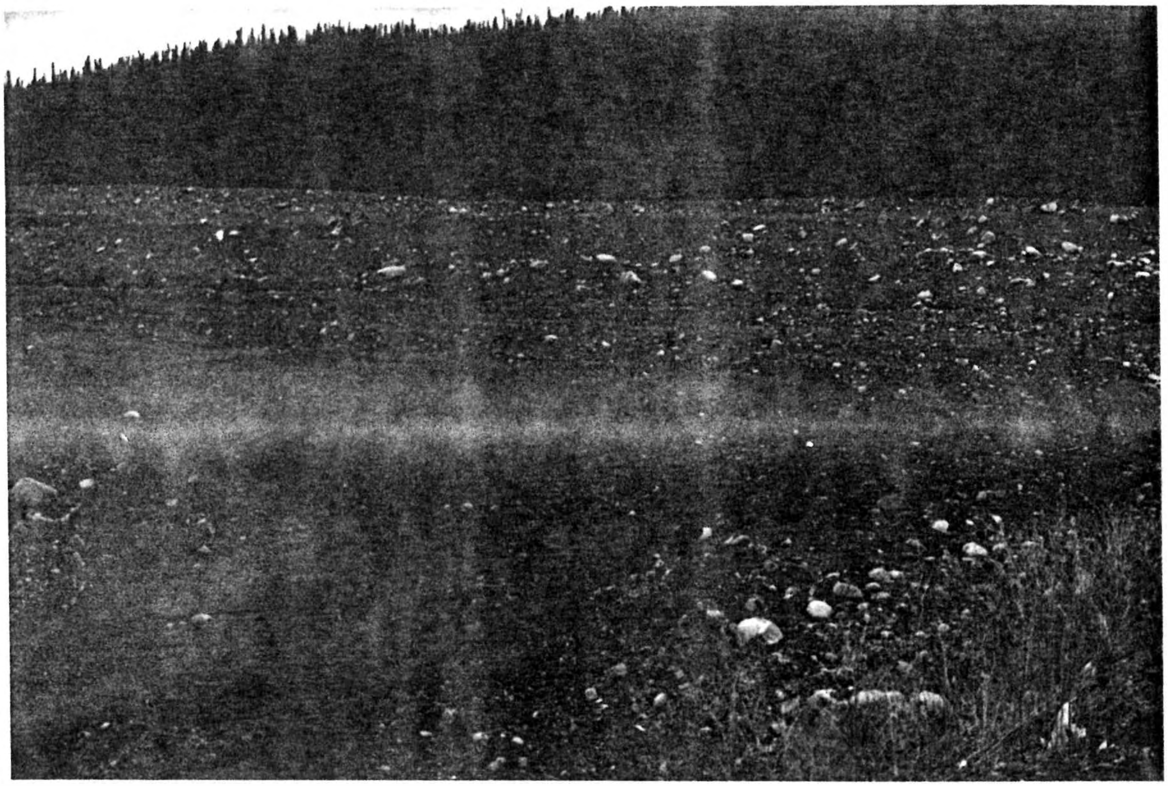


Photo 8: View of recent mudflow retrogressing towards the canal dyke.

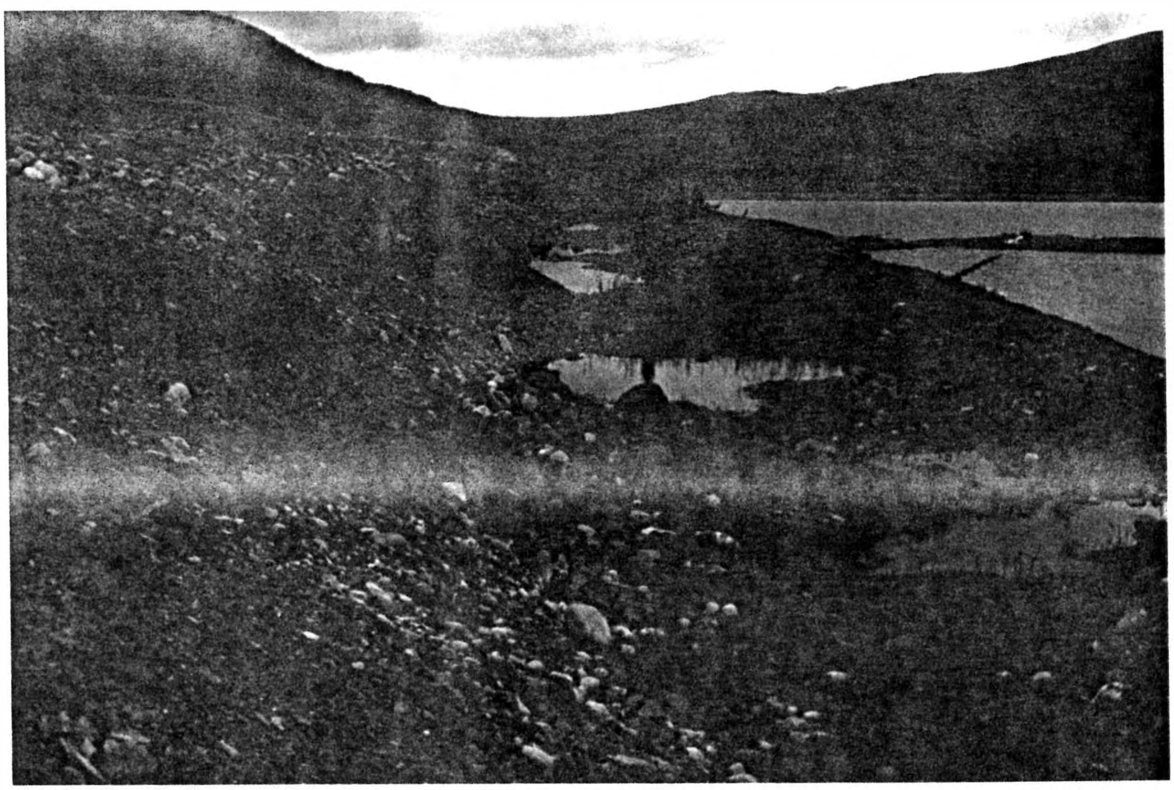


Photo 9: Seepage from the canal is ponded in localized depressions along the toe of the dyke.

Photo 10: Upper segment of drop weirs. Note individual blocks displaced from their original positions.

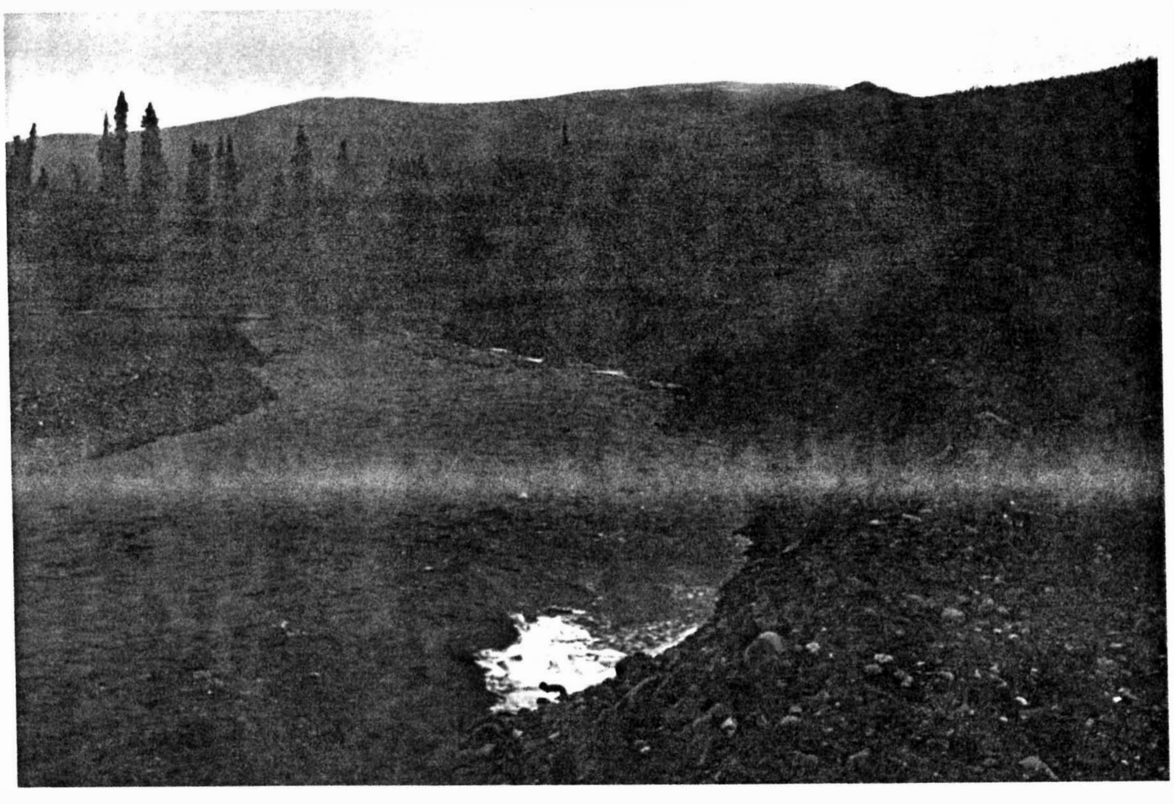


Photo 11: Diversion canal outfall. Note gravel bar on left and eroding bank on right side.

