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FINAL REPORT
ASSESSMENT OF REMEDIAL MEASURES FOR ARCTIC GOLD & SILVER TAILINGS SITE

Prepared for:

THE ARTIC GOLD & SILVER WORKING GROUP

Under the Direction of:

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
1000 - 9700 Jasper Avenue
Edmonton, Alberta
T5J 4E2

Prepared by:

STEFFEN ROBERTSON AND KIRSTEN (CANADA) INC.
Suite 800, 580 Hornby Street
Vancouver, B.C. V6C 3B6
Tel: (604) 681-4196 • Fax: (604) 687-5532
E-mail: vancouver@srk.com Web site: www.srk.com

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1.0 INTRODUCTION

On June 16, 1998, Public Works and Government Services Canada (PWGSC) commissioned Steffen Robertson and Kirsten (Canada) Inc. (SRK) to provide scientific and geotechnical services related to the remediation of the Arctic Gold and Silver mill site and tailings facility, near Carcross in the Yukon Territory. The principal concerns to be addressed by the remediation plan were the threats posed to human health and the environment by the tailings, mine rock and water which comes into contact with either of these materials.

Initially, SRK's scope of work was to review relevant background documents, visit the site and then review and verify design and specification documents prepared by PWGSC. The site visit was completed on July 24, 1998, and included representatives from SRK, PWGSC, INAC (Indian and Northern Affairs Canada) and the Carcross Tagish. During the site visit, all parties agreed that further investigations and evaluation of options were required before deciding on the most appropriate remediation plan. SRK's terms of reference were expanded to include the development of a plan for further investigation and evaluation of options, and preparation of a conceptual design. On August 18, 1998, SRK submitted a letter recommending further investigations, which were subsequently approved by PWGSC.

This report summarizes the results of the recent investigations and, based on this new information, evaluates the most appropriate remedial measures for the site. Preliminary cost estimations have also been presented.

2.0 INVESTIGATIONS

Field work at the site was carried out between August 24 and September 25, 1998. Laboratory tests were completed in September and October 1998. The following sections describe the investigations and refer to appendices containing detailed results.

2.1 Survey

The general layout of the site of the Arctic Gold and Silver site is shown on Figure 2.1. The site was surveyed by Underhill Geomatics Ltd. of Whitehorse, Yukon Territory. The ground survey consisted of:

- Topography (0.5m contours) of the tailings dam, surrounding berms, and tailings surface;
- Topography (0.5 to 1 m contours) of the surrounding area;
- Partial survey of the diversion ditch;
- Survey of all boreholes and well installations (ground and datum marks);
- Delineation of exposed windblown and spilled tailings;
- Delineation of all waste ore piles for both position and volume calculations; and
- Installation and survey of lake level staff gauges and marker posts for positioning during lake sampling.

The results of the site survey are presented in Figure 2.2. All elevations and positions are related to an arbitrary datum point located on the site.

2.2 Drilling

Boreholes were completed to investigate subsurface conditions at the locations shown on Figure 2.2. Specific objectives were to:

- Determine the thickness of the tailings for volume calculations;
- Install groundwater monitoring wells in the tailings and underlying native soils in order to determine groundwater flow directions;
- Enable a preliminary determination of one area for use as a potential borrow source; and
- Assess and collect samples of the tailings and native soils for environmental and geotechnical laboratory testing.

The drilling was carried out using a CME 750 auger drill mounted on a balloon-tired all-terrain vehicle operated by Midnight Sun Drilling Ltd. of Whitehorse. EBA Engineering (EBA) of Whitehorse provided field supervision and undertook borehole logging.

Bulk samples were collected from the solid stem auger holes. All samples were bagged and labeled with the borehole number and collection depth.

The borehole logs and the EBA report describing the geotechnical investigation are presented in Appendix A. Isopachs of tailings thickness interpreted from the borehole and survey data are presented in Figure 2.2. Two sections through the tailings are illustrated in Figure 2.3.

2.3 Laboratory Testing

2.3.1 Geotechnical Testing

Bulk samples collected from the drilling program were transported to the EBA laboratory in Whitehorse for routine geotechnical testing. The results of this testing are included in Appendix A.

2.3.2 Tailings Geochemical Testing

Bulk samples of the tailings were segregated into strongly oxidized (beige or light yellowish colour) and less oxidized (grey colour) when collected. The samples were shipped to CESL Engineering in Vancouver for laboratory testing. The environmental properties of the tailings had been tested in two previous programs. The current testing was therefore limited to:

- Analyses for gold and silver content (head grade analyses); and,
- Bottle roll tests to measure the amount of alkali needed to neutralize the tailings acidity and the proportion of gold and silver that is extractable using cyanide.

The samples were composited using a riffle screen and standard laboratory procedures. Tests were completed on one composite of the strongly oxidized material and one composite of the less oxidized material. The results are provided in Appendix B.

2.4 Water Sampling

2.4.1 Surface Water

Laberge Environmental Services (LES) of Whitehorse carried out surface water sampling on September 6th and 7th, 1998. Samples were collected from the stream diversion upstream of the tailings, the unnamed lake and from Tank Creek. The lake sampling locations were estimated by LES and plotted on an obliquely oriented aerial photo of the site that was later transferred to a site plan. The approximate sample locations are shown on Figures 2.1 and 2.2.

The sample locations were described as:

- D-1, diversion ditch near NW corner of the tailings impoundment;
- D-2, diversion ditch near road to mine (dry, no sample available).
- D-3, diversion ditch near road to mine;
- P-1, inflow to the unnamed lake;
- P-2, in the unnamed lake, adjacent to discharge point in zone of influence;
- T-1, Tank Creek at outlet of the unnamed lake; and
- T-2, Tank Creek ~350 m downstream of the unnamed lake, in a canyon.

Sample collection notes on pH, total dissolved solids (TDS) and several other parameters are given in Table 2.1 below.

TABLE 2.1
Surface Water Sampling Field Notes

Sample ID	Sample Type	T (°C)	pH	Diss. O_2 (mg/L)	Diss. O_2 (%)	Est. Flow (liters/s)	Conductivity (µS/cm)
D-1	Surface Water	7.1	7.42	9.4	91	1 to 2	111.6
D-3	Surface Water	10.5	7.36	9.8	105	2 to 3	87.1
P-1	Surface Water	9.0	6.83	8.2	82	15	60.5
P-2	Surface Water	9.1	7.10	10.5	108	-	71.1
T-1	Surface Water	8.6	7.52	10.7	107	-	64.6
T-2	Surface Water	7.8	7.69	11.1	110	122	68.3

Notes: – = Indicates that no data was collected for this sample.

The samples were subsequently shipped to ASL Analytical Services Laboratories Ltd. (ASL) in Vancouver and analysed for:

- Total metals;
- Dissolved metals;
- Dissolved mercury; and
- TDS, pH, electrical conductivity (EC), and sulphate.

The dissolved metals samples were not filtered or preserved until analyzed in the laboratory. Total metals samples were preserved with nitric acid in the field. All samples were stored and shipped to ASL in a cooler with ice packs. Results of the analyses are given in Appendix C. The LES report in included in Appendix D.

2.4.2 Groundwater

Groundwater samples were collected on September 12, 1998 by M. Billowits (EBA) from the monitoring wells using dedicated teflon bailers. Well MW-1S and MW-6 were not sampled. Sample identification numbers and sampling notes are given in Table 2.2.

TABLE 2.2
Groundwater Sampling Field Notes

Sample ID	Sample Type	pH	Conductivity (µS/cm)
MW1-D	Groundwater	7.4	460
MW2	Groundwater	5.5	3580
MW3	Groundwater	8.0	290
MW4	Groundwater	5.8	6800
MW5	Groundwater	4.0	4020

The samples were shipped to ASL and analyzed for:

- Dissolved metals; and
- TDS, pH, EC, and sulphate.

The dissolved metals samples were not filtered or preserved until analyzed in the laboratory. All samples were stored and shipped to ASL in a cooler with ice packs.

Results of the analyses are given in Appendix C. Measurements of the depth to water and piezometric elevations are provided on the borehole logs (Appendix A).

2.5 Delineation of Windblown Tailings

A layer of windblown tailings has covered an area to the northeast of the tailings impoundment. This material is quite distinctive, due to its beige colour, when compared to the underlying soil.

The extent of the windblown tailings is shown on Figure 2.2. Measurements indicate the thickness of windblown tailings ranges from 0.05 to 0.25 m. The average thickness is about 0.2 m.

2.6 Delineation of Other Sources

Other potential contaminant sources identified in the earlier investigations included:

- Ore piles;
- Spilled tailings; and
- The decant outfall which extends from the tailings impoundment to unnamed lake.

The areas corresponding to these potential sources were surveyed by Underhill Geomatics Ltd., and their locations are shown on Figure 2.2.

The thickness of the spilled tailings is variable due to the hummocky terrain. Therefore, no representative depth measurements were possible. Scattered measurements indicate the tailings thickness is only 0.03 m of over much of the area, and a maximum of 0.35 m close to the lake. The average thickness of spilled tailings is about 0.20 m.

Soil samples (TS-C1 to C3) were collected from the decant outfall (Figure 2.2), beneath the tailings impoundment, in order to assess the level of contamination in the underlying native soils. The results of the soil analyses by ASL are given in Appendix C.

2.7 Lake Sediment Sampling

Sediment sampling was carried out in the unnamed lake by LES at the same time as the surface water sampling (7th and 8th of September, 1998). Sediment samples were collected using a petite ponar dredge supplied by INAC. Core samples were collected at sites P-2 and P-3 with a soil probe provided by INAC, however the probe proved inadequate for the deeper sampling sites (P-4 to P-8). The locations of the sampling points P-2 to P-6 were triangulated from known points on land. The locations of sampling points P-1, P-7 and P-8 were estimated by LES and plotted on an obliquely oriented air photo of the site and then transferred to the site plans (Figure 2.1 and 2.2).

Sediment samples were stored in ziplock bags, sealed, and transported in coolers with ice packs to ASL Analytical Services Laboratories Ltd. in Vancouver for analysis. All samples were analyzed for arsenic and mercury. The core samples were sealed and archived in at ASL in their cold storage facility. Results of the analyses are presented in Appendix C. The LES report in included in Appendix D.

2.7 Landfill

There is a landfill site approximately 600 m east of the tailings impoundment, immediately north of the road to Montana Mountain (Figure 2.4). Domestic waste is exposed at various locations across the landfill.

Samples were obtained from three locations in the vicinity of the landfill (LF-S1 to LF-S3) and sent to a laboratory for chemical analysis. The results are included in Appendix E.

2.8 Investigation of Potential Borrow Areas

One borehole (PH2) and five test pits (EBA-1 through EBA-5) were completed in a potential borrow area north of the plant site (Figure 2.2). The borehole was drilled using the same equipment and techniques described in Section 2.2. The test pits were excavated using a track-mounted excavator. EBA directed both the drilling and the test pit excavations and logged the pit walls. Representative samples were obtained from each test pit and returned to the EBA laboratory in Whitehorse for gradation, compaction, and permeability testing.

The EBA report describing the geotechnical investigation at the potential borrow area is included in Appendix A of this report. The log of borehole PH2 is presented in Appendix B of the EBA report. The test pit logs and permeability test results are included in Appendices C and D, respectively, of the EBA report.

An alternative borrow area was identified close to Carcross. Geotechnical data compiled by EBA in relation to this borrow area is included in Appendix F of this report.

3.0 EVALUATION OF INVESTIGATION RESULTS

3.1 Surface Water

Figure 2.2 shows sampling points for which dissolved arsenic concentrations were measured. The blue dots correspond to surface water samples; the green circles to groundwater samples.

The Canadian Council of Ministers of the Environment (CCME) guidelines indicate the maximum allowable concentration of dissolved arsenic for fresh water organisms is 0.050 mg/L. The maximum allowable concentration of dissolved arsenic recommended for drinking water is 0.025 mg/L.

The following conclusions can be drawn from the water quality data:

- Arsenic concentrations in surface water samples (i.e. in the diversion ditch, the unnamed lake and Tank Creek) are below the CCME freshwater aquatic life and drinking water criteria (i.e. below 0.025 mg/L) except for a sample taken in 1997 in the decant outfall that leads to the unnamed lake. This sample (97-BTT-WQ-S-1) had an arsenic concentration of 28.4 mg/L, which indicates that although discharges to this channel may be infrequent, the associated arsenic concentration is high. The outflow was not re-sampled in the 1998 field program as no water was flowing in the channel at the time.

- The concentrations of arsenic at surface water sampling points upstream of the tailings impoundment are very low (i.e. less than or equal to 0.0006 mg/L). The concentrations of mercury at these points are below detectable limits (<0.0005 mg/L), suggesting that high mercury levels found in an earlier sample from the

diversion ditch were anomalous. We conclude that the Arctic Gold and Silver site is the only significant source of surface water contamination in the area.

- In the unnamed lake below the tailings impoundment, arsenic levels are two to four times higher than the upstream values, with the higher levels measured nearest to the tailings impoundment. However, arsenic concentrations remain below the CCME criteria.

- Arsenic concentrations in Tank Creek downstream of the site are higher than in the unnamed lake, but again remain below the CCME criteria.

3.2 Groundwater

The groundwater table was below the tailings at all points measured (Figure 2.3). Currently, therefore, there is no evidence of groundwater passing through the tailings from the upgradient side. Hence there is no need for additional groundwater or surface water diversions. The water table may rise in spring, but due to the low permeabilities of the tailings and foundation soils, it is unlikely that significant horizontal flow through the tailings would result.

Groundwater samples taken from piezometers screened below the tailings show elevated concentrations of dissolved arsenic. The highest concentration, 88 mg/L, was observed in MW-5. A similarly high concentration, 20 mg/L, was observed in MW-4.

Groundwater monitoring wells were not installed down-gradient of the impoundment. As a result, the direction and rate of flow of the contaminated groundwater seepage cannot be determined. However, it is reasonable to assume that the contaminated groundwater flows towards the unnamed lake and/or Tank Creek (Figure 2.3) and therefore represents a potential source of surface water contamination.

3.3 Tailings Impoundment

3.3.1 Depth and Volume

The tailings impoundment occupies an area of about 20,000 m^2. Over most of the area, the tailings vary in thickness from 1.2 to 3.8 m and are underlain by a thin organic layer and glacial till. Based on the tailings isopachs shown in Figure 2.2, the volume of tailings is estimated to be about 27,200 m^3.

3.3.2 Physical Properties

The tailings consist of two layers distinguished by the extent of oxidation (as evidenced by the characteristic rust colour associated with the presence of ferric hydroxide in the tailings). The upper layer typically consists of beige fine sand that is more oxidized than the material below it. The lower layer consists of dark grey silt and sand and is relatively unoxidized. The thickness of the upper oxidized layer varies from about 0.8 to 1.7 m, but is typically about 1.1 to 1.2 m.

The upper layer is over 90% sand (with 10% fines) and is damp to moist with moisture contents that typically vary from 10 to 15%. The lower layer is 10 to 85% sand (with 15 to 90% fines) and is moist to wet with moisture contents that typically vary from 30 to 40%.

No density values were obtained but it is likely that the dry density of the tailings is in the range of 1.4 to 1.6 tonnes per cubic metre.

3.3.3 Geochemical Properties

The geochemical properties of the tailings are discussed in the PWGSC March 1998 report entitled "Phase III Environmental Assessment of the Arctic Gold & Silver Mill and Tailings Impoundment." Table 3.1 provides a summary of geochemical information from that report. In brief, the tailings are strongly acidic, and contain very high levels of total and soluble arsenic.

3.3.4 Precious Metal Value

Table 3.2 presents results of the metallurgical tests on the composite tailings samples. The recoverable gold and silver values were calculated using the following assumptions (current as of November 4, 1998):

- Gold price = $290 US/oz
- Silver price = $4.92 US/oz
- 1 $US = 1.524 $CDN.

With 27,200 m^3 of tailings at a dry bulk density of 1.4 to 1.6 tonnes/m^3, and an average depth of oxidation of 1.1 m over a surface area of approximately 20,000 m^2, the recoverable precious metal value of the tailings is as follows:

- Value in $CDN for 1.4 t/$m^3$ = $2,230,000
- Value in $CDN for 1.6 t/$m^3$ = $2,550,000

TABLE 3.1
Tailings Geochemical Properties (from PWGSC, 1998)

Parameter	Range	Average
Acid Base Accounting		
Paste pH	1.8 to 3.5	2.6
AP ($kgCaCO_3/t$)	0.63 to 92	20
NP ($kgCaCO_3/t$)	-23 to -2.5	-12
NNP ($kgCaCO_3/t$)	-107 to -3.1	-33
Solids Metals[1]		
Al (%)	0.09 to 0.41	0.22
As (ppm)	3193 to >10,000	6712
Cu (ppm)	29 to 1266	164
Fe (%)	1.1 to 5.73	2.8
Pb (ppm)	590 to 4222	1730
Ag (ppm)	25 to >200	82
Zn (ppm)	33 to 643	183
Soluble Metals[2]		
Al (mg/L)	3.1 to 99	33
As (mg/L)	0.30 to 50	17
Cu (mg/L)	0.34 to 6.4	3.4
Fe (mg/L)	6.5 to 287	136
Pb (mg/L)	<0.05 to 3.7	1.4
Ag (mg/L)	0.03 to 0.20	0.12
Zn (mg/L)	0.36 to 13	5.6

1. From ICP Analyses
2. From leach extraction testing

TABLE 3.2
Results of Tailings Metallurgical Testing

Parameter	Strongly Oxidized Tailings	Less Oxidized Tailings
Assay Gold Content (g/t)	3.51	1.70
Assay Silver Content (g/t)	239.0	121.0
Alkali ($Ca(OH)_2$) Consumption (kg/t)	48.7	33.4
Cyanide (NaCN) Consumption (kg/t)	7.58	7.85
CN-Extractable Gold[1]	68.5%	75.1%
CN-Extractable Silver[1]	67.7%	74.5%
Recoverable Gold Value ($CDN/t)	$34.11	$18.11
Recoverable Silver Value ($CDN/t)	$38.94	$21.70
Proportion (m^3)	15,300	11,900
Proportion (tonnes) at density of 1.4 t/m^3	21,420	16,660
Proportion (tonnes) at density of 1.6 t/m^3	24,480	19,040

1. Recovery rates

3.4 Submerged Tailings in the Lake

The tailings sediment sampling completed to date gives an indication of the aerial extent of the arsenic contaminated sediments (Figure 2.2). In particular, as shown by the arsenic results provided in Figure 2.2 and Appendix C, there is a distinct difference between the zone of very high arsenic levels (assumed to be tailings solids) and the low to moderate arsenic levels in the sediment found elsewhere in the lake.

Based on the limits indicated by Figure 2.2, the submerged tailings occupy an area of about 12,700 m^2. The LES sampling program provided an indication of tailings thickness at two locations: 2.5 cm at P-2 and 1 cm at P-3 (LES memorandum of December 10, 1998 in Appendix D). Assuming an average thickness about 2 cm, the volume of tailings is about 250 m^3. As some level of contamination almost certainly extends into the natural sediments underlying the tailings, the zone of contaminated material (tailings and natural lake sediments combined) might be, on average, about 5 cm thick. With this thickness, the volume of contaminated material would be 600 m^3.

Mercury levels in the sediments ranged from 0.03 to 0.115 ppm for the samples collected. The two highest levels, 0.11 ppm at P-2, and 0.115 ppm at P-3, coincided with the two highest arsenic levels measured. The other samples do not appear to

correlate with the presence of tailings solids, as delineated by the sediment arsenic levels.

Air photos of the unnamed lake suggest there is a line of tailings following what appears to be a creek channel from the decant outflow. It is reasonable to assume that those tailings were present prior to the beaver dam that created the lake. The broader, more lightly contaminated area may be attributable to dispersion of the original spill, recent discharges into the lake, or the formation of hydroxide precipitates as acidic tailings water is neutralized in the lake.

The water quality and sediment studies cannot show how significant the underwater tailings are as a source of arsenic. However, as mentioned above, arsenic concentrations in unnamed lake remain below CCME criteria.

3.5 Other Sources of Metal Contamination

3.5.1 Windblown Tailings

The windblown tailings cover an area of about 5,000 m^2. At an average thickness of 0.2m, this corresponds to 1,000 m^3. The water table is below the tailings. Although no chemical analysis of the windblown tailings was completed, they are likely to be similar to tailings in the impoundment, i.e. acidic and high in arsenic.

3.5.2 Spilled Tailings

The spilled tailings occupy an area of about 1,500 m^2. Assuming an average thickness of 0.2m, the estimated volume of spilled tailings is 300 m^3.

3.5.3 Decant Outfall

The soils immediately beneath the decant outfall have relatively low arsenic levels, indicating the effect of the tailings discharged at the decant outfall is confined to the few cubic metres of tailings present within decant the outfall.

3.5.4 Rock Piles

There are ten small piles of mine rock (Piles 1 to 10) and one ore storage pad (of unknown thickness beneath Piles 1 to 5). Table 3.3 summarizes the estimated volume associated with each area.

TABLE 3.3
Estimated Mine Rock Quantities

Item	Quantity (m^3)[1]	Subtotals
Pile 1	65	Piles 1 to 5 245 m^3
Pile 2	4	
Pile 3	10	
Pile 4	113	
Pile 5	53	
Base of ore storage for Piles 1 to 5	1,210	1,210
Pile 6	105	Piles 6 to 10 243 m^3
Pile 7	20	
Pile 8	6	
Pile 9	106	
Pile 10	6	
TOTALS	**1,698**	**1,698**

1. Estimated from topographic map provided by Underhill Geometics Ltd.

In addition to the mine rock, there is a ramp used to feed ore to the crusher. This ramp was apparently constructed using local soils, although there are probably sporadic amounts of spilled ore on the cover of the ramp. The volume of this ramp is estimated to be 10,000 m^3. While it is very unlikely the ramp is a significant source of dissolved metal concentrations, it does represent a safety hazard due to its steep slope.

3.6 Unnamed Lake

The unnamed lake immediately west of the Arctic Gold and Silver tailings impoundment is a relatively recent feature. During operations, this lake did not exist. It was formed as a result of road construction and, following the end of operations, beaver activity. The road embankment extends westward from the former mill site at the location shown on the site plan (Figure 2.2). It was constructed to provide access to a pumphouse at another lake located west of Tank Creek. The pumphouse provided the water supply to the Arctic Gold and Silver mill (Larry Barrett, personal communication). The road includes a 1 m diameter culvert where it crosses Tank Creek. The culvert was plugged by beavers to form the unnamed lake. The beavers have also built a conventional beaver dam on top of the road embankment, which has raised the water level in the lake.

The suitability of the road embankment and beaver dam as a water retaining structure is questionable. There is a concern that this dam could fail, allowing an uncontrolled

discharge of lake water and, with it, some of the arsenic contaminated sediments that lie in the bottom of the unnamed lake. The beaver dam and road embankment should either be breached and Tank Creek re-established in its original location, or the beaver dam and road embankment modified or replaced to develop a properly engineered water retention dam.

Prior to breaching the dam, the unnamed lake would need to be drained in a controlled fashion (e.g. by pumping or siphoning). The existing culvert and road embankment fill would then be removed to restore the original channel. The excavated fill could be placed on the tailings impoundment. All excavated slopes should be graded to an angle not steeper that 3 horizontal to 1 vertical to ensure long-term erosion resistance. The tailings exposed in the lake floor and any contaminated soil would need to be excavated and placed on the tailings impoundment as part of this option.

If the lake is to be maintained, a geotechnical investigation to evaluate the condition of the fill and underlying soils would be required. Based on the results of this investigation, a modification or replacement structure could be designed and installed. This would include, for example, removal of the existing culverts, the development of a low permeability core zone and the installation of a spillway structure to pass peak floods. For as long as the dam is in place, it will require periodic inspections and routine maintenance.

3.7 Landfill

The area where domestic waste is exposed at the landfill totals approximately 600 m^2. Part of the landfill has been covered by local soils and it is good practice to cover and revegetate the portions of the landfill which remain exposed. Material from the ramp could be used as cover.

