Poushinsky Consulting Ltd.

VENUS MINE TAILINGS

Study of Remedial Options

PB 6535 0101

MARCH 1994

Klohn-Crippen

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1. INTRODUCTION

1.1 General

The Conrad Gold District (including the area around the Venus mine) has been worked and explored intermittently since the 1920's. During the 1960's a more detailed exploration of the Venus mine was carried out. The mine is located on the west side of Windy Arm adjacent to the paved highway between Carcross, in the Yukon Territory, and Skagway, Alaska. A stamp mill erected in the 1920's below the mine remains and is a popular tourist stop for travellers on the highway.

In the early 1970's a 300 tpd (ton per day) mill was constructed to process ore from the Venus mine. It was located on the east side of the highway, north of the mine/stamp mill location, and approximately 22 km south of Carcross (see Figure 1). Tailings were produced from the short-lived milling operation and were placed in a small natural depression at the edge of Windy Arm (Tagish Lake). The mill has since been dismantled.

There is some concern about the long term environmental stability of the mine tailings. The purpose of this report was to review the remediation options available and to provide a preliminary screening of the options.

The volume of the natural depression which forms the tailings pond was likely enhanced by excavation to form perimeter dikes. These dikes were constructed of uncompacted natural granular material and are pervious structures. Seepage and erosion from the tailings has caused environmental alteration of the lake in the vicinity of the tailings area. It has also resulted in high Arsenic (As) levels in and on natural berries adjacent to the site.

In the early 1980's a mill was constructed at the 'New' Venus Mill site located in British Columbia. The site includes a 100 tpd crushing and milling plant, and was designed to process an additional 100 tpd of the 'old' tailings from the 1970's operation. An engineered tailings impoundment was also constructed to provide storage of mill tailings. The mill had a very short-lived operation prior to shut-down and may only have produced 800 tons of tailings, with effluent from the operation being placed in the impoundment.

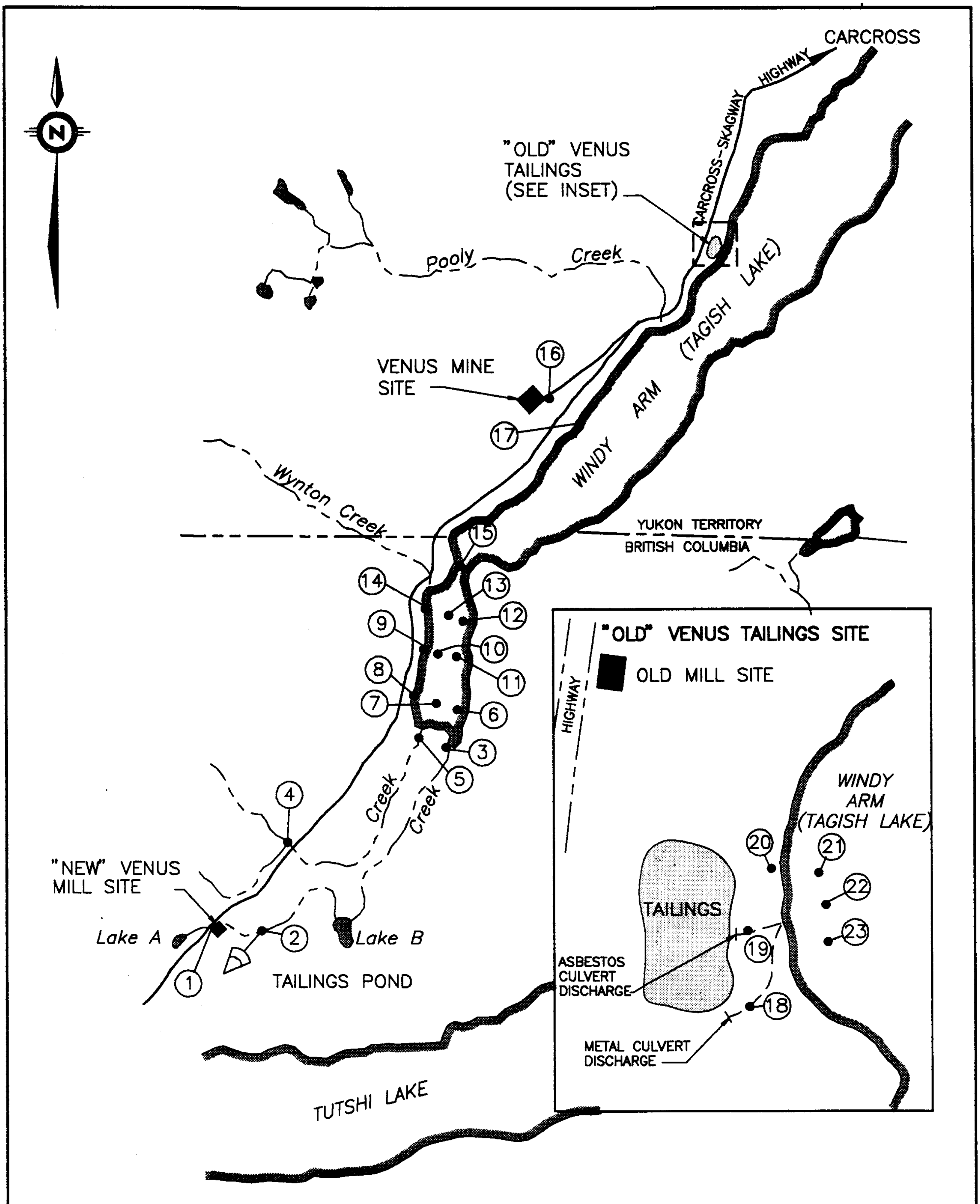

FIGURE 1: GENERAL LOCATION AND BASELINE WATER QUALITY STATIONS – PLAN
(AFTER ENVIRONMENT CANADA REPORT No. 81-18)

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1.2 Remedial Options

Water quality data has been collected in windy arm since 1975. A 'baseline' study was carried out in 1980 by Environment Canada, prior to the intended start-up date of the new mill. Water quality sampling has continued since that time and has generally followed the stationing established by the 1980 report, shown on Figure 1. All water quality sampling has been limited to tests analyzing 'total' parameters of water chemistry. No analysis for dissolved metal chemistry has been carried out to date.

The tailings are recognized as being a potential source of elevated levels of various metals which could flow and wash into the adjacent lake. The observed impact of the material on the environment includes 'total' metal levels which exceed certain water quality criteria, and elevated levels of Arsenic in wild berries adjacent to the tailings. It has also been concluded that a reduction in bio-diversity exists in the lake in the area of the tailings. Warning signs are posted against the consumption of berries at the site.

Based on the observed 'total' water quality data and the elevated arsenic levels in plants the site requires remediation to minimize environmental impact. An assessment of remedial options including concepts and methodologies, cost estimates, and estimates of effectiveness are provided in this report. The remedial options assessed focus primarily on the fact that the existing site does not provide control of either seepage flows or erosion of the fine material. The effectiveness of each remedial option is based primarily on the control the option provides.

The remedial options considered in this study include:

1a) isolate tailings with a simple (permeable) cover;

1b) isolate tailings with an impermeable cover;

1c) isolate tailings with an impermeable cover and a groundwater cutoff, and;

2a) move tailings to the 'new' Venus mill tailings facility.

In recognition of the reported precious metals content of the tailings, and the existing mill facility at the 'new' Venus mill, a further option (2b) has been reviewed and assessed. Option 2b assesses the potential for reprocessing the tailings at the new mill, and includes estimates for refurbishing and operating the mill, a review of available metallurgical data, and estimates for expected recovery.

The scope of work for this report is outlined in the Klohn-Crippen letter dated February 1, 1994 addressed to Poushinsky Consulting. This letter serves as terms-of-reference and is included in Appendix I. Mr. Scott Broughton, P.Eng. (B.C.) visited the site in late October 1993, to assess site conditions of both the 'old' tailings and the 'new' mill.

2. BACKGROUND AND OWNERSHIP

The 'old' Venus mine tailings are the result of a brief mining and milling operation from late 1970 up to mid-1971. The operation reportedly processed a total of approximately 60,000 tons of ore. A review of the amount of concentrate produced from the operation yields an estimate of the total tonnage of tailings stored at this site. The estimate is based on two sources of information with slightly different amounts quoted, and therefore range between 56,627 to 59,972 tons. The total amount of tailings was reduced slightly in 1981 when 400 tons were excavated.

The original mine and 'old' tailings purchased by United Keno Hill Mines Ltd. in 1979. After review of the property UKHM began construction of the new mill in B.C. The following permits and water licenses were issued at that time for the mill site:

BC-MOE	Pollution Control Permit PE-6019 (September 24, 1981) Permit to discharge effluent of a 100 tpd mill under the conditions specified in the application.
BC-MEMPR	Reclamation Permit MX-1-4 (M-148) August 1980
Water License	Approval for Fresh Water Supply Reservoir Application # 0367498 (BC-MOE, issued August 14, 1981) (BC-MEMPR, issued June 1, 1981)

Subsequent to a brief period of operation, UKHM shut down the mine/mill operation in 1981, and it has remained under care and maintenance since that time. UKHM are the current owners of the Mine in the Yukon Territory and Mill site in B.C.

During the late 1980's the old tailings at the site of the 1970's operation became "abandoned" and were declared to be a placer-type of deposit. A single Yukon Placer Claim has been staked which includes mineral rights to the abandoned tailings. This claim is registered as Sandpiper-2 and is owned by Mr. R.G. Hilker of Calgary, Alberta.

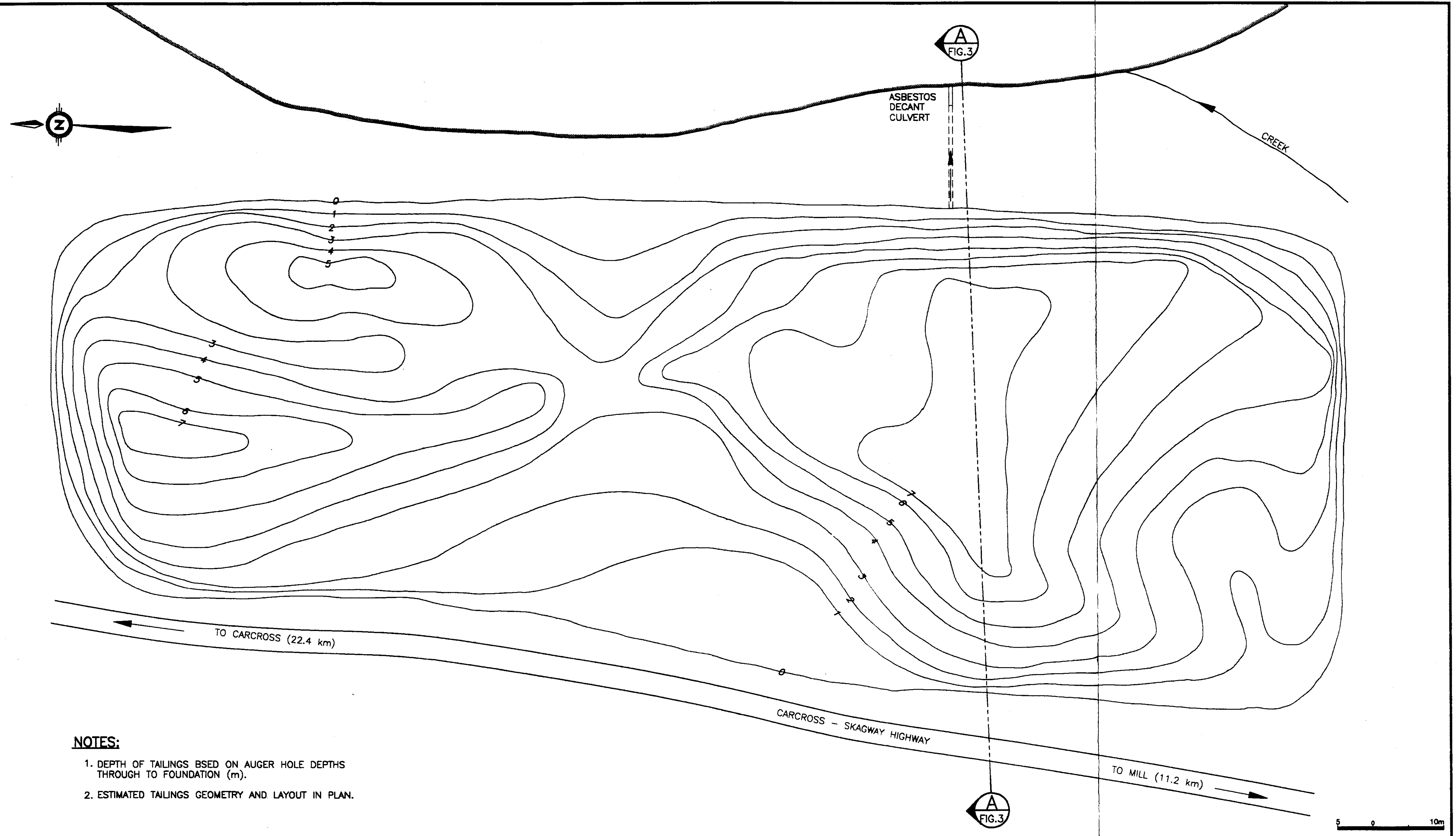
3. REVIEW OF EXISTING CONDITIONS

The existing conditions at the old tailings site were visually assessed during the site visit in October 1993. Supplementary information regarding water, estimates of total tonnage and volume, and precious metal grades comes from a variety of sources.