3.3 INTERMEDIATE DAM

Water level in the tailings pond was only slightly below the sill elevation of the emergency spillway, controlled by the overflow through the decant channel (Photo 12).

Clean-up of the emergency spillway is required. It would be prudent to grade the sill by selective placement of heavy rip-rap.

A crack paralleling the upstream edge of the crest in the south sector of the dam (reported by Golder in 1986) is partly effaced. The probable cause is differential settlement between the core and granular facing of the dam or freeze-thawing of the upstream shell. It is our opinion that this crack has little significance insofar as the stability and integrity of the dam is concerned.

The north abutment is stable. The south abutment upstream from the dam is affected by a number of shallow instabilities. These chiefly take place within the waste dumps, deposited over the original slope during the diversion canal construction.

The stability of the south abutment should be monitored because of ongoing thaw of permafrost. However, there is very little surface evidence of the subgrade deterioration to date.

In concluding, the integrity of the Intermediate Dam is currently governed by the stability of both spillways. Consequently, these structures should be carefully maintained and monitored.

3.4 CROSS VALLEY DAM

This dam is located approximately 500 m downstream from the intermediate structure. It is almost 20 m high above the valley floor and more than 500 m wide, and was constructed to its ultimate elevation

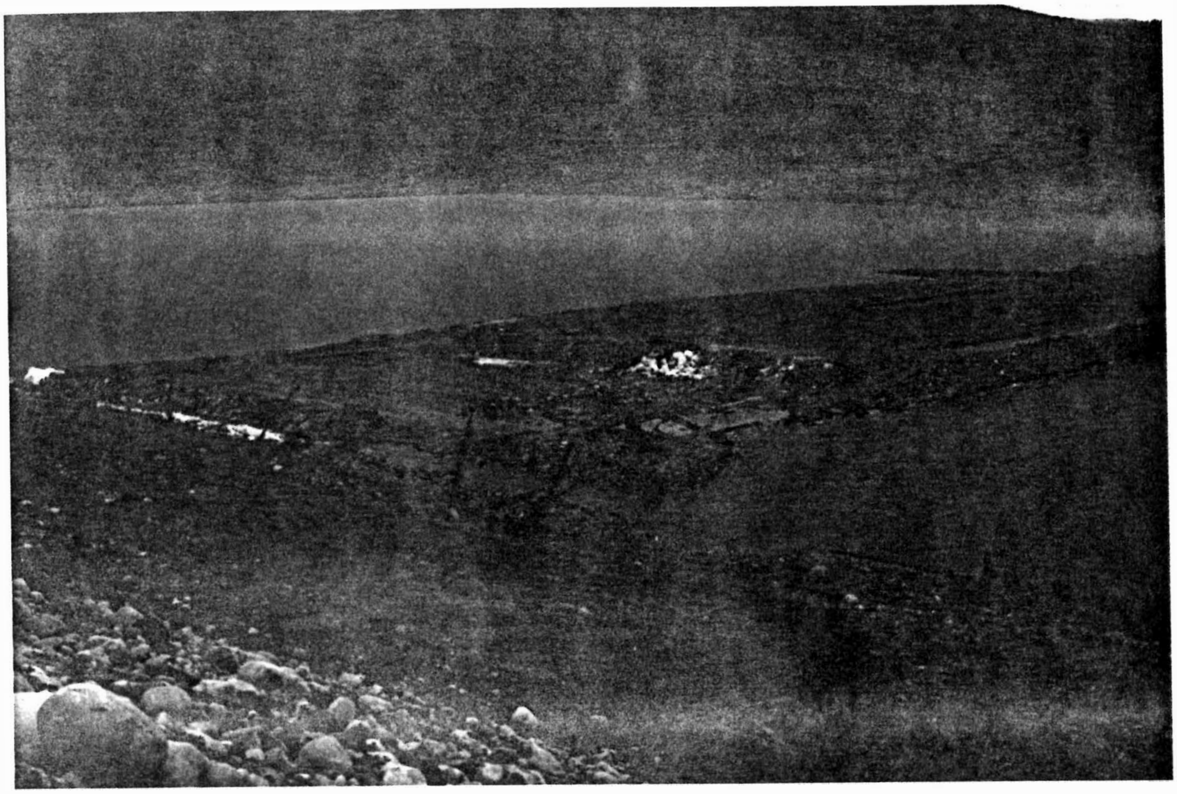


Photo 12: View of the decant, emergency spillway and adjacent embankment of the Intermediate Dam. The integrity of this structure, at the present time, is governed by the stability of both spillways.

(1066 m a.s.l.). Cross Valley dam represents a key structure ensuring the design objectives of the entire Down Valley scheme.

The dam thermal regime, distribution of pore pressures, ground movement and seepages are monitored by the company personnel. Some of the monitoring data (except piezometer readings) are presented and summarized in Golder's 1986 report.

Our examination of the dam crest revealed existence of cracks which are locally arcuate and elsewhere subparallel with the upstream edge (Photo Nos. 13 and 14). The width of cracks range from 5 mm to 75 mm. They probably occurred relatively recently since they were not observed by Mr. H.G. Gilchrist during his October, 1986 site inspection. However, no major deformations have been identified on either slope of the dam.

Since the cracks are, in most instances, closer to the upstream edge (except the centre of the dam and at the south abutment where they are approximately in the middle of the crest) settlement or an instability of the upstream face of the dam is suspected. This deformation may be influenced by the reported increase in the piezometric levels beneath the upstream blanket (between October, 1984 and October, 1986 in the range of 1.4 to 2.8 m) as well as beneath the core (between 0.88 and 2.26 m). A detailed survey of the cracks and review and analysis of soil and pore pressure data should be undertaken in order to determine the probable causes and to evaluate the possible consequences of these deformations.

Heavy seepages occur at both dam abutments and along the dam toe (Photo Nos. 15 and 16). The total seepage flow (measured at weir W3) reached a peak volume of 128 l/sec (1685 igpm) in July and August, 1986. The volume of seepage discharged from both abutments is quite similar, approximately 18 l/sec (240 igpm) at each one. Consideration should be given to the fact that additional flow occurs below the ground surface and bypasses the measuring stations. It is our opinion that the apparent decrease in seepage flows at the onset of winter is caused by frost penetrating the ground and driving the seepage flow, at least in some areas, underground. The available data confirms a relationship between the water level in the reservoir and surface seepage flow.

While the volume of apparent seepage is high, reduction of percolation capability of the surface material may result in increased pore pressure and be detrimental to the dam stability.

Examination of decant and emergency spillways revealed significant erosion and channelization.

It is our opinion that the extent of surface cracks observed on the dam and volume of seepage require a thorough evaluation. We recommend that the mining company be requested to undertake:

- detailed surveys of cracks and recent pore pressures,
- evaluation of the dam stability,
- regular and frequent (for example, monthly) monitoring of piezometers and seepage flows,
- frequent visual inspections of cracks (relative to installed reference points) and other surface features.

In addition, the repairs recommended in the 1986 performance monitoring report should be undertaken, specifically:

- grading and where required armouring of both spillways.

3.5 NORTH INTERCEPTOR DITCH

A brief review of the north valley wall surface runoff collector system confirmed that fairly intensive maintenance and repair work is required. Previous construction activities and erosion caused significant damages to the dykes and locally resulted in blockages of the drainage trench. It appears, that armouring of critical channel sections is required.