3.8 Potential Borrow Sources

The borrow area investigation north of the mill foundation revealed that the typical soil profile consists of about 0.5 m of fill and organic soils overlying a till comprised of sand and gravel with some fines. Based on four gradation analyses, the fines content is typically about 11 to 13%, although it was as high as 22% in one sample. The material is not suitable for construction of a low permeability cover that is intended to minimize infiltration.

EBA has indicated (M. Billowits, pers. comm.) that, near Carcross, there are areas from which fine grained, lacustrine soils, which are well suited for applications requiring a low permeability soil, can be borrowed. No evaluation of this alternative area was undertaken as part of this study, but site investigation and laboratory testing data compiled from previous studies from two sites by EBA have been included in Appendix F. These results confirm the suitability of the material from either of these sites for use as a low permeability cover.

4.0 ANALYSIS OF REMEDIAL MEASURES

4.1 Remediation Alternatives

SRK's earlier letter (August 18, 1998) outlined remediation objectives and alternatives for the Arctic Gold and Silver site. The letter concluded that seven remedial measures were worthy of further consideration, subject to the results of additional investigations.

The seven alternatives considered worthy of further consideration were:

1. Do nothing;
2. Control access to the site;
3. Reduce contact with surface and ground water;
4. Cover the tailings;
5. Consolidate tailings and other into a smaller area;
6. Chemically amend the tailings; and,
7. Reprocess the tailings.

The following sections briefly discuss each of these measures.

4.2 Do Nothing

The "do nothing" alternative was rejected because of the human health hazard, continuing dispersion of tailings, and the potential for future deterioration of surface water quality.

The high arsenic level in the tailings makes them a hazard to human health. Although human activity on the site is limited to occasional recreational use, and hence little exposure to the tailings, a "do nothing" approach would curtail all future activities in the area. In its current state, the site is not suitable for development of any kind.

Tailings are being blown out of the impoundment by wind, and may be washed out of the impoundment through the decant structure. A "do nothing" approach would not control further dispersal of the tailings and the potential for more widespread contamination.

As mentioned in Section 3, water quality samples indicate that surface water below the site remains in compliance with CCME criteria for drinking water and freshwater aquatic life. However, a simple calculation shows that, if groundwater contamination is not curtailed, surface water quality could deteriorate in future. The area of the tailings impoundment is approximately 2 ha. The area of the catchment contributing to unnamed lake is approximately 660 ha. Assuming equal precipitation and equal infiltration across the catchment, water that falls on the impoundment is diluted approximately 330 (=660/2) times in the unnamed lake. Current arsenic concentrations in the groundwater below the impoundment are as high as 88 mg/L. Applying the dilution factor of 330 to that concentration indicates that concentrations in unnamed lake could in future become as high as 0.27 mg/L, well above the CCME criteria. Even at the lower groundwater concentration of 20 mg/L, the diluted concentration remains above the CCME criteria.

4.3 Control Access

Building a fence would limit the potential for human exposure. However, it would not control either the dispersal of the tailings or the groundwater contamination. This option is therefore rejected from further consideration.

4.4 Reduce Contact with Surface and Groundwater

As discussed in Section 3.4, tailings are present in unnamed lake, but are apparently not causing arsenic levels in the lake to exceed CCME criteria. Since the tailings have been present for some time, it is likely that the current situation is stable and that there will be no future increases in contamination from the in-lake tailings. We conclude that the in-lake tailings do not need to be removed as long as the lake remains in place.

However, it should be noted that a large portion of the unnamed lake only exists because beavers have blocked the culvert that once drained the area. If that situation changes, all or part of the currently submerged tailings would be exposed to oxygen, and could become a more significant source of contamination. In that case, removal of the exposed tailings from the watercourse would be necessary.

The results of the groundwater investigation at the tailings impoundment show that the water table is below the tailings. Hence, there are no groundwater inputs to the tailings, and any measures to further control groundwater inputs would be pointless. Control of groundwater contamination down-gradient from the site is considered as part of the alternatives considered below.

4.5 Consolidate and Cover Tailings and Other Wastes

Consolidation of wastes to the tailings impoundment and construction of a soil cover over the consolidated material remain under consideration. This alternative would prevent human contact and further dispersion of the tailings, and could reduce the risk of future surface water contamination.

Table 4.1 outlines the activities that would be required, and presents a rationale for each.

The quality of the cover system as an infiltration barrier will be strongly dependent on the borrow material. As mentioned in Section 3.8, the borrow material identified at the site as part of the EBA investigation is not suitable for constructing a low permeability cover that minimises infiltration. At best, that material would act as a storage layer, allowing some precipitation to be captured and subsequently evaporated. Regrading of the surface would promote runoff and thereby reduce infiltration. However, it is therefore uncertain whether this alternative would be adequate to prevent further groundwater or surface water contamination.

As shown in Appendix F, two borrow areas close to Carcross contain clays and silt/clay mixtures. Either of these materials is appropriate for constructing a low permeability cover and, subject to proper installation, would be a suitable infiltration barrier.

TABLE 4.1
Activities For The Consolidate and Cover Alternative

Activity	Rationale
Plug the decant structure	Eliminates the flow of poor quality seepage from the decant structure and the concerns over the safety hazard and threat to physical stability of impoundment related to the decant structure
Move spilled and wind blown tailings to the surface of the tailings impoundment	Consolidates tailings, making the control of potential off site contamination easier to achieve
Move mine rock to the surface of the tailings impoundment	
Move ramp material to the surface of the tailings impoundment	Eliminates the safety hazard associated with the ramp, and provides relatively inexpensive material for changing site drainage
Grade the surface of the tailings impoundment so it sheds water	Promotes surface drainage, thereby reducing the opportunity for water to infiltrate into the tailings and become contaminated
Place a 0.3 m thick cover of low permeability soil on the impoundment surface	Promotes surface drainage, inhibits infiltration through tailings, reduces the potential for human exposure, and provide soil for revegetation
Construct erosion resistant ditch to convey surface water from the surface of the impoundment to the unnamed lake	Promotes runoff and reduces the risk of future tailings exposure or release as a result of erosion
Upgrade the existing road/dam and remove any in-lake tailings exposed as a result of this upgrade	Reduces the risk of dam failure leading to downstream flooding
Cover the landfill with 0.3 m of material from the ramp	Eliminates the threat to human health and safety

Table 4.2 presents a cost estimate for the "consolidate and cover" alternative. The costs shown assume that the cover material would have a low permeability and would be obtained from the borrow area near Carcross. As such, upgrading of the site access road would be required. Furthermore, the cover material would require moisture conditioning and controlled compaction. This option also assumes that the road/dam that separates the north end of the unnamed lake from Tank Creek will be modified to provide a higher level of safety against potential breaches of this structure. In particular, the structure would be lowered by as much as 3 m, an erosion protected spillway would be installed and any tailings exposed as a result of the lower lake level would be hauled to the tailings impoundment and covered with low permeability soil. Further details associated with this option are provided in Appendix G.

TABLE 4.2
Cost Estimate for the Consolidate and Cover Alternative

Activity	Units	Quantity	Unit Cost	Cost
Dismantle cribbing & plug both decant structures	lump	1	$15,000	$15,000
Move windblown tailings to TI	m^3	1,000	$12.00	$12,000
Move spilled tailings to TI	m^3	300	$20.00	$6,000
Move mine rock to TI	m^3	1,700	$10.00	$17,000
Move ramp material to TI	m^3	10,000	$6.00	$60,000
Grade/proof roll surface of TI	m^2	20,000	$2.50	$50,000
Place 0.3 m cover [1] on the TI	m^3	6,000	$20.00	$120,000
Excavate ditch through TI dyke	m^3	800	$10.00	$8,000
Contour ditch for surface runoff	m	100	$10.00	$1,000
Place rip-rap and channel protection	m^3	125	$30.00	$3,750
Upgrade the road/dam next to lake[2]	lump	1	$71,430	$71,430
Place 0.3 m cover on the landfill	m^3	200	$10.00	$2,000
Revegetate disturbed areas	ha	4.5	$3,000	$13,500
Subtotal (rounded to the nearest $1000)				$380,000
Contingencies (@20%)				$76,000
Subtotal				$456,000
Engineering design and supervision (@15%, rounded to the nearest $1,000)				$68,000
Total[3]				**$524,000**

Footnotes to Table 4.2:

1. Cost assumes that the borrow source is near Carcross; road to site will be upgraded and the borrow material will be compacted.
2. The cost of this item assumes that the tailings are removed from the lake in winter. If the tailings removal is done in summer, the total cost of this item rises to $93,030 .
3. If the tailings are removed from the lake in summer, the total cost rises about $30,000 to $554,000. Further details are provided in Appendix G.

Consideration was given to replacing the 0.3 m soil cover with a geosynthetic clay liner (GCL) and a 0.1 m soil layer composed of local borrow. While it is likely that the GCL would result in a cover with lower infiltration that the natural soil cover, the incremental cost of the GCL would likely be about $300,000 higher than the consolidate and cover option. The consolidate and cover option based on a 0.3 m cover with soil imported from Carcross is, therefore, preferred.

This option relies on relatively simple technology. The risk of large variations in the cost is low; plus or minus 15% is the probable confidence level associated with the estimated total cost quoted in Table 4.2. However, due to uncertainty in relation to the

detailed bathymetry and tailings thicknesses in the unnamed lake, the contractual details associated with the upgrade of the road/dam will require a degree of flexibility.

4.6 Chemical Amendment and Reprocessing

4.6.1 Chemical Amendment

Chemical amendment of the tailings through the addition of alkali would neutralize acidity and convert soluble metals to less soluble mineral forms. However, as shown by the results of the metallurgical tests, a substantial amount of alkali, approximately 48 kg $Ca(OH)_2$ per tonne of tailings, is required to attain alkali conditions. Assuming 27,200 m^3 of tailings with a dry bulk density of 1.4 to 1.6 tonnes/m^3, and a cost of $200 per tonne of $Ca(OH)_2$, the alkali alone would cost approximately $366,000 to $418,000. The cost of re-handling the tailings to mix in the lime could add as much as $5/tonne, or an additional $190,000 to $218,000. This would bring the cost of the chemical amendment to between $556,000 and $635,000. Furthermore, after the chemical amendment, the tailings would still be able to produce acidity in future, and would therefore need to be covered or further treated. We conclude that chemical amendment alone is prohibitively expensive and does not provide sufficient assurance that the current environmental problems will not recur.

4.6.2 Chemical Amendment and Reprocessing Combined

Chemical amendment becomes more attractive if it is part of a re-processing option. As shown in Section 3.3.4, there is anywhere from $18 to $34 worth of recoverable gold and $21 to $38 worth of recoverable silver in each tonne of the tailings. Again assuming 27,200 m^3 of tailings with a dry bulk density of 1.4 to 1.6 tonnes/m^3, the recoverable metal value (gold plus silver) in the impoundment is between $2,230,000 and $2,550,000.

The costs of reprocessing would depend on the method used. The tailings are amenable to three types of processing: heap leaching; vat leaching on site; and, regrinding followed by cyanide leaching at the New Venus Mill.

4.6.2.1 Heap Leaching

The heap leaching alternative would require:

- Construction of a lined leaching pad (probably incorporating a double liner and a leach detection and collection system);
- Alkali addition and agglomeration of the tailings;
- Stacking of the agglomerated tailings on the lined leaching pad;
- Leaching of the heap with alkaline cyanide solution to extract the gold and silver as cyanide complexes;
- Passing the leach solution through activated carbon columns to strip the gold and silver from the cyanide;
- Stripping of the carbon to recover the gold and silver.

At the end of the processing, the cyanide solution would need to be detoxified. The heap would also need to be decommissioned, probably by covering with a low permeability liner.

Table 4.3 provides rough cost estimates for the heap leaching alternative. The preliminary nature of the metallurgical testing does not allow accurate estimates of reagent and detoxification costs, which are the largest components of the estimated costs. More accurate estimation of the other costs is therefore not warranted. For this estimate, we have assumed a cyanide consumption of 1 kg NaCN per tonne of tailings. That estimate is considerably less than was required in the preliminary test. However, it is more in line with full-scale experience elsewhere.

Table 4.3 has a 25% contingency to allow for items such as consolidation and cover of the waste rock, upgrade of the road/dam adjacent to the unnamed lake (as discussed in Section 4.5), further metallurgical tests, tailings dewatering, the leasing of activated carbon columns and the shipment of the loaded carbon off site for the gold and silver recovery.

The potential revenue from the heap leaching option, assuming the density of the tailings is 1.5 t/m^3, is $2,391,000. Based on the cost estimate in Table 4.3 ($2,498,000), there would be a net cost (about $107,000) to utilize the heap leaching option. However, this option has significant environmental benefits, since the tailings would be consolidated on site to a smaller surface area, neutralized, and encapsulated by a low permeability liner and a low permeability cover.

TABLE 4.3
Rough Estimates of Costs for Heap Leach Alternative

Lime addition		
	kg $Ca(OH)_2$ per tonne of tailings	48.7
	unit cost per tonne of $Ca(OH)_2$	$200
	tonnes $Ca(OH)_2$	1987
	Subtotal lime cost	$397,392
Agglomeration and stacking		
	unit cost per tonne for excavation	$5.00
	unit cost per tonne for agglomeration and stacking	$2.00
	Subtotal agglomeration and stacking cost	$285,600
Cyanide addition		
	kg NaCN per tonne of tailings	1
	kg NaCN	40,800
	unit cost per kg of NaCN	$5.00
	Subtotal cyanide cost	$204,000
Liner for pad and ponds		
	m average height of pile	6
	m^2 area of pile	4533
	excess for ponds	50%
	m^2 required to be lined	6800
	unit cost of liner	$40
	Subtotal liner cost	$272,000
Solution detoxification		
	kg NaCN	40,800
	mg/L NaCN in solution	100
	m^3 solution	408,000
	unit detox cost per m^3	$1.00
	Subtotal detox cost	$408,000
Cover for heap		
	m^2 area of pile	4533
	excess	20%
	m^2 required to be covered	5440
	unit cost of cover	$40
	Subtotal cover cost	$217,600
Subtotal (rounded to the nearest $1,000)		$1,785,000
Contingencies (@25%)		$446,000
Engineering design and supervision (@15%)		$268,000
Total		**$2,498,000**

The costs in this table are based on an in situ tailings dry density of 1.5 t/m^3.

The following additional studies would need to be carried out before this option could be fully evaluated:

- Further definition of the "ore" reserve (allow $10,000 for a drilling program consisting of approximately 100 auger holes, including inspection and sampling);

- Further testing of the leaching characteristics of the tailings (allow $6,000 for a metallurgical program consisting of gradation analyses and bottle roll tests);
- Assessment of the handlability of the grey, unoxidised tailings (allow $1,500 for a test pit program in the tailings to confirm the handlability and stackability of the tailings); and
- Detailed engineering evaluation (allow $7,000 for an evaluation suitable for a "go – no go" decision).

The total cost of these studies is $24,500. Allowing 20% for contingencies, about $30,000 is required to determine the economic feasibility of the heap leaching alternative. This program would take 1 to 2 months to complete.

The heap leaching alternative (and any other reprocessing alternative) would also require regulatory approval. Engineering design studies, environmental impact assessment and hearings associated with the regulatory approval process could cost in the order of $225,000, and require up to one year to complete.

While heap leaching technology is well established, the financial risks associated with this option are higher then for options which do not rely on the economic benefits of gold and silver recovery. Examples of factors affecting the risk include the northern climate, the small size of the "ore body", the inability of laboratory testing to properly model the realities of a full scale leach pad and potential changes in gold and silver prices.

4.6.2.2 Vat Leaching

The vat leaching option would probably consist of:

- Possible regrinding of the tailings to expose metal surfaces;
- Washing to remove accumulated soluble metals;
- Cyanide leaching of the gold and silver;
- Discharge of the tailings to a lined impoundment.

Costs for this option have not been estimated because they are much more dependent on operating parameters that cannot be estimated from the preliminary tests. Furthermore, the need for a second impoundment for the re-processed tailings is likely to make this option more expensive and of less environmental benefit than heap leaching.

4.6.2.3 Reprocessing Using the New Venus Mill

The possibility of using the new Venus mill for reprocessing tailings was explored in a Klohn-Crippen (KC) report dated March 1994 and entitled Venus Mine Tailings, Study of Remedial Options. The new Venus mill is situated a few kilometres south of the B.C.-Yukon border on the Carcross-Skagway Highway. It was constructed in the early 1980's with the intention of processing 200 tpd of ore from the Venus mine and the old tailings from the Venus operation of the 1970's. In addition to the process plant, a tailings impoundment capable of storing well in excess of 100,000 m^3 was constructed. Although these facilities have been "mothballed," studies to reopen the process plant were undertaken in 1983/1984 and again in 1988.

The reprocessing option would consist of:

- Dewatering the tailings, to facilitate handling and trucking;
- Excavating and hauling the tailings to the new Venus mill;
- Upgrading the road at the new Venus mill;
- Refurbishing the new Venus mill and purchase of a new genset;
- Regrinding the tailings so that they are about 50% passing the No. 200 sieve;
- Cyanide leaching of the tailings;
- Discharge of the tailings to the existing tailings impoundment
- Pumping the pregnant solution to the Merrill-Crowe circuit to obtain a precious metal precipitate; and
- Shipping the precipitate offsite for refining.

Table 4.4 provides a rough cost estimate for this option. The main costs associated with this option include the cost of refurbishing the mill and the processing and refining costs. In both cases, the unit costs have been taken from the KC report of 1994. The revenue is based on the results of testing by Lakefield on samples of the Venus tailings. While these tailings are likely to be similar to the Venus tailings, there is a risk that the recoveries could be less in the tailings from Arctic Gold & Silver.

Table 4.4 shows that the costs for reprocessing at the New Venus Mill would be roughly equal to the costs associated with heap leaching. However, the off site reprocessing would not provide the long term benefits associated with consolidating and encapsulating the tailings on site.

TABLE 4.4
Cost Estimate for the Reprocessing at the New Venus Mill

Activity	Units	Quantity	Unit Cost	Cost
Dewater tailings	lump	1	$5,000	$5,000
Excavate and haul tailings	m^3	27,200	$10.00	$272,000
Wash truck wheels	lump	1	$27,200	$27,200
Road preparation at mill site	m^3	300	$90.00	$27,000
Refurbishing of the mill	lump	1	$500,000	$500,000
Operating and refining costs [1]	tonnes	40,800	$21.00	$856,800
Upgrade road/dam for unnamed lake	lump	1	$60,000	$60,000
Revegetate disturbed areas	ha	4.5	$3,000	$13,500
Subtotal (rounded to the nearest $1,000)				$1,762,000
Contingencies (@30%)				$528,000
Engineering design and supervision (@15%)				$264,000
Total				**$2,554,000**

5.0 CONCLUSIONS AND RECOMMENDATIONS

The recent additional investigations at the Arctic Gold and Silver site have clarified remediation objectives and alternatives. SRK concludes that two alternatives remain worthy of consideration:

- Consolidate and cover the tailings and other wastes (combination of options 4 and 5, as discussed in Section 4.5);
- Chemically amend and reprocess the tailings (combination of options 6 and 7 as discussed in Section 4.6.2.1).

5.1 Consolidate and Cover Alternative

The main benefits of the "consolidate and cover" alternative are prevention of human contact and further dispersion of the tailings, and the reduction of future surface water contamination downstream of the tailings impoundment. This alternative could proceed to final design with limited additional investigation. Our estimate of the cost for this option is $538,000, excluding the cost of permitting. As the borrow material identified on site will not produce a low permeability cover, the cost estimate assumes that low permeability material from Carcross will be hauled to site and used to develop a compacted cover over the tailings. The road/dam at the north limit of the unnamed lake will be lowered by as much as 2 m. Any tailings exposed as a consequence of this action will be hauled to the tailings impoundment and covered a

with low permeability cap. Additional material will be placed on the upstream side of this structure to bolster its stability, and a spillway will be installed to pass extreme flood events.

The uncertainty associated with this alternative is relatively low, and it should be plus or minus 15% (i.e. ± .$80,000).

The technology associated with this alternative is such that the work could be undertaken using labour and conventional earthmoving equipment available in the region. Most of the work would be undertaken over a single construction season. The removal of the tailings exposed at the east margin of the lake would be done during the subsequent winter and the low permeability cap would be placed over these tailings the following summer. Multiyear funding would, therefore, be required but the amount required in the second year would be relatively minor.

5.2 Amend and Process Alternative

The "amend and reprocess" alternative is attractive from an environmental perspective because it would allow neutralization and complete encapsulation of the tailings, as well as a net reduction in the area impacted. The general site cleanup and modifications to the road/dam adjacent to the unnamed lake would also be required as part of this alternative. Rough calculations show there is a potential to recover most of the costs of this option. However, the preliminary metallurgical tests undertaken in this investigation are not adequate to support accurate cost estimates. Furthermore, there are concerns over the handlability and stackability of the grey, unoxidized tailings that must be resolved. Therefore, unlike the consolidate and cover alternative, the amend and process alternative cannot proceed to design without significant further investigation, the cost of which would be in the order of $25,000 to $30,000. As well as a drilling program, this would include additional metallurgical tests and more accurate cost estimates. If the results indicate economic feasibility, the reprocessing alternative would then need to enter a regulatory approval process that could be both expensive and protracted. These costs are not included in the estimate included with this report.

Heap leaching technology is well established, although few operations of this type have been done in the North. What distinguishes this option from most conventional mining operations is that the leaching would be done over about 2 to 4 months in the summer and early fall. Nevertheless, the financial risks associated with this option are higher then for options that do not rely on the economic benefits of gold and silver

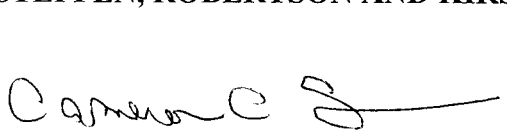
recovery. Factors affecting the risk include the northern climate, the small size of the "ore body", the inability of laboratory testing to properly model the realities of a full scale leach pad and potential changes in gold and silver prices. It is likely, therefore, that uncertainty associated with this alternative is about plus or minus 25% of the projected revenues (i.e. ± .$600,000).

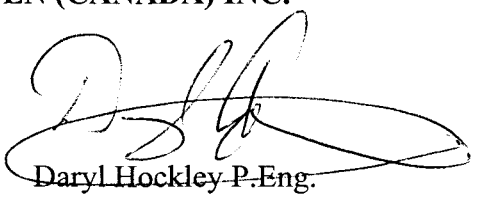
The technology associated with the earthworks portion of this alternative is similar to the consolidate and cover alternative and could, therefore, be undertaken using labour and conventional earthmoving equipment available in the region. Importation of specialist technical skills would likely be required for the installation of high density polyethylene geomembranes, as well as the operation of the equipment required for the processing of the pregnant leach solution. Support personnel in these two areas could likely be obtained from the local work force and would be in the order of 10 to 12 man-months.

The feasibility assessment could proceed this year and, depending on the results of that assessment, the alternative could be implemented the following year. Detoxification of the leached tailings would likely be done the same year, but the final capping of the heap and revegetation would likely have to be done the following year. Multiyear funding over a 2 to 3 year period would, therefore, be required.

This final report **Assessment of Remedial Measures for Arctic Gold & Silver Tailings,** has been prepared by:

STEFFEN, ROBERTSON AND KIRSTEN (CANADA) INC.