Approximately 57,000 to 60,000 tons (51 700 to 54 400 tonnes) of tailings were placed, of which approximately 400 tons (360 tonnes) were removed in the early 1980s. An upper limit estimate of the amount of tailings stored is 60,000 tons (54 400 tonnes).

Observations made during the site visit indicate that some volume of tailings has also been eroded into the lake from the south-east corner of the site. An excavation through the perimeter dike was made to allow easy access for removal of tailings as discussed. The dike excavation permits the erosion and transport of the fine material during periods of intense runoff, such as storms and spring melt. The result is that an unknown volume of tailings may now exist in the lake further reducing the tonnage presently at the site.

Estimates of tonnage have also been calculated based on the records of auger hole sampling which was carried out prior to the removal of 400 tons in 1981. The depth of tailings observed in each hole has been plotted and contoured, and was used to calculate total volume. Figure 2 illustrates the depth of tailings contours. The estimated volume based on the calculation of total tailings is 39 900 m^3. Comparison of the total tonnage and volume yields a tailings density of approximately 1.4 tonnes/m^3. This is consistent with recorded densities for similar tailings sites and confirms the estimate of total tonnage.



NOTES:

1. DEPTH OF TAILINGS BSED ON AUGER HOLE DEPTHS THROUGH TO FOUNDATION (m).
2. ESTIMATED TAILINGS GEOMETRY AND LAYOUT IN PLAN.

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PROJECT: VENUS MINE TAILINGES STUDY

TITLE: 'OLD' VENUS MINE TAILINGS SITE DEPTH CONTOURS

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Figure 2 illustrates the observed depth of the tailings as recorded during the auger sampling campaign. Analysis of samples at various depths in each of the 22 holes lead to a reported overall precious metal grade (UKHM) for the tailings of 0.09 oz/ton Au (gold) and 1.31 oz/ton Ag (silver). It was observed that some holes had a sufficiently low grade at depth to make them unattractive for reprocessing. Therefore, the total amount of tailings for reprocessing is reported as roughly 36,800 tons (33 400 tonnes). A volume calculation using the depth of tailings with the UKHM cutoff grade yielded a volume of 22 100 m^3. At a density of 1.4 tonnes/m^3 the amount of tailings above that cutoff is calculated to be 34,100 tons (30 100 tonnes). A reprocess amount of 33 000 tonnes has been assumed for the evaluation of option 2b, using the grades specified by UKHM.

The existing tailings site is confined by natural ground and bedrock exposures to the north and west sides. A portion of the east (lake) side is also confined by natural ground with bedrock exposure to the northern end. The south side and the southern section of the lake side are confined by a man-made perimeter dike. The dike is constructed with natural granular soils and is pervious. The south east corner (observed to be the location at which the dike was highest) no longer has any confinement due the excavation previously discussed.

A review of available air photographs confirms that the site is characterized by a linear depression which is parallel to the lake shore. This feature may be the result of large scale slope deformation due to a natural slump in the rock slope above. The slump probably occurred as glacial ice was retreating thousands of years ago, and is currently stable. The tailings are located in this structure, and it is assumed that the site is an area of groundwater discharge. Some of the tailings are also expected to exist below lake level.

During operation of the mill, tailings were likely spigotted from the perimeter dikes on the south and east side. This method of deposition creates a 'beach' of coarser tailings sand adjacent to the dike. The beach slopes down gradient (in this case to the north and west) and forms a 'pond' away from the spigot areas, closer to the mill, for reclaim of process water. The result is a natural gradation of tailings ranging from coarse sand size particles near the dike to very fine 'slimes' within the area of the pond. The fines reduce water infiltration and form a perched water table (and pond) over the area.

Originally, the pond was protected from overtopping during peak flow periods by a decant system. An asbestos decant pipe continues to drain the tailings by carrying the discharge through the east dike to the shore line of the lake. The intake to the pipe is now covered with tailings, however, it still drains water from the pond. The observed flow in October, 1993, after light precipitation was approximately 5 ℓ/s. The dike and tailings excavation at the southeast corner of the site also provides a discharge point for surface runoff. Although this was not observed at the time of site visit, flow patterns in the tailings sand suggest this has been the case.

Very little characterization of the tailings has been carried out, other than the auger sampling previously discussed. Those samples were specifically tested for precious metal content. Other samples were taken by Hilker (1988) to assess various reprocess options.

Samples were also taken by Davidge (1984) as part of a regional study to investigate the presence of Thiobacillus ferrooxidans as a means of assessing whether acid generation was established at various northern mine sites. The conclusion of that report was that the bacteria were present at Venus but that the ore had sufficient neutralizing capacity to limit the establishment of the natural process. This conclusion is supported by several years of sampling and recording the pH of the decant water, which has been consistently alkali. No obvious signs of acid generation, including leaching or precipitation of the material was observed at the time of the site visit in 1993.

No detailed topographic survey of the site has been carried out. Several assumptions have been made with respect to the layout based on visual inspection. In addition, assumptions have also been made based on the review of all the available information regarding the impact on water quality. These assumptions are stated where applicable in the following sections.

4. ASSESSMENT OF EXISTING WATER QUALITY

The water chemistry of Windy Arm in the area of the Venus Mine, and the chemistry of local creeks in the area of the new Venus Mill has been studied previously in numerous campaigns since 1975. The available data is summarized in Table 4.1.

Table 4.1 - Available Water Chemistry Data

YEAR	Investigator	Area	Parameters
1975	Environment Canada	Windy Arm	Metals and general parameters
1980	Environment Canada	Venus mine New Venus mill	Metals and general parameters - water - sediments - bottom fauna
1980-81	Slaney & Company Ltd.	Venus Mine New Venus mill Windy Arm	Metals and general parameters - water - sediments - bottom fauna
1983	unknown	Venus Mine	Arsenic
1984	Indian and Northern Affairs Canada	Venus Mine	Metals and general parameters
1985	Environment Canada	Venus Mine	Arsenic
1985	Indian and Northern Affairs Canada	Venus Mine	Metals and general parameters
1986	Environment Canada	Venus Mine	Metals and general parameters
1987	Environment Canada	Venus Mine	Metals and general parameters
1989	United Keno Mines Limited	New Venus mill	Metals and general parameters

Of the studies listed above, the 1980 Environment Canada Study was most complete and is used herein as a baseline study. The stations listed in the report are used as reference stations and are shown in Figure 1. A detailed description of each station is provided in the Environment Canada Report.

4.1 Summary of Water Quality

Select water quality data was compared to Canadian Water Quality Guidelines, Raw Drinking Water (RDW) and Freshwater Aquatic Life (FWAL) criteria. The data used for comparison are as follows:

- 1980 Environment Canada;
- 1984 Indian and Northern Affairs
- 1985 Indian and Northern Affairs; and
- 1989 United Keno Hill Mines (U.K.H.M).

For comparison purposes, the data was grouped into two areas namely:

- Old Tailings Area (Stations 18-23);
- New Tailings Area (Stations 1-15).

(note: see Figure 1 for Station Locations)

'Old' Venus Tailings Area

As previously described, the 'old' tailings area is drained by a decant pipe station (#19). Water from the decant exceeds FWAL criteria for most years in levels of Arsenic (As), and Zinc (Zn). In 1980 FWAL criteria were also exceeded for Iron (Fe), Lead (Pb), and Manganese (Mn). Mercury (Hg) was considered to be at background levels but exceeded FWAL criteria.

To the south of the 'old' tailings area, Station #18 shows exceedance of FWAL levels of Zn for more than one year. On single years the level of Aluminum (Al) has been exceeded. Mercury was at background levels but exceeded FWAL criteria.

To the northeast of the 'old' tailings area, Station #20, which is a groundwater seepage point, shows levels of As in 1980 that exceed FWAL criteria (this was the only year of testing for Station #20). Mercury was at background levels but exceeded FWAL criteria.

Station #22 is in the lake approximately 20 m offshore from the tailings area. Levels of Zn and Al exceeded FWAL criteria for 1980. Mercury was at background levels but exceeded FWAL criteria.

Lake bottom sediment samples around the tailings area (station #'s 21, 22, 23) showed high levels of Cyanide (CN), Pb and Zn, and increased levels of Fe, Mn and Al. Lake bottom bio-diversity was found to be lower than typical of other lakes in the area.

A study of berries near the 'old' tailings revealed high levels of As. Elevated levels were observed in berries (implying uptake of dissolved As), and on the surface of berries (implying wind-blown as-contaminated tailings).

'New' Venus Tailings Area

Water chemistry in the 'new' tailings area is expected to be representative of background conditions. In 1989 chromium (Cr) and Pb tested above FWAL criteria. The source of these metal contaminants is unknown and the results may represent lab or sampling error. Mercury was also recorded above FWAL criteria but at background levels.

Lake bottom sediments downstream of the new tailings area show consistently low levels of metals. Lake bottom and creek bottom bio-diversity is at normal levels except at stations #2 and #5 where it is considered low.

Table 4.2 - Summary of Parameters Exceeded for Fresh Water Aquatic Life Criteria

LOCATION	STATION	PARAMETER EXCEEDED
'Old' Tailings Area	18	Al, Hg, Zn
	19	As, Fe, Pb, Mn, Hg, Zn
	20	As, Hg
	22	Al, Hg, Zn
'New' Tailings Area	4	Hg, Cu, Pb
	7	Hg

Note: see Figure 1 for station locations.

The exceeded parameters identified may represent mineral constituents which are common to the rocks in the Venus mine area.

Mercury may have been used in processing or panning in the past. However, in all stations including those remote from and upstream of mining areas, Hg exceeded FWAL criteria by 2 to 3 times. The natural background level may therefore be in excess of FWAL as indicated in the samples.

5. ON-SITE Tailings REMEDIAL OPTION-1

5.1 General

Surface water and groundwater from the 'old' tailings area exceed the criteria for fresh water aquatic life (FWAL) in several parameters. Also lake bottom sediments are unusually high in metals and other contaminants producing low aquatic bio-diversity.

All water samples taken in previous studies were tested for total parameters and did not distinguish between the dissolved components and particulate components. The high pH of the samples suggests that the majority of metals measured in the samples may be part of the suspended solids (greater than 40 micron) component. Metals may be present in the dissolved state at a higher pH but generally they must first be dissolved or leached at a low pH. A low pH may imply that acid mine drainage is taking place, however, there is little evidence for this, as previously described.

Without further data, and for the reasons mentioned above, it was assumed that the contamination of surface water and groundwater is due to the transport of the particulate component of the tailings water. The major source of the contaminants is likely from the entrainment of these small particles as water flows through and over the tailings. The particles are likely to have been exposed to physical weathering such as freeze thaw processes. In addition, storm water and spring melt water probably erodes some of the tailings into the lake on a regular basis. The suspended solids component likely drops out in the lake and accumulates on the lake bottom, resulting in sediment contamination and low bio-diversity. The measured levels of metals in the lake water samples could similarly represent particulates which are mobilized by wave action and lake currents.

This model highlights what is concluded to be the key problem with the existing tailings site: no control exists for the prevention of physical transport of particulate matter. In the absence of an engineered means of control for the site, options have been assessed which provide varying degrees of on-site control. Each option was evaluated in terms of its effectiveness to control transport of contaminants.

The model must also account for the presence of Arsenic in local berries. This provides a point of conflict to the assumption that physical transport is the only means of contamination from the site. Berries take up dissolved Arsenic through their roots implying that the source of Arsenic is in a dissolved form. Arsenic may, however, be mobilized in neutral to alkali environments, allowing groundwater to transport dissolved Arsenic to roots. Therefore, the occurrence of dissolved Arsenic is not inconsistent with the particulate transport model and does not necessarily imply leaching processes such as Acid Rock Drainage of the tailings.

The berries sampled previously, showed a higher arsenic concentration on their skins than in the berries themselves. This may indicate that berries are contaminated more by wind-borne transport of the fine tailings than by dissolved Arsenic. Control of the physical transport of tailings would significantly reduce the impact on lake water quality, lake bottom sediment loading, and wind-borne contamination of the area. A cover over the tailings area will provide varying degrees of isolation from erosion and transport processes, depending on the type of cover chosen. Three cover options have been evaluated for this study.