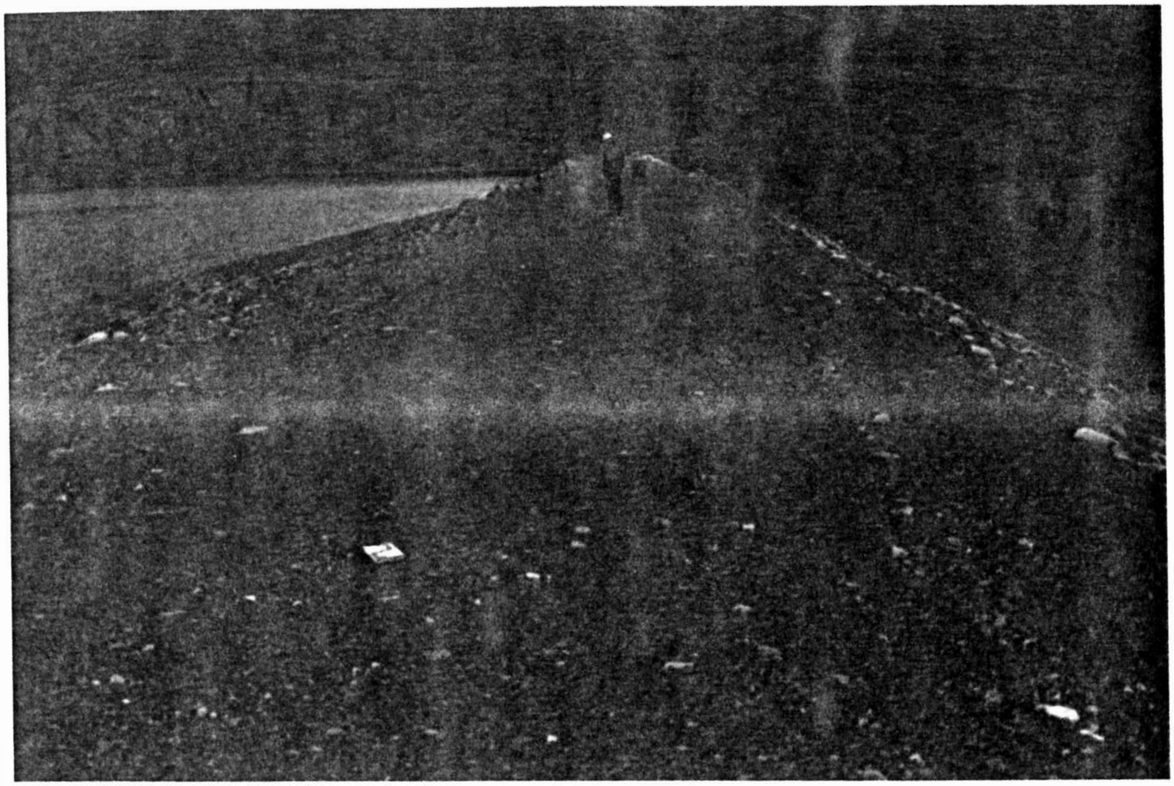


Photo 13: Crest of the Cross Valley dam looking south. An arcuate crack in front; further to the south the crack parallels the upstream edge of the crest.

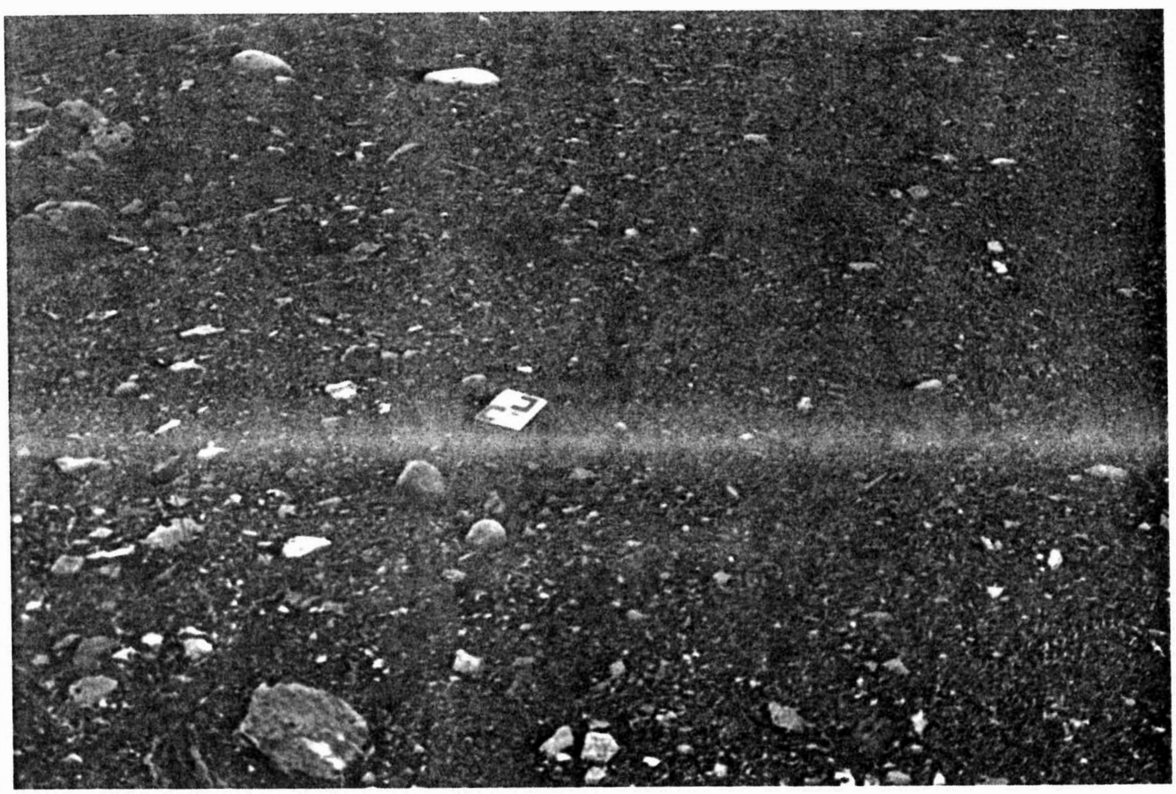


Photo 14: A wide open crack at the south abutment.

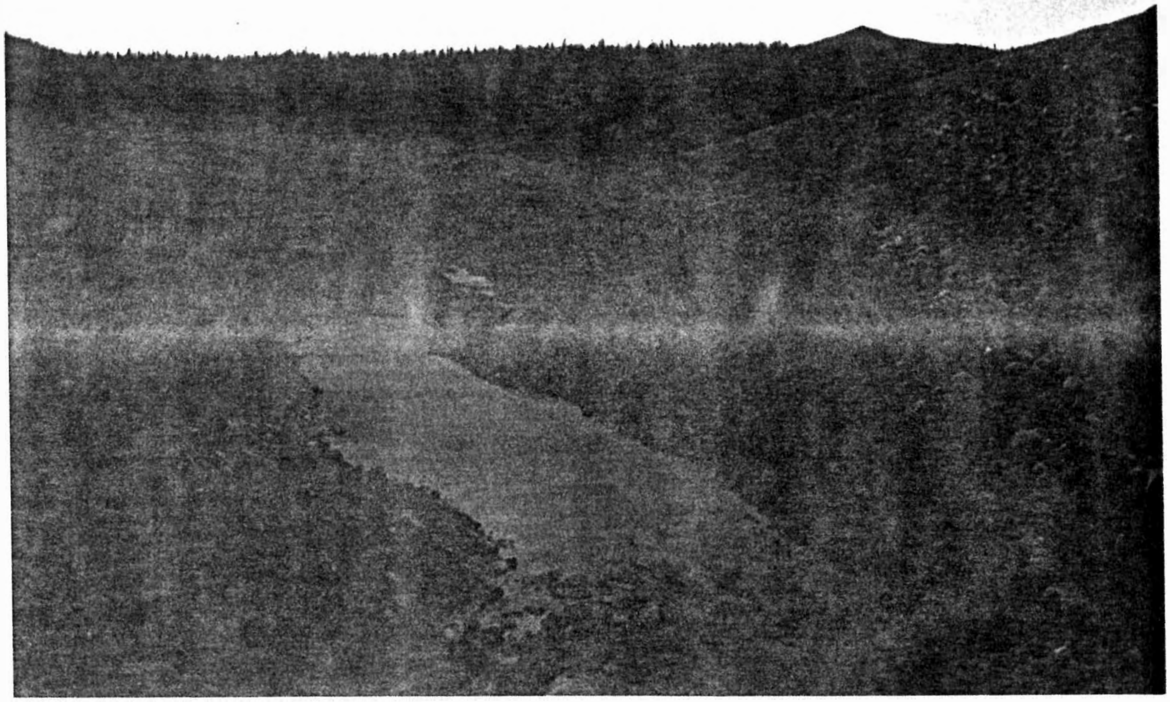


Photo 15: Seepage discharges from the south abutment and along the toe of the dam.