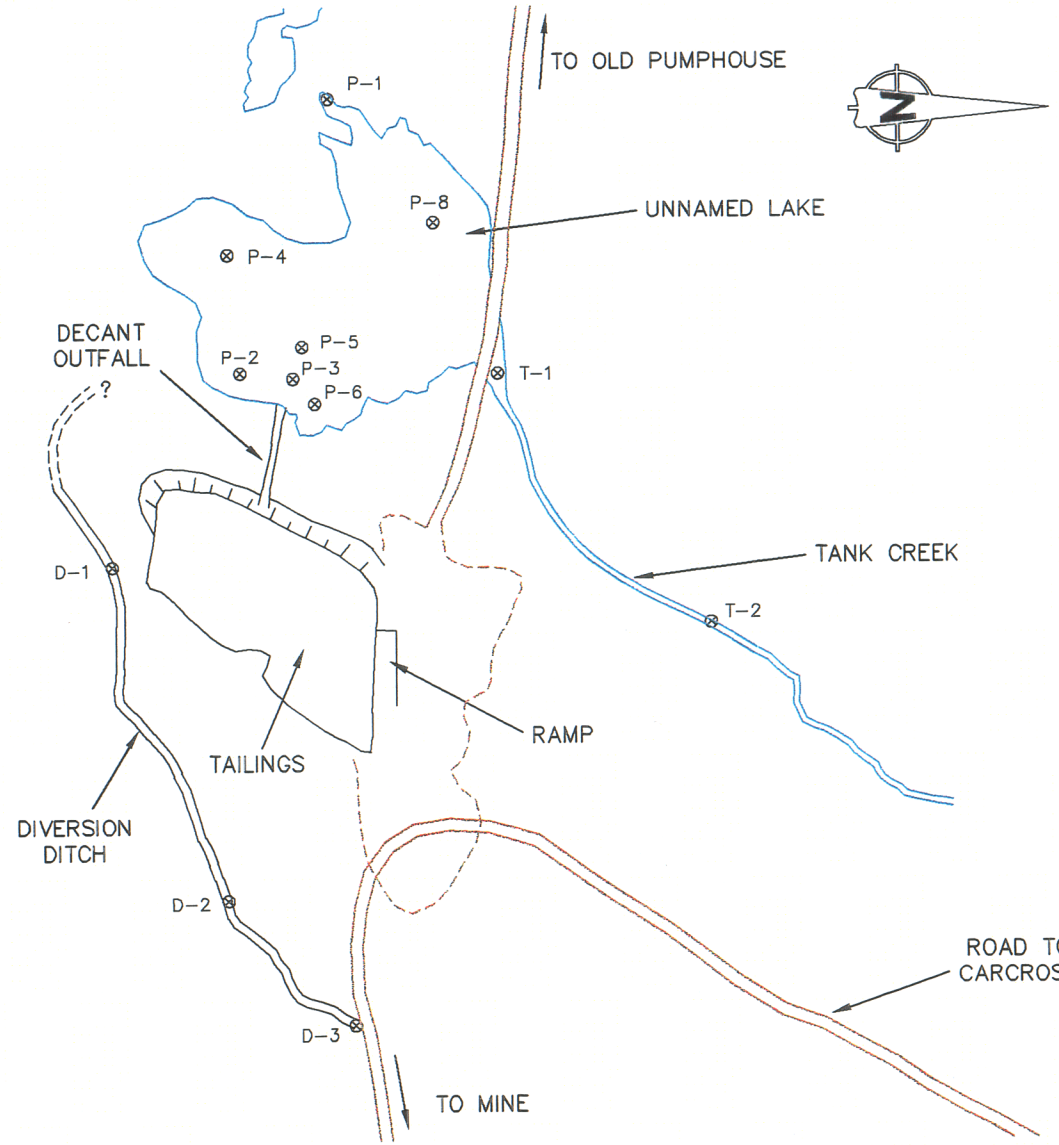




Cam Scott, P.Eng.
Principal Engineer

Daryl Hockley P.Eng.
Principal Engineer

FIGURES



⊗ LES SAMPLE POINT

SAMPLE POINT LOCATIONS PROVIDED BY
LABERGE ENVIRONMENTAL SERVICES(LES)

APPROXIMATE SCALE 1:5,000

STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

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ARCTIC GOLD AND SILVER

SITE OVERVIEW PLAN AND LES SAMPLE LOCATIONS

PROJECT NO.	DATE	APPROVED	FIGURE
1CP001.07.01	DEC. 1998		2.1

FILE REF: LOCATION.DWG

NOTE:
Sample T-2 is located further downstream towards Carcross.

T-2

Water Elevation:
75.06
Staff Gauge
No. 2

Approximate direction

Culvert 1230mm dia.
Outlet Invert Elev. 79.371

Culvert 1800mm dia.
Invert Elev. 78.306

Approx. Centreline of Tank Creek

T-1

UU 78
Bearing Post

Beaver Dam
Water on road in this area

UU 76
Bearing Post

Trash Pile
46 cubic m.

Willow

Spruce

EBA-1

1965 Pontiac

EBA-3

Test Site PH2

EBA-2

Well
Water Level
Elev. 80.30

EBA-4

Conc. Foundation
11m x 9.2m
Average Height=1m

EBA-5

Wood Frame Building
6.6m x 5.0m

To CARCROSS

Wooden Box

Mill Fdn. Conc.

Pile 9

Pile 8

Pile 10

Wood Frame Building
10m x 4m

Conc. Fdn.
9.0m x 4.0m

Pile 6

Pile 7

Old Truck

UU 1418

RAMP

WINDBLOWN TAILINGS

ORE STORAGE

Pile 1

Pile 2

Pile 3

Pile 4

Pile 5

Willow and Spruce

Bearing Post
UU 76

P-1
approx. location

P-8
approx. location
21

P-6
16400

P-5
9430

Spilled Tailings Area

unnamed lake
Lake Elevation
81.399

P-3
31300

P-2
25100

Staff Gauge
No. 2

APPROX. LIMIT OF TAILINGS IN LAKE

UU 76
Bearing Post

TS-C3

TS-C2

TS-C1

Decant

Outfall

208

841

UU 997

Log Pile

TAILINGS POND

TAILINGS THICKNESS ISOPACH

MW-1

MW-2

MW-3

MW-4

MW-5

MW-6

MW-8

MW-10

MW-15

BH-1

BH-2

BH-3

BH-4

BH-5

BH-6

BH-7

BH-8

BH-9

BH-10

BH-11

BH-12

BH-13

BH-14

BH-15

BH-16

3.5m

3.0m

2.5m

2.0m

1.5m

P-7
approx. location
804

P-4
83

Right Bank of Swampy Area

UU 74

UU 75

UU 998

D-1

D-2
no water present in the ditch

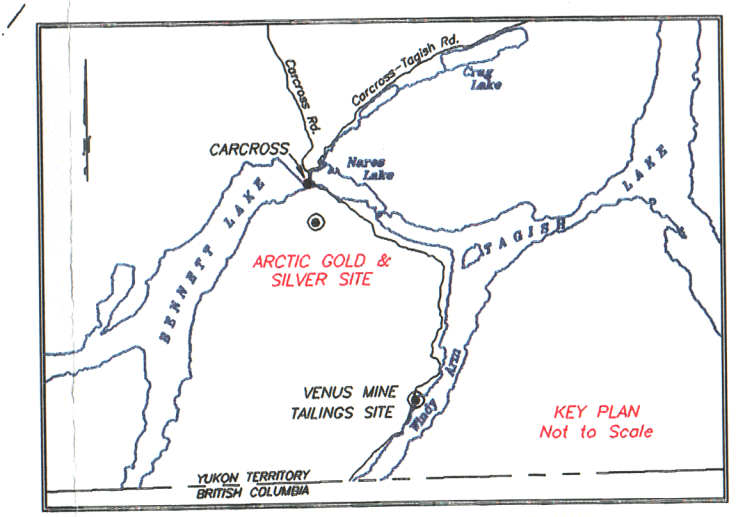
D-3
approx. location of spring

Approx. Centreline of Diversion Ditch

LEGEND

BH-3	BOREHOLE OR MONITORING WELL LOCATION
P-5 9430	SEDIMENT SAMPLING LOCATION FOR SOIL CHEMISTRY (WITH ARSENIC LEVEL IN PPM)
MW-2	GROUNDWATER SAMPLING LOCATION
T-1	SURFACE WATER SAMPLING LOCATION

0 20 40 60 80 100 metres
1: 2000



NOTE:

Coordinates and elevations are arbitrary and derived from UU control point 1000. The direction of the North arrow was derived from the compass bearing taken between control points UU1418 and UU 997.

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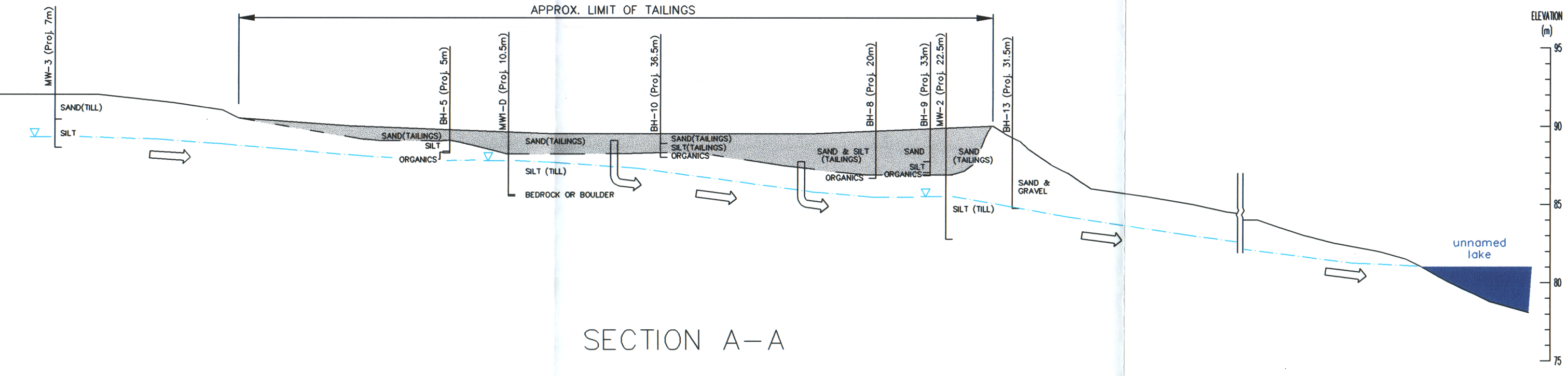
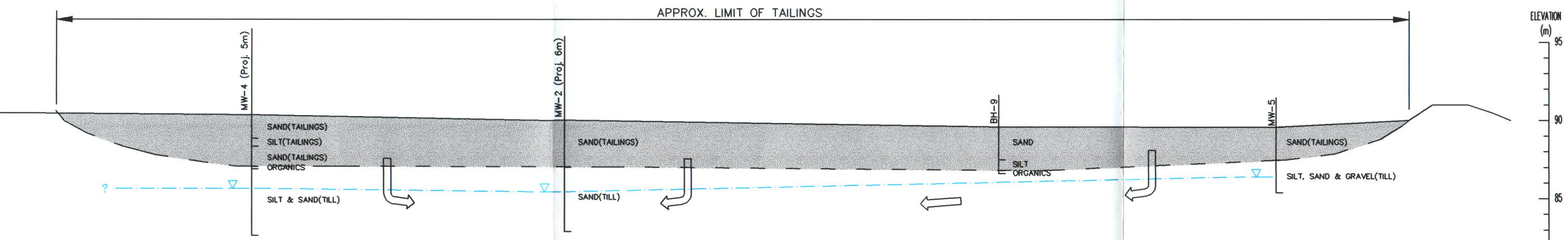
ARCTIC GOLD AND SILVER

PLAN OF TAILINGS AREA

PROJECT NO.	DATE	APPROVED	FIGURE
1CP001.07.01	DEC. 1998		2.2



SECTION A–A



SECTION B–B

LEGEND

TAILINGS

GROUNDWATER FLOW DIRECTION

HORIZONTAL 0 5 10 15 20 25 metres
1:500

VERTICAL 0 2.5 5 7.5 10 12.5 metres
1:250

2X VERTICAL EXAGGERATION

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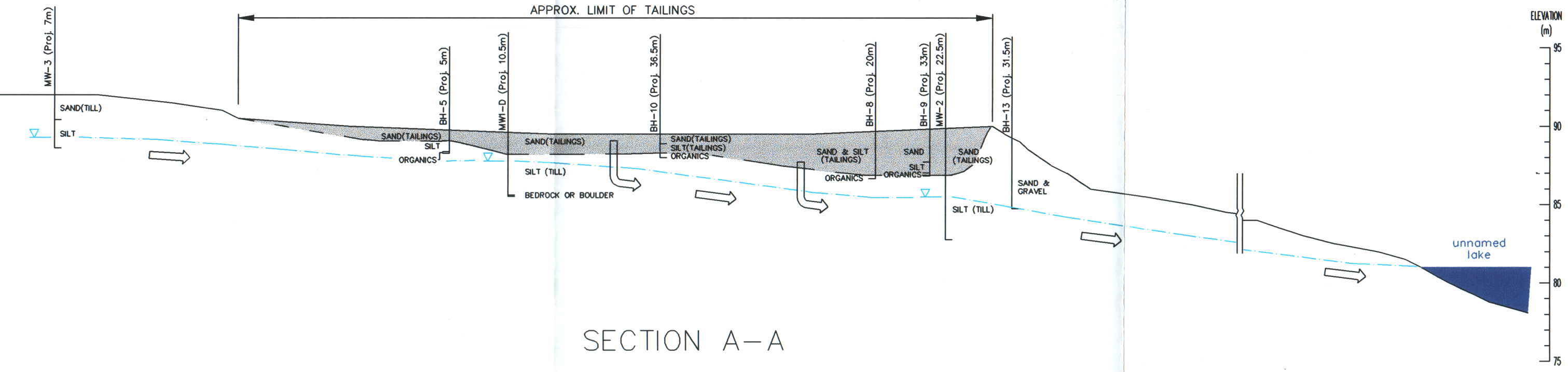
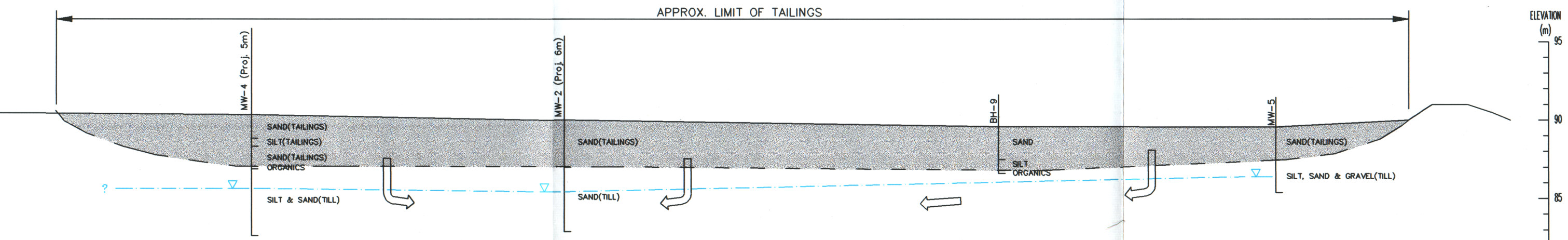
ARCTIC GOLD AND SILVER

SECTION A–A AND B–B

PROJECT NO.	DATE	APPROVED	FIGURE
1CP001.07.01	DEC. 1998		2.3



SECTION A–A



SECTION B–B

LEGEND

TAILINGS

GROUNDWATER FLOW DIRECTION

HORIZONTAL 0 5 10 15 20 25 metres
1:500

VERTICAL 0 2.5 5 7.5 10 12.5 metres
1:250

2X VERTICAL EXAGGERATION

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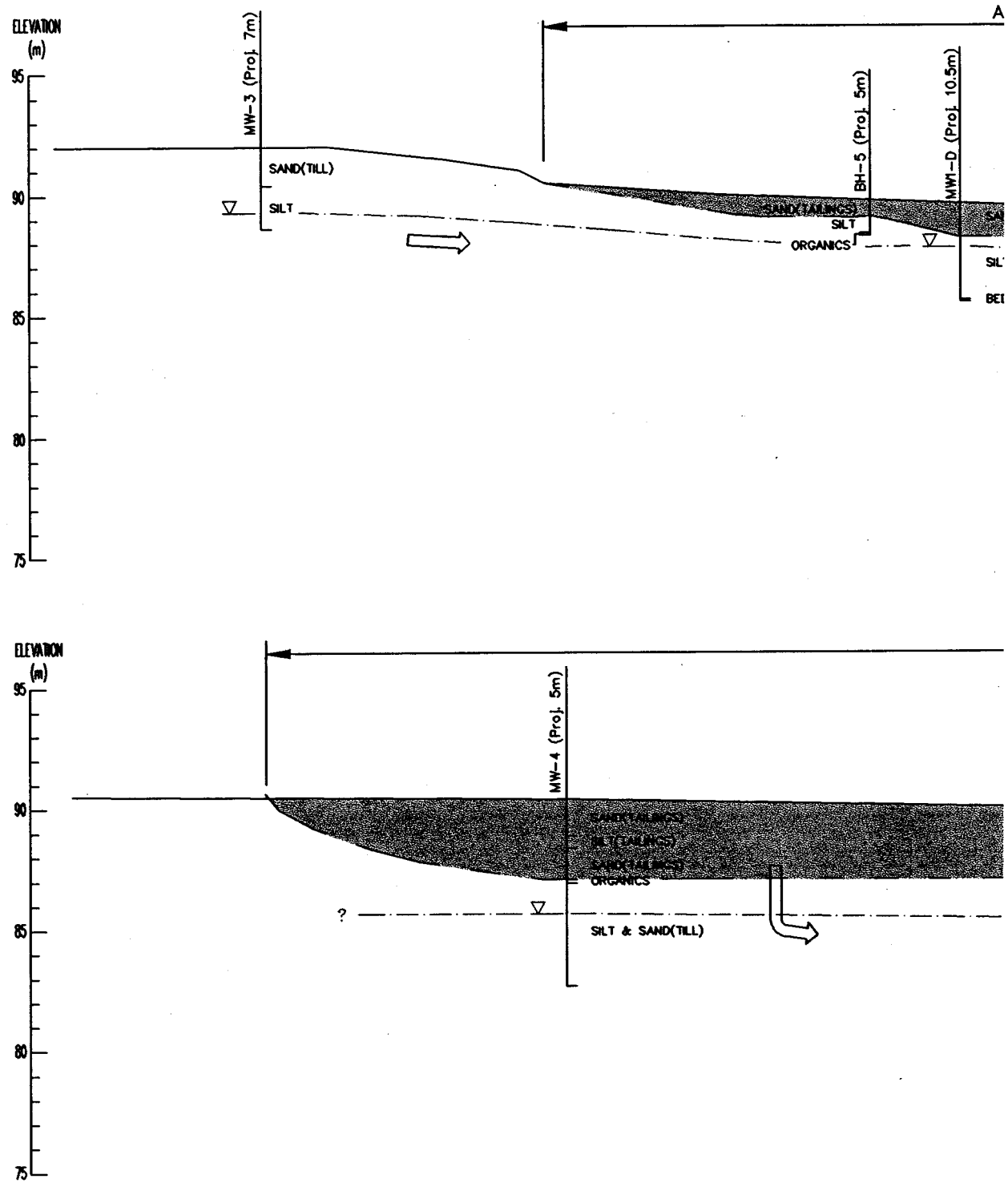
ARCTIC GOLD AND SILVER