1a. Simple Cover
Constructed of pervious sand and gravel (and riprap where appropriate) this option will reduce surface water and wind erosion but will not significantly reduce water flowing into or from the tailings through pervious materials;

1b. Impermeable Cover and Capillary Break
Constructed of compacted till (impermeable) and coarse rock drainage layers, this design will minimize surface water inflows, thus reducing outflow. Groundwater flows would not be significantly reduced.

1c. 1b + Groundwater Diversion/Cutoff
Similar to option 1b with the addition of a perimeter diversion/ groundwater cutoff which will minimize groundwater inflows to the tailings material, further reducing outflow.

A conceptual cross-section through the tailings is shown on Figure 3. The profile is based on the depth of tailings indicated by auger drilling with conceptual designs for each option also shown.

The options are conceptually rated as low, medium, or high in terms of their relative effectiveness in (1) reducing surface erosion; (2) reducing dissolved parameters transported by surface water, and by groundwater, and (3) reducing plant Arsenic uptake.

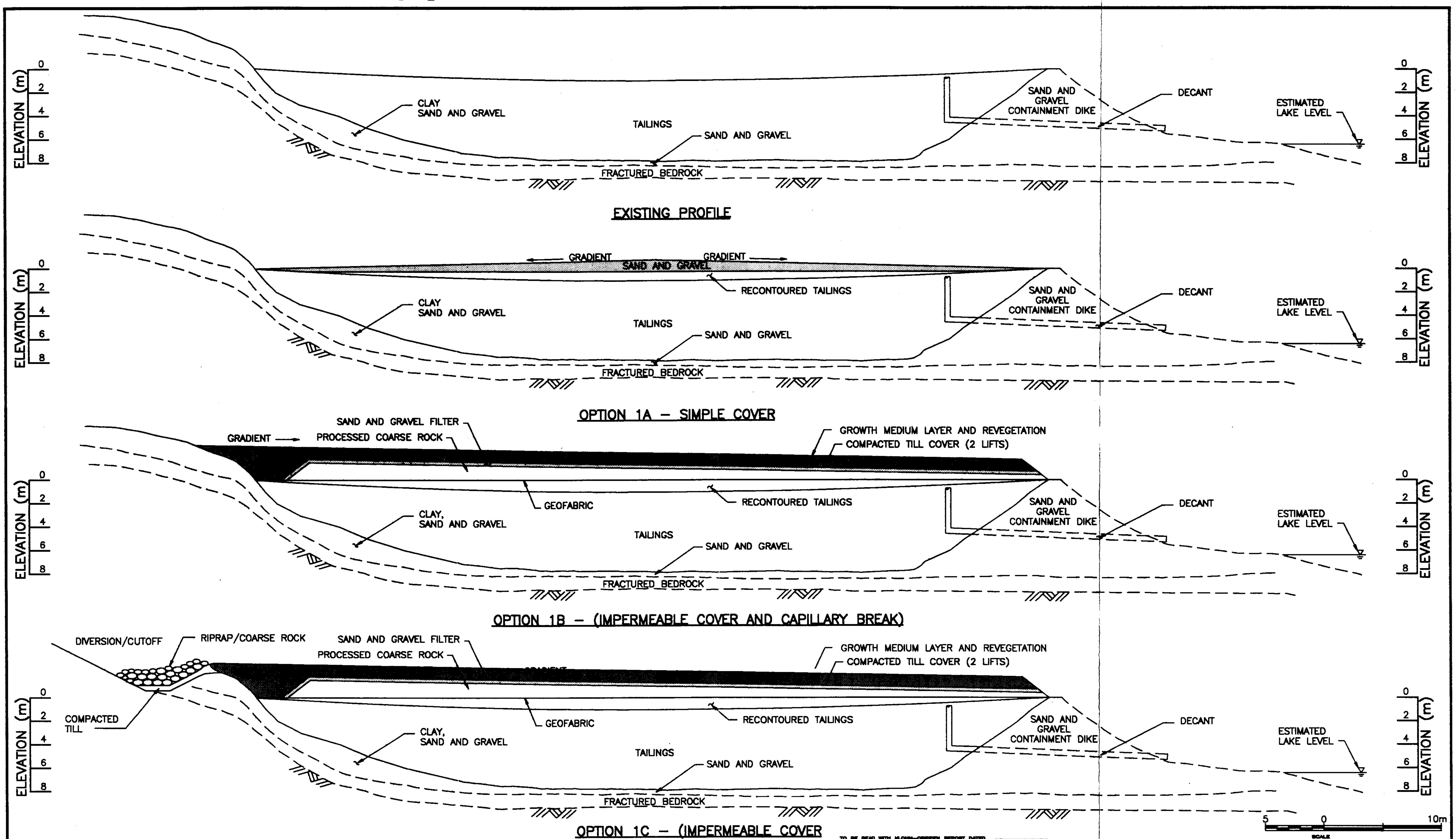
5.2 Option 1a - Simple Cover

A simple cover consisting of sand and gravel placed over the tailings would limit surface erosion by wind and water. The reduction in erosion in conjunction with reduced frost penetration depth would result in reduced transport of particulate. Groundwater will continue to be affected by the flow of dissolved Arsenic, thus Arsenic is likely to continue to contaminate berries in the adjacent areas.

The effectiveness of the simple cover to reduce particulate loading to the lake is rated as low-medium. The cover will not be effective in lowering dissolved arsenic uptake (if present) in the immediate tailings or downgradient area, thus the effectiveness is rated as low.

5.3 Option 1b - Impermeable Cover and Capillary Break

An impermeable cover system consisting of a coarse processed rock (capillary break and drainage layer) overlain by a compacted till layer will have greater effectiveness than the simple cover in reducing contaminant transport. The cover will provide greater tailings



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isolation since the drainage layer will carry away surface infiltration water. The cover will be effective in reducing or eliminating surface erosion of the tailings. Plants will not have access to the contaminated groundwater in the area of the cover because of the compacted layer, but will have access to contaminated water downgradient of the tailings.

The effectiveness of the impermeable cover system to reduce particulate loading to the lake is rated as high. The effectiveness of this cover for erosion protection of the tailings is also rated as high. The cover will be effective in reduction of Arsenic uptake in the immediate tailings area but not downgradient, thus the effectiveness is rated as medium.

The coarse rock layer would be placed on a geofabric which will effectively filter the tailings. While the thickness of this layer varies (as shown on Figure 3), the average thickness is 1.5 m. The drain material will also produce a trafficable surface upon which the till would be placed. Compaction of the till under appropriate moisture content conditions will produce a plastic impermeable cover capable of sustaining minor deformation, with a long useful lifetime.

5.4 Option 1c - Impermeable Cover, Capillary Break, and Groundwater Cutoff

The installation of an up-slope groundwater cutoff in conjunction with the Option 1b cover would result in a further reduction in the amount of groundwater movement through and around the tailings. An upstream perimeter ditch excavated down to - unfractured bedrock would provide the most effective cutoff. The down-slope bank of the ditch would be lined with compacted till. The ditch would then be backfilled with coarse rock to act as a flow-through system and protect the till.

The additional effectiveness of the groundwater cutoff gives it a medium-high effectiveness rating in reducing the dissolved component to the lake. The ratings for reduction of surface erosion and plant arsenic uptake are not enhanced significantly by the groundwater cutoff and are thus rated high, and medium, respectively.

5.5 Location and Description of Cover Construction Materials

The following section outlines potential borrow locations for the till and gravel materials, and describes some of the relevant properties of each.

Glacial till can be readily obtained at the United Keno Hill Mines millsite area. In 1980, Geocon (1975) Ltd. conducted a geotechnical study for UKHM which focused on the plantsite area. That study indicated that glacial till occurs in significant quantities at the site.

The millsite area is located in a broad valley which is covered with a significant thickness of 'clayey sand till' in a dense to very dense state. Till was used to construct the existing tailings dam and similar material will likely be suitable to use as a compacted cover. An extensive drilling program was conducted to determine the soil condition and thickness. All of the 18 holes drilled intersected glacial till. The following paragraph from the Geocon Ltd. report describes the material:

> Glacial till is generally a silty sand with some clay and varying amounts of fine to coarse gravel and occasional cobbles. ... the till varies from a sandy silt with traces of fine gravel to a gravelly sand with fine to coarse gravel and only traces of a clayey silt.

Because the till contains the occasional cobble, quality control will be necessary to remove large cobbles prior to placement and compaction.

Gravel sources are probably available closer to the old tailings site. A large alluvial fan exists at the base of Pooly Creek and will likely provide a variety of coarse angular material. The various cover options will require different materials from this site. The simple cover may use pit-run gravel only, whereas options 1b and 1c require a screen plant to produce coarse-rock for the capillary break. The rejects from this screen may be used in the filter zone or mixed with other materials to form an uncompacted growth medium.

5.6 Construction Methodology

A road constructed from the highway to the tailings pond would enable trucks and other equipment to access the tailings. The road would start at the northwest corner of the pond and traverse the western side for the entire length of the tailings site.

Covers should be constructed so that disturbance to the existing tailings and to the surrounding land is minimized. In light of this precaution, a surface water collector ditch and a settling pond would be constructed outside the tailings area at the southeast corner. This will collect all of the surface water flowing off of the tailings during the construction period and assist in removal of suspended sediment.

The existing pond currently covers a third of the tailings area during the summer months and will need to be drained prior to placing any cover. The pond could be drained by placing a pump in a small excavation in the tailings and pumping the water into a tank truck. The truck could haul the water to the tailings impoundment at the mill site and treat it at that location if required. Once the surface water is removed a network of six well-points could be installed and connected to a single pump to further dewater the tailings. This water would also be transported and treated.

Prior to placing any material on the tailings, the surface of the tailings should be recontoured to an even grade, to reduce material requirements for the cover options. The surface of the tailings may be recontoured by using a small, wide-track dozer to push the material.

A geofabric should be used prior to the placement of coarse rock on tailings. Coarse processed rock would be screened at the borrow site and transported to the tailings in highway trucks.

Excavated till will be hauled by tandem highway dump trucks. The dump trucks would unload the till directly onto the coarse rock layer.

The till would be spread in two compacted lifts to achieve maximum compaction. A dozer and compactor will spread and compact the till. Placement of the till should extend 1.5 m beyond the limits of the tailings on all sides.

The current surface area of the tailings is approximately 11 000 m^2 based on the UKHM plan drawing which shows the 1980 test hole locations (N.T.S. Sheet No. 105 D-2). A 1.5 m cover overlap increases the cover area by roughly 720 m^2.

6. OFF-SITE Tailings REMEDIAL OPTION - 2

6.1 General

The second tailings remedial option includes physically transporting the material to an engineered impoundment elsewhere. Option 2a involves excavating the tailings and placing them in the existing tailings impoundment located at the new millsite in British Columbia. Option 2b involves excavating the tailings, reprocessing them in the new mill with subsequent placement in the impoundment. Prior to the detailed evaluation of either alternative, an assessment of the adequacy of the existing impoundment is required.

6.2 Assessment of Existing Impoundment

Drawing D-1001 shows the design sections of the new tailings impoundment and tailings dam. The conditions of the tailings impoundment and the construction of the tailings dam are described in the following sections.

Tailings Impoundment

The tailings impoundment is located at El. 810 m in the base of a broad glacial valley, 1500 m in width, between two ranges of mountains which rise to over El. 1720 m. The topography in the valley base is undulating terrain formed by glacial till and glaciofluvial deposits. Muskeg is present in depressions and at the base of stream channels incised into the till.

The impoundment has been situated over an old, inactive stream valley incised about 10 m down through the till deposits. The valley is about 50 m wide at the crest and the base of the valley extends down to as low as El. 800 m. Boreholes drilled at the impoundment site indicate the local stratigraphy consists of up to 40 m of glacial till overlying bedrock. The till is reported to consist of silty sand to clayey sand with varying amounts of fine to coarse gravel and occasional cobbles. There is up to 5 m of muskeg lining the base of the creek valley. The flanks of the valley consist of glacial till with no or little surficial organic cover.