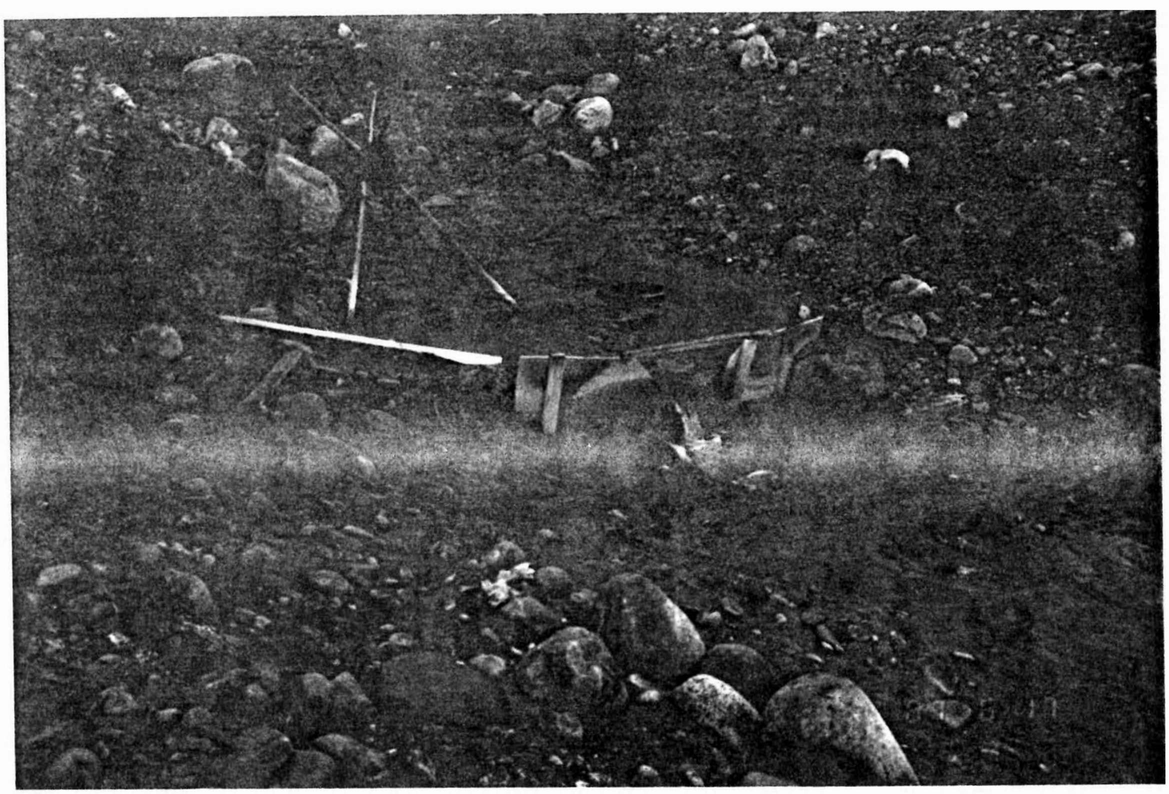


Photo 16: Heavy seepage from the north abutment.

4.0 NORTH FORK CAUSEWAY

The dump across the North Fork of Rose Creek, containing a throughflow drain, was advanced to the north side of the creek channel at the time of the site visit. Select waste rock (gneiss, locally called calcium-silicate rock) is dumped from the crest of the waste pile and large blocks are segregated at the base of the dump and in front of the advancing dump face (Photo 17). As anticipated, the material is segregated on the dump slope. However, there is a considerable variation in the quality and material sizes, both in vertical as well as horizontal directions. Our field observations are summarized below:

- the rock appears to be of medium strength and occasional blocks disintegrate on impact,
- the base layer, comprising very large blocks up to 1.5 m in diameter is only 2 to 3 m thick,
- some of these blocks also break down to smaller fragments upon impact,
- the subgrade (floodplain material) is relatively soft and some large blocks sink into the soil,
- rock fragments, ranging from 0.2 to 0.6 m in diameter, prevail above the basal (very coarse) layer to a level some 7 m above the valley floor (Photo 18). However, pockets of smaller fragments in the 0.05 to 0.1 m range locally occur (Photo 19),
- on the other hand, accummulation of larger sized rock fragments can be encountered at much higher levels above the valley bottom (Photo 20),

- infrequent blocks of schist and mineralized rocks (i.e. containing sulphides) are incorporated into this waste.

Material variation is obviously governed by the quality of the rock at the source, rather than because of construction procedures. This rock is obviously the most competent type locally available and its quality could possibly be correlated to a medium strong sandstone.

Further monitoring of construction procedures, including at least random documentation on rock quality and gradation, will assist in evaluation of the performance of this drain.

It is understood that the mining company did not make any provisions for monitoring of this structure following its completion. It is therefore recommended to request that the company develops and institutes a monitoring program which would provide actual data on the following aspects of this experimental facility:

- flows and levels of impounded water,
- upstream and downstream sediment loadings,
- hydraulic capacity of the drain,
- physical stability of the drain and the adjacent dump sectors.

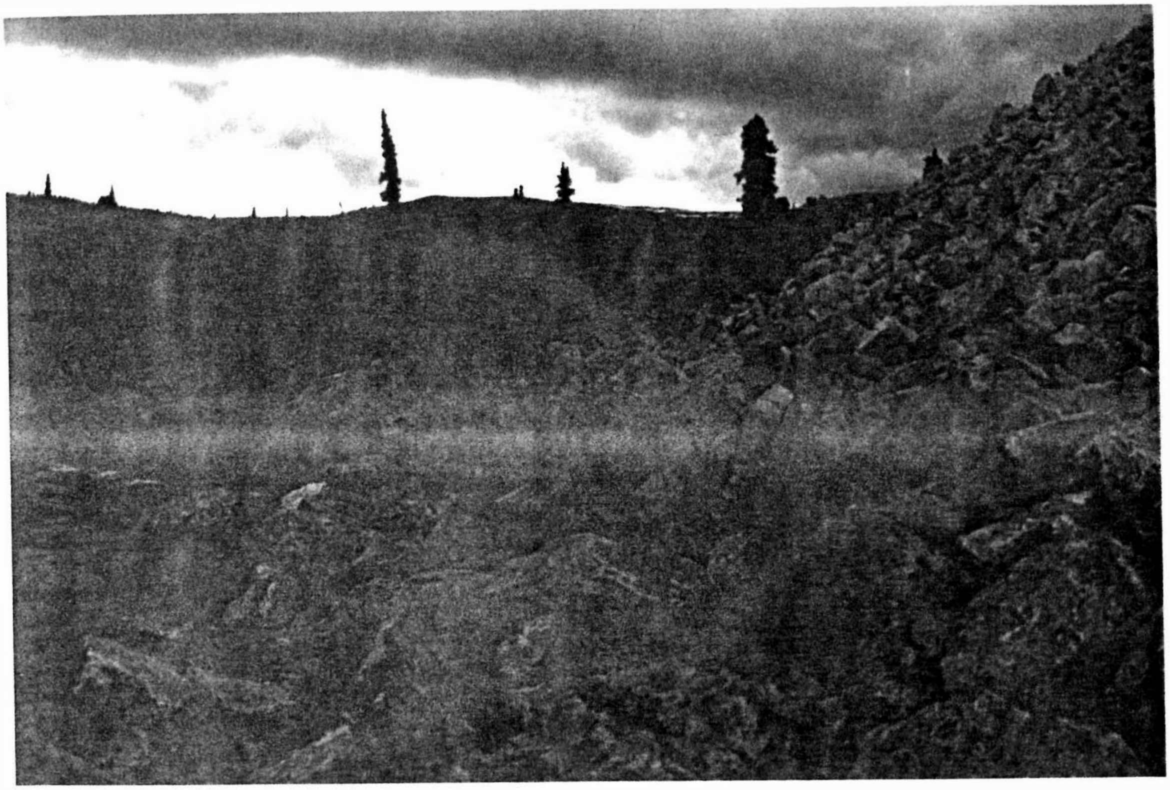


Photo 17: End-dumped boulders forming the base of the drain are 0.5 to 1.5 m in diameter and form a layer 2 to 3 m thick.

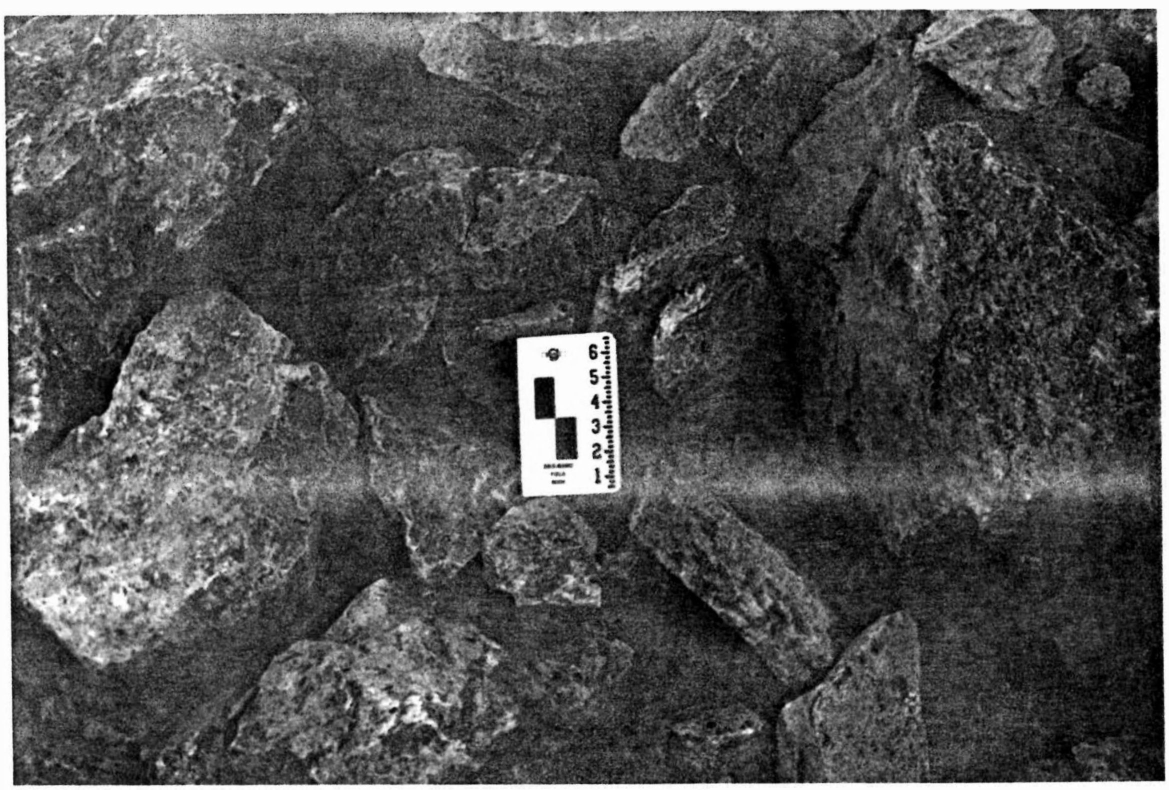


Photo 18: Typical rock sizes (0.2 to 0.6 m in diameter), approximately 5 m above the valley floor.