SECTION A–A AND B–B

PROJECT NO.	DATE	APPROVED	FIGURE
1CP001.07.01	DEC. 1998		2.3

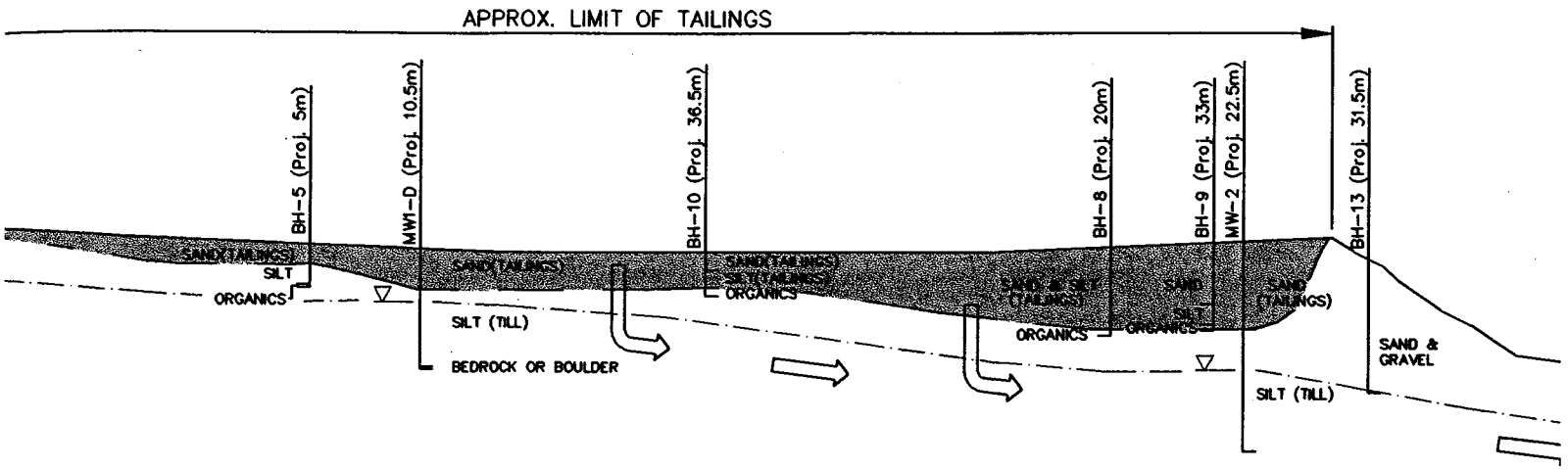


LEGEND

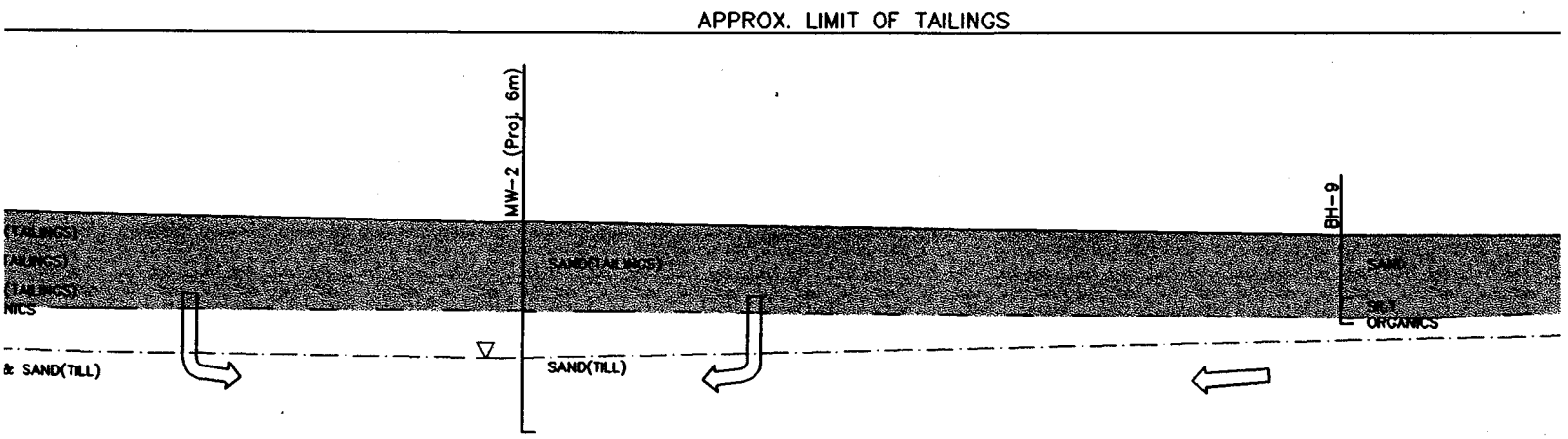
TAILINGS

GROUNDWATER FLOW DIRECTION

FILE REF:EX-SECTION.DWG



SECTION A–A



SECTION B–B

FLOW DIRECTION

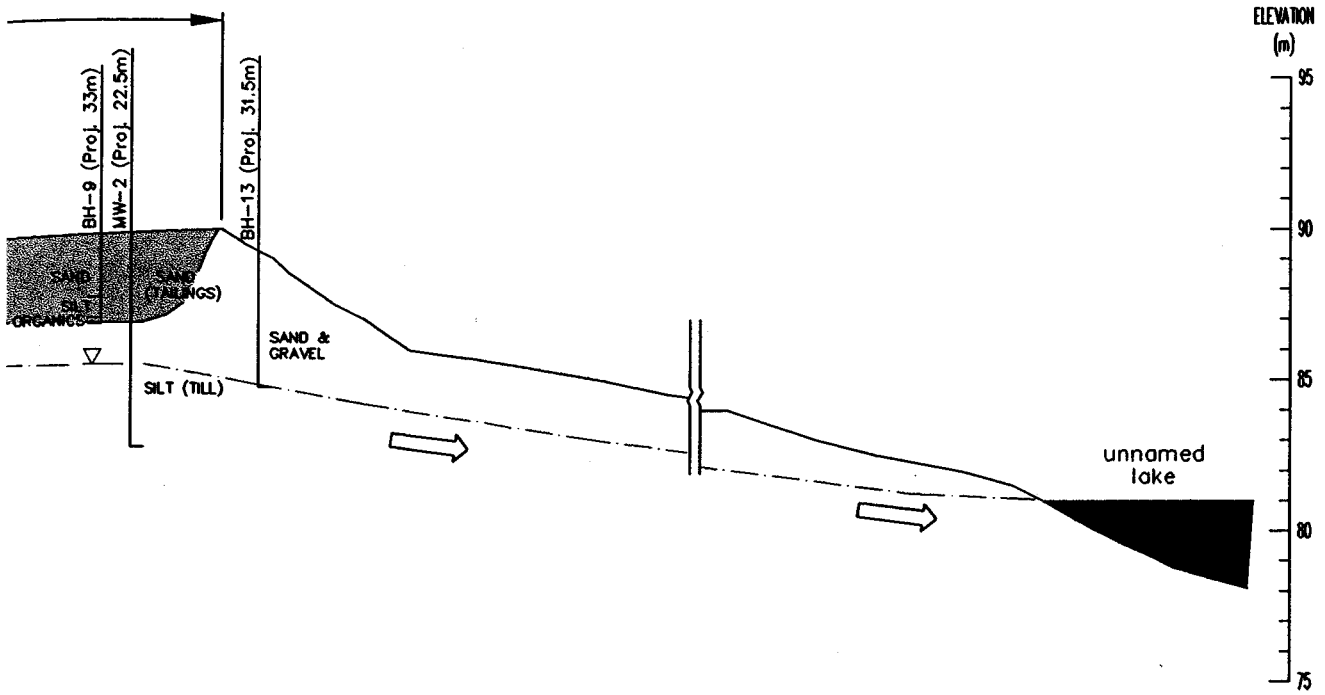
HORIZONTAL 0 5 10 15 20 25 metres
1:500

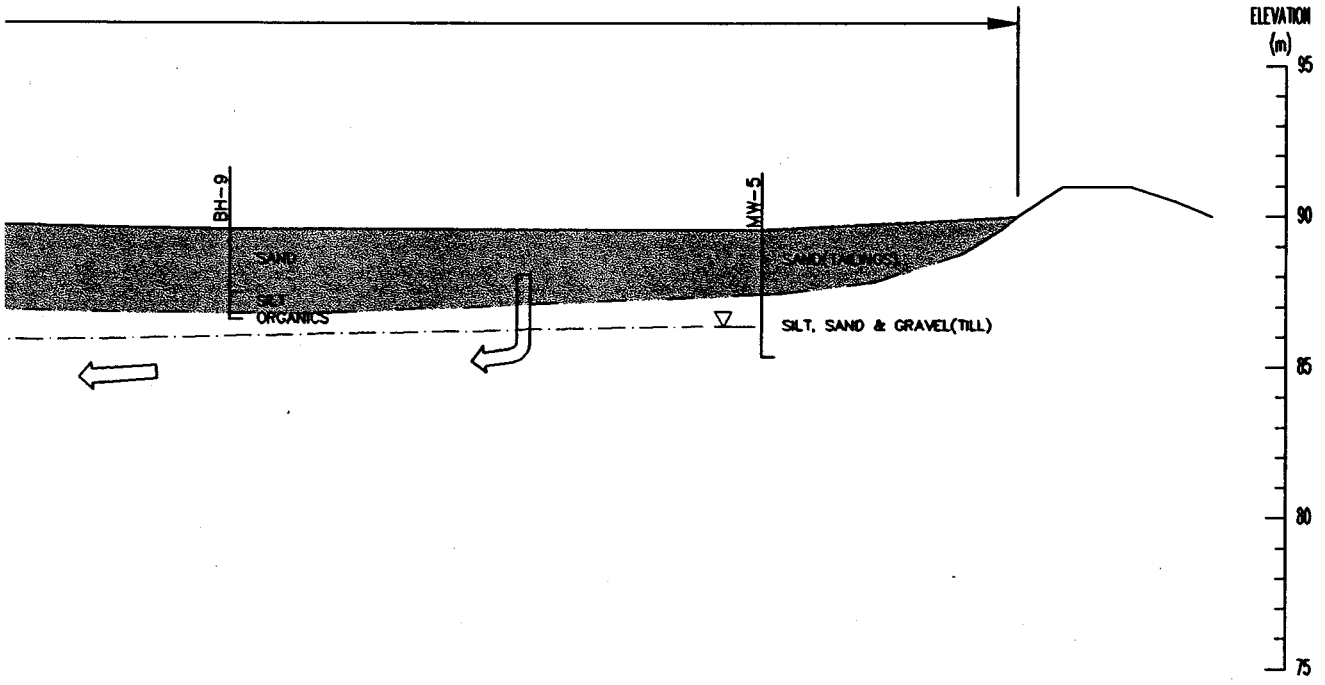
VERTICAL 0 2.5 5 7.5 10 12.5 metres
1:250

2X VERTICAL EXAGGERATION

STEFFEN ROBE
Consulting En

PUBLIC WO
GOVERNMENT SEF





STEFFEN ROBERTSON AND KIRSTEN Consulting Engineers	ARCTIC GOLD AND SILVER			
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA	SECTION A–A AND B–B			
	PROJECT NO. 1CP001.07.01	DATE DEC. 1998	APPROVED	FIGURE 2.3

APPENDIX A
Geotechnical Report by
EBA Engineering

December 4, 1998 EBA File: 0201-98-13563

Steffen, Robertson and Kirsten (Canada) Inc.
Suite 800
580 Hornby Street
Vancouver, B.C.
V6C 3B6

Attention: Mr. Cam Scott, P.Eng.

Dear Sir:

Subject: Summary Report of Investigation
Arctic Gold & Silver Tailings Site

1.0 INTRODUCTION

This report presents a summary of the data obtained from various site investigation tasks performed in support of the reclamation alternatives study for the above referenced site (Site). The work program was conducted in accordance with the scope of work outlined in the letter from SRK dated August 28, 1998 which is enclosed in Appendix A. This report also contains the results of the test pit investigation in the vicinity of a potential borrow source for capping materials that was conducted for PWGSC, Environmental Services in support of the reclamation study.

2.0 SITE INVESTIGATION

The site investigation involved the following tasks:

- Drilling and installation of ground water monitoring wells, including borehole logging and sample collection for physical laboratory testing.
- Drilling within tailings to confirm thickness of tailings spatially throughout the impoundment area. Several bulk samples of the tailings material were to be collected during this confirmatory drilling work to obtain a composite sample for metallurgical testing.

The drilling program was supervised by Michael Billowits, P.Eng., of EBA between the dates of August 29, 1998 and September 1, 1998 and involved drilling 16 boreholes and 7 monitoring wells within the vicinity of the tailings impoundment area. As well, two probeholes were drilled in the vicinity of potential fine grained borrow areas. These probeholes were advanced to verify that the proposed borrow investigation program would be worth pursuing since results of the initial drilling at the site indicated both shallow ground water and a relatively shallow depth to

refusal (each of which could restrict future borrowing activities). The drilling was performed with solid stem augers for the 16 boreholes and 2 probeholes with samples taken from cuttings at the base of the lead auger flight. The monitoring wells were installed with hollow stem augers according to recognized industry standards[1]. For well locations 13563-MW3 to –MW5, the borehole was advanced initially with solid stem augers in order to penetrate the dense, cobbly till material to the saturated zone. Following this, the wells were completed using hollow stem augers. Standard penetration tests were conducted while sampling with 50 mm diameter split spoon samplers during hollow stem augering.

All boring, monitoring well, and test pit locations are depicted on Figure 1 and the logs are enclosed in Appendix B. Figure 1 consists of a modified version of the topographic base plan provided by Underhill Geomatics Ltd. to include EBA boring and test pit locations which correspond to the labeling system depicted on the logs enclosed in Appendix B. The results of the physical laboratory tests are presented following the logs from which the sample derived. Due to a delay in the approval of the laboratory program, the samples were stored in the EBA lab for approximately two months prior to the testing work. As such, it is noted that the moisture contents reported on the logs could be 5%-20% less than actual *in situ* conditions, depending on the fines content of the particular sample.

The following summary comments are made with respect to the results of the delineation boreholes to determine thickness of tailings material at the Site:

Photo 1: Tailings profile.

- Ten boreholes were advanced to characterize the depth and characteristics of the tailings material. The tailings consisted of two layers distinguished by the extent of oxidation (as evidenced by the characteristic rust colour associated with the ferric hydroxide presence in the tailings). As seen in Photo 1, the profile of the tailings consisted of an upper surface layer of more oxidized (beige) sand material with an underlying stratum of less oxidized (dark grey) silt and sand material.
- The upper surface layer consisted primarily of fine sand sizes and was damp to moist with moisture contents typically in the order of 10% to 15%. As seen in the representative particle size gradations for samples 2 and 16 in Appendix B, there is over 90% fine sand material in the upper tailings material.
- The lower tailings stratum consisted of finer soil sizes and was moist to wet with moisture contents ranging from 30% to 40%. Refer to samples 8 and 11 in Appendix B for representative particle size gradations of this material. Fines content ranged from 15% to 90% in those samples tested. As could be expected, the higher fines content observed

[1] ASTM Designation: D 5092-90 (Reapproved 1995). Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers.

with increased depth of tailings corresponded to higher moisture contents (due to the higher field capacity) and a lesser degree of oxidation.

- As described in the following table, the total thickness of the tailings averaged 1.4 m at the middle and east portions and 2.5 m at the west (near dam) portion. The average thickness of the underlying, unoxidized material was approximately 0.6 m.

PORTION OF TAILINGS	# OF BH IN THIS PORTION	AVG. DEPTH OF OXIDIZED TAILINGS (m)	AVG. DEPTH UNOXIDIZED TAILINGS (m)	TOTAL DEPTH OF TAILINGS (m)
West (dam)	3	1.7	0.8	2.5
Middle	3	0.8	0.6	1.4
East	4	1.0	0.4	1.4

- Particular care was taken to segregate the oxidized and unoxidized tailings material during collection of the bulk samples used for geochemical testing purposes. Bulk samples were retrieved from each of the ten boreholes, with total collected masses for the oxidized and unoxidized materials of 62 kg and 27 kg, respectively.
- As seen in Photo 2, the tailings ended at a distinct organic layer. The organic material was wet, dark brown, and partially decayed. The organic layer was underlain by a dense silt, sand, and gravel soil which was inferred to consist of native morrainal till.
- The underlying till material consisted of a characteristically heterogeneous mixture of clay, silt, sand, and gravel with average proportions of 9%, 44%, 25%, and 22%, respectively based on two samples tested.
- There was oversize material within the till matrix which made drilling very difficult. Refusal in the till occurred in all deeper boreholes, with depths of refusal ranging from 1.5 m to 7.7 m and an average depth of 4.6 m.

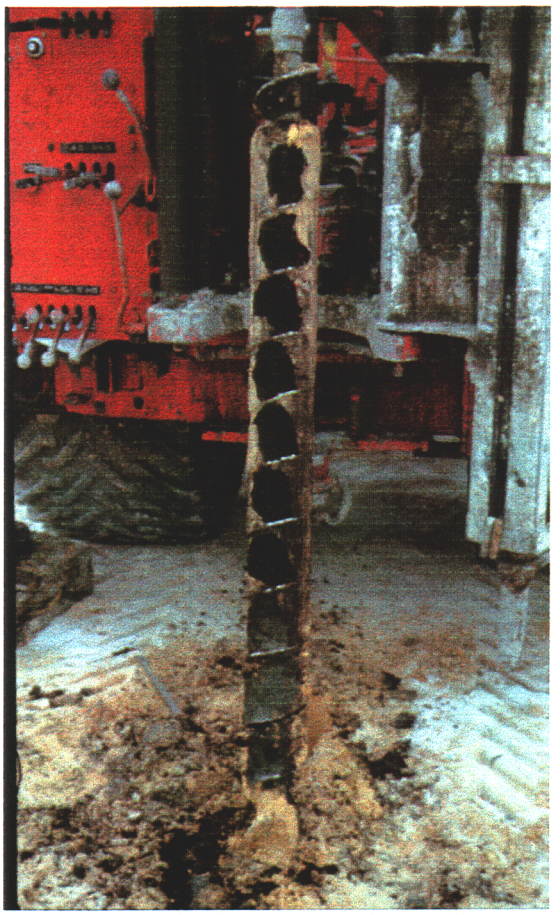


Photo 2. Underlying organics and till.

3.0 GROUND WATER INVESTIGATION

The following summary comments are made with respect to the results of monitoring well installation and ground water testing programs at the Site:

- The monitoring well construction details are presented on the logs in Appendix B.
- To determine if there is a potential of lateral ground water flow through the tailings, five monitoring wells were installed at four locations spatially throughout the tailings impoundment area. A multiple piezometer installation (shallow and deep) was completed at the vicinity of 13563-MW1 since the tailings appeared saturated in this area. The shallow well was placed to determine if the static water level was within the tailings, and if so, to determine the vertical hydraulic gradient. Based on qualitative observations during drilling, free water appeared to be in the vicinity of the tailings/underlying till interface at the monitoring well locations 13563-MW1D and 13563-MW5. However, as seen on the borehole logs in Appendix B, the static water level was observed to be below the bottom of the tailings at all well locations. The shallow well completed within the tailings, 13563-MW1S remained dry during measuring events. The static water levels shown on the borehole logs have been determined from water level measurements taken on September 10, 1998 once the ground water conditions were stabilized following drilling. Based on a single monitoring event, ground water seepage does not appear to be flowing laterally through the tailings. It is noted that this may not be the case during seasonal high ground water conditions.
- To assist in the evaluation of ground water flow and water quality outside of the tailings impoundment area, monitors 13563-MW3 and 13563-MW6 were installed. Based on the topography of the site and on an interpretation of drainage features from aerial photos, the locations were inferred as being hydraulically upgradient of the tailings area. This assumption was validated by on-site calculations using accurate survey data of monitors 13563-MW1 through –MW4 provided by Underhill Geomatics Ltd. on 98/8/31. The horizontal direction of ground water flow was determined to be toward the west, roughly in a direction parallel to monitors 13563-MW1D and –MW2. As seen on the well installation details, monitor 13563-MW6 was constructed for piezometric measurements only. It is noted that the static water level at –MW6 was very close to the existing ground surface, with extensive free water observed while removing the solid stem augers (see Photo 3).

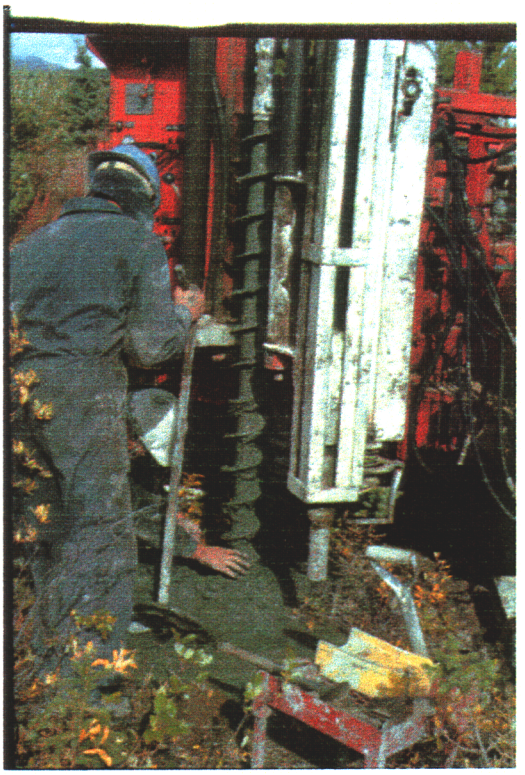
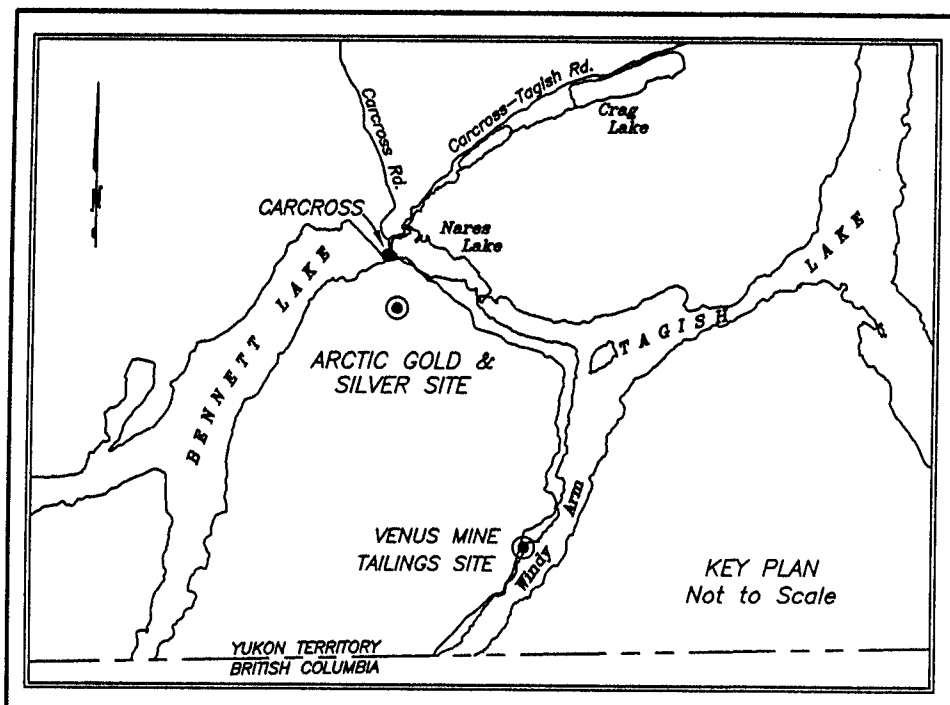


Photo 3. Location of MW6



ELEVATIONS OF WELLS:

Well No.	Top of PVC Casing:	Ground:
13563–MW1S	90.357	89.639
13563–MW1D	90.164	89.591
13563–MW2	90.713	90.015
13563–MW4	91.052	90.351
13563–MW5	90.232	89.576
13563–MW3	92.368	91.629
	Top of plastic pipe:	
MW – 6	92.769	91.912

Note: MW–6 did not have

13563–TP1
1965 Pontiac
Approximate direction To CARCROSS
13563–PH2
13563–TP2
13563–TP3
Well Water Level Elev. 80.30
13563–TP4
13563–TP5
Willow
Willow
ORE STORAGE
Willow
RAMP
UU 1418
13563–PH1
Willow
13563–BH1
13563–BH2
13563–BH3
13563–BH14
13563–BH15
13563–MW4
13563–BH4
13563–BH7
Willow and Spruce
TAILINGS POND
13563–BH13
13563–BH12
13563–BH11
13563–MW2
13563–BH8
13563–MW1S
13563–MW1D
13563–BH6
13563–BH5
13563–MW3
Willow
UU 997
Center Line of Creek
Lake
UU 76 BEARING POST
13563–MW6
13563–BH9
13563–BH10
Willow
13563–BH16
13563–MW5
Willow
UU 998

– BASE PLAN PROVIDED BY UNDERHILL GEOMATICS LTD.

SCALE 1:1500

EBA Engineering Consultants Ltd.

CLIENT: STEFFEN, ROBERTSON AND KIRSTEN

PROJECT: ARCTIC GOLD AND SILVER MINE TAILINGS NEAR CARCROSS, YUKON

TITLE: SITE PLAN BOREHOLE, TESTPIT AND MONITORING WELL LOCATIONS

DATE	98/12/03	DWN.	JSB	CHKD.	MEB	FILE NO.	0201-98-13563	DRWG. NO.	FIGURE 1	REVISION	1

- Several attempts (13563-BH11 through –BH16) were made to complete a monitoring well within the vicinity of the existing embankment fill dam located along the west periphery of the tailings impoundment area. However, due to the presence of extensive cobbles and boulders, this was not possible. From observations made while drilling borehole 13563-BH13, it appeared that the dam embankment ended at a depth of 4.2 m below ground surface (elevation of approximately 85.8 m) and there did not appear to be saturated conditions within the 4.5 m depth of drilling at this borehole location. As well, the static water level at monitor 13563-MW2, which is in the vicinity of 13563-BH13, was at an elevation of 85.49 m. From this, and based on the very coarse nature of the dam construction, it does not appear that there is a phreatic surface within the dam embankment but rather in the vicinity of the dam base and the underlying till soil.
- Ground water sampling was conducted in accordance with recognized industry protocols[2] on September 10, 1998. Specific methods included purging (two well casing volumes) and ground water sampling with dedicated PVC bailers at each monitor location. Field filtering of dissolved metals samples was not possible, and as such, preservatives were not added to these sample containers. Samples were stored in coolers and maintained at or below 4°C with ice packs during immediate transport to ASL Ltd. in Vancouver. The design of the analytical test program was assumed by Mr. Michael Royle of SRK. Results of the field measurements made during sampling have been detailed in the following table:

Well ID	Depth to water below top PVC casing (m)	pH	Conductivity (mS/cm)
13563-MW3	3.15	8.0	0.39
13563-MW6	1.80	N/M	N/M
13563-MW1S	Dry	N/M	N/M
13563-MW1D	2.40	7.4	0.46
13563-MW5	3.97	4.0	4.02
13563-MW2	5.36	5.5	3.58
13563-MW4	5.51	5.8	6.80
Lake	81.36*	N/M	N/M

Notes: * elevation measured on staff gauge installed by Underhill Geomatics Ltd.
N/M = not measured

- Response testing was conducted at selected well locations on September 22, 1998 to determine the approximate hydraulic conductivity of the soils for use in ground water flux calculations. A slug withdrawal, single borehole response test method was conducted in accordance with recognized industry protocols[3]. The test involved recording the initial static water level in the well, removing a 'slug' of water to a known depth, and recording the rise in water level with time until at least 70% of the original

[2] ASTM Designation: D4448-85a (Reapproved 1992). Standard Guide for Sampling Groundwater Monitoring Wells.
[3] ASTM Designation: D4050-91. Standard Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems.

static water level had recovered in the well. The results of the response tests have been summarized below. The analysis of the response was assumed by SRK.