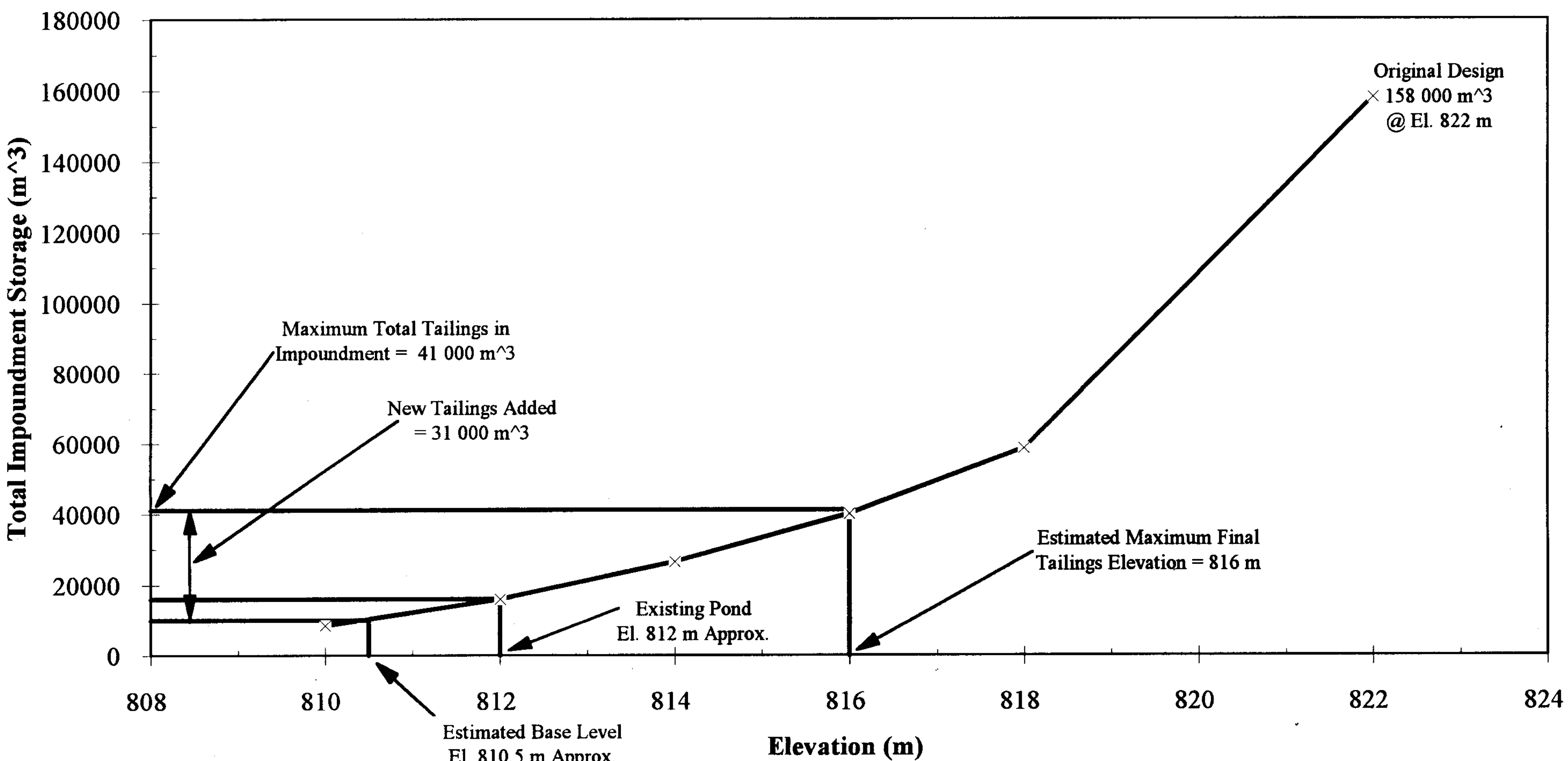
Three laboratory permeability tests on the till gave permeability values ranging between 2×10^{-6} cm/s and 6×10^{-8} cm/s. These low values indicate that the till below the impoundment provides a good low permeability lining below the impoundment. Two consolidated, undrained triaxial tests gave a friction angle of between 35° and 40°, which is consistent with observations in similar material from other sites.

The impoundment is formed by the tailings dam (built to El. 823 m) at the downstream end, and a saddle between two rock ridges at the upstream end. Allowing for 1 m of freeboard, the maximum storage capacity is about 158 000 m^3. This volume includes 26 000 m^3 of fill which was borrowed from within the impoundment for construction of the tailings dam. This fill was excavated from the flanks of the creek valley. An approximate storage-elevation curve for the impoundment is shown on Figure 4.

At the time of the site inspection the water level in the impoundment was at about El. 812 m (less than one third full). It is understood that approximately 800 tons of tailings may have been deposited in the impoundment in previous operations. From Figure 4, the elevation of the base level of the impoundment is estimated at El. 810.5 m, 1.5 m below the estimated water level. The actual elevation of the pond and the base level should be confirmed for final design.

A 0.6 m diameter steel decant pipe is provided in the left abutment to prevent potential overtopping of the tailings dam. The decant consists of a vertical section of pipe which rises to El. 822 m (assumed). It is presumed, based on good practice, that the pipe extends vertically down into the native foundation till to join with a horizontal section of pipe which extends underneath the dam to discharge beyond the downstream toe.

Figure 4 'New' Venus Mill Site
Tailings Impoundment Storage - Elevation Curve



Tailings Dam

The tailings dam was constructed in 1981, and is a homogeneous earthfill structure constructed of compacted glacial till with a 0.5 m thick internal semi-vertical sand and gravel drain to control seepage levels, and to prevent piping and seepage that may occur along a defect in the fill placement. The dam was provided with a 4 m crest width and upstream and downstream slopes of 2H:1V and 2.5H:1V, respectively. The dam slopes are covered with 0.3 m of coarse gravel slope protection.

All muskeg located at the base of the stream valley was reportedly excavated below the full footprint of the dam. A minimum 4 m wide and 2 m deep seepage cut-off trench was excavated into the till below the dam. The maximum height of the dam is up to 22 m at the centre of the creek valley. On the flanks of the valley, the dam is about 6 m in maximum height and tapers gradually towards the abutments. The total crest length of the dam is about 280 m.

Assessment of the dam design concludes that the upstream slope of the dam is too steep given the shallow thickness of gravel slope protection, and the fact that the dam may retain water for long periods of time. Saturation of the upstream till slope, effects of freeze-thaw, and seasonal fluctuations of the pond level could cause shallow instability and failure of the upstream slope. It is noted that cracks were reported by Geocon at the upstream crest of the main dam of the fresh water pond (west side of highway) in 1983. Instability of the tailings dam may not have occurred to date because of the low pond levels maintained in the impoundment.

No problems with seepage through the tailings dam are reported in the available information. However, unusual seepage would not be expected at the low pond levels maintained behind the dam. Seepage will increase as the pond level is raised and more of the dam length impounds water. A small, concentrated seepage leak at the downstream toe of the fresh water pond dam was noted soon after filling in 1981. In 1983, the seepage was estimated to be 0.3 ℓ/s. Minor seepage was also noted by SRK in 1988 at the toe of the polishing pond downstream of the main tailings dam.

A preliminary seepage analysis for the existing impoundment has been carried out. An estimated upper bound limit of 0.1 ℓ/s of seepage through the dam and base of the impoundment was calculated assuming a till permeability of 1×10^{-6} cm/s, and that no major defects exist in the till foundation or dam which could cause concentrated seepage. A total seepage of less than 0.1 ℓ/s would be hard to detect in the field and agrees with the historical absence of visual seepage from the dam.

Water Balance

The fact that the impoundment is less than one third full indicates that the pond has apparently reached an equilibrium between precipitation and surface water inflow, evaporation losses and seepage losses. Table 6.2 presents a preliminary annual water balance for the impoundment based on the estimated average annual hydrological parameters shown on Table 6.1. A total catchment area of 4.5 ha was measured from existing plans and the pond surface area is approximately 0.3 ha.

Estimates of average hydrological parameters are based on data obtained for Atlin, B.C. and Whitehorse. This data is summarized in Table 6.1.

Table 6.1 - Average Hydrology Parameters

	ATLIN	WHITEHORSE	ESTIMATED VENUS MILL SITE
Rainfall (mm)	192.2	145.5	-
Snowfall (mm)	134.9	136.6	-
Precipitation (mm)	327.1	251.2	300
Degree Days above 0°C	1611.6	1763.7	-
Lake Evaporation (mm)	-	482.7	440

Table 6.2 - **Estimated Water Balance for Existing Impoundment**

	AREA (m^2)	ANNUAL AVERAGE VALUE (mm)	VOLUME (m^3)
Inflow			
- precipitation on pond	3000	300	900
- precipitation on catchment	42 000	300	12 600
Outflow			
- evaporation from pond	3000	440	1320
- evapotranspiration from catchment	42 000	200	8400
Net annual water surplus reporting to pond			3780

The net average annual water surplus reporting to the pond is estimated to be 3780 m^3 which corresponds to an average total seepage rate of 0.12 ℓ/s to maintain the pond in balance. Reasonable variation of the precipitation evaporation and evapotranspiration values in Table 6.1 indicates average total seepage rates could range from 0.05 ℓ/s to 0.20 ℓ/s. This range agrees with the maximum seepage rate of 0.1 ℓ/s calculated for the existing dam and impoundment in the previous section.

Based on the water balance, and review of the site investigations and dam design, the existing impoundment is assessed as being "tight", with no apparent "defects" in the foundation or dam. The present seepage rate from the impoundment is nominally 0.1 ℓ/s, or less.

The above statement does not discount the possibility of abnormal seepage during future tailings deposition when the pond level is raised. Most of the impoundment does not yet retain water and the possibility of abnormal seepage still remains. Proper monitoring of the impoundment during filling should be carried out to assess seepage, as for any water-retaining dam.

6.3 Expected Volume and Elevation

The tailings to be transported to the impoundment consist of a fine grained sand with about 45% passing the No. 200 sieve. The amount of tailings is estimated to be about 54 400 tonnes which corresponds to about 39 900 m^3 assuming a deposited density of 1.4 tonnes/m^3. For design purposes, a maximum volume of 40 000 m^3 of tailings has been assumed. From Figure 4, final elevation of the deposited tailings could rise as high as El. 816 m, assuming horizontal deposition of the tailings. As shown on Drawing D-1001 this tailings level will be contained within the pre-existing creek valley.

6.4 Option 2 - Impact on Water Quality

Moving the tailings to the tailings facility at the new Venus mill will remove the source of the existing contamination and should result in a long term return of water quality to background levels in the old tailings area. The excavation of the tailings must be complete, and tailings must be contained during removal to prevent tailings from entering the lake.

When in place at the New Venus mill tailings impoundment the tailings could impact the local environment at that site. Seepage rates from the tailings impoundment are expected to be very low as discussed. A historic water balance of the pond based on the assumption of average precipitation and a constant water level indicates a present seepage rate of about 0.1 ℓ/s. This amount may increase because of the higher water levels in the pond after tailings deposition. The tailings in the pond are likely to be covered in water.

With the tailings submerged in water and the low anticipated seepage rates, the overall impact to the environment in terms of dissolved and suspended sediment is rated as low. Arsenic uptake by plants at the old tailings site should be eliminated.

Removing the tailings would have a more positive effect on the water quality in Windy Arm than any of the Option 1 alternatives. The source of the contaminants would be removed, except for the portion that may already exist below lake level.

These conclusions do not include final closure of the new site, and a detailed closure plan will be required for permitting.

6.5 Option 2a - Place Tailings in Existing Impoundment at New Millsite

The following section outlines a method for excavating the tailings and placing them in the existing tailings impoundment at the new mill. This method involves using an excavator to load the tailings into lined tandem dump trucks which would then haul the tailings to the impoundment.

Prior to excavating, the tailings should be dewatered, as previously discussed for Option 1. Road building would also be required prior to excavating the tailings.

Tailings that accumulate on the tires of the trucks would be removed before the trucks enter the highway. Pressurized water could be used for this purpose. If water is used, the location of the wash station must be selected so that the wash water flows into the excavated portion of the tailings pond. Therefore the wash station must be upstream of the excavation. The trucks should be equipped with tarps to cover the tailings during the drive to the mill so that the tailings are not blown off.

Excavation should begin at the north end of the pond, and proceed to the south end. This method of advance will minimize the potential for sediment transport to the lake during excavation.

Once all the tailings have been excavated, final clean up and filling of the ditch and settling pond would be carried out.

An access road exists from the highway to the tailings impoundment at the millsite. It is assumed that this road is in reasonable condition.

Trucks could drive to the bottom of the tailings impoundment to dump the tailings, rather than simply dumping the tailings from the crest of the dam. Photographs of the impoundment that were taken in late October 1993 show that an access ramp to the bottom of the impoundment exists. However, the bottom of the road is partially water covered. This water may need to be pumped out and treated in the downstream ponds.

6.6 Option 2b - Reprocess Tailings in New Mill

6.6.1 Background

The following section provides a summary of existing metallurgical and process information. The methodologies and costs included are conceptual only, and a detailed feasibility study is required to confirm the processes and costs assumed. The "new" mill was designed to treat 100 tons/day of lead/zinc ore to recover separate lead and zinc concentrates by flotation. In addition, a 100 ton/day tailings reclamation circuit was included for reprocessing of the old tailings during the summer months. This circuit was designed to recover gold and silver by cyanidation, filtration and the Merrill-Crowe process to produce a precious metal precipitate for shipping to refineries.

The new mill was briefly started up, and the majority of the equipment is still at the site. Estimates were made in 1983/84 by two different contractors of the cost to refurbish the equipment for operation. In 1988, a detailed examination of the equipment was made by Melis Engineering to assess its suitability for operation.