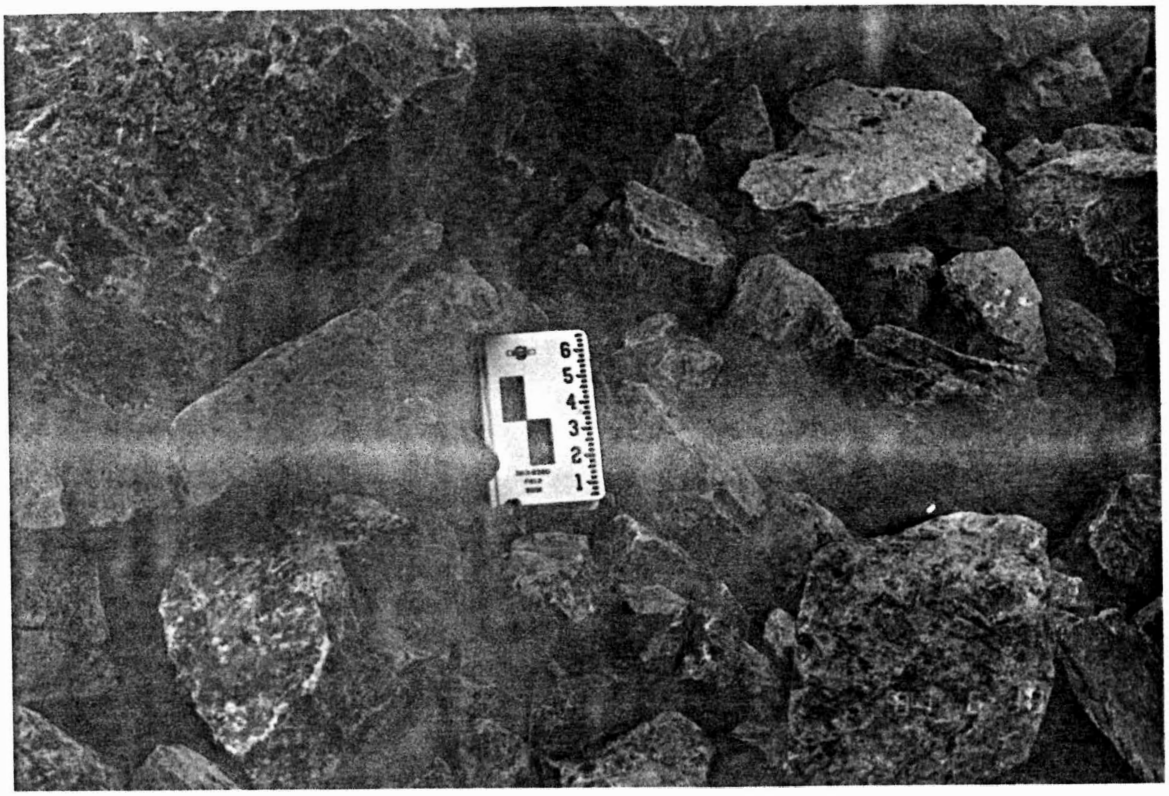


Photo 19: Smaller sized rock is locally encountered. Location - approximately 5 m above valley floor.

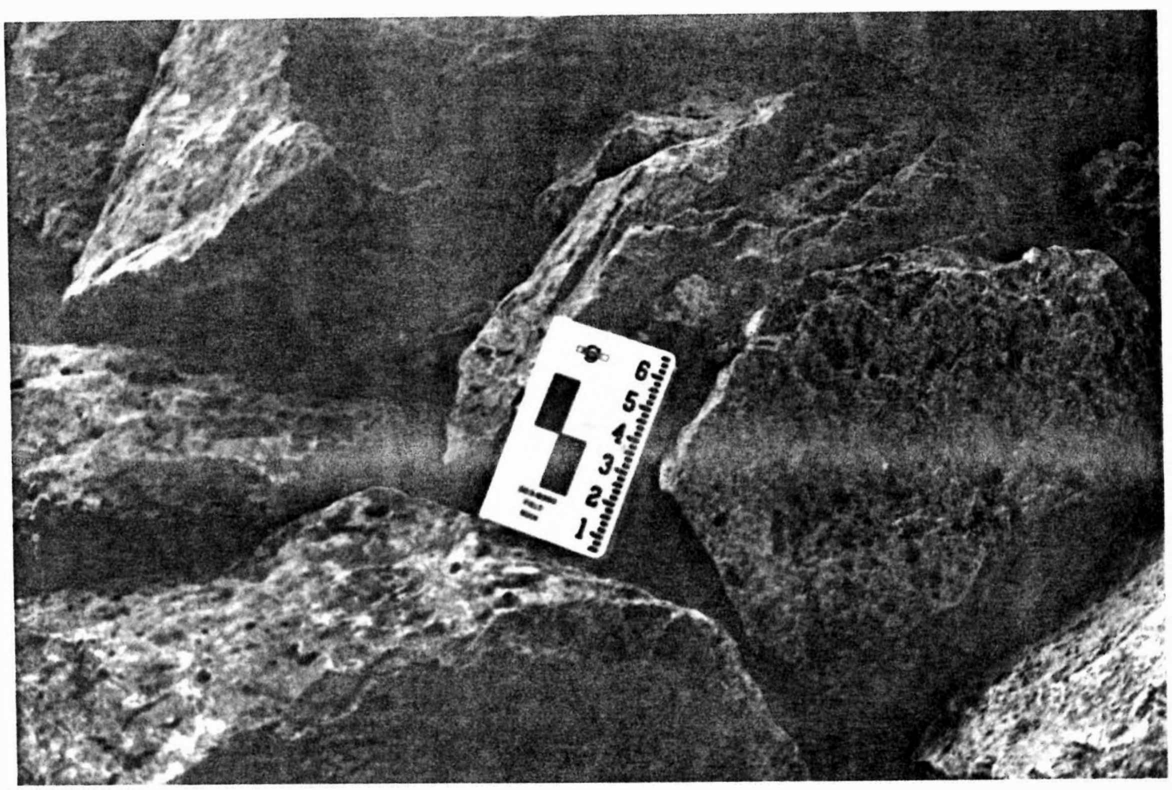


Photo 20: Accummulation of larger blocks 15 m above the valley floor.

5.0 WASTE DUMPS

A few randomly selected waste dump sectors located along the west perimeter of the mine area (chiefly between the North Fork of Rose Creek and relocated Faro Creek) were reviewed.

Mine waste is predominantly comprised of broken fragments of schistose-type rock of low durability. However, larger blocks of more durable gneiss-type rock are relatively frequent. There is a significant variation in the gradation as well as quality of waste rock from one location to another.

The angle of repose of the waste is in the order of 35 degrees. Observation of sporadic exposures in the toe region of the waste dumps indicates that their foundation is comprised of colluvial as well as glacial materials.

The overall stability of these dumps appears to be good. Our inspection revealed localized instabilities such as those documented on Photo Nos. 21 and 22.

While these instabilities are apparently infrequent, they document relatively low Factor of Safety (at least for the dump surfaces) and are indicative of possible long-term stability problems which could locally develop. In our view it would be prudent to:

- acquire a map showing the current configuration of the dump, and

- classify the dumps according to their stability.

Such documentation would form a base for the development of an abandonment plan.

Photo 21: Unstable crest of a waste dump located immediately upstream from the North Fork Causeway.