AGS-98-MW1-D		AGS-98-MW2		AGS-98-MW3	
Time (min)	Depth (m)	Time (min)	Depth (m)	Time (min)	Depth (m)
0	3.55	0	7.2	0	3.68
0.5	3.48	0.5	7.14	0.5	3.64
1	3.44	1.5	7.12	1	3.63
1.5	3.34	2.5	7.11	2	3.61
2.5	3.27	9.5	7.03	3.25	3.59
3.5	3.17	13.5	6.99	7.25	3.55
5.5	3.02	20.5	6.93	12.25	3.51
7.5	2.93	31.5	6.83	34.25	3.38
9.5	2.85	39.5	6.76	52.25	3.34
12	2.74	52.5	6.65	72.25	3.29
14.5	2.66	72.5	6.54	87.25	3.26
19.5	2.58	92.5	6.44		
24.5	2.54	122.5	6.33		
		152.5	6.23		
		252.5	5.98		
		352.5	5.79		

Notes: -depth is given as below top PVC pipe
-existing dedicated bailers were used for slug withdrawal
-an attempt was made to complete a response test on 13563-MW5, however, there wasn't enough water present to obtain representative rising head data

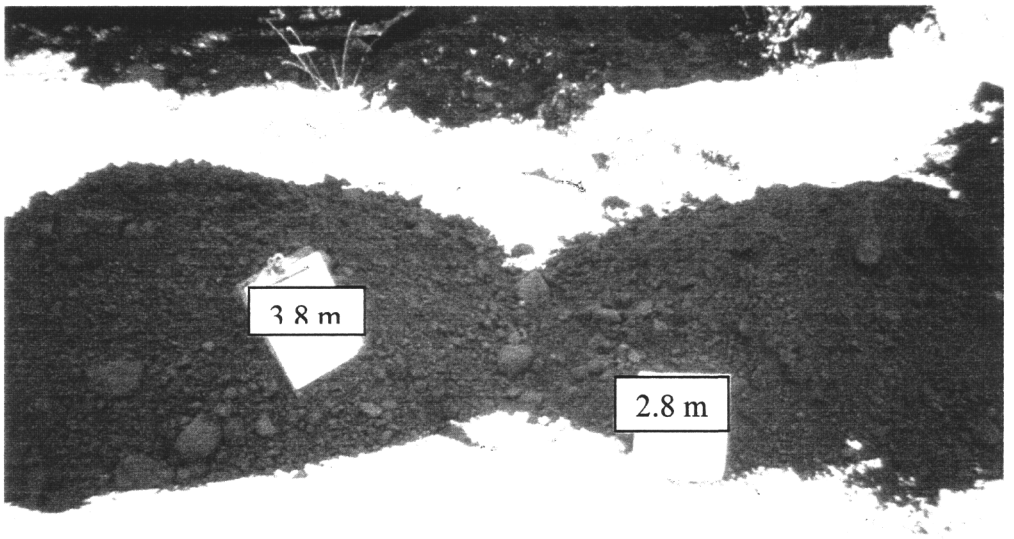
4.0 BORROW INVESTIGATION FOR CAPPING MATERIAL

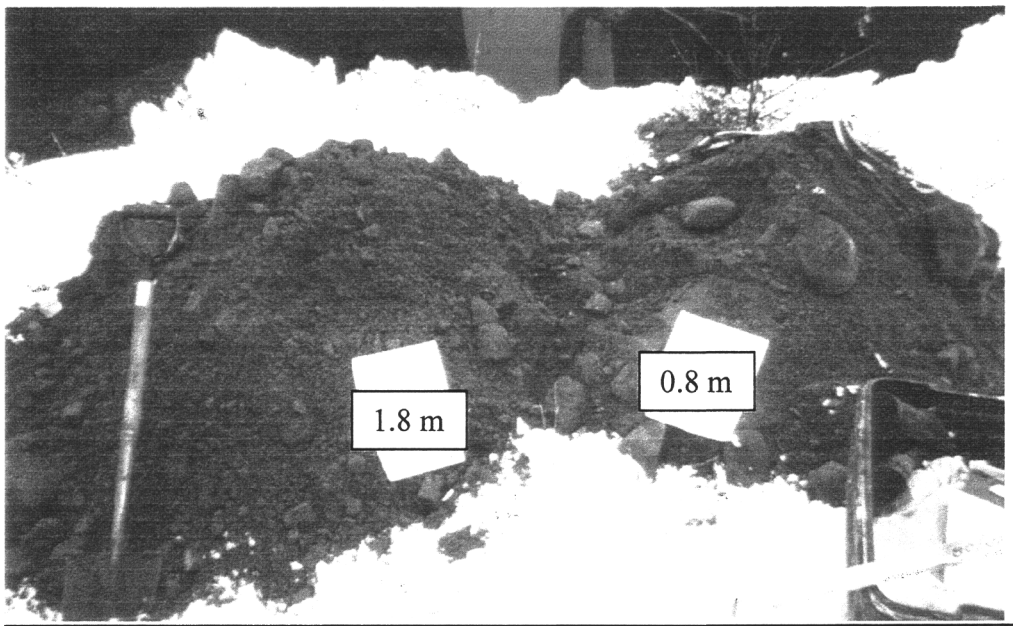
The following summary comments are made with respect to the results of the test pitting program conducted in the vicinity of the potential fine grained borrow source:

- Five test pits were excavated on October 8, 1998 at the locations depicted on Figure 1 to determine the physical characteristics and variability of soils contained within the area of potential low permeability cover material. The soil stratigraphy with depth is shown on each individual borehole log in Appendix C, with physical laboratory test results following the test pit log from which the sample derived.
- The maximum depth of test pits ranged from 3.0 m to 4.9 m below ground surface. The soil profile was relatively consistent throughout the investigation area with a sand and gravel, some silt morainal till material. Four grain size analyses were conducted on representative soil samples from the test pits with the following summary table of relative grain size proportions:

Test Pit (depth range)	% clay and silt	%sand	% gravel
13563-TP1 (0.8-1.0 m)	13	34	53
13563-TP1 (1.8-2.0 m)	12	45	43
13563-TP2 (1.8-2.0 m)	11	41	48
13563-TP3 (2.8-3.0 m)	22	33	45

- As seen in the above table, the till is composed primarily of sand and gravel sizes, with an average fines content of approximately 15%. As well, the soil matrix consisted of approximately 5% cobbles by volume to a maximum diameter of 300 mm. A photographic documentation of the typical soils encountered is shown in Photos 3 and 4, following.

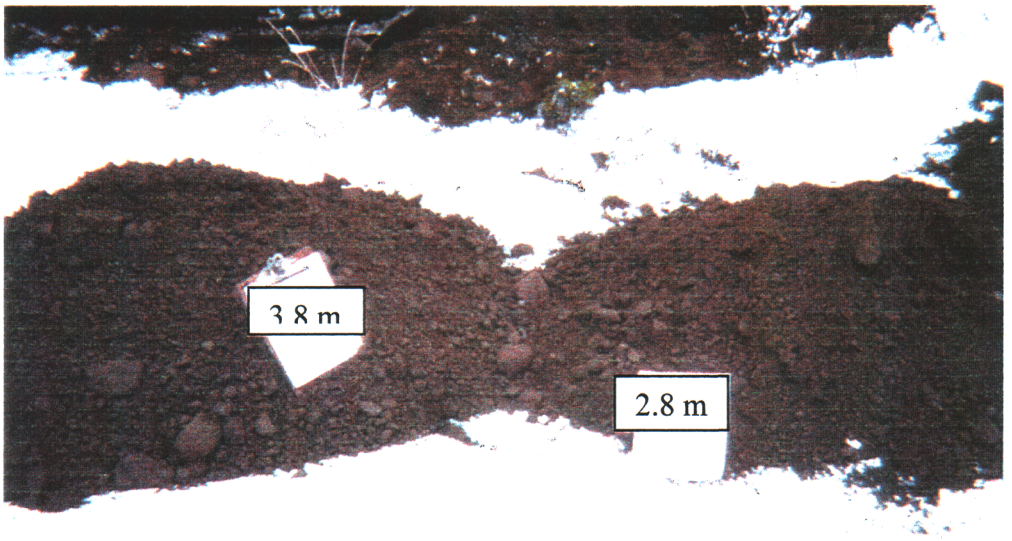


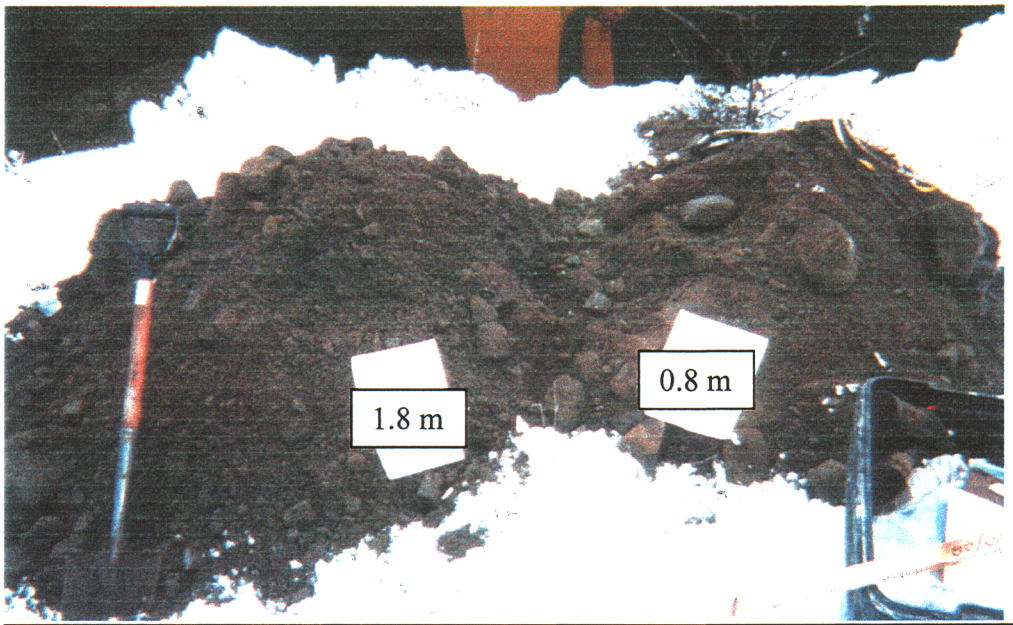


Photos 3 and 4. Soil piles from samples at varying depths at 13563-TP4

Test Pit (depth range)	% clay and silt	%sand	% gravel
13563-TP1 (0.8-1.0 m)	13	34	53
13563-TP1 (1.8-2.0 m)	12	45	43
13563-TP2 (1.8-2.0 m)	11	41	48
13563-TP3 (2.8-3.0 m)	22	33	45

- As seen in the above table, the till is composed primarily of sand and gravel sizes, with an average fines content of approximately 15%. As well, the soil matrix consisted of approximately 5% cobbles by volume to a maximum diameter of 300 mm. A photographic documentation of the typical soils encountered is shown in Photos 3 and 4, following.





Photos 3 and 4. Soil piles from samples at varying depths at 13563-TP4

- The moisture content in the till soil was in the order of 5-8%. Ground water seepage occurred in all test pit locations at depths ranging from 2.1 m to 4.5 m below ground surface. In general, more extensive unsaturated soils were encountered with increased distance to the west of the road.
- To evaluate the effectiveness of the potential borrow source as a low permeability cover, remoulded constant head hydraulic conductivity tests were conducted on composite samples. Three samples were prepared for the permeability testing to model various scenarios for soil placement as capping material at the site. The moisture density relationship (Proctor) was determined, and the remoulded sample was then prepared to 90% Standard Proctor Density (SPD) at the corresponding optimal moisture content for use in the permeability test. The 90% SPD estimate was considered to be representative of very low compaction effort and with minimal quality control density testing during construction. The laboratory results are presented in Appendix D. A description of the sample preparation, the particle size distribution of the sample, and the constant head permeability test results are presented in the following table.

Sample	Description	%fines	%sand	%gravel	K (cm/sec)
P-1	Sample 6 from BH2 (2m), screened to remove >25 mm diameter particles	13	47	41	4.4 E-03
P-2	Sample 11 from BH3 (3m), no modifications	22	33	45	5.4 E-03
P-3	Composite of samples 1 and 2 from BH1, screened to remove >25 mm diameter particles	18	62	20	2.5 E-03

- As seen on the above table, there does not appear to be a significant change as a result of screening oversize portions. The geometric mean of the K results is in the order of 4.1E-03 with a standard deviation of just 1.5E-03. This variance is considered insignificant in relation to the relative accuracy of such a test in estimating hydraulic conductivity for unsaturated soils.

5.0 CLOSURE

The information presented in this report has been prepared for the exclusive use of Steffen, Robertson, and Kirsten (Canada) Inc. and PWGSC, Environmental Services and for the specific application to the development described in Section 1.0. This report has been prepared in consideration of and is subject to the EBA General Conditions, attached.

We trust the above summary information is suitable for your purposes. If engineering interpretation is required for the analysis of the data presented herein, please advise. EBA has enjoyed working with your organization on this project and we would be pleased to assist you on future endeavours of this nature.

Yours truly,
EBA Engineering Consultants Ltd.

Michael E. Billowits, M.Sc., P.Eng.
Project Engineer

MEB/

EBA Engineering Consultants Ltd. (EBA)
GEOTECHNICAL REPORT - GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions"

A.1 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

A.2 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

A.3 LOGS OF TEST HOLES

The test hole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

A.4 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

A.5 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

A.6 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

A.7 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

A.8 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

A.9 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

A.10 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

A.11 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

A.12 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the clientÕs expense upon written request, otherwise samples will be discarded.

A.13 STANDARD OF CARE

Services performed by EBA for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

A.14 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

APPENDIX A:

SCOPE OF WORK

STEFFEN, ROBERTSON AND KIRSTEN (CANADA) INC.
Consulting Engineers and Scientists

Suite 800
580 Hornby Street
Vancouver, B.C.
Canada
V6C 3B6

Tel: (604) 681-4196
Fax: (604) 687-5532

August 28, 1998
Project Number 1CP001.07

EBA Engineering Consultants Ltd.
151 Industrial Road, Unit 6
Whitehorse, Yukon
Y1A 2V3

BY FAX: (867) 668-4349

Attention: Mr. Michael Billowits, P. Eng.

Dear Michael:

RE: ARCTIC GOLD AND SILVER, SITE INVESTIGATION

Thank you for meeting with Michael Nahir of Public Works and Government Services Canada (PWGSC) and myself on August 26, 1998. As discussed in the meeting, PWGSC has retained Steffen Robertson and Kirsten (Canada) Inc. (SRK) to evaluate alternative strategies for rehabilitating the Arctic Gold and Silver mill tailings facility, near Carcross, Yukon. The scope of the project as a whole is described in the attached work plan (letter to PWGSC, dated August 18, 1998).

Part of the evaluation process involves field investigations, as described in the work plan, to be completed within the next few weeks. Although much of the work will be completed by SRK, PWGSC or INAC, we would like to involve EBA in the program to take advantage of your skills and local presence. As we discussed in the meeting, the work plan originally assumed that EBA would conduct all of the geotechnical laboratory testing, as well as conduct field investigations to confirm the results of your earlier borrow reconnaissance studies at the site. However, following the August 26, 1998, meeting, Michael Nahir and I discussed ways in which EBA's involvement could be broadened to include supervising the drilling and installation of groundwater monitoring wells within the tailings area. Based on discussions with Mr. Nahir, it was decided to expand EBA's involvement to include the following.

Groundwater Investigation

- EBA to supervise drilling and installation of groundwater monitoring wells at Arctic Gold and Silver tailings facility, including logging the boreholes and collecting samples for testing.

- EBA to supervise drilling of solid-stem auger boreholes within the tailings to confirm thickness of tailings, to provide in-fill data to that provided by the monitoring wells. This is in place of the hand augering described in the work plan.

- EBA to collect and prepare a composite bulk sample of tailings for metallurgical testing (as part of solid stem auger drilling).

- EBA to prepare logs and well installation diagrams. Draft logs and installation diagrams to be faxed to SRK by September 4, 1998, or if for some reason the drilling is delayed, within two working days following completion of the drilling.

  EBA to develop and sample monitoring wells for water quality, as well as measure static water levels. PWGSC or SRK will arrange with analytical laboratory to complete the analyses.

- EBA to test (in consultation with SRK) selected samples of tailings and underlying soils for grain size distribution and other index properties.

- EBA to prepare brief report presenting the completed logs, installation diagrams and test results, and describing the methods used and any pertinent observations.

PWGSC has retained Midnight Sun to complete the drilling, using a CME 750 mounted on balloon tires. The rig will mobilize to Arctic Gold and Silver as soon as it has finished its work at the Venus site. Drilling at Arctic Gold and Silver could begin as early as Saturday, August 29, 1998. Michael Royle of SRK is currently in Whitehorse and will be at the Arctic Gold and Silver site with you for at least one full day when drilling begins. Mr. Royle will provide details of the work required at that time (general requirements are discussed in the attached work plan). Actual borehole locations will be determined in the field in consultation with Mr. Royle. Mr. Royle will also provide instructions for collecting and preparing the metallurgical sample, and for requirements for water quality sampling. Please contact Mr. Royle at the Edgewater Hotel (667-2572).

The project budget only allows for 3 days of drilling. Therefore, rather than setting out a rigid program of borehole locations and depths, adjustments will be required in the field depending on the efficiency of the rig and crew and any particular difficulties encountered. Selection of samples for geotechnical laboratory testing will be completed in consultation with SRK.

In addition to the three days of field time during drilling, we have allowed for one more man day to develop and sample the monitoring wells (four man days, total, in the field). We assume that EBA will require not more than three man-days to complete data compilation (logs, installation diagrams, etc.) and reporting.

Borrow Investigation

We have allowed for two days of test pitting by EBA to verify the results of your earlier reconnaissance of potential borrow sources in the immediate vicinity of the site, plus two man-days for data compilation and reporting, and $1000 for laboratory testing. Additional investigations to locate sources of low permeability soil may be required as part of the Stage 2 investigation, but only if the initial evaluation of options show that a low permeability soil cover is definitely required.

We hope that EBA agree and are able to complete the work described above, and look forward to working together with you on this project, and possibly others in the future. If you are unable to complete the work described above, please let us know as soon as possible so that we can make other arrangements.

Yours truly,

STEFFEN, ROBERTSON AND KIRSTEN (CANADA) INC.

Rodney C. Olauson,
Project Manager

cc: Michael Nahir, PWGSC, Edmonton
Michael Royle, SRK, Whitehorse

August 18, 1998
Project Number: 1CP001.06

Public Works and Government Services of Canada
1000 - 9700 Jasper Avenue
Edmonton, Alberta T5J 4E2

Attention: Mr. Michael Nahir

Dear Michael:

RE: ARCTIC GOLD AND SILVER TAILINGS

On June 16, 1998, Public Works and Government Services Canada (PWGSC) commissioned Steffen Robertson and Kirsten (Canada) Inc. (SRK) to provide scientific and geotechnical services related to the remediation of the Arctic Gold and Silver mill site and tailings facility, near Carcross, Yukon. Initially, SRK's scope of work was to review relevant background documents, visit the site and then review and verify design and specification documents prepared by PWGSC. The site visit was completed on July 24, 1998, and included representatives from SRK, PWGSC, INAC (Indian and Northern Affairs Canada) and the Carcross Tagish. During the site visit, all parties agreed that further investigations and evaluation of options are required before deciding on the most appropriate remediation plan. SRK's terms of reference were expanded to include developing a plan for the further investigation and evaluation of options, and preparation of a conceptual design. This letter presents our recommendations for further investigations, as well as presenting a revised work scope and schedule for SRK's services, based on our new terms of reference.

1.0 REMEDIATION OBJECTIVES

Table 1 presents a list of objectives that are taken into consideration in all mine closure and remediation projects, and briefly describes their relevance for the Arctic Gold and Silver tailings. The final column of the table shows our initial ranking of the importance or relevance of each objective. We understand that community meetings will be held in the next weeks and will better define end use objectives for the site. Once that information is available, the ranking of remediation objectives can be finalized.

The table is generally self-explanatory, but our ranking of water quality concerns as "potentially major but uncertain" needs explanation. We have reviewed water quality data collected in 1975, 1988, 1996 and 1997. The data clearly show that heavily contaminated water drains from the tailings into the unnamed lake below the tailings embankment. However, there is no clear evidence that the contamination has a significant impact beyond the unnamed lake. Furthermore, there is some indication that other as yet unknown sources of contamination may be significant. Hence it is uncertain whether actions to control contaminated drainage from the tailings will have a significantly beneficial effect. Resolving that uncertainty is one objective of the investigations recommended below.

2.0 POSSIBLE REMEDIAL MEASURES AND INFORMATION NEEDS

Table 2 lists alternative measures that could be undertaken to remediate the three major concerns at the site, i.e. physical stability, the human health hazard associated with exposure to the tailings, and degradation of water quality. It is important to consider all possible alternatives so that further investigation can be designed to provide the information needed to select and design the best one.

- The "do nothing" alternative is included as a baseline. Clearly it would not remediate any of the three "major" concerns.

- Controlling access to the tailings, probably by means of fencing and warning signs, would minimize direct contact of people with the tailings. It would not eliminate exposure to dust, nor address the other "major" concerns.

- There are many types of covers that could be constructed over the tailings. A simple soil cover would be sufficient to stop wind blowing off tailings dust and prevent human exposure. Minor improvements might include drainage control and/or revegetation to prevent erosion. In general, it can be much more difficult to build a cover that will also reduce the infiltration of rainwater and snowmelt through the tailings, which would be necessary to reduce the release of contaminated drainage. Furthermore, because it is not clear that the tailings are the only source of contaminants, the effectiveness of even a perfect infiltration barrier is questionable.

- Consolidating other contaminated materials into the tailings area would remove concerns associated with other parts of the site. This alternative would probably be combined with covering of the tailings along with the relocated material. Consolidating the tailings into

one end of the impoundment would reduce the amount of surface needing to be covered, and allow the current decant system to be removed.

- Construction of a low infiltration cover will only control water that percolates downwards into the tailings. It would not affect any groundwater that might be flowing laterally through the tailings. Control of surface water and/or relocation of tailings away from groundwater discharge areas (areas where groundwater flows upwards or laterally out of the original ground surface) might be required if infiltration is not the only source of contaminated drainage.

- Chemical amendment of the tailings could through addition of lime or limestone would neutralize acid salts and convert soluble metals to less soluble mineral forms. Alkali addition has been used successfully at other sites, but only on wastes with relatively low acidity. It is likely to be prohibitively expensive at this site due the high acidity.

- Reprocessing of the tailings is an alternative that needs to be considered. The tailings undoubtedly contain significant metal value. Whether that value can be recovered economically, without creating a greater environmental problem, remains to be seen.

Table 3 lists the types of information that would be needed to assess each of the possible remedial measures. An intermediate step in such an assessment would be resolving the uncertainties associated with water quality, and the information needs for that are also included in the table.

Again the table is self-explanatory. Two general conclusions can be drawn. First, a surprising variety of information is needed to correctly choose among remedial measures. Second, it would be prudent to collect the information in stages, so that some alternatives (and their information needs) can be eliminated as early as possible.

3.0 RECOMMENDED INVESTIGATION

Table 4 outlines our recommendations for the further investigation. We have separated many tasks into two stages. The object of the Stage 1 activities will be to allow most of the remedial alternatives to be eliminated from further consideration. The number of more costly and time-consuming Stage 2 activities could then be reduced. Stage 2 activities, if required, would provide information needed for final design.

The expected activities are described in the following subsections.

Task 1 Topographic Mapping

A topographic map is required to delineate areas and investigation sites, to serve as a basis for volume calculations, and, ultimately, to provide a base plan for construction drawings. Ideally, a map of an area spanning 500 x 500m around the tailings impoundment would be mapped from low level air photos. However, if the photos do not exist, that option might be prohibitively costly. A less costly alternative would be to commission local surveyors to map specific areas of interest, such as the tailings area, in detail (preferably to 0.5 m contours), and then fill in the surrounding areas in less detail (e.g. at a 1 m contour interval).

Items to be shown on the map include:

- crests, toes and breaks in slope of dams, berms, windrows and ditches;
- outlines of buildings and building foundations;
- floor slab elevations for building foundations;
- locations, orientation and invert elevations of pipes and culverts;
- locations of decant structures and water wells;
- alignment of surface drainage gullies (including those that are dry at the time of the survey);
- the location of the landfill beside the road to the south of the tailings and mill area; and,
- locations of ore piles (both crushed and coarse).

Outlines of specific features of interest, such as the tailings deposit itself, the extent of windblown tailings, and outlines of former ore stockpile areas, should be clearly flagged in the field prior to the survey so that these can be picked up by the surveyors. It would also be helpful if someone familiar with the site, such as Larry Barrett, could be present on site at the time the survey is completed to point out specific features such as the water well at the former camp site, all existing building foundations, decant structures and culverts.