This report has used the previous estimates to provide a conceptual assessment of the amount of work required to put the cyanidation circuit in working order and to design a tailings retreatment process.

6.6.2 Process Description

Conceptually, reclaimed tailings will be trucked to the millsite in highway dump trucks for reprocessing. The tailings will be processed at a rate of 200 tons/day. This reprocessing rate is determined primarily by the available equipment for cyanide leaching. Three 20 ft x 22 ft high tanks exist in the mill. A 48 hour residence time is required and can be provided by the existing tanks. (Original design rate was 100 tpd of flotation tailings plus 100 tpd of reclaimed tailings).

At a rate of 200 tonnes/day it will take 165 days of operation to treat the estimated 33 000 tonnes of old tailings material. Allowing for 90% plant availability this increases to 183 days. This indicates that two operating seasons of 92 days each (approximately 3 months) will be required. Four months of operation was considered appropriate since the mill will require work prior to start-up and after shutdown.

Tailings will be dumped from the trucks as received into a hopper and fed at a controlled rate to a conveyor and then to a ball mill for regrinding. The tailings material will have an estimated 15% to 20% moisture content and so may be sticky and difficult to handle. For this reason, a screw conveyor at the bottom of the receiving hopper has been assumed to provide a positive means of feeding the conveyor.

The 100 Hp ball mill has been sized to provide 5 Kwh/tonne of power with a conservative safety margin. Based on experience, this should be sufficient to regrind the tailings from 50% minus 200 mesh to 90% minus 200 mesh. The fine grind is required to ensure proper operation of the air lift agitators in the leaching circuit. (Previous operators reported problems with these units on coarse material).

The ball mill will operate in closed circuit with a cyclone to ensure proper classification prior to leaching. Cyclone underflow will return to the ball mill while cyclone overflow will feed a 10 ft high capacity thickener. The thickener will recover water for reuse in grinding and will thicken the reground tailings to 50% solids prior to leaching. Cyanide and lime will be added to the ball mill.

Cyanidation leaching will take place in three 20 ft x 22 ft high leach tanks with air-lift agitators. These three tanks will provide 48 hours residence time at 200 tonnes/day. Following leaching the slurry will be dewatered and washed on a 5 ft.w x 60 ft.l horizontal belt filter. Pregnant solution from the filter will be pumped to the Merrill-Crowe circuit. Filtered and washed tailings will be repulped with barren solution and pumped to the tailings pond. Recovery in leaching is estimated at 30% for gold and 65% for silver based on test work at Lakefield in 1980.

The Merrill-Crowe circuit includes a clarifying leaf filter, Crowe tower, vacuum pump and two precipitate filter presses. Gold and silver will be recovered by zinc precipitation into a precious metal precipitate which will be shipped offsite in drums for refining into doré bullion.

Barren solution after precipitation will be reused in the process as much as possible. Barren bleed will be treated in a cyanide destruction circuit and then used for repulping tailings material before it is pumped to the tailings disposal area.

Figure 5 illustrates the flowsheet graphically.

Table 6.3 - Design Criteria - Tailings Reprocessing

Tonnage of tailings to be treated	36 400 tons (33,000 tonnes)
Seasonal treatment in summer months assumed	
Number of treatment seasons	2
Tonnes/season	16,500
Operating days/season (@ 200 t/d) @ 100% availability	83
Operating availability	90%
Required operating days/season	92
Available hours (92 x 24 hours)/season	2,208
Operating hours/season	1,988
Tonnes/operating hour	8.3

Table 6.3 - Design Criteria - Tailings Reprocessing (continued)

Specific gravity - dry solids (assumed)	3.2
Moisture - as received - %	15-20
Tailings assay - Au oz/tons	0.09
Tailings assay - Ag oz/tons	1.31
Estimated recovery - Au %	30
Estimated recovery - Ag %	65
Lime consumption - lb/ton (15 kg/t)	3.0
Cyanide consumption - lb/ton (2.0 kg/t)	4.0
Leaching residence time - hours	48

6.6.3 Capital and Operating Cost Estimates

Capital Cost

The capital cost for refurbishing of the existing equipment has not been estimated in detail. Estimates were made in 1983 by Commonwealth Construction and in 1984 by Doug Redden (Contractor) of the labour costs for refurbishing the Venus mill. These costs were $309,00 and $228,000 respectively. Allowing for inflation and for purchase of a new genset to provide power for the reprocessing operation an allowance of $500,000 has been made for the estimate of capital cost.

Operating Costs

Estimated operating costs are summarized in the following table:

ITEM	$/YEAR	$/TONNE
Labour	96,000	5.82
Reagents - Leaching	57,800	3.50
Power	83,000	5.03
Cyanide Destruction	78,200	4.74
Precipitate Treatment	7,700	0.47
Operation and Maintenance Supplies	20,000	1.21
TOTAL	$342,700	$20.77

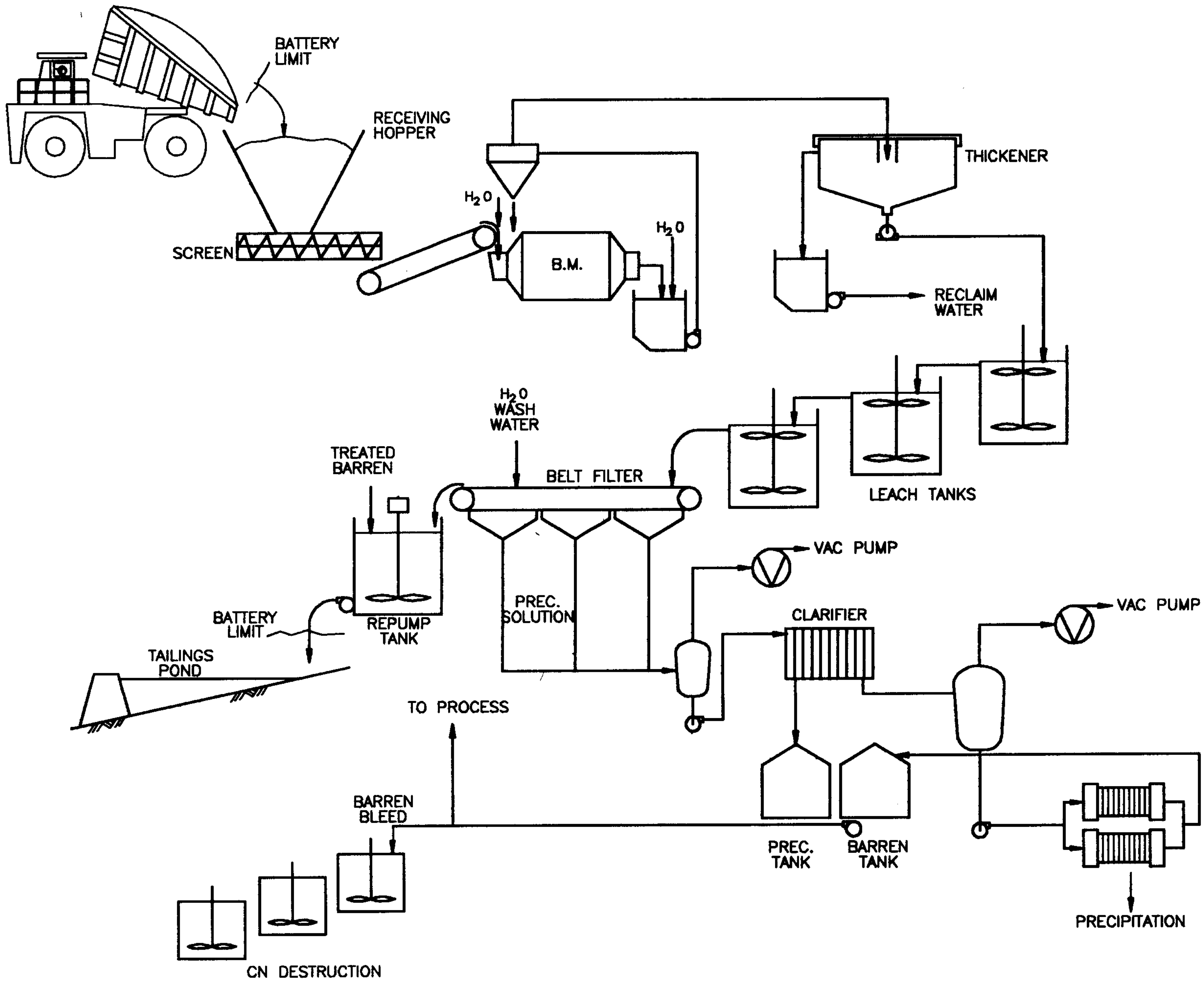


FIGURE 5 – TAILINGS RETREATMENT

Labour

The operating crew will consist of one operator per shift (four total) plus an additional two persons on day shift for reagent mixing, cleanup and supervision. A cost of $4,000/man-month has been assumed based on $17.00/hour base rate and allowing 30% for fringe benefits. For the anticipated four month operating seasons the cost of labour is estimated at:

6 men x 4 months x $4,000/month = $96,000/year

Reagents - Leaching

Reagents used for cyanide leaching will include lime and cyanide. The estimated reagent consumptions are based on the Lakefield laboratory test work done on the Venus ore in 1980. Budget prices (FOB site) for reagents were obtained from suppliers.

REAGENT	CONSUMPTION (kg/tonne)	CONSUMPTION (kg/year)	COST ($/kg)	COST ($/year)
Lime	1.5	24 750	0.20	5,000
Cyanide	2.0	33 000	1.60	52,800
TOTAL				$57,800

Power

An estimated 150 Hp will be required for process equipment operation. An additional allowance has been made for non-process items such as heat, light, camp, etc. A 250 KW generator should be sufficient for the total loading. Based on 80% loading and operating 115 days per season the estimated power consumption is then:

250 x 0.8 x 115 x 24 = 552 000 Kwh/year

A cost of \$0.15/Kwh is assumed to cover all costs associated with operation and maintenance of the diesel generator. This results in an estimated annual power cost of \$83,000/year.

Cyanide Destruction

Various options are available for cyanide destruction including alkaline chlorination, SO_2/Air and hydrogen peroxide. Either alkaline chlorination or SO_2/Air could be used with only minor modifications to existing equipment at Venus. The SO_2/Air system has been assumed based on order of magnitude costs obtained from Inco Exploration & Technical Services of \$5.00/kg of CN destroyed.

It has been assumed that only the barren bleed from the Merrill-Crowe circuit will be treated at an estimated rate of 50 USgpm and with a 500 ppm CN content. On this basis 136 kg CN/day will be destroyed. The cost is then \$680/day or \$78,200/year for a 115 day season.

Precipitate Treatment

A precious metal precipitate will be produced at site and shipped to refineries offsite for further treatment and production of doré bullion. Typical refining charges for such material are \$5.00/oz Au and \$0.35/oz Ag with 97.5% of both metals payable. Refining costs will then be:

METAL	Oz REDUCED	Oz PAYABLE	\$/Oz TREATMENT	\$ TREATMENT
Gold	982	957	5.00	4,785
Silver	30,995	30,220	0.35	10,577
TOTAL				\$15,362

This cost will be spread over two years or \$7,681/year.

Operating and Maintenance Supplies

An allowance of $20,000 per year has been made for the cost of operating and maintenance supplies required for the plant operation.

6.6.4 Economics

The economics of the reprocessing operation are summarized in the following pro-forma metallurgical balance and estimate of gross revenues.

METALLURGICAL BALANCE							
PRODUCT	S.TONS	ASSAYS (oz/t)		OUNCES		% DISTRIBUTION	
		Au	Ag	Au	Ag	Au	Ag
Plant Feed	36,400	0.09	1.31	3,276	47,684	100	100
Precipitate				982	30,995	30	65
Tailings	36,400	0.06	0.46	2,294	16,689	70	35

GROSS REVENUES					
METAL	OUNCES RECOVERED	PRICE (US$/0Z)	PRICE (CDN$/0Z)	GROSS REVENUES	
				(CDN$)	(CDN$/tonne)
Gold	982	375.00	507.00	497,900	15.09
Silver	30,995	5.40	7.30	226,300	6.85
TOTAL				$724,200	$21.94

* US/CDN exchange rate of US$1.00 = C$1.35 used.

6.6.5 Milling Summary

Conceptually the equipment at the Venus mill can be used for reprocessing of the tailings material in a cyanidation leaching circuit to recover gold and silver in a precipitate form. An allowance of $500,000 is estimated as the capital required for refurbishing the existing equipment.

The estimated operating cost for the refurbished mill operation is $342,700 per year or $20.40/tonne of tailings treated. This is based on treating the tailings in two summer operating seasons of approximately five months each.

The anticipated revenue from the operation is estimated at $724,200 (based on current gold and silver prices) or $21.94/tonne treated.

7. SUMMARY OF OPTION EFFECTIVENESS ON WATER QUALITY

A summary of the estimated effectiveness of each remediation option is presented in Table 7.1. These ratings are qualitative, and based on assumptions for flow rates and contaminant transport as previously discussed.