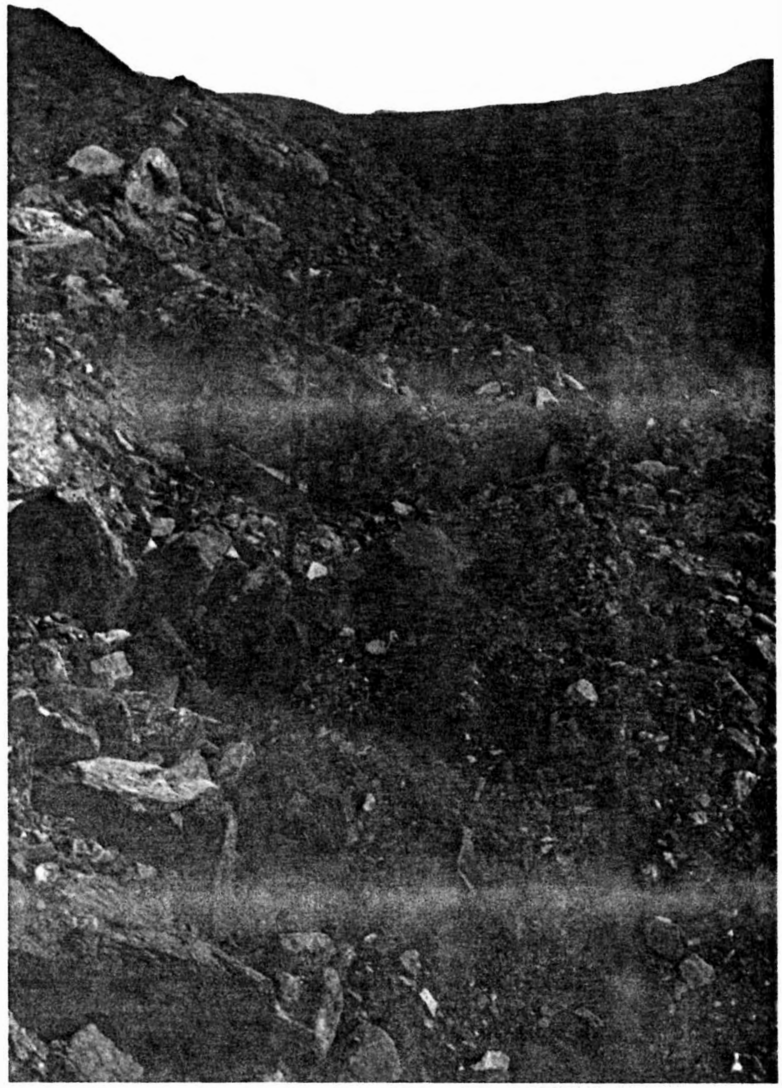
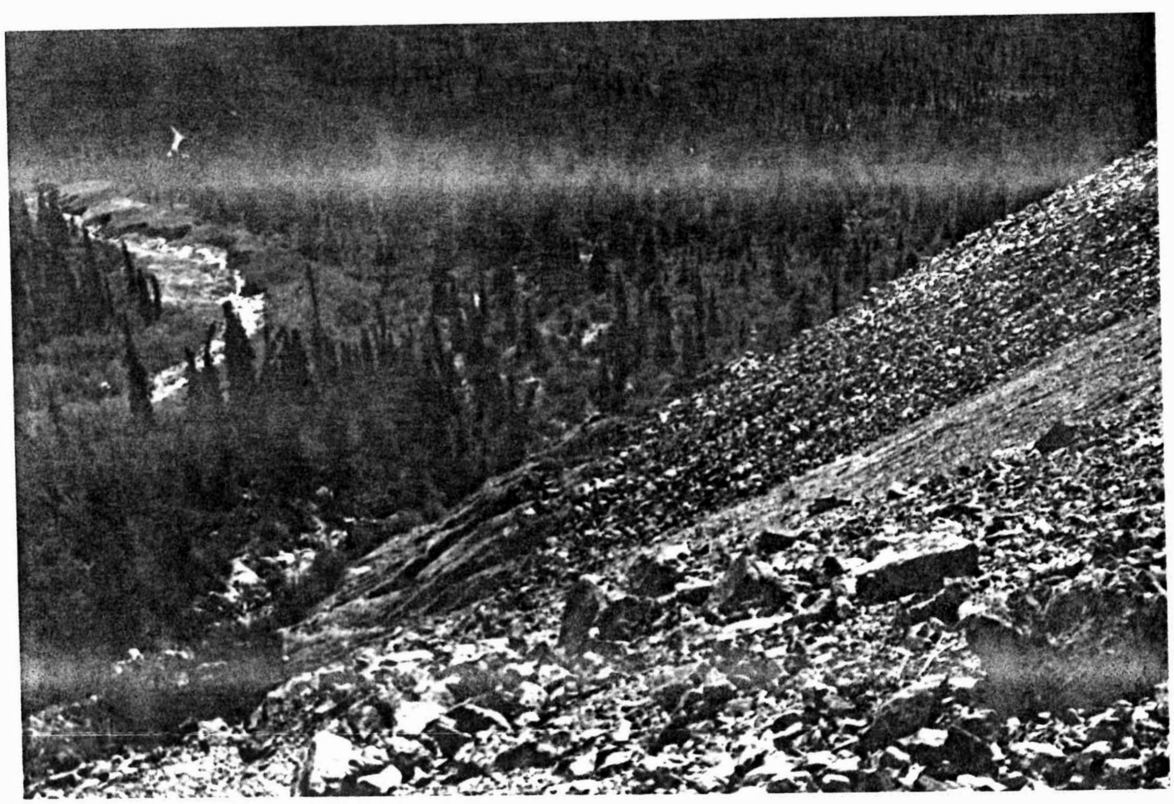


Photo 22: Unstable dump at the relocated Faro Creek.



6.0 GRUM AND VANGORDA MINE AREAS

Curragh Resources presented a conceptual development plan of the Vangorda Plateau deposits in March, 1987. The development of the Grum and Vangorda deposits will eventually replace production from the Faro Pit. Major structures and facilities (Figure 2) which must be put in place prior to the commencement of mining include:

- new haul road,
- Grum deposit dewatering,
- Grum waste dump,
- Vangorda Creek diversion,
- Vangorda pit dewatering,
- Vangorda waste dump
- sedimentation ponds.

The development studies mainly concentrated on the ore deposits exploration. It is our understanding that previously commissioned geotechnical studies primarily considered pit slope conditions while relatively little work has been undertaken for the above listed mine facilities.

6.1 GEOMORPHIC SETTING

Vangorda Plateau encompasses level to gently rolling terrain. Steeper slopes exist along the Vangorda Creek valley which drains this region into the Pelly River, located about 8 km to the southwest. The average elevation at the Grum mine site is 1310 m, although the surrounding region exceeds 1980 m elevation.

Overburden cover consists primarily of morainal and glaciofluvial deposits with a maximum thickness in excess of 100 m (Hole DL-1). These deposits include tills (heterogeneous mixtures of clay, silt, sand, and gravel), uniform silts, sands and gravels. Pockets of permafrost exist