The map should be made available both in printed paper copy, and as an electronic drawing file in AutoCAD format, with appropriate elevations assigned to drawing entities ('z' coordinates). Permanent survey control points should be established in the field, so that they can be used to tie in features throughout the investigation and during construction.

Task 2 Surface Water Sampling

To narrow the uncertainty about the importance of the tailings as a contaminant source, we recommend that water quality samples be collected from all drainages entering the unnamed lake, and along the creek that is diverted south of the tailings. While many of these drainages have been sampled in the past they have not all been sampled together during the same sampling event. Concentration and flow data for all drainages at a single point in time are required to assess the relative impact of the tailings on downstream receiving waters. The area between the toe of the tailings dam and the shoreline of the unnamed lake should be inspected for seeps, and these seeps should also be sampled and analyzed. Ideally, the surface water sampling would be timed to coincide with INAC's planned sampling of Tank Creek.

Samples would be analyzed for both total and dissolved metals, at method detection limits appropriate for comparison with CCME guidelines for freshwater aquatic life. Analysis for arsenic should be at a method detection limit of 0.0001 mg/L. Other parameters to be included in the analysis include pH and temperature (measured in the field), conductivity, total dissolved solids, total hardness, alkalinity or acidity, sulphate, and mercury.

Task 3 Tailings Investigations

Previous investigations have characterized the geochemical properties of the tailings, but not their physical characteristics. The objective of the recommended Stage 1 investigations are to measure the depth of the tailings across the impoundment, determine the shape (topography) of the bottom of the tailings deposit, collect samples of tailings for grain size analyses, and prepare a weighted average composite sample for metallurgical tests. The field portion is intended to be carried out, to the extent possible, with a hand auger only. However, much of the tailings deposit is likely to be too deep to penetrate with a hand auger. In those areas it may be possible to locate the bottom of the tailings using dynamic cone penetration testing, which could be completed in conjunction with the hydrogeologic investigation (Task 5). Grain size analysis (mechanical sieve with hydrometer) would be completed in a laboratory on approximately 10 samples. Approximately 50 kg of composite tailings samples should be prepared for metallurgical testing.

More extensive investigations may be needed to support design of some alternatives. If necessary, these investigations would be carried out in Stage 2 and would probably require test pits to be excavated.

Task 4 Delineation of Other Sources

Other contaminant sources that should be delineated include the wind blown tailings, the former ore and waste rock stockpiles, the drainage ditch extending from the former mill building to Tank Creek, and the tailings spills above the unnamed lake. Initially, these sources should be delineated by sketching on the topographical map, and by surface sampling and analysis. Test pits may be required in Stage 2.

Task 5 Hydrogeologic Investigation

While the tailings investigation described in Task 3 above, will provide information regarding the size, shape and physical properties of the tailings, additional information will be required to determine groundwater flow patterns. Like other aspects of the investigation the hydrogeologic investigation can be divided into two stages. The first stage would concentrate on determining if there is a potential for lateral flow through the tailings (due to influx of groundwater), or if infiltration from surface is the only significant influx. If the Stage 1 investigation indicates that groundwater influx into the tailings could be significant, then more detailed investigations would be completed as part of Stage 2.

We recommend that the Stage 1 hydrogeologic investigation be limited to the tailings area only. If the results indicate a significant groundwater pathway, up-gradient and down-gradient investigations would be needed in Stage 2.

The tailings area investigation should include drilling, logging, soil sampling, installation of piezometers, water level reading and water quality sampling at 4 or 5 locations within the impoundment and at 2 locations along the centreline of the dam. The cost estimate assumes three 12 hour days of drilling and piezometer installation. Barring unforeseen problems, that should allow piezometers to be installed at 6 or 7 locations. Piezometers should be screened within the tailings (or embankment fill) and in any conductive unit identified below the tailings (or embankment fill). All soil and tailings samples should be analyzed for moisture content. Samples of soil from directly below the tailings should also be analyzed for arsenic. Samples of embankment fill materials should be analyzed for grain size distribution.

The Stage 2 investigation, if required would include permeability tests in the tailings area, and up-gradient and down-gradient piezometer installations.

Task 6 Lake Sediment Samples

We understand that INAC will complete a comprehensive sediment sampling program to determine the nature, extent and depth of tailings and contaminated sediments within the

unnamed lake to the west of the tailings impoundment. This information will be helpful in determining whether the in-lake tailings have a significant effect on water quality.

Tailings solids were observed within the bottom of the ditch that extends from the outlet of the decant to the lake, and these tailings deposits appear to extend beneath the surface of the lake itself. Iron hydroxide precipitates were also observed beneath the surface of the pond along the shoreline. The tailings solids were probably deposited during operations, before the area had been flooded by the beaver dam. The hydroxides have probably precipitated more recently, after the beaver dam construction flooded the area. The objective of the sediment sampling, therefore, is to determine the extent and depth of the main deposit of tailings solids, as well as to determine the extent of contamination from precipitates and suspended tailings solids over a wider area of the pond.

A staged approach is recommended, starting with closely spaced sampling in the area where tailings solids are known or suspected to be present on the pond bottom, then moving radially outward at a wider spacing. Initial sampling could be completed with a grab sampler, particularly to define the extent of the main tailings deposits, and metal contents in the near surface sediments elsewhere in the lake. Once the lateral extent has been determined, core samples should be collected to determine the thickness of tailings solids, and also to collect samples of the underlying sediments for determining background metal concentrations. It is recommended that at least three additional core samples be collected outside the main tailings deposit to provide additional baseline samples.

Sample locations should be recorded by triangulation to known points on shore, GPS, or other suitable means. If GPS is used, GPS readings (with < 1m accuracy) should also be taken for survey control points established on land so that the sample locations can be tied into the project coordinate system used in the topographic base plan. The water level elevation at the time of the survey should also be recorded so that sample depths can be converted to elevations.

Selected sediment samples should be submitted for metals analysis. We recommend that relatively few samples (say, not more than 12) be submitted for analysis in Stage 1. The remainder of the samples should be preserved and archived in case additional analyses are required under Stage 2.

Task 7 Metallurgical Testing

Metallurgical tests to determine whether tailings re-processing might be feasible are typically carried out in several steps. The first step is to complete head grade anaylses and a single bottle

roll test (under normal conditions) to get an indication of metal recoveries. We recommend this step be part of the Stage 1 investigation.

The next step in such testing is normally a multiple bottle roll test with a wide range of leaching conditions. This step might be needed in Stage 2. (Subsequent steps to design include bench scale and/or bulk testing).

Task 8 Borrow Source Characterization

An initial air photo investigation and ground reconnaissance program has identified potential sources of silty soils (glacial morraine deposits) that may be suitable for use as low-permeability cover material. This initial investigation identified targets for further investigation, but it did not include any subsurface sampling or testing.

As part of Stage 1, a preliminary subsurface investigation program should be completed to determine the physical characteristics and variability of the soils contained within these target areas, as well as to get a general idea of the extent and depth of these deposits. The work would likely entail two days of test pit investigations using a backhoe under the direction of a geotechnical engineer or technician. Selected samples would be submitted for grain size determination, and the remaining samples archived. For the cost estimates we have assumed that a total of eight samples will be submitted for grain size determination (mechanical sieve with hydrometer).

Task 9 Cost Estimates

Cost estimates should be prepared for all reasonable remediation alternatives at the end of Stage 1. We recommend using a unit cost method only. Contractor estimates would not be required until after Stage 2. (Note: PWGSC has already compiled unit cost estimates for most of the activities that would be required, especially for the cover alternatives.)

4.0 COST ESTIMATES FOR FIELD INVESTIGATION

Table 5 presents cost estimates for the Stage 1 investigations. A "Task 10" has been added to allow for results of the investigation to be reviewed, compiled and summarized in a report.

We understand that INAC will provide the labour for the surface water sampling and for the sediment sampling, and have not included this labour within the cost estimate. We have, however, included an estimate of the laboratory costs for analyzing the samples.

To save on shipping costs and help speed up turn-around time, we recommend that routine geotechnical testing, such as moisture content determinations and grain size analyses be completed locally. EBA Engineering Consultants Ltd. (EBA) of Whitehorse are qualified to complete this work. We have assumed that the borrow source characterization (Task 8) will also be completed by EBA, as they have already completed the initial reconnaissance to identify target areas.

It is assumed that all consultants (other than SRK), surveyors, drillers, testing laboratories and equipment operators will be contracted directly by PWGSC or INAC. If subcontracted through SRK, SRK would have to apply at 15% handling charge to all subcontractors' billings.

5.0 RELATIONSHIPS TO OVERALL PROGRAM

To ensure that the investigation meets both schedule constraints and the needs of the Task Force, we propose the following schedule and interactions.

Provide investigation plan to Task Force for review	ASAP
Receive comments and revise plan	ASAP
Complete Stage 1 field work, review results and analyze options	by Sept. 11, 1998
Meeting with Task Force to review Stage 1 results	Mid-September
Stage 2 field investigations, as required	Early Sept. to Oct. 1
Option evaluation and preparation of draft design report	Oct. 1 to Oct. 15
Receive Task Force commentary on recommended remediation plan	Oct. 31
Finalize design report and cost estimates	Nov. 1998
Present design recommendations to Task Force (PWGSC)	Nov/Dec 1998
Prepare construction drawings and specifications (PWGSC)	Winter 98/99
Review construction drawings and specifications (SRK)	Winter 98/99
Tender process (PWGSC)	Spring 99
Construction (PWGSC supervision)	Summer 99
Inspection and maintenance (PWGSC)	Summer 2000

We understand that SRK's role will be limited to reclamation of the tailings and mine rock only, and that PWGSC will look after all other aspects of the site remediation, including removal of scrap, building demolition, clean up of contaminated soils, and closure of the refuse dump. Close cooperation will be required between SRK and PWGSC, however, to ensure that all aspects of the site remediation are coordinated into a single, practical plan. We also understand that INAC will be able to provide support in terms of surface water sampling and

lake sediment sampling. Local drillers, surveyors and geotechnical consultants will also be included in the overall team.

The scope of services to be provided by SRK under our existing contract with PWGSC includes the following activities:

- site inspection and review of background information;
- review of design and specification documents; and,
- preparation of a report summarizing the design assessment and presenting recommendations to ensure design integrity.

The site inspection and data review have been completed, and has shown that additional investigations and evaluation of alternatives are required before final design documents can be prepared. As a result, design and specification documents were not available for our review. Instead, SRK was requested to prepare this work plan for developing the final design. We suggest, therefore, that the existing contract be amended to substitute preparation of the work plan for verification of design. As the cost involved in both is approximately equivalent, there would be no need to change the contract price, only the definition of the deliverables.

All subsequent work, starting with execution of the Stage I investigation would not be covered under existing contracts and therefore will require new arrangements to be made. Estimated costs for completing the Stage I investigation are presented in Table 5. Estimated costs for the overall investigation, evaluation and design process are presented in Table 6. Please note that the cost estimates presented in Table 6 will depend to a large extent on the outcome of the initial investigation and could vary from those shown.

Yours truly,

STEFFEN ROBERTSON AND KIRSTEN (CANADA) INC.

Daryl Hockley, P.Eng.
Principal Engineer

cc: Colin Kingman, PWGSC, Vancouver

TABLE 1
Remediation Objectives for Arctic Gold and Silver Tailings

Objectives	Description	Initial Ranking
Physical stability	No evidence of instability in tailings dyke. Dry conditions make instability unlikely.	Minor
	Clear evidence of wind erosion. Wind blown tailings may cause off site contamination of soil and vegetation.	Major
	Decant structures in advanced state of deterioration. Failure could lead to release of tailings solids (by internal erosion) or overtopping of dam.	Major
Geochemical stability and water quality	Tailings already in advanced state of oxidation and acid generation. Previously oxidized tailings represent source of soluble arsenic. Future oxidation unlikely to significantly increase arsenic discharges. Remediation of current source very difficult.	Major
	Degradation of surface water quality by tailings in lake, tailings erosion, tailings drainage and/or contaminated groundwater.	Potentially major but uncertain
Human health and safety	Potential for human exposure to arsenic and other metals in tailings dust and/or by direct contact.	Major
	Decant inlet is open and presents safety hazard. Easily fixed.	Major

TABLE 2

Major Concerns and Possible Remedial Measures for Arctic Gold & Silver Tailings

	Physical Stability	Human Health Hazard	Water Quality
1) Do nothing	No	No	No
2) Control access	No	Yes	No
3) Cover tailings			
a) Dust control only	Yes	Yes	No
b) Dust and erosion control	Yes	Yes	No
c) Infiltration control	Yes	Yes	?
4) Consolidate sources			
a) Move ore and w/r to tailings	No	No	?
b) Cover consolidated material (as above)	Yes	Yes	?
c) Reduce tailings footprint	No	No	?
5) Reduce contact with g/w and surface water			
a) Improve surface diversions	No	No	?
b) Remove tailings from g/w contact	No	No	?
c) Remove in-lake tailings	No	No	?
6) Chemical amendment of tailings	No	Yes	?
7) Reprocess tailings	Yes	Yes	?

TABLE 3
Information Needs for Assessing Remedial Measures for Arctic Gold and Silver Tailings

	Further define water quality concerns	Do nothing	Control access	Cover tailings	Consolidate sources	Reduce contact with ground and surface water	Amend tailings	Reprocess tailings
1) Topographic survey		✔	✔	✔	✔	✔	✔	✔
2) Surface water quality	✔	✔	✔	✔	✔	✔	✔	✔
3) Tailings characterization								
a) Depth (thickness)				✔	✔		✔	✔
b) Grain size				✔			✔	✔
c) Composite sampling							✔	✔
d) Detailed profiles					✔		✔	✔
4) Delineate other sources								
a) Extent and location		✔	✔		✔			
b) Quantities					✔			
5) Hydrogeologic investigation								
a) Piezometric levels				✔		✔	✔	✔
b) Groundwater quality	✔	✔		✔		✔		
c) Permeability						✔		
d) Flow patterns						✔		
6) In-lake tailings								
a) Locations	✔				✔	✔		
b) Depths and properties					✔	✔		
7) Metallurgical properties								
a) Grade and leachability								✔
b) Contained acidity							✔	✔
c) Optimal recovery								✔
8) Borrow sources								
a) Location				✔				
b) Quality and quantity				✔				
9) Cost estimates			✔	✔	✔	✔	✔	✔

TABLE 4
Recommended Investigations (Stage 1 and 2) for Arctic Gold and Silver Tailings

	Stage 1	Stage 2
1. Topographic mapping	✔	
2. Surface water sampling	✔	
3. Tailings investigations		
3.1 Depth measurements	✔	
3.2 Grain size analyses	✔	
3.3 Composite Sampling	✔	
3.4 Test pits		✔
4. Delineate other sources		
4.1 Surface mapping	✔	
4.2 Test pits		✔
5. Hydrogeologic investigation		
5.1 Piezometer installation in tailings area	✔	
5.2 Water level readings	✔	
5.3 Water quality samples	✔	
5.4 Permeability tests		✔
5.5 Additional piezometers		✔
6. Sediment samples		
6.1 Sample collection and analysis of selected samples	✔	
6.2 Additional analysis (if required)		✔
7. Metallurgical testing		
7.1 Initial bottle roll test	✔	
7.2 Optimization tests		✔
8. Borrow source characterization		
8.1 Initial reconnaissance	✔	
8.2 Delineation and testing		✔
9. Cost estimates		
9.1 Preliminary	✔	
9.2 Detailed		✔

APPENDIX B:

DRILLING PROGRAM RESULTS

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH1
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH1	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.55 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0	■	1				SAND (tailings) – fine grained, trace of silt, beige, damp
						– becomes varved (oxidation zones with mustard yellow colour intermixed with beige colour)
1.0	■	2		SP-SM		
	■	3				– becomes beige again, no yellow oxidized material
	■	4				
2.0	■	5				SILT & ORGANICS (decayed organics)– soft, low plasticity, wet, black – difficult drilling starts
						SAND,SILT & GRAVEL (till) – trace of clay, poorly graded, dense, damp, brown, traces of oxidation surrounding gravel and coarse sand particles
3.0	■	6		GM		END OF BOREHOLE @ 3.0 m
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 3 m
	REVIEWED BY: JRT	COMPLETE: 98/08/29
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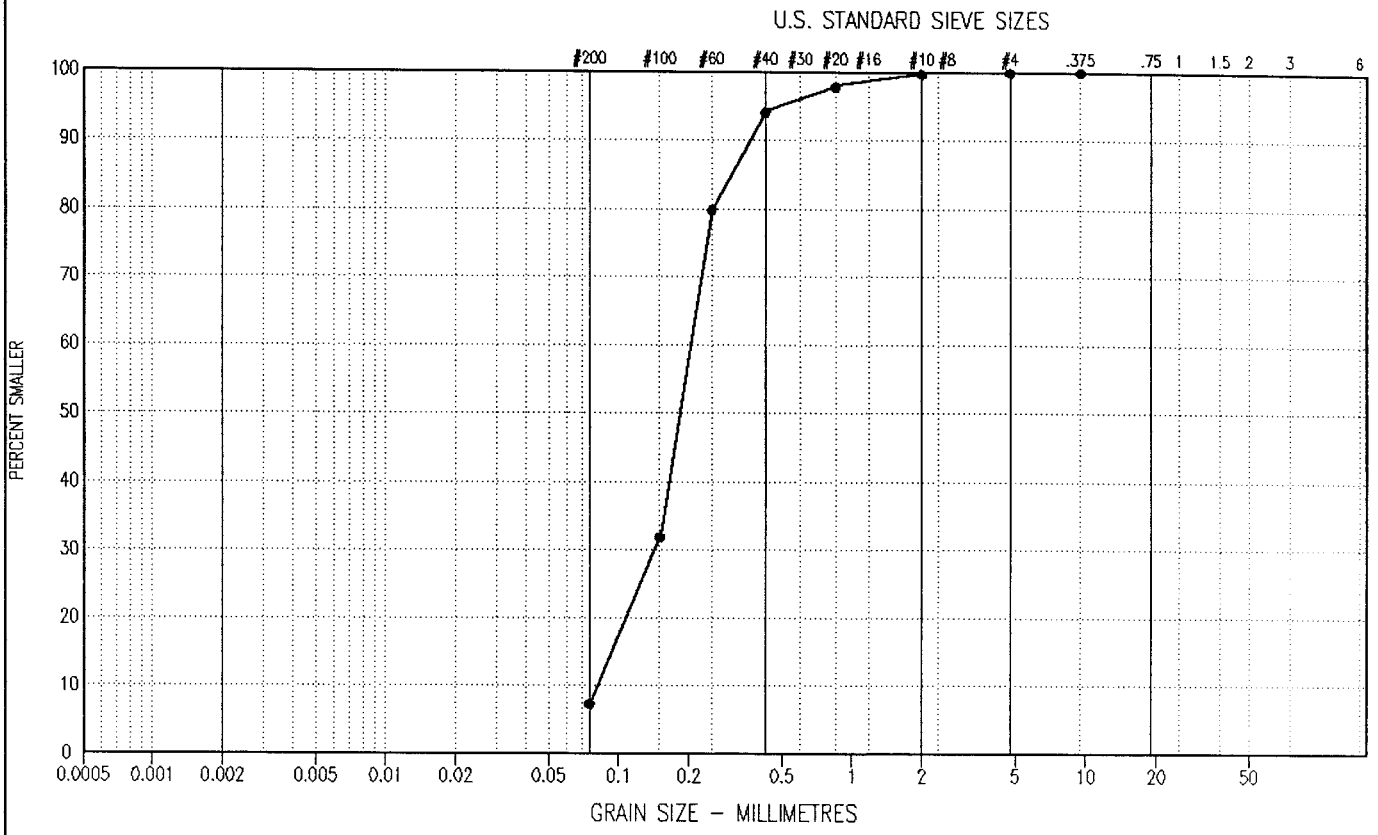
EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●——●	13563-BH1	0.70 – 0.80	7	93	0	2.5	1.2	SP-SM

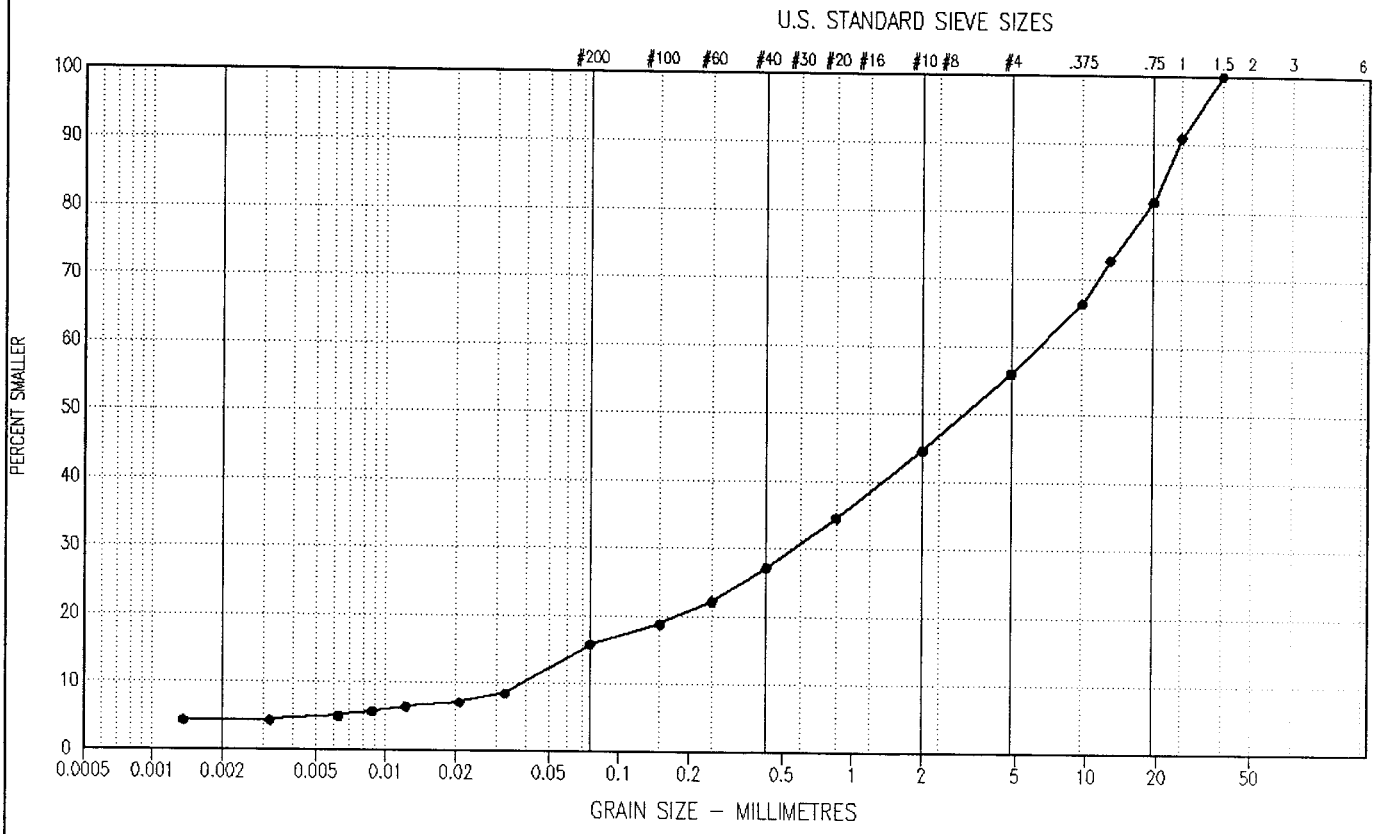
Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C
			CLAY %	SILT %	SAND %	GRAVEL %			
●——●	13563-BH1	2.80 – 3.00	4.2	12	40	44	159.7	1.3	GM