Table 7.1 - Summary of Remedial Options

OPTION		EFFECTIVENESS OF OPTION ON COMPONENTS		
		DISSOLVED COMPONENTS	PARTICULATE COMPONENTS	PLANT ARSENIC UPTAKE
1a)	Simple cover	low	low-medium	low
1b)	Impermeable cover with capillary break	medium	high	medium
1c)	Cover with diversion/cutoff	medium-high	high	medium
2a, b)	Move tailings to new Venus Mill tailings impoundment	high	high	low *

* option does not include closure plan

A qualitative relative estimate of the reduction in loading to the lake has been determined by comparisons of existing and expected flows. A simple cover, as specified, will have no impact on water inflows. It is expected to reduce particulate components by minimizing erosion of the material. Installation of an impermeable cover could result in a 25% reduction in total inflows to the tailings. With a groundwater cutoff the total reduction of inflows may be as much as 50%. These estimates of expected seepage flows are used in part to establish the ratings for each option shown in Table 7.1.

Ratings for Option 2 are based on expected seepage calculated for the new impoundment. Total seepage flows from that site are expected to be about 0.1 ℓ/s. This is considered to be at least a 50 times reduction in flow compared to the existing site (since the old tailings site has a decant discharge of 5 ℓ/s) and has influenced the qualitative rating for both dissolved and particulate components.

A marginal reduction in downstream water quality is likely to occur at the new site by placing tailings in the impoundment. The small amount of seepage expected will likely have similar water quality to the existing decant. Due to the lack of dissolved water chemistry data, and based on the arguments put forth previously regarding the likely mode of transport, it is expected that water quality criteria will be exceeded (at downstream seepage points) for parameters which may be dissolved at high pH. Based on observations from the existing data, the primary parameter of concern will be dissolved arsenic.

It should be noted that the concentration of dissolved arsenic at a seepage point immediately downstream of the tailings dam and ponds will be diluted by a catchment area roughly 18 times that of the impoundment prior to entering the lake. This will significantly reduce the concentration of the dissolved components if present.

8. COST ESTIMATE

A detailed cost estimate for each option has been carried out. Costs are based on the conceptual remedial options previously discussed. Assumptions have been made with respect to the distance and availability of cover materials.

Details with respect to Option 2b for reprocessing costs are discussed in that section. Revenues generated are subtracted from costs to operate and refurbish the mill.

All costs are estimates based on existing information, and as such have been increased by a 30% contingency to reflect unknowns in actual site conditions. Detailed design and feasibility studies will be required prior to the implementation of any of the remedial options. Cost estimates for engineering and construction/site supervision have not been included in the total cost summary. Costs are expected to be proportional to the complexity of the option selected. Site supervision will also be similarly affected.

Table 8.1 through 8.5 provide a summary of the cost estimates for each conceptual remedial option.

Figure 6 graphically illustrates a summary of total estimated cost for each option.

Table 8.1 - Cost Estimate for Option 1a - Simple Cover

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE ($)	COST ($)	SUBTOTAL ($)
Preparation					
Access Roads to Tailings	200	m	90	18 000	
Recontouring Tailings	3 700	m^3	2.50	9 250	
Subtotal					27 000
Dewatering					
Tailings Surface Water, Water in Tailings	Lump Sum		40 000	40 000	
Subtotal					40 000
Constructing Cover					
Supply and Place Sand and Gravel	5 900	m^3	6	35 400	
Subtotal					35 000
Subtotal					102 000
30% Contingency Allowance					31 000
Total Estimated Cost					133 000

Note: Engineering and construction/site supervision costs not included.

Table 8.2 - Cost Estimate for Option 1b - Impermeable Cover

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE ($)	COST ($)	SUBTOTAL ($)
Preparation					
Access Roads to Tailings	200	m	90	18 000	
Temporary Ditch Construction	50	m	25	1 250	
Settling Pond Construction	Lump Sum		30 00	3 000	
Recontouring Tailings	3 700	m^3	2.50	9 250	
Subtotal					32 000
Dewatering					
Tailings Surface Water, Water in Tailings	Lump Sum		400 00	40 000	
Subtotal					40 000
Constructing Cover					
Supply and Place Geofabric	11 800	m^2	10	118 000	
Supply and Place Processed Rock	18 800	m^3	20	376 000	
Supply and Place Sand and Gravel	4 000	m^3	6	24 000	
Supply and Place and Compact Till	14 700	m^3	15	220 500	
Supply and Place Growth Medium	4 600	m^3	7	32 200	
Seed and Mulch	15 400	m^2	1	15 400	
Subtotal					786 000
Subtotal					858 000
30% Contingency Allowance					257 000
Total Estimated Cost					1 115 000

Note: Engineering and construction/site supervision costs not included.

Table 8.3 - Cost Estimate for Option 1c - Impermeable Cover and Diversion/Cutoff

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE ($)	COST ($)	SUBTOTAL ($)
Preparation					
Access Roads to Tailings	200	m	90	18 000	
Temporary Ditch Construction	50	m	25	1 250	
Settling Pond Construction	Lump Sum		3 000	3 000	
Recontouring Tailings	3 700	m^3	2.50	9 250	
Subtotal					32 000
Dewatering					
Tailings Surface Water, Water in Tailings	Lump Sum			40 000	
Subtotal					40 000
Constructing Cover					
Supply and Place Geofabric	11 800	m^2	10	118 000	
Supply and Place Processed Rock	18 800	m^3	20	376 000	
Supply and Place Sand and Gravel	4 000	m^3	6	24 000	
Supply and Place and Compact Till	14 700	m^3	15	220 500	
Supply and Place Growth Medium	4 600	m^3	7	32 200	
Seed and Mulch	15 400	m^2	1	15 400	
Subtotal					786 000
Diversion / Cutoff					
Ditch Excavation + D/S Liner	350	m	90	31 500	
Subtotal					32 000
Subtotal					890 000
30% Contingency Allowance					267 000
Total Estimated Cost					1 157 000

Note: Engineering and construction/site supervision costs not included.

Table 8.4 - Cost Estimate for Option 2a - Place Tailings in Existing Impoundment at New Mill Site

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE ($)	COST ($)	SUBTOTAL ($)
Preparation					
Access Roads to Tailings	500	m	90	45 000	
Temporary Ditch Construction	50	m	25	1 250	
Settling Pond Construction	Lump Sum		3 000	3 000	
Subtotal					49 000
Dewatering					
Tailings Surface Water, Water in Tailings, Water in Sump	Lump Sum		40 000	40 000	
Subtotal					40 000
Excavate Tailings					
Excavate and Haul Tailings	39 900	m^3	10	399 000	
Excavate Natural Soil	3 300	m^3	12	39 600	
Wash Truck Wheels	Lump Sum		42 000	42 000	
Subtotal					481 000
Mill Site					
Road Preparation	300	m	90	27 000	
Subtotal					27 000
Subtotal					597 000
30% Contingency Allowance					179 000
Total Estimated Cost					776 000

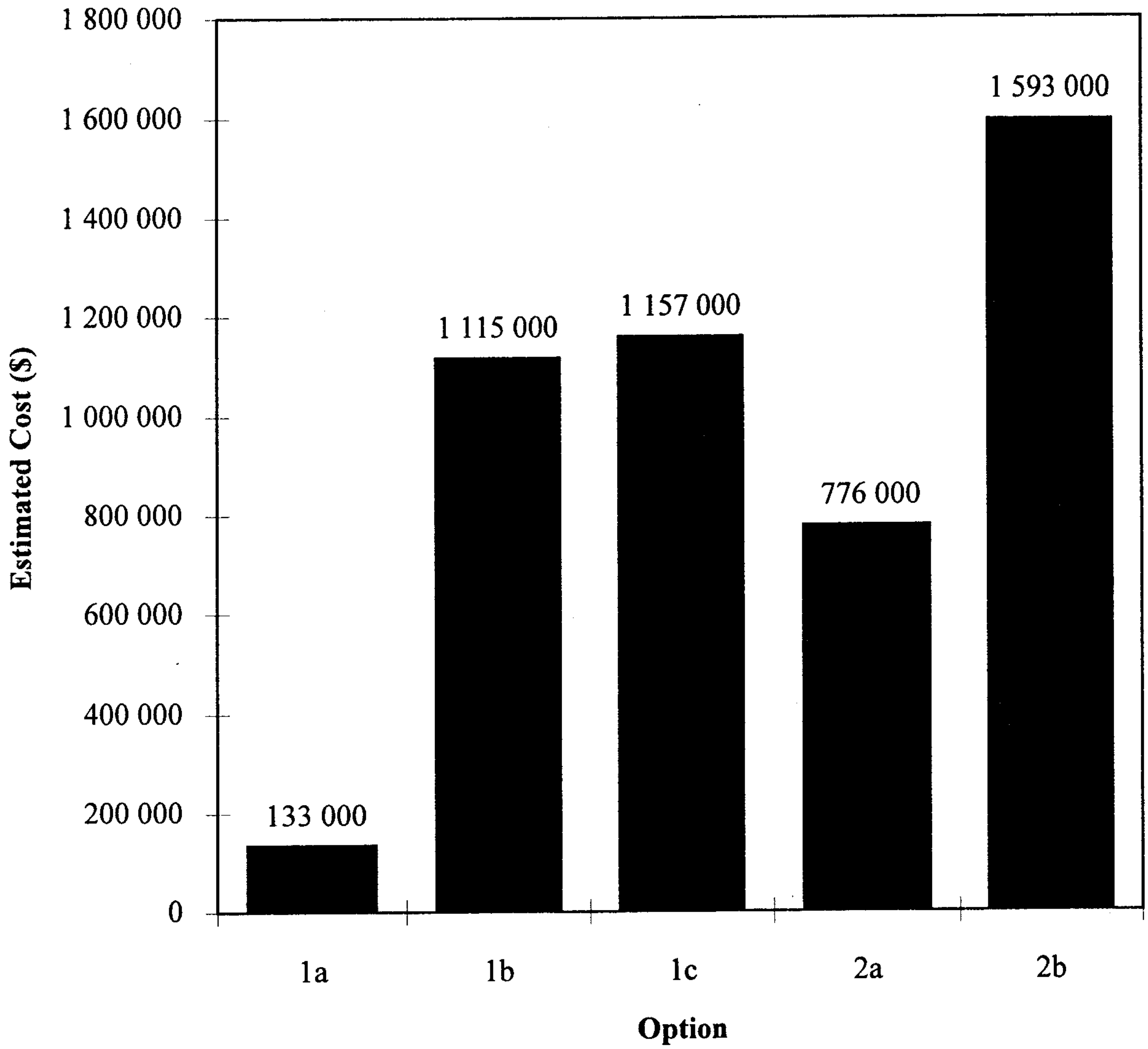
Note: Engineering and construction/site supervision costs not included.

Table 8.5 - Cost Estimate for Option 2b - Process Tailings in New Mill

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE ($)	COST ($)	SUBTOTAL ($)
Preparation					
Access Roads to Tailings	500	m	90	45 000	
Temporary Ditch Construction	50	m	25	1 250	
Settling Pond Construction	Lump Sum		3 000	3 000	
Subtotal					49 000
Dewatering					
Tailings Surface Water, Water in Tailings, Water in Sump	Lump Sum		40 000	40 000	
Subtotal					40 000
Excavate Tailings					
Excavate and Haul Tailings	39 900	m^3	10	399 000	
Excavate Natural Soil	3 300	m^3	12	39 600	
Wash Truck Wheels	Lump Sum		42 000	42 000	
Subtotal					481 000
Mill Site					
Road Preparation	300	m	90	27 000	
Process Tailings					
New Mill Equipment	Lump Sum		500 000	500 000	
Operating + Refining Costs	33 000	tonnes	20.77	685 410	
Subtotal					1 212 000
Subtotal					1 782 000
30% Contingency Allowance					535 000
Subtotal					2 317 000
Revenue Generated by Processing					(724 000)
Total Estimated Cost					1 593 000

Note: Engineering and construction/site supervision costs not included.

Figure 6 Summary of Total Cost Estimates for Remedial Options



9. SUMMARY OF COST VERSUS EFFECTIVENESS

- Option 1a
  Has the lowest cost of all options with a low rating of effectiveness. The permeable cover will reduce particulate loading but will otherwise be of minimum effectiveness. A better assessment of effectiveness could be calculated if dissolved water quality parameters were available.

- Option 1b
  Will be effective in reduction and transport of particulate, and will also result in a reduction in net flow. This is assumed to cause a reduction in dissolved arsenic transport. The cost of this option requires further tailings characterization prior to final design.

- Option 1c
  Will further reduce flow by reducing groundwater inflows, thus improving the effectiveness of the concept. Further characterization of the tailings is required to justify the estimated costs.

- Option 2a
  Moving the tailings to an engineered and controlled site provides an effective means of remediating the tailings problem. While the new site is considered to be good, moving the tailings will have a marginal impact downstream of the impoundment.