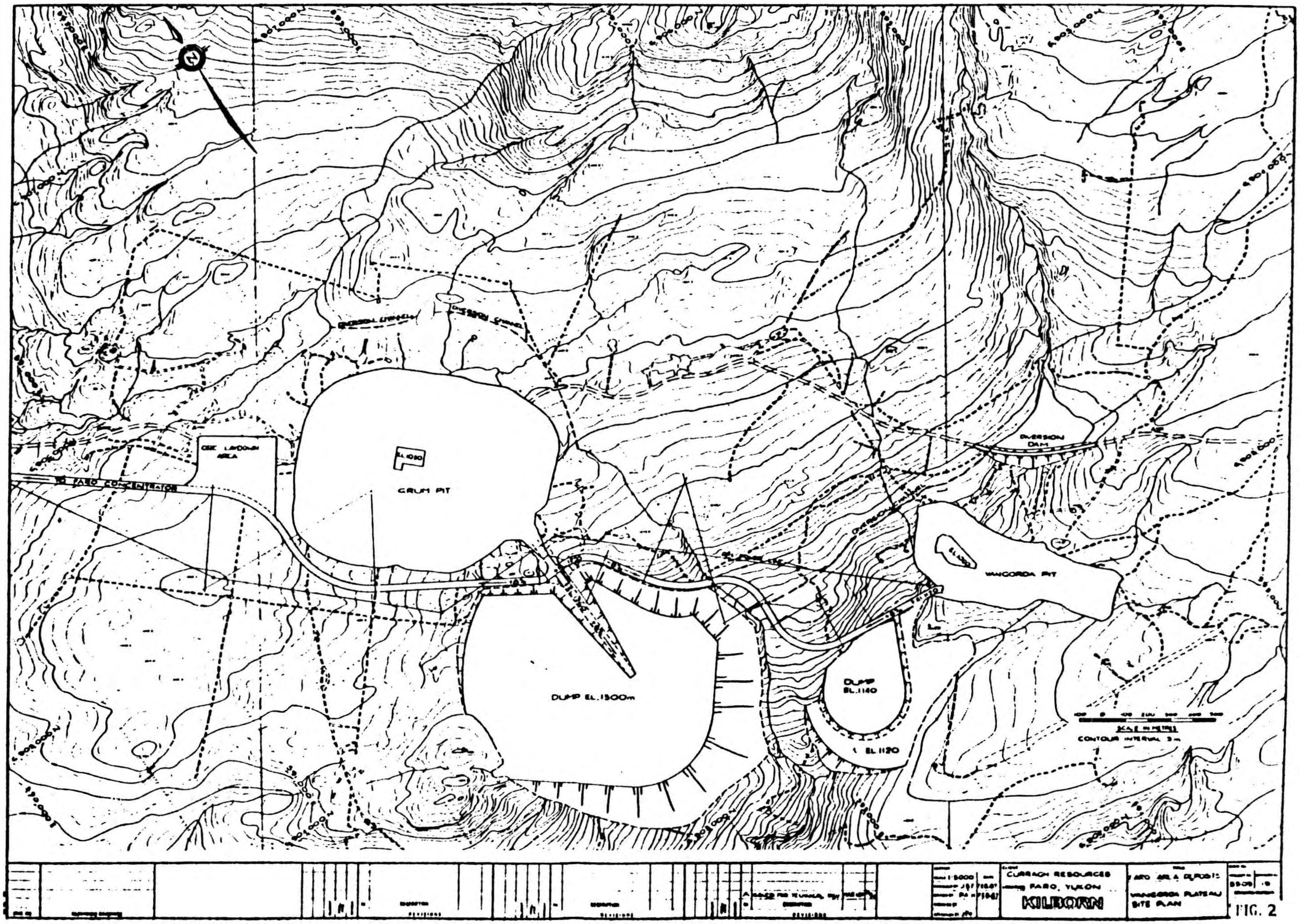

TO FARO CONCENTRATOR
ORE LAYDOWN AREA
GRUM PIT
DIVERSION CHANNEL
DIVERSION DAM
VANGORDA PIT
DUMP EL.1300m
DUMP EL.1140
EL.1120
SCALE IN METRES
CONTOUR INTERVAL 5 m
1:5000
CURRAGH RESOURCES
FARO, YUKON
KILBORN
FARO AREA DEPOSITS
VANGORDA PLATEAU
SITE PLAN

FIG. 2

in the general area. The depth of overburden varies significantly across the Plateau. Bedrock is apparently at shallow depths along the southeast boundary of the proposed Grum pit and in the Vangorda valley. Bedrock exposures exist at the southwest boundary of the proposed Grum waste dump.

Metamorphic rocks forming the southwest flank of the Anvil arch include biotite-muscovite schists, calc-silicate gneiss and biotite-muscovite phyllites. Mineralization in the currently mined Faro pit occurs in the schist whereas the Grum and Vangorda deposits occur within the phyllites.

The Grum Deposit is complex and consists of three to five separate sulphide horizons with appreciable thicknesses of intervening barren phyllite. The ore horizons are contorted into a complex polyphase fold structure.

The Vangorda Deposit is similar to Grum but smaller and shallower. The deposit consists of one major ore horizon which is contorted into a sub-horizontal to slightly northwest plunging fold. Because of the shallow depth of overburden, there is a possibility that oxidation of the Vangorda ores may be significant.

6.2 FIELD OBSERVATIONS AND CONCERNS

While the main objective of the field visit was to review the general terrain conditions, an attempt has been made to correlate the setting with the existing conceptual plan of the proposed mining activities. This resulted in some concerns, briefly summarized below:

- Grum pit area should be drained, including Doal Lake. This will result in increased flows along the east boundary of the proposed waste dump. The proximity of this drainage channel to the dump, its stability and possible sediment transport should be examined in detail.

- Dewatering of the Grum pit (and possibly of the Vangorda pit as well) will likely produce large volume of water which will be discharged into the surface drainage system. Both physical as well as chemical impacts should be reviewed.

- While the overall terrain configuration of the area designated for the disposition of waste from the Grum pit appears to be suitable for the dump (Photo 23), there are localized zones comprising soft overburden and minor drainage courses (Photo 24). A detailed evaluation of the foundation conditions with the emphasis on the final dump configuration is required.

- A large volume of till overburden would be apparently placed into the Grum waste pile. It is of interest to note that an existing till waste located at the Grum lagoon is unstable (Photo 25).

- Proposed diversion of Vangorda Creek (Photo 26) will be a major problem at the abandonment stage of the operation. It will be impossible to ensure the long-term integrity of the diversion dam and diversion canal without continuous maintenance.

- The location of the Vangorda waste dump within the Vangorda Creek valley would preclude relocation of the stream back into its original channel at the time when mining is suspended. The waste dump would eventually become unstable, providing a significant source of material to be transported downstream.

- There appears to be a more suitable location for this waste dump, within a terrain depression adjacent to the south side of the pit (Photo 28). Two small streams currently flowing into this depression will be cut away from their drainage basins by the pit.

Photo 23: View of the proposed Grum Waste Dump area, looking across the Vangorda Creek valley.

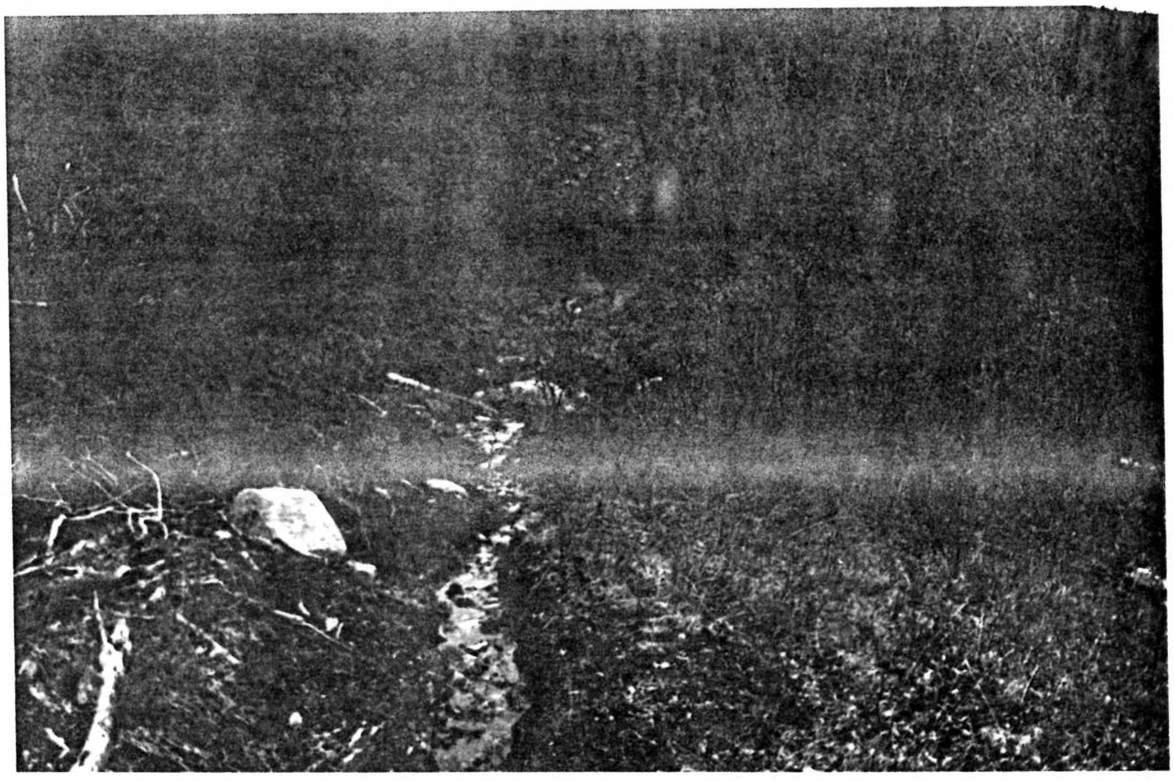


Photo 24: One of minor drainage courses traversing the proposed Grum waste pile area.

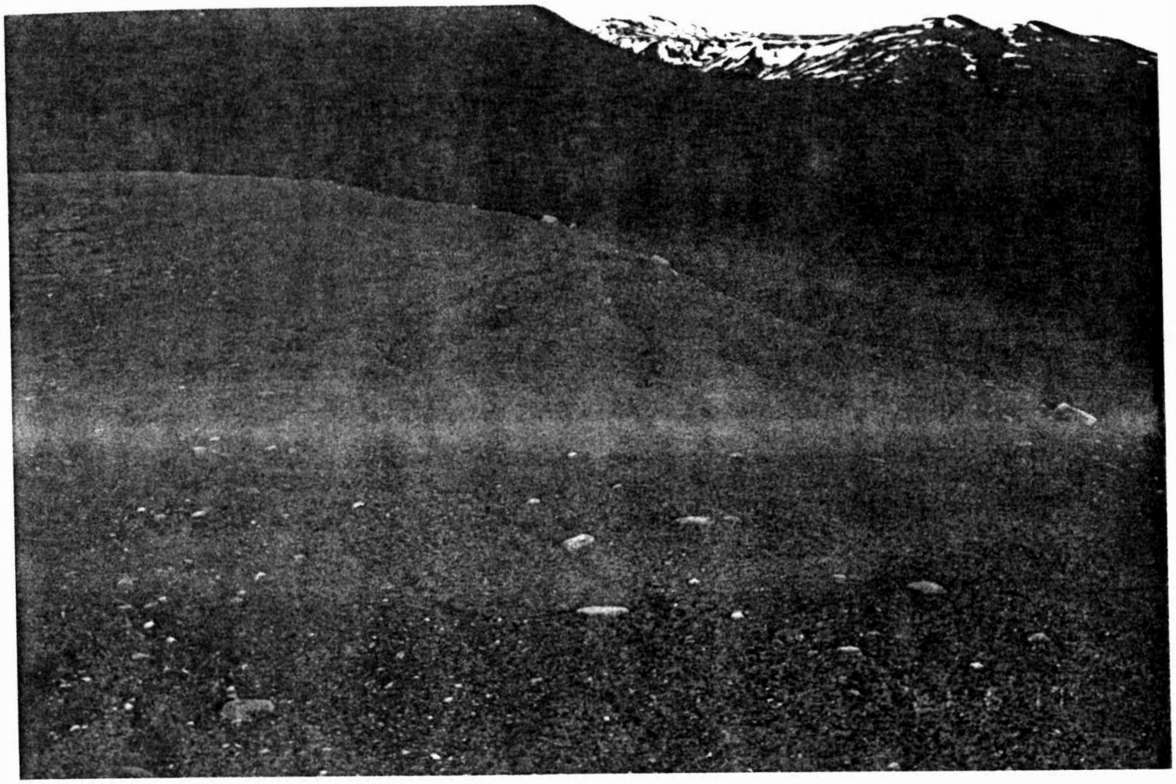


Photo 25: Glacial till waste dump at the existing Grum lagoon is unstable.