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH2
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH2	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.8 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ☰ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0	■	7				SAND (TAILINGS) - fine grained sizes, beige, some yellow oxidized intrusions throughout, damp T = 7.6 degree C.
1.0	■	8		SM		- tailings become dark grey in colour, still fine grained sand sizes, some silt, moist
2.0	■	9				ORGANICS - some sand tailings mixed throughout, black, fibrous, semi-decay, wet T = 7.2 degree C.
						BEDROCK OR BOULDERS - grinding action
						REFUSAL @ 1.8 m
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0

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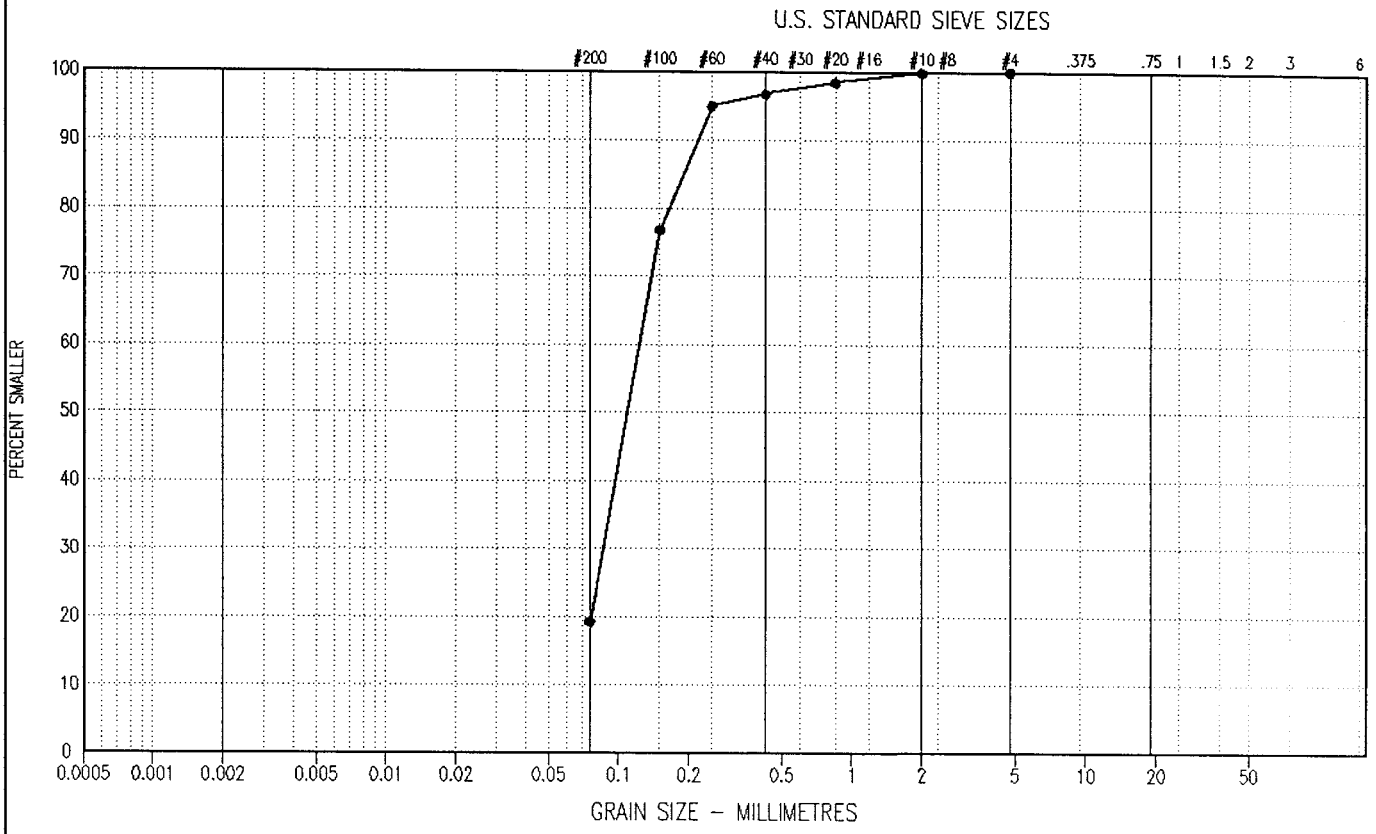
EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●—●	13563-BH2	1.30 – 1.50	19	81	0	2.0	1.0	SM

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH3
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH3	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.9 m

SAMPLE TYPE ■ GRAB SAMPLE ▨ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0	■	10				SAND (TAILINGS) – fine grained sand sizes, poorly graded (well sorted), beige with yellow oxidation throughout, medium dense, damp
1.0	■	11				SILT (TAILINGS) – some fine sand, some clay, low plasticity, soft, wet, dark grey in colour
2.0						ORGANICS – black, fibrous, semi-decayed (very thick organic layer)
3.0	■	12				SILT – some fine sand, non-plastic, firm, moist, dark grey, no oxidation
	■	13				
4.0						
5.0						END OF BOREHOLE @ 4.5 m
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 4.5 m
	REVIEWED BY: JRT	COMPLETE: 98/08/29
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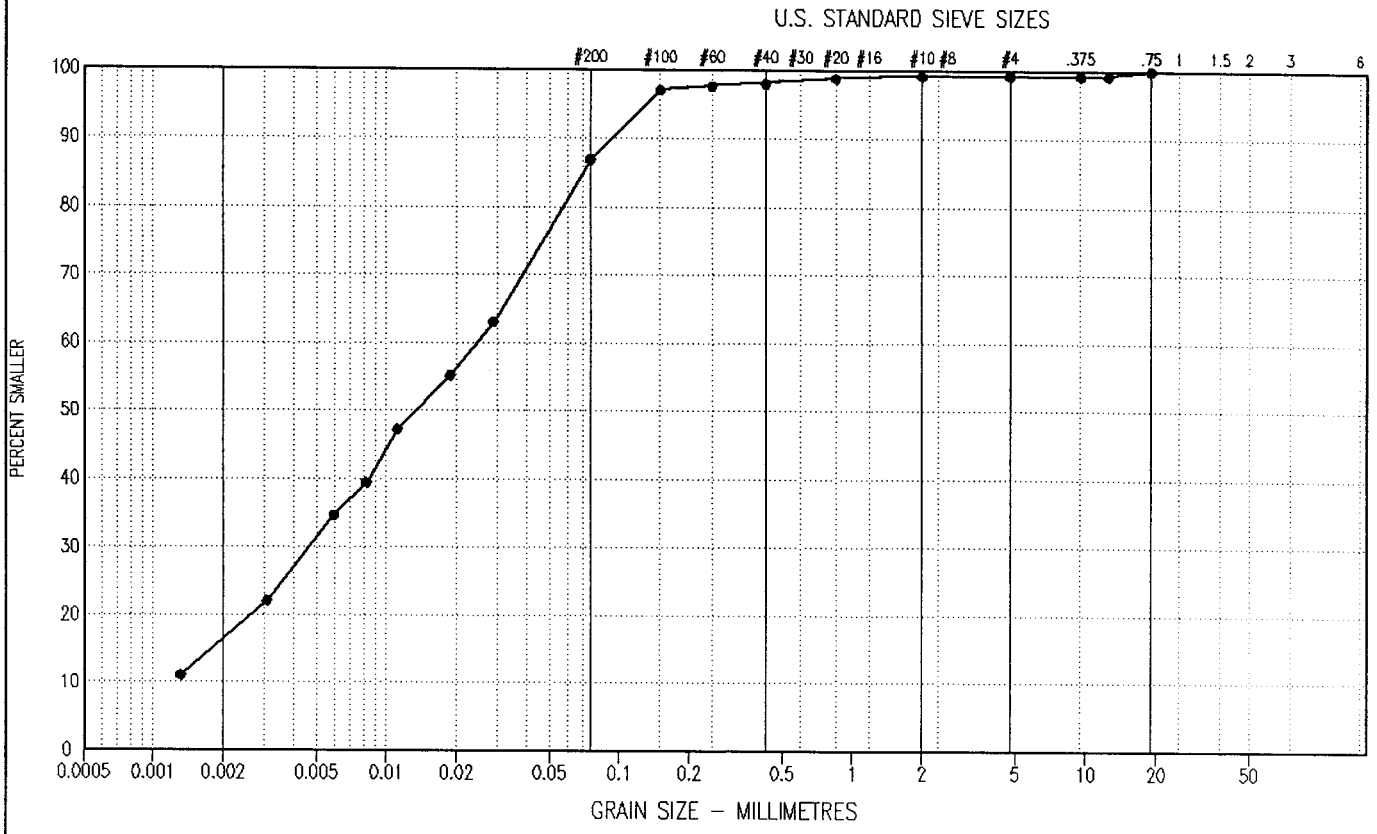
EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION CLAY %	SILT %	SAND %	GRAVEL %	Cu	Cc	U.S.C
●	13563-BH3	1.20 – 1.40	15.3	72	12	1	–	–	

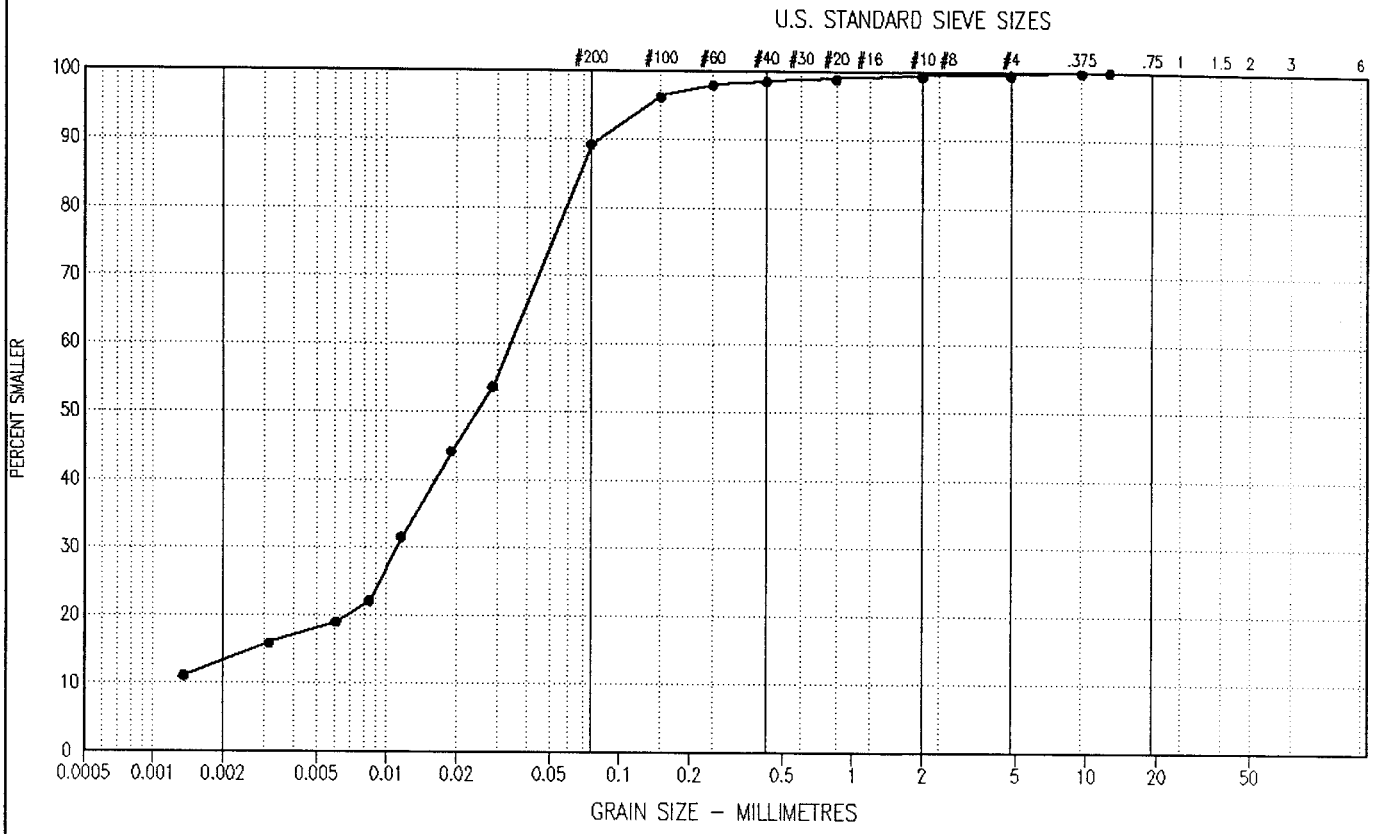
Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C
			CLAY %	SILT %	SAND %	GRAVEL %			
●	13563-BH3	3.40 – 3.50	12.7	76	10	1	–	–	

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH4
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH4	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.7 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0	■	14				SAND (TAILINGS) – trace of silt, medium dense, poorly graded, damp, beige with yellow oxidation zones throughout (varied)
1.0	■	15				SAND – silty (tailings), medium dense, poorly graded, moist, dark grey
						ORGANICS – fibrous, black, partially decayed
2.0						END OF BOREHOLE @ 1.5 m
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0

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SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH5
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH5	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.9 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION(m)
0.0						SAND (TAILINGS) - some silt, fine grained sizes, poorly graded damp, beige with yellow/orange oxidation zones throughout (varied)	
1.0						SILT - trace of fine sand (tailings), non-plastic, soft, wet, dark grey, traces of oxidation	89.0
						ORGANICS - black, fibrous	
2.0						END OF BOREHOLE @ 1.5 m	
3.0							87.0
4.0							
5.0							85.0
6.0							
7.0							83.0
8.0							

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

EBA Engineering Consultants Ltd.
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REVIEWED BY: JRT	COMPLETE: 98/08/29
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SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH6
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH6	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.75 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0	■	16		SP		SAND (tailings) - silty, poorly graded, moist, beige and orange
						SILT - some sand, non-plastic, firm, moist, grey
1.0	■	17				SAND - some silt, poorly graded, medium dense, moist, beige
						ORGANICS - fibrous, black
						END OF BOREHOLE @ 1.5 m
2.0						
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 89.0, 87.0, 85.0, 83.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

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REVIEWED BY: JRT	COMPLETE: 98/08/29
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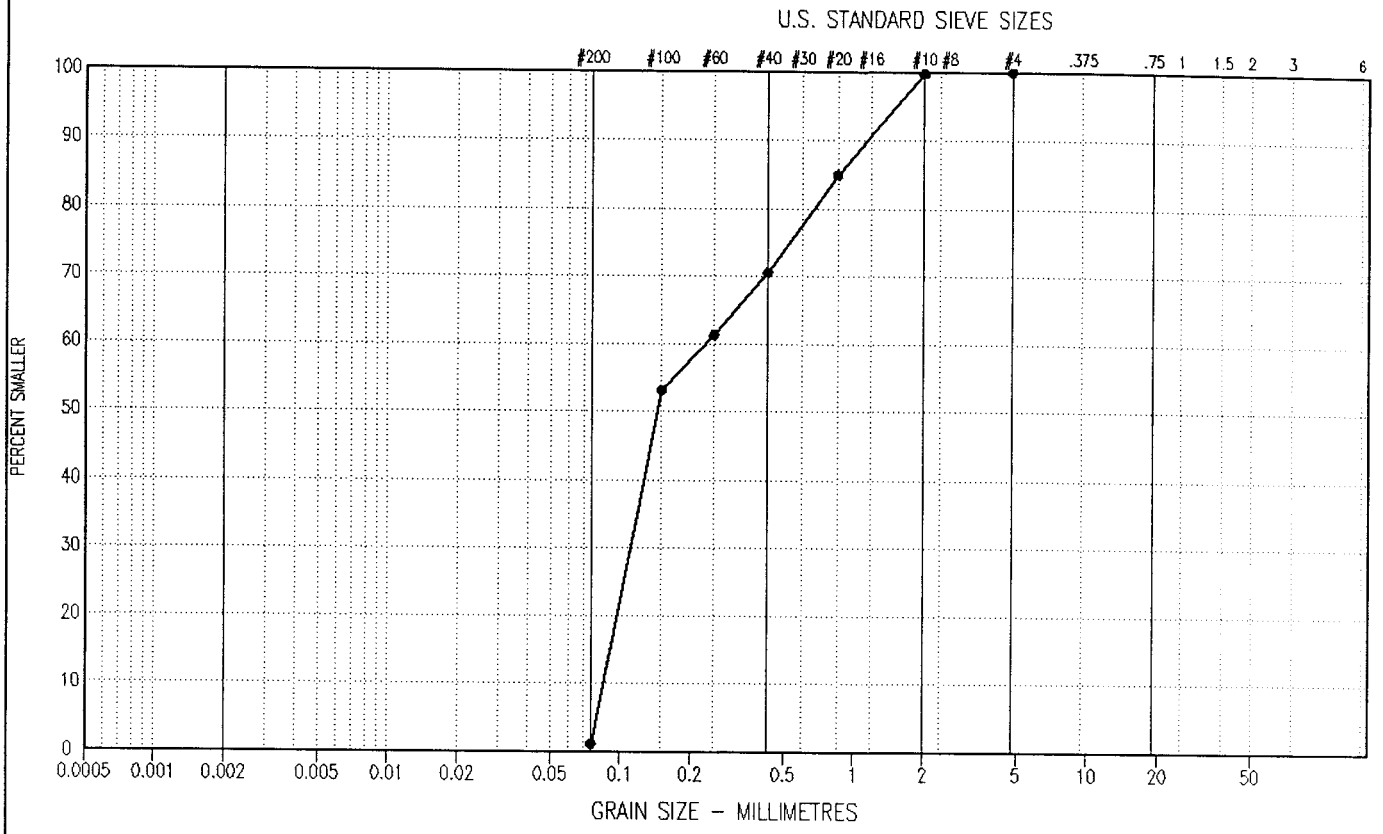
EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●——●	13563–BH6	0.20 – 0.40	1	99	0	2.7	0.7	SP

Project: 0201–98–13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH7
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH7	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.2 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0	■	18				SAND & SILT (TAILINGS) - fine grained sand sizes, med. dense, damp, beige with yellow-orange oxidation throughout
1.0	■	19				- tailings become grey in colour, some silt, orange oxidation throughout zones
2.0	■	20				SILT & ORGANICS - wet and soft, black fibrous organics
						- drilling becomes grinding
	■	21				SILT AND SAND (TILL) - trace of gravel, dense, poorly graded, moist, grey with orange brown oxidation throughout
3.0						END OF BOREHOLE @ 3.0 m
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0, 82.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 1.6 m
	REVIEWED BY: JRT	COMPLETE: 98/08/29
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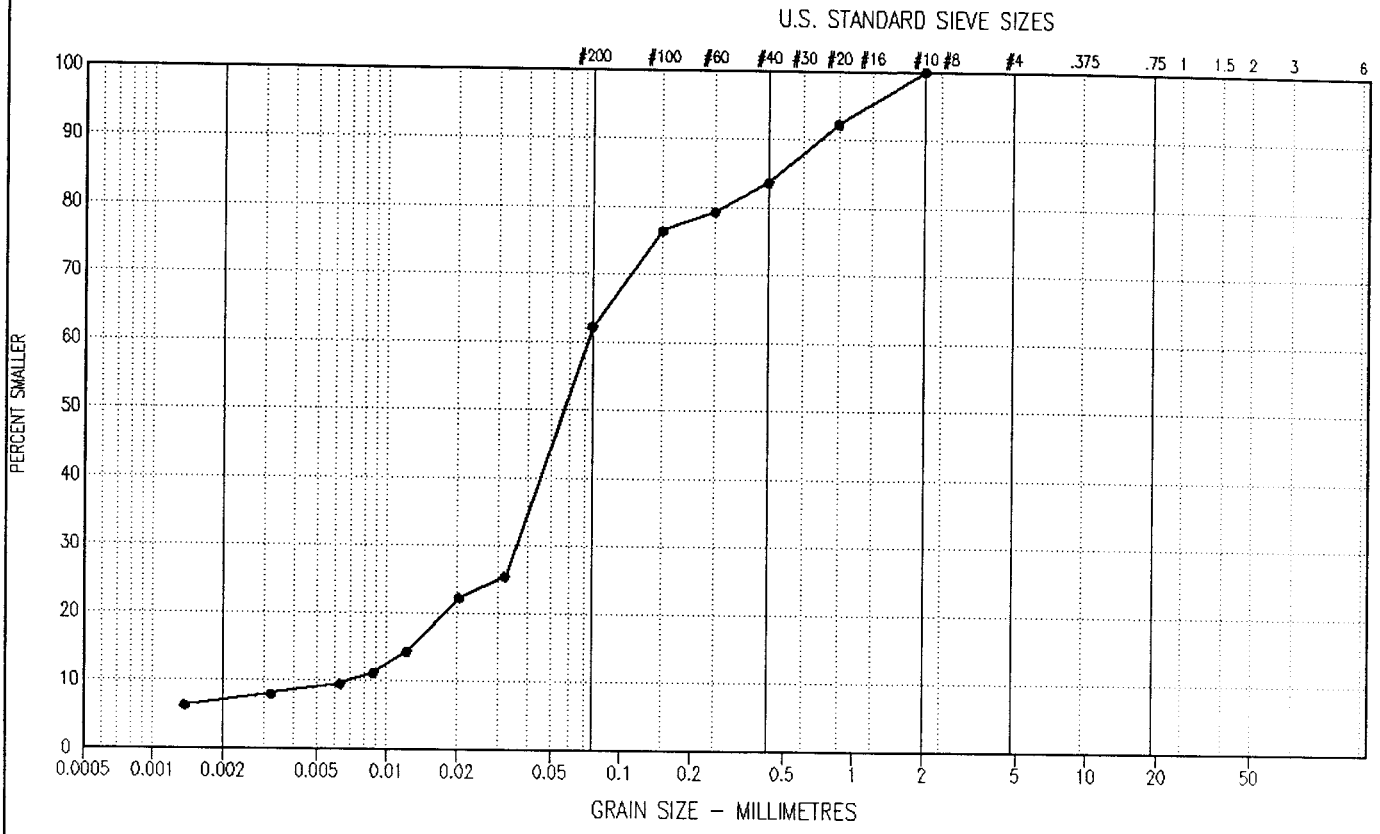
EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C
			CLAY %	SILT %	SAND %	GRAVEL %			
●——●	13563-BH7	1.00 – 1.20	6.8	55	38	0	10.3	2.7	

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH8
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 C/W Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH8	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.9 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION(m)
0.0	■	22				SAND & SILT (TAILINGS) – fine grained sand sizes, damp, beige and yellow/orange (oxidation)	
1.0							89.0
	■	23E				– becomes grey	
2.0							
	■	24E					
3.0						ORGANICS – drilling becomes difficult	87.0
						END OF BOREHOLE @ 3.0 m	
4.0							
5.0							85.0
6.0							
7.0							83.0
8.0							

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

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LOGGED BY: MEB	COMPLETION DEPTH: 3 m
REVIEWED BY: JRT	COMPLETE: 98/08/29
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SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH9
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH9	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.6 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						SAND - silty, fine sand sizes, beige, with orange oxidation throughout
1.0						
2.0						SILT - wet, soft, dark grey
3.0						ORGANICS END OF BOREHOLE @ 3.0 m
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 89.0, 87.0, 85.0, 83.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: MEB	COMPLETION DEPTH: 3 m
REVIEWED BY: JRT	COMPLETE: 98/08/29
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SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH10
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH10	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.25 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						SAND (tailings) – silty, beige, moist
1.0						SILT (tailings) – sandy, grey, wet
						ORGANICS – partially decayed
2.0						END OF BOREHOLE @ 1.5 m
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 89.0, 87.0, 85.0, 83.0, 81.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: MEB	COMPLETION DEPTH: 1.5 m
REVIEWED BY: JRT	COMPLETE: 98/08/29
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SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH11
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH11	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.05 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0	■	24G				SAND & GRAVEL - trace of silt, poorly graded, dense, difficult drilling, damp, brown
1.0	■	25				- more gravel insitu than retained on solid shaft - drilling becomes difficult
2.0						AUGER REFUSAL @ 1.7 m
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0, 82.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: MEB	COMPLETION DEPTH: 1.7 m
REVIEWED BY: JRT	COMPLETE: 98/08/29
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98/12/05 12:09PM (YUKON-B)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH12
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH12	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.05 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ☰ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						SAND & GRAVEL - trace of silt, poorly graded, dense, damp, brown
1.0						
2.0						
						- very difficult drilling throughout
						AUGER REFUSAL @ 2.7 m
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0, 82.0