  In addition, the option of moving tailings to this site assumes it will remain under "care and maintenance" and does not include costs for permanent closure or a closure plan for the mill.

- Option 2b
  Assumes similar conditions to option 2a above, and has similar effectiveness. A component of the reprocessing option would include a reduction of arsenic in tailings and/or treatment of tailings slurry to precipitate arsenic in the impoundment. This would decrease the impact of dissolved arsenic transported by groundwater in seepage below the dam, if this is shown to be a concern after further characterization.

10. CONCLUSIONS AND RECOMMENDATIONS

This report presents an assessment of the remediation options for about 55 000 tonnes of mine tailings for the Venus Mine. The main concerns with the tailings appear to be due to wind blown and surface water erosion of tailings which result in elevated arsenic levels in plants and the degradation of the water quality in Windy Arm. There is also a potential for surface infiltration and groundwater contamination which discharges to the lake.

Five major options were reviewed and the "best" options include:

- 1b impermeable cover and capillary break;
- 1c 1b plus groundwater diversion/cutoff;
- 2 place tailings in existing impoundment at new millsite.

Cost estimates for each option have been carried out and are for comparative use only. More detailed design and costing is required prior to the execution of any of the remedial options.

The assessments described in this report have been based on the available data and interpretation of existing conditions. Final selection of an option and final design should occur only after more detailed characterization of the tailings material. This could be achieved quickly to allow remedial work to proceed this season. The proposed investigations are also required to provide a baseline for future assessment of the effectiveness of the remedial works.

On-site cover options outlined in the report could be phased over time to ultimately achieve an impermeable cover. This approach would allow total costs to be spread over a longer time period and permit evaluations of the effectiveness of each phase by comparison of water quality data. Phase I may include construction of Option 1a (simple cover) and monitoring. A subsequent construction phase to create an impermeable cover could then be carried out several years later.

A very small net value is estimated from the reprocessing of the tailings, and is likely to be insufficient to justify the capital cost required for refurbishing. A more detailed review of the capital cost might reduce the expenditure required but it is unlikely that the costs can be lowered enough to significantly change the economics. Other factors which affect the economics, including labour costs, training programs, etc. should also be included in a mill feasibility study.

The following recommendations are made.

1. To fully evaluate the actual effectiveness of any of the remedial options, a water monitoring program is recommended. Laboratory tests and arsenic speciation of the tailings should be carried out to determine the potential for arsenic leaching.

2. Additional water samples should be collected in the area of the old tailings and tested for dissolved and total metals, as well as general parameters. The sample locations should correspond to stations #18, #19 and #22. In addition to these stations sampling of the tailings pore water should be carried out if any of the cover options is selected. This could be done by installation of small 2-inch diameter PVC monitoring wells. Two such wells would be required, one near the surface and the other about two thirds of the way into the tailings. The amount of seepage from the tailings should be measured at the time of sampling to assist in the estimation of overall lake loading.

3. Additional surface water sampling will be required in the new Venus Mine tailings area if the tailings are to be moved there. Downstream of the tailings pond are two ponds connected in series before the water is released to a local creek. Each of these ponds should be sampled for dissolved and total metals and general parameters. Subsurface water samples should also be taken further downstream in the marsh to provide background data so that the effectiveness of remediation may be assessed. Seepage rates from the tailings pond should be measured at the time of sampling.

4. An assessment of the requirements for Provincial and Territorial permits and licenses for the mill is also required. The original permits will require updating.

5. Additional metallurgical testwork should be carried out to more accurately assess the anticipated recoveries of gold and silver and to check the reagent consumptions. The original testwork done in 1980 was on tailings material from a flotation test and may not be representative of the material which has been in the tailings impoundment for the last 14 years.

6. Work index tests should be carried out to more accurately estimate the size of grinding mill required for regrinding the tailings.

7. Efforts should be made to increase gold recovery in any future metallurgical testwork. The project economics could be significantly improved by improving gold recovery.

8. A detailed topographic survey of the existing tailings is required to finalize cost estimates if any of the Option 1 alternatives is selected.

KLOHN-CRIPPEN CONSULTANTS LTD.

Scott E. Broughton, P.Eng. (B.C.)
Project Manager

Peter S. McCreath, P.Eng.
Senior Water Resources Engineer

REFERENCES

Air Photographs Showing the Mine Site Area (1979).

"Assays from Venus Tailings Dam." An Anonymous Page of Assay Results. Date Unknown.

Bandola, D. "Budget to Refurbish Plantsite at Venus Mines." Letter from Commonwealth Construction Company to D.M. Dingwall of Falconbridge Ltd. August 29, 1983.

Biles, G. "Summary of Lakefield Test Work on Venus Tailings Sample." Letter to T. Dickson. Date Unknown.

Bondar-Clegg & Company Ltd. Geochemical Lab Report. Two Pages of Results of Analyses on Samples Taken from Venus Mill Site Stockpiles. October 22, 1986.

Brown, D.S. A Letter from Hitec Ore Processing Inc. to J.C. Cowen of United Keno Hill Mines Limited. February 25, 1986.

Burns, B. "Venus Mine Water Sample Results." Letter from the Indian and Northern Affairs Canada, Northern Affairs Program to Dennis Prince of United Keno Hill Mines. September 28, 1984.

Carcross/Tagish Indian Band. "Proposal to Undertake a Contaminated Waste Site Clean-up, Carcross, Yukon." Letter to Ron Chambers of Northern Affairs. February 7, 1994.

Carter, J.M. "Venus Mill Lease." Letter from Skukum Gold Inc. to J.C. Cowan of United Keno Hill Mines Limited. September 28, 1988.

"Conceptual Description. Venus Mineral Processing Plant." Five Anonomous Pages. Date Unknown.

Cornett, D. "Venus Mine Tailings Pond & Receiving Water Sample Results." Letter from the Indian and Northern Affairs Canada, Northern Affairs Program to Dennis Prince of United Keno Hill Mines. February 11, 1986.

Cowan, C. "Venus Mill, Ore Stockpiles." Letter from Falconbridge Limited to Vance Thornsberry of Skukum Gold Inc. September 20, 1988.

Davidge, D. "Oxidation of Yukon Mine Tailings." Environment Canada, Environmental Protection Service, Regional Program Report 84-15. May, 1984.

Draft Letter of Agreement Between R.G. Hilker and United Keno Hill Mines Limited Concerning the Reclamation of the Old Venus Tailings. February 17, 1994.

Dreher, W. "Proposed Works Pertaining to Water License for Venus Mine." Letter from the Province of British Columbia, Ministry of Environment to United Keno Hill Mines Limited. April 14, 1981.

Dreher, W. "Water License Application on Keno Lake." Letter from the Province of British Columbia, Ministry of Environment to United Keno Hill Mines Limited. August 14, 1981.

Environment Canada, Laboratory Services. Chemical Analysis of Water Samples Taken Near the Old Venus Tailings Pond. Lab Reference No. 870522. October 2, 1987.

F.F. Slaney & Company Limited and Aquatic Resources Ltd. "Environmental Investigations. Venus Mineral Processing Plant. Windy Arm in the Yukon Territory and British Columbia." December, 1981.

Falconbridge Nickel Mines Limited. "Lakefield Research Report on Venus Tailings." Inter-office Memorandum from F.G.T. Pickard to P.L. Munro. December 19, 1979.

Falconbridge Nickel Mines Limited. "Venus Water Licence Application in British Columbia for the Mill." Inter-office Memorandum from L.S. Price to P.E. Van Tasssel. November 12, 1980.

Falconbridge Nickel Mines Limited. "Venus Pollution Permits - B.C." Inter-office Memorandum from L.S. Price to P.L. Munro. November 13, 1980.

Falconbridge Nickel Mines Limited. "B.C. Water Take Permit. Attached Forms." Inter-office Memorandum from L.S. Price to R.E. Van Tassel/G.S. Dundas. February 9, 1981.

Falconbridge Nickel Mines Limited. "Trip Report - Venus Project - August 6 to August 21, 1981." Inter-office Memorandum from G.M. Slowikowski to P.J. Raleigh. September 3, 1981.

Falconbridge Nickel Mines Limited. "Visit to Venus Mill for Start-up - September 2 to October 3." Inter-office Memorandum from C.P. Patel to G.S. Dundas/R. Gagnon. October 8, 1981.

Falconbridge Nickel Mines Limited. "Venus Mill Operations." Inter-office Memorandum from C.P. Patel to G.S. Dundas. November 16, 1981.

Falconbridge Nickel Mines Limited. "Venus Mine. Plant Site - Development Plan." Drawing VM-10-101. March 1, 1982.

Falconbridge Nickel Mines Limited. "Review of Metallurgy for the Venus Mill." A Memorandum Sent from S.O. Fekete to J.C. Cowan. January 16, 1984.

Falconbridge Nickel Mines Limited. "Venus Mill Reconditioning." Memorandum from S.O. Fekete to J.C. Cowan. May 3, 1984.

Falconbridge Nickel Mines Limited. "Permitting and Related Ongoing Liabilities in Connection with the Venus Plantsite, Attlin Area, B.C." Inter-office Memorandum from R.H. Tays to J.C. Cowan. April 13, 1988.

Ferguson, R.H. Letter from the Province of British Columbia, Ministry of Environment to United Keno Hill Mines Limited Regarding Pollution Control Permit No. PE-6019. September 24, 1981.

Ford, C.E. "Water Samples." Letter from United Keno Hill Mines Limited, Venus Mining Division to D. Prince of United Keno Hill Mines Limited. July 14, 1986.

Geocon (1975) Ltd. "Abandoned Tailings Pond Test Hole Locations." Drawing No. A-1170. March 12, 1980.

Geocon (1975) Ltd. Geotechnical Studies. "Proposed Tailings Disposal Area and Plant. Venus Mine. Windy Arm Lake, British Columbia." May 2, 1980.

Geocon (1975) Ltd. "Addendum A. Tailings Disposal Area Design. Geotechnical Studies. Proposed Tailings Disposal Area and Plant. Venus Mine. Windy Arm Lake, British Columbia." June 30, 1980.

Geocon (1975) Ltd. "Addendum B. Tailings Disposal Area Design. Geotechnical Studies. Proposed Tailings Disposal Area and Plant. Venus Mine. Windy Arm Lake, British Columbia." November 25, 1980.

Geocon Inc. "Geotechnical Inspection Visit. Main Dam, Fresh Water Pond. Venus Mine, B.C." Letter Report. July 5, 1983.

Godin, B. and Osler, Tim R. "A Survey and Comparison of Arsenic Concentrations in Water, Soils and Vegetation Between the Venus Mine Property and the Mount Nansen Property, Yukon." Environment Canada, Environmental Protection Service. October 1985.

Hall, E.J. Letter from the Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources to Ken Watson of United Keno Hill Mines Limited Regarding an Annual Reclamation Report. April 3, 1989.

Hanrieder, D.A. and Dickson, T.A. and Holzapfel, J. "Venus Millsite Visit." Eight Pages of Handwritten Notes. September 20, 1982.

Heskin, B.A. Letter from Environment Canada, Environmental Protection to R.H. Ferguson of the Waste Management Branch, Ministry of Environment. November 4, 1980.

Hilker, R.G. "Venus Placer Geological Report. Data Compilation Evaluation. Conrad Gold District - Yukon. Windy Arm Area of Tagish lake." Confidential Report. September 3, 1992.

Hitec Ore processing Inc. "A report on the Examination of Samples Submitted by United Keno Hill, Venus Mining Division." February 11, 1986.

Jack, M.E. "Baseline Study of the Watershed Near Venus Mine, Yukon and Venus Mill, British Columbia." Environment Canada, Environmental Protection Service, Regional Program Report No: 81-18. October 1981.

Lakefield Research of Canada Limited. "An Investigation of the Recovery of Gold and Silver from a Tailings Sample Submitted by United Keno Hill Mines Limited." Progress Report No. 1. December 14, 1979.

Lakefield Research of Canada Limited. "An Investigation of the Recovery of Lead and Zinc from Ore Samples Submitted by United Keno Hill Mines Limited." Progress Report No. 2 (Venus Property). July 2, 1980.

MacDonald Consultants Ltd., and Acres Western Limited. "Venus Mine. Feasibility Report." October, 1968.

Melis Engineering Ltd. "Skukum Creek Project - Venus Mill Inspection Report - MEL Project No. 161." Prepared for Skukum Gold Inc., Vancouver, British Columbia. September 6, 1988.

Munro, P.L. "United Keno Hill Mines Limited - Venus Project (Present Reclamation Permit MX-1-4)." Letter from United Keno Hill Mines Limited to V. Pakalniskis of the Ministry of Energy Mines and Petroleum Resources. July 30, 1980.

North West Survey Corporation (Yukon) Ltd. Air Photograph Flight Line Map of the Carcross Area. 1979.