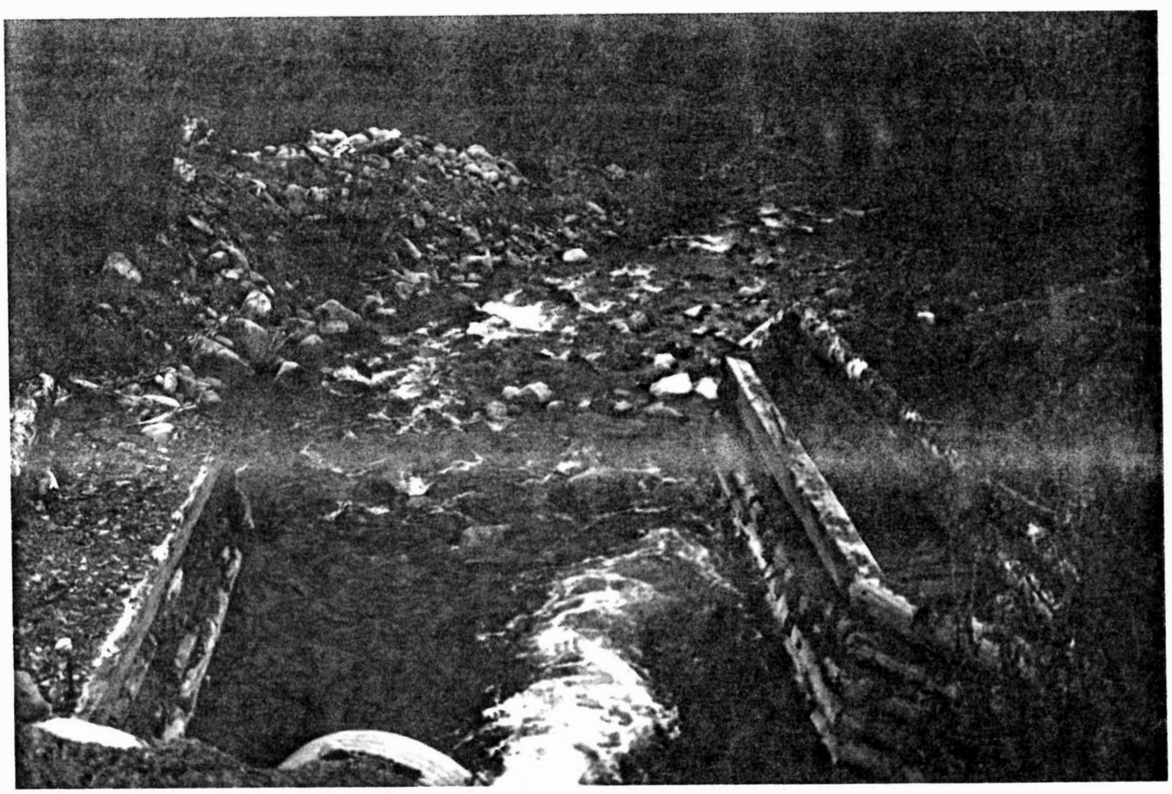


Photo 26: Vangorda Creek at the proposed diversion dam location.

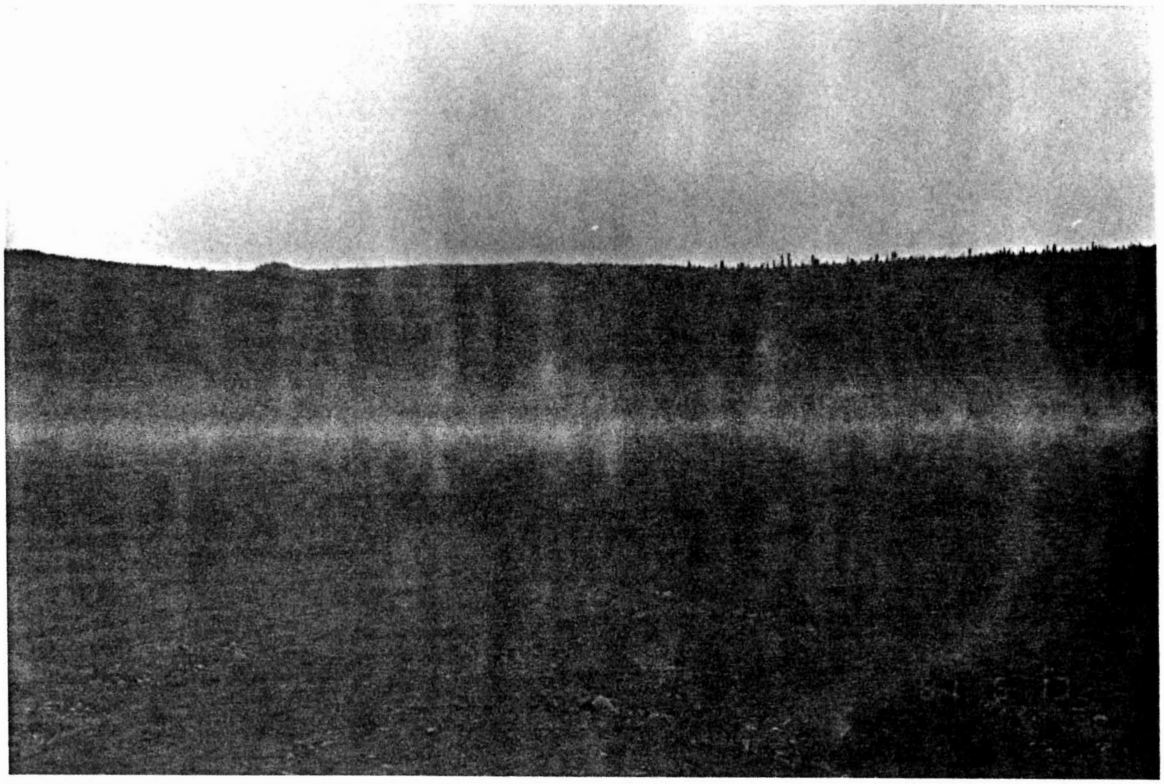


Photo 27: Proposed site of the Vangorda Creek diversion dam.

Photo 28: Terrain depression immediately east of the proposed Vangorda waste dump.

7.0 CLOSURE

The site visit confirmed that the main structures of the Down Valley Scheme perform, at the present time, in accordance with the design objectives. However, significant cracks and heavy seepage encountered on the Cross Valley Dam require detailed evaluation.

The Fresh Water Reservoir Dam experiences similarly adverse conditions.

It is apparent that the Rose Creek Diversion canal requires ongoing and periodical maintenance. It would be of interest to keep records of these maintenance costs.

In general, the waste dumps are stable. Random inspection of one sector confirmed the existence of local instabilities. It would be prudent to evaluate the waste dump stability on a systematic basis.

The construction of the flow through drain and causeway across the North Fork of Rose Creek was in progress. Since this structure is quite significant from the economical as well as hydrological standpoints, the lack of commitment to monitor flow parameters, sediment transport and physical stability is lamentable.

It would be prudent to establish inspection check lists for each major structure to ensure consistency of data and observations made.

The frequency of performance monitoring could be modified. It is possible to reduce the frequency of instrument readings in zones showing no distress or if very little change in data is expected. On the other hand, the monitoring of piezometers and seepages on the Cross Valley Dam and the Fresh Water Reservoir Dam should be more frequent during the warm season than in the past. Installation of reference points for monitoring of cracks is also recommended.

Our review of terrain conditions at the proposed Grum and Vangorda mines resulted in some concerns, namely regarding the stability of waste dumps and diversion of Vangorda Creek.

Respectfully submitted,

GEO-ENGINEERING (M.S.T.) LTD.

Milos Stepanek, M.Sc., P. Eng.
Principal Consultant

MS/jlw#4

G052-4