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LOGGED BY: MEB	COMPLETION DEPTH: 2.7 m
REVIEWED BY: JRT	COMPLETE: 98/08/29
Fig. No:	Page 1 of 1

98/10/02 11:34AM (YUKON-8)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH13
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger then	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH13	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.05 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ☰ 75 mm SPOON ▯ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION(m)
0.0						SAND & GRAVEL – trace of silt, poorly graded, dense, damp, brown	90.0
1.0						– auger action indicated cobbles throughout	
2.0						– difficult drilling	88.0
3.0							
4.0						– drilling becomes easier	86.0
5.0						END OF BOREHOLE @ 4.5 m NOTE: Hole advanced 0 – 4.5 m with solid shaft initially, then with hollow shaft – auger refusal with hollow shaft at 2.7 m – based on auger action, base of berm estimated at depth of 4.2 m	
6.0							84.0
7.0							
8.0							82.0

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

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LOGGED BY: MEB	COMPLETION DEPTH: 4.2 m
REVIEWED BY: JRT	COMPLETE: 98/08/29
Fig. No:	Page 1 of 1

98/10/02 11:28AM (YUKON-8)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH14
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH14	UTM ZONE: 8 N6666200 E515600	ELEVATION: 87 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						SAND (TAILINGS) – fine grained GRAVEL & SAND – poorly graded, dense, damp
1.0						AUGER REFUSAL ON BOULDER @ 0.6 m Note: Entensive exposed cobbles and boulders in area, monitoring well installation unlikely (no further attempts)
2.0						
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 87.0, 85.0, 83.0, 81.0, 79.0

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LOGGED BY: MEB	COMPLETION DEPTH: 0.6 m
REVIEWED BY: JRT	COMPLETE: 98/08/31
Fig. No:	Page 1 of 1

98/10/02 11:28AM (YUKON-8)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH15
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH15	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.9 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						SAND (TAILINGS) - fine grained sand sizes, poorly graded, moist, beige, oxidation
1.0						
2.0						- becomes dark grey and wet @ approximately 2.1 m
3.0						
4.0						SILT (TILL) - sand and gravel, non-plastic, poorly graded, very dense, high gravel content (difficult drilling), moist, brown, trace of oxidation around gravel
		32	50			
5.0						AUGER REFUSAL @ 4.8 m
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0

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LOGGED BY: MEB	COMPLETION DEPTH: 4.8 m
REVIEWED BY: JRT	COMPLETE: 98/08/31
Fig. No:	Page 1 of 1

98/10/02 11:54AM (YUKON-8)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-BH16
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-BH16	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.3 m

SAMPLE TYPE ■ GRAB SAMPLE ⊘ NO RECOVERY ⊠ STANDARD PEN. ▤ 75 mm SPOON ▥ CRREL BARREL

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						SAND (TAILINGS) – poorly graded, medium dense, moist, beige, orange yellow
1.0	■	36				– becomes dark grey
2.0						SILT (TILL) – sand & gravel, auger action indicates cobbles, very dense, moist, brown
3.0	■	37				AUGER REFUSAL @ 3.0 m NOTE: Damaged auger flights
4.0						
5.0						
6.0						
7.0						
8.0						

■ STANDARD PENETRATION ■ 24 48 72 96

PLASTIC M.C. LIQUID 8 16 24 32

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 89.0, 87.0, 85.0, 83.0, 81.0

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LOGGED BY: MEB	COMPLETION DEPTH: 3 m
REVIEWED BY: JRT	COMPLETE: 98/08/31
Fig. No:	Page 1 of 1

98/10/02 11:28AM (YUKON-8)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-MW1S
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Hollow Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-MW1S	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.639 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | NW CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SAND (TAILINGS) - silty, poorly graded, moist, beige and orange (oxidation)
1.0					SILT (TAILINGS) - some sand, low plasticity, soft, wet, dark grey
					ORGANICS
					END OF BOREHOLE @ 1.5 m
					NOTE: No free water in monitor at completion - PVC standpipe approximately 0.8 m above ground surface
2.0					
3.0					
4.0					
5.0					
6.0					
7.0					
8.0					
9.0					
10.0					

■ STANDARD PENETRATION ■ 10 20 30 40

◆ VAPOUR EMMISSIONS ◆ 120 240 360 480

PLASTIC M.C. LIQUID 10 20 30 40

▲ PERCENT CLAY ▲ 20 40 60 80

◆ PERCENT SILT OR FINES ◆ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

■ PERCENT GRAVEL ■ 20 40 60 80

ELEVATION(m): 89.0, 87.0, 85.0, 83.0, 81.0

EBA Engineering Consultants Ltd.
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LOGGED BY: MEB	COMPLETION DEPTH: 1.5 m
REVIEWED BY: JRT	COMPLETE: 98/08/30
Fig. No:	Page 1 of 1

98/12/05 12:08PM (WELL10)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-MW1D
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Hollow Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-MW1D	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.591 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | NW CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SAND (TAILINGS) - silty
1.0					
2.0					SILT (TILL) - sandy, some gravel, moist, dense, brown
3.0					
4.0	⊠	23S			BEDROCK OR BOULDER - split spoon sample 23 had wet soft silt till underlain by rock (granite) dry
5.0					REFUSAL @ 4.1 m NOTE: PVC standpipe approx. 0.6 m above ground surface
6.0					
7.0					
8.0					
9.0					
10.0					

■ STANDARD PENETRATION ■ 10 20 30 40

◆ VAPOUR EMMISSIONS ◆ 120 240 360 480

PLASTIC M.C. LIQUID 10 20 30 40

▲ PERCENT CLAY ▲ 20 40 60 80

◆ PERCENT SILT OR FINES ◆ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

■ PERCENT GRAVEL ■ 20 40 60 80

ELEVATION(m): 89.0, 87.0, 85.0, 83.0, 81.0

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LOGGED BY: MEB	COMPLETION DEPTH: 4.1 m
REVIEWED BY: JRT	COMPLETE: 98/08/30
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98/12/05 05:44PM (WELL10)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-MW2
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Hollow Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-MW2	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.015 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | NW CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SAND (TAILINGS) – silty, fine grained sand sizes, poorly graded, moist, beige, oxidation
3.0					SAND (TILL) – gravelly, non-plastic, dense (difficult drilling), moist, traces of oxidation
4.0					
4.5	▼				
	☒	26	40		– becomes wet @ 4.5 m
6.0					
	☒	27	60		– split spoon sample had pieces of fractured granite intermixed in till very dense
7.0					
	☒	28			– split spoon advanced 10 cm in 50+ blows, rock chips in sample
7.1					AUGER REFUSAL @ 7.1 m
10.0					

■ STANDARD PENETRATION ■ 10 20 30 40

◆ VAPOUR EMMISSIONS ◆ 120 240 360 480

PLASTIC M.C. LIQUID 10 20 30 40

▲ PERCENT CLAY ▲ 20 40 60 80

◆ PERCENT SILT OR FINES ◆ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

■ PERCENT GRAVEL ■ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0, 82.0, 80.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 7.1 m
	REVIEWED BY: JRT	COMPLETE: 98/08/30
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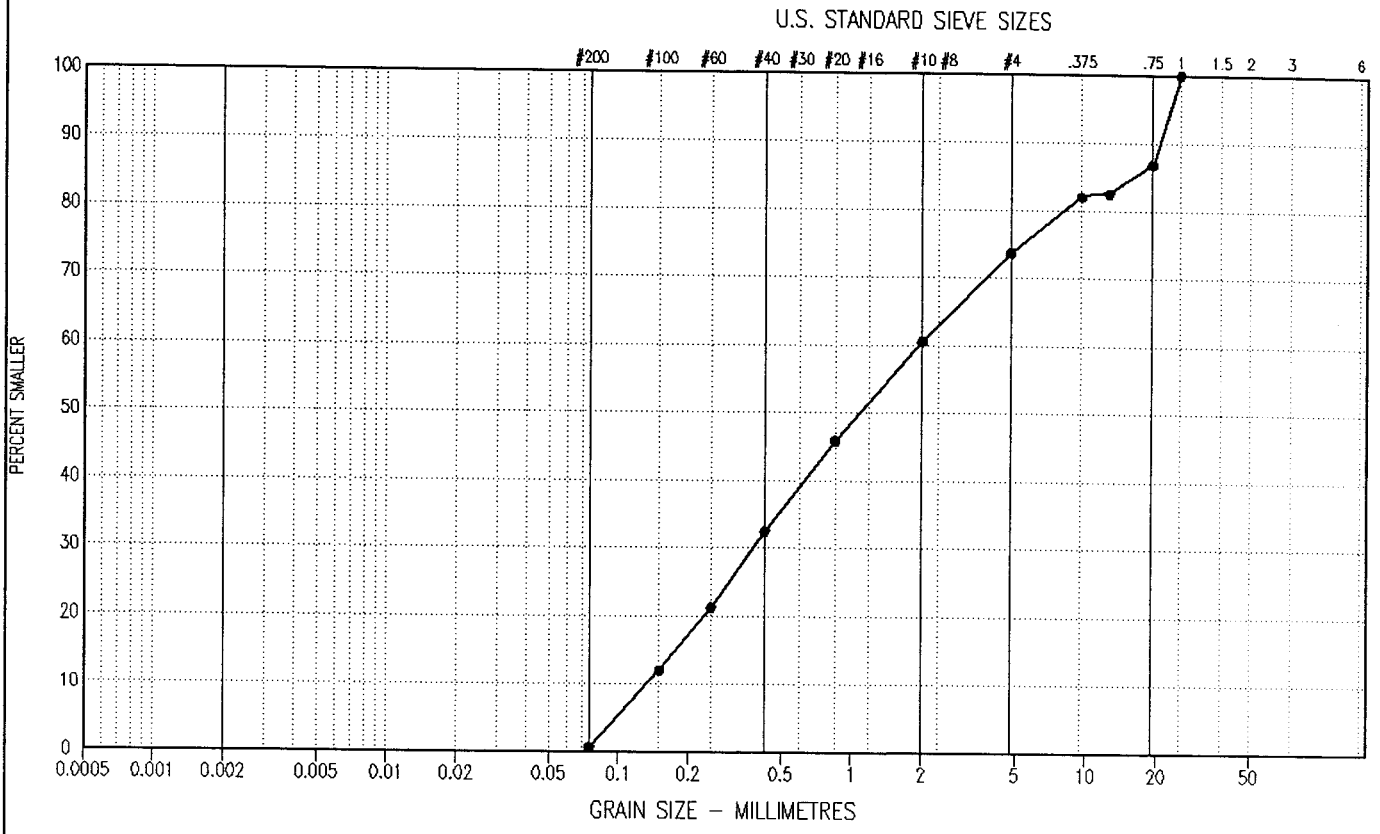
98/12/05 12:08PM (WELL10)

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●——●	13563-MW2	6.00 – 6.30	1	73	26	14.3	0.6	SP

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-MW3
ARCTIC GOLD & SILVER - CARCROSS, YT	DRILL: CME 750 c/w Hollow Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-MW3	UTM ZONE: 8 N6666200 E515600	ELEVATION: 91.629 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT-SP. | CRREL BARREL | NW CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

■ STANDARD PENETRATION ■ 10 20 30 40

◆ VAPOUR EMMISSIONS ◆ 120 240 360 480

PLASTIC M.C. LIQUID 10 20 30 40

▲ PERCENT CLAY ▲ 20 40 60 80

◆ PERCENT SILT OR FINES ◆ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

■ PERCENT GRAVEL ■ 20 40 60 80

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION(m)
0.0					SAND (TILL) - some silt, gravelly, poorly graded, dense, damp, brown	91.0
1.0						
		29				
2.0					SILT - some sand, some gravel, drilling action indicates cobble @ 2.7 m, firm, non-plastic, moist, brown, oxidation around gravel sizes	
						89.0
3.0		30			- very difficult drilling starts @ 2.7 m	
					AUGER REFUSAL @ 3.4 m NOTE: MW3 dry at completion (98-08-30 @ 7 pm), however, static water level of 3.10 m below top of PVC on 98-9-1 @ 12 pm	
4.0						
5.0						87.0
6.0						
7.0						85.0
8.0						
9.0						83.0
10.0						

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LOGGED BY: MEB	COMPLETION DEPTH: 3.4 m
REVIEWED BY: JRT	COMPLETE: 98/08/30
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98/12/05 12:08PM (WELL10)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-MW4
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Hollow Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-MW4	UTM ZONE: 8 N6666200 E515600	ELEVATION: 90.351 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | NW CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SAND (TAILINGS) – silty, fine grained, poorly graded, medium dense, moist, beige with orange/yellow oxidation intrusions
1.0					
2.0					SILT (TAILINGS) – some sand, low plasticity, wet, dark grey
					SAND (TAILINGS) – trace of silt, poorly graded, medium dense, moist, grey with yellow oxidation zones
3.0		33			
					ORGANICS – black, wet, fibrous
		34			SILT & SAND (TILL) – very dense, poorly graded, wet, brown with some green tinge around silt, difficult drilling
4.0					
5.0					
6.0		35			
7.0					– very difficult drilling
8.0					AUGER REFUSAL @ 7.7 m – advanced to 7.7 m with solid stem, then switched to hollow stem and had refusal at 6.4 m
9.0					
10.0					

■ STANDARD PENETRATION ■ 10 20 30 40

◆ VAPOUR EMMISSIONS ◆ 120 240 360 480

PLASTIC M.C. LIQUID 10 20 30 40

▲ PERCENT CLAY ▲ 20 40 60 80

◆ PERCENT SILT OR FINES ◆ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

■ PERCENT GRAVEL ■ 20 40 60 80

ELEVATION(m): 90.0, 88.0, 86.0, 84.0, 82.0, 80.0

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LOGGED BY: MEB	COMPLETION DEPTH: 7.7 m
REVIEWED BY: JRT	COMPLETE: 98/08/31
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98/12/05 12:08PM (WELL10)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-MW5
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Hollow Stem Augers	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-MW5	UTM ZONE: 8 N6666200 E515600	ELEVATION: 89.576 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | NW CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

■ STANDARD PENETRATION ■ 10 20 30 40

◆ VAPOUR EMMISSIONS ◆ 120 240 360 480

PLASTIC M.C. LIQUID 10 20 30 40

▲ PERCENT CLAY ▲ 20 40 60 80

◆ PERCENT SILT OR FINES ◆ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

■ PERCENT GRAVEL ■ 20 40 60 80

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SAND (TAILINGS) – silty, damp, beige, oxidation throughout
1.0					– becomes dark grey, wet (saturated)
2.0					SILT, SAND & GRAVEL (TILL) – very dense, difficult drilling, wet, brown
3.0 ▼					
4.0					AUGER REFUSAL @ 4.2 m with solid stem NOTE: Auger Refusal @ 3.75 m with hollow stem
5.0					
6.0					
7.0					
8.0					
9.0					
10.0					

ELEVATION(m): 89.0, 87.0 ▼, 85.0, 83.0, 81.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 3.75 m
	REVIEWED BY: JRT	COMPLETE: 98/08/31
	Fig. No:	Page 1 of 1

98/12/05 12:08PM (WELL10)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-MW6
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-MW6	UTM ZONE: 8 N6666200 E515600	ELEVATION: 91.912 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | NW CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SILT (TILL) – some sand, gravelly, drilling action indicates cobble present, non-plastic, firm, moist, brown with slight green tinge
1.6		39			
3.0					– drilling becomes easier, till becomes wet
4.0					– drilling becomes difficult again
6.0		40			
6.6					AUGER REFUSAL ON BEDROCK OR BOULDER @ 6.6 m
					NOTE: Monitor consists of 50 mm diameter PVC pipe with filter cloth around 1.5 m section pushed into open hole to a depth of 3.8 m below ground surface (no sand pack or bentonite seal and no protective steel casing)

■ STANDARD PENETRATION ■ 10 20 30 40

◆ VAPOUR EMMISSIONS ◆ 120 240 360 480

PLASTIC M.C. LIQUID 10 20 30 40

▲ PERCENT CLAY ▲ 20 40 60 80

◆ PERCENT SILT OR FINES ◆ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

■ PERCENT GRAVEL ■ 20 40 60 80

ELEVATION(m): 91.0, 89.0, 87.0, 85.0, 83.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 6.6 m
	REVIEWED BY: JRT	COMPLETE: 98/08/31
	Fig. No:	Page 1 of 1

98/12/05 12:07PM (WELL10)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-PH1
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-PH1	UTM ZONE: 8 N6666200 E515600	ELEVATION: 92.8 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SPT PENTRATION 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	PERCENT GRAVEL 20 40 60 80 / PERCENT SAND 20 40 60 80 / PERCENT SILT OR FINES 20 40 60 80 / PERCENT CLAY 20 40 60 80	INSTRUMENTATION DATA	ELEVATION(m)
0.0						SILT & SAND (TILL) – gravelly, exposed cobbles and boulders at surface, moist				92.0
1.0						– difficult drilling starts, wet				
2.0						– very difficult drilling starts				
3.0						AUGER REFUSAL @ 2.1 m on boulder bedrock NOTE: Probe hole drilled to find depth to refusal within area of potential borrow material				90.0
4.0										
5.0										88.0
6.0										
7.0										86.0
8.0										
9.0										84.0
10.0										

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LOGGED BY: MEB	COMPLETION DEPTH: 2.1 m
REVIEWED BY: JRT	COMPLETE: 98/09/01
Fig. No:	Page 1 of 1

98/12/05 12:20PM (YUKON-10)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	BOREHOLE NO: 13563-PH2
ARCTIC GOLD & SILVER – CARCROSS, YT	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13563
SRK BH# AGS-98-PH2	UTM ZONE: 8 N6666200 E515600	ELEVATION:

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SPT PENTRATION 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	PERCENT GRAVEL 20 40 60 80 / PERCENT SAND 20 40 60 80 / PERCENT SILT OR FINES 20 40 60 80 / PERCENT CLAY 20 40 60 80	INSTRUMENTATION DATA	ELEVATION(m)
0.0						SAND (TILL) – silty, gravelly, dense, poorly graded, damp, brown				0.0
1.0						– difficult drilling starts				
		43								
2.0										-2.0
3.0						– drilling not as difficult				
4.0										-4.0
5.0						– grinding action again – saturated conditions @ approx. 5.0 m				
		44								
6.0										-6.0
7.0										
8.0										-8.0
9.0						END OF BOREHOLE @ 9.0 m NOTE: Probe hole drilled to find depth to refusal (no refusal within 9.0 m) and depth of unsaturated material for use as borrow (approx. 5.0 m)				
10.0										-10.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: MEB	COMPLETION DEPTH: 9 m
REVIEWED BY: JRT	COMPLETE: 98/09/01
Fig. No:	Page 1 of 1

98/10/02 11:17AM (YUKON-10)

APPENDIX C:

TEST PIT PROGRAM RESULTS

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	TEST PIT NO: 13563-TP1
ARCTIC GOLD & SILVER	DRILL: 225 CAT HOE	PROJECT NO: 0201-98-13563
CARCROSS, YT	UTM ZONE: 8 N6666200 E515600	ELEVATION:

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

SOIL DESCRIPTION

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SILT & SAND & GRAVEL – PUSHED DEBRIS
					ORGANICS LAYER
					SAND & GRAVEL (till) – loose, damp, orangey–brown, cobbles – (8" – 12" diameter)
1.0	■	1	GM		
					SAND & GRAVEL(till) – some silt, med–dense, damp, brownish grey, cobbles 6" to 10" in diameter
2.0	■	2	SP–SM		
					– moist
3.0	■	3			
					– more silt
4.0	■	4			
					– dense, hard digging free water
5.0					END OF TESTPIT @ 4.8 m
6.0					
7.0					
8.0					

■ STANDARD PENETRATION ■ 10 20 30 40

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

DEPTH(ft) 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0

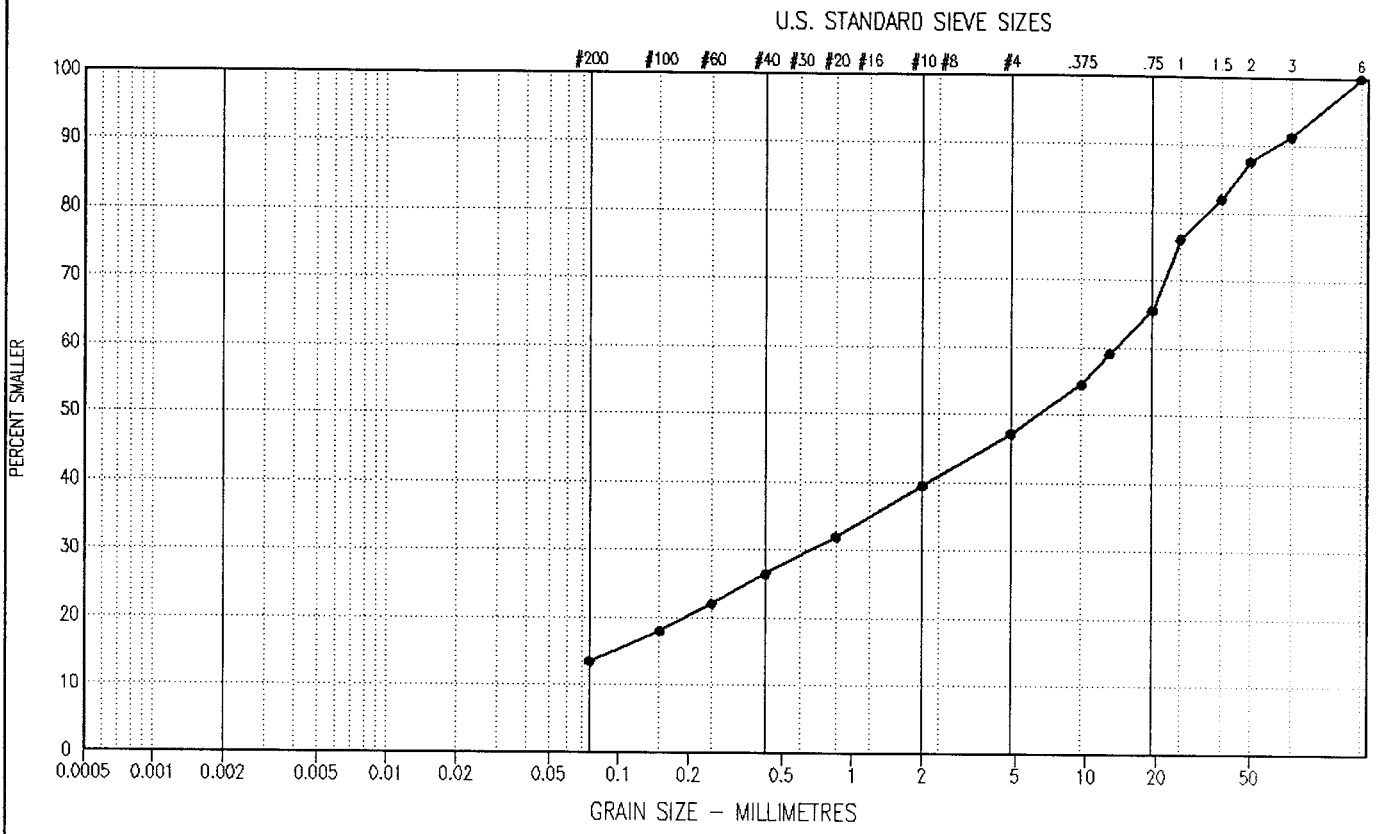
EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: CPC	COMPLETION DEPTH: 4.8 m
	REVIEWED BY: MEB	COMPLETE: 98/10/08
	Fig. No:	Page 1 of 1

98/12/06 01:22PM (YUKON-TB)

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●——●	13563-TP1	0.80 – 1.00	13	34	53	–	2.0	GM