"Ore Processing Plant for Venus Mine." Five Anonomous Pages. Date Unknown.

Patel, C. "Notes on Moth-Ball Venus Mill." Eleven Handwritten Pages. November 5, 1981.

Price, L.S. "Application for a Water Licence. United Keno Hill Mines Limited. Mill for Venus Mine." Letter from United Keno Hill Mines Limited to W. Dreher of the Water Rights Branch, Ministry of Environment, Province of British Columbia. November 14, 1980.

Prince, D. Letter from United Keno Hill Mines Limited to Colin Wykes of Environment Canada, Environmental Protection Service, Yukon Branch. February 12, 1985.

Rafuse, V. "Test Hole Results." United Keno Hill Mines Limited, Elsa. March 14, 1980.

Rand & Edgar. "Agreement Between Skukum Gold Inc., United Keno Hill Mines Ltd. and Omni Resources Inc. (the "Agreement")." Letter to Karen Perry of Falconbridge Limited. May 26, 1988.

Redden, D. "Proposal and Recommendation to Put Venus Mill in Proper Operating Order." A Letter to Doug Prince of United Keno Hill Mines Limited, Venus Mining Division. April 9, 1984.

Robson, W. and Weagle, K. "The Effect of the Abandoned Venus Mines Tailings Pond on the Aquatic Environment of Windy Arm, Tagish Lake, Yukon Territory." Fisheries and Environment Canada, Environmental Protection Service, Regional Program Report 78-13. May, 1978.

Robinson, W.C. "Venus Mine Project. Fresh Water Supply Reservoir." Letter from the Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources to D.L. Munro of United Keno Hill Mines Limited. June 1, 1981.

Robinson, W.C. "Venus Mine Project. Fresh Water Supply Reservoir." Letter from the Ministry of Energy, Mines and Petroleum Resources to D.L. Munro of United Keno Hill Mines Limited. June 1, 1981.

Skermer, N.A. "Venus Mill Foundation Drainage." Letter from Steffen Robertson and Kirsten to Michael G. Stoner of Omni Resources Inc. September 13, 1988.

Skukum Gold Inc. "Potential Water Problems at Venus Mill Facility." Memorandum from M.G. Stoner to Jim Carter. September 25, 1988.

Steffen Robertson and Kirsten. "Venus Tailings Impoundment." Letter to Omni Resources Inc. September 30 , 1988.

Thornsberry, V. "Venus Mill, Ore Stockpiles." Letter from Skukum Gold Inc. to Chris Cowan of United Keno Hill Mines Ltd. September 19, 1988.

United Keno Hill Mines Limited. "Venus Project Feasibility Study." March 28, 1980.

United Keno Hill Mines Limited. "Stage I Report for Venus Mine." May, 1980.

United Keno Hill Mines Limited. Application for a Permit to Discharge Effluent from the Ore Treatment Plant. July 8, 1980.

United Keno Hill Mines Limited. Application for a Permit to Discharge or Emit Contaminant(s) into the Air from Exhaust of Ore Crushing Plant Dust Collection System. July 8, 1980.

United Keno Hill Mines Limited. Application for a Permit to Discharge Refuse from Ore Processing Plant for Venus Mine. July 8, 1980.

United Keno Hill Mines Limited. "Report in Application for a Reclamation Permit. Venus Mine." September, 1980.

United Keno Hill Mines Limited. " Venus Mine Tailings Facility. Outstanding Items from Meeting of September 3, 1980." Letter to R.T. Martin of the Ministry of Energy, Mines and Petroleum Resources. December 1, 1980.

United Keno Hill Mines Limited. "Venus Mill Site Stockpiles." Four Hand Written Pages. October 7, 1986.

United Keno Hill Mines Limited. "Venus Tailings." Forty-seven Page Fax from D.R. Prince to J.C. Cowan. March 15, 1988.

Van Tassell, R.E. "Drill Testing of the Old Venus Tailings Pond." Eight Pages Including Volume, Tonnage and Grade Calculations and a Map. March 15, 1980.

"Venus Mine - Water Samples - 1983." Two Anonymous Pages Reporting Arsenic Levels in Water. 1983.

Venus Mines Ltd. (N.P.L.). "Operating Statistics 1970 and 1971." Two Anonymous Pages. Date Unknown.

"Venus Tailings Summary." Three Anonymous Pages Summarizing the Testwork that Lakefield Research of Canada Limited Conducted in 1979. Date Unknown.

Watson, Ken W. "Report on the 1989 Water Sampling Program. Venus Millsite Area." United Keno Hill Mines Limited. September 22, 1989.

Watson Ken W. Letter from United Keno Hill Mines Limited to E.J. Hall of the Ministry of Energy, Mines and Petroleum Resources Regarding the Water Sampling Program in the Summer of 1989 at the Venus Millsite Area. September 28, 1989.

Whitehorse Assay Office Ltd. One Page of Results of Assays on Venus Tailings Samples. August 7, 1979.

Wright Engineers Ltd. "An evaluation of Venus Mine Ltd." May 10, 1971.

Wykes, Colin. Letter from Environment Canada, Environmental Protection to Dennis Prince of United Keno Hill Mines Ltd. February 25, 1985.

APPENDIX I

PROPOSAL LETTER

KLOHN-CRIPPEN
A Merger of:
Klohn-Crippen, Klohn Leonoff, Crippen Division of Simons. Toronto Division of Simons

Our File: PB 6535 01 February 1, 1994
MIN 95

Poushinsky Consulting
11 Chalet Crescent
Whitehorse, Yukon,
Y1A 3H2

Dr. N. Poushinsky
President

Venus Mine Tailing Study

Dear Nick:

Further to our recent telephone conversations regarding the office-based study of mitigative options for the Venus Mine Tailings located at the 1970's mill-site on the west side of Windy Arm (Tagish Lake). We understand that your unsolicited proposal to the Federal Government to carry out socio-economic and technical evaluation studies for capping or physically moving the tailings has been accepted. Mr Scott Broughton of Klohn-Crippen visited the tailing site in the Yukon and the new (1980's) Venus mill-site in British Columbia in late October, 1993.

We understand that you will carry out project management and related tasks for the project. Klohn-Crippen will provide technical and cost estimating support as a sub-consultant. The total project costs are estimated to be $65,000. As discussed, Klohn-Crippen's budget for the study will be $25,000 plus expenses.

The study and reporting are to be completed in draft form by March 15, 1994, and a community presentation will be required to discuss the various options in a public forum.

Our component of the project includes the evaluation and costing of two primary mitigative options. The first option includes minimizing water quality problems caused by the tailings by covering the material with an impermeable layer, thus reducing the water inflow. The second option includes physically excavating and transporting the material to the 'new' Venus mill-site in B.C. The advantage of this option is that a tailings impoundment facility which is capable of storing the material exists at that site. The latter option has two alternatives including simply transporting and storing, or transporting, reprocessing and storing the tailings. Revenue generated by reprocessing the material would offset all or part of the cost of re-commissioning and operating the mill.

A detailed assessment of each option and alternative is required such that the project can be advanced. The study will include the assessment of existing conditions and water quality. Methodologies for each concept will be developed and cost estimates for the required mitigative work will be made. For the re-processing alternative, costs for commissioning, power, and operation of the mill will be calculated. An assessment of the metal value and expected recovery rate using process methods compatible with the existing mill will also be made.

A review of the new Venus Mill tailing facility design and construction records will be made to confirm that it provides a suitable storage site. In addition, an assessment of water storage and a water balance for the impoundment will also made.

The study of each option will also include an assessment of water quality for the current condition, during construction of a cover or excavation, and upon completion of an option. Permitting requirements for each option will be considered.

A draft report summarizing the study work will be delivered for your review in the first week of March, 1994. A final report will be prepared after we have received your comments.

The following personnel have been assigned to the project team:

Mr. Scott Broughton, P.Eng. will be our Project Manager. He will coordinate the work within the project team. Scott will also carry out much the detailed review, analysis, and reporting. Scott has 9 years of experience on a wide variety of mining projects, including feasibility and cost related studies for development and construction.

Mr. Ted Dobinson, P.Eng. is our Senior Cost Estimator. Ted has over 25 years of construction and cost estimating experience on a variety of mining and civil projects. He will carry out all of the cost estimating required for the project.

Mr. Brad Piteau, E.I.T, will be Project Engineer. Brad is a mining engineering graduate and has recent experience on a mine design/plan for which he assessed various development alternatives and carried out cost estimates for development.

We understand that you have budgeted $25,000 plus expenses for our component of this project. We accept this as an appropriate amount for the required work, and will advise you as required regarding our budget status and the completion of major tasks. This amount does not include applicable taxes and all charges will be as per our "General Conditions of Agreement" attached.

If you have any questions or comments regarding this letter of commitment, please do not hesitate to call.

Yours very truly,

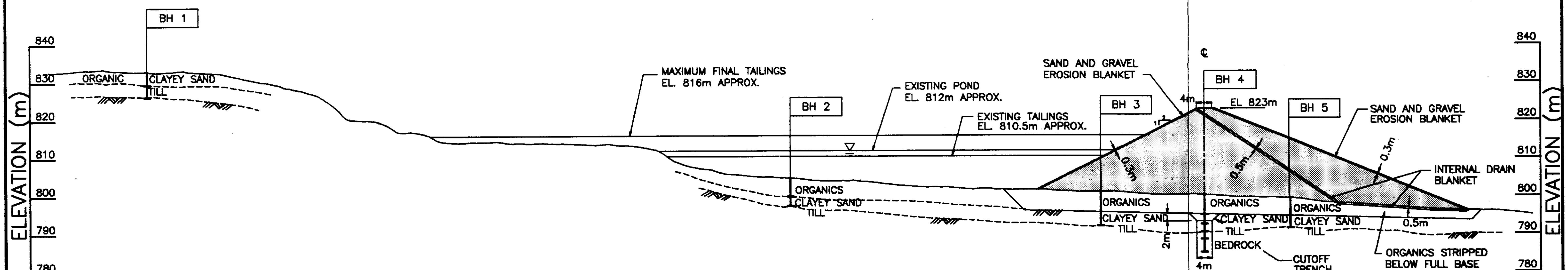
KLOHN-CRIPPEN CONSULTANTS LTD.

Scott E. Broughton, P.Eng.
Mining/Geotechnical Engineer

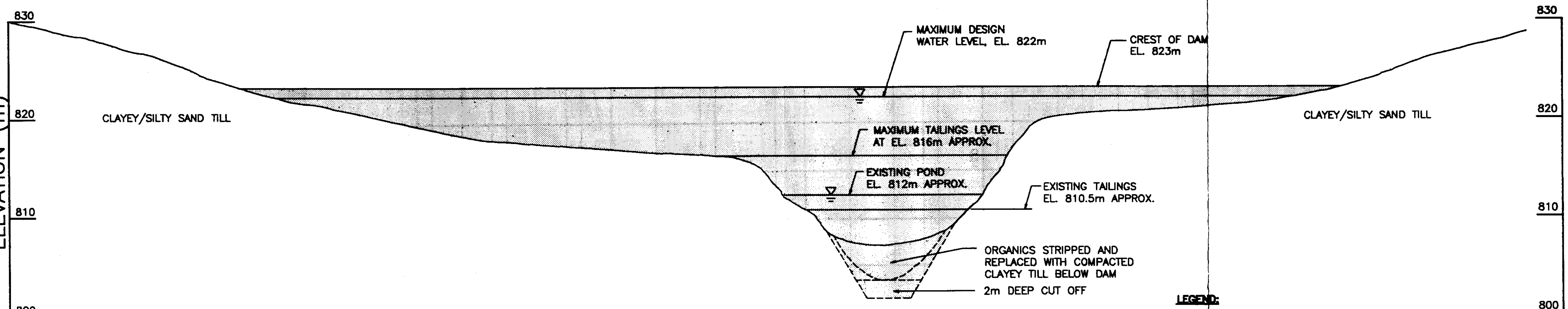
SEB:ms
Attach.

DRAWINGS

DRAWING B-1001 - VALLEY BOTTOM PROFILE AND DAM CENTRE LINE PROFILE



VALLEY BOTTOM PROFILE



DAM CENTRELINE PROFILE

VERTICAL EXAGGERATION 2.5X

LEGEND:

INTERPRETED SOIL/ROCK CONTACTS

WATER LEVELS

NOTES:

DRAWING SECTIONS AFTER GEOCON (1975)LTD.
DRAWING A1170-9

SCALE 10 0 20m

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED

KLOHN-CRIPPEN		DATE
DESIGNED	HDP	MAR.94
DRAWN	CYW	MAR.94
CHECKED		
RECOMMENDED		
APPROVED		

KLOHN-CRIPPEN

CLIENT: POUSHINSKY CONSULTING

PROJECT: VENUS MINE TAILINGS STUDY

TITLE: VALLEY BOTTOM PROFILE AND DAM CENTRELINE PROFILE

PROJECT No. PB6535 01 | DWG. No. D-1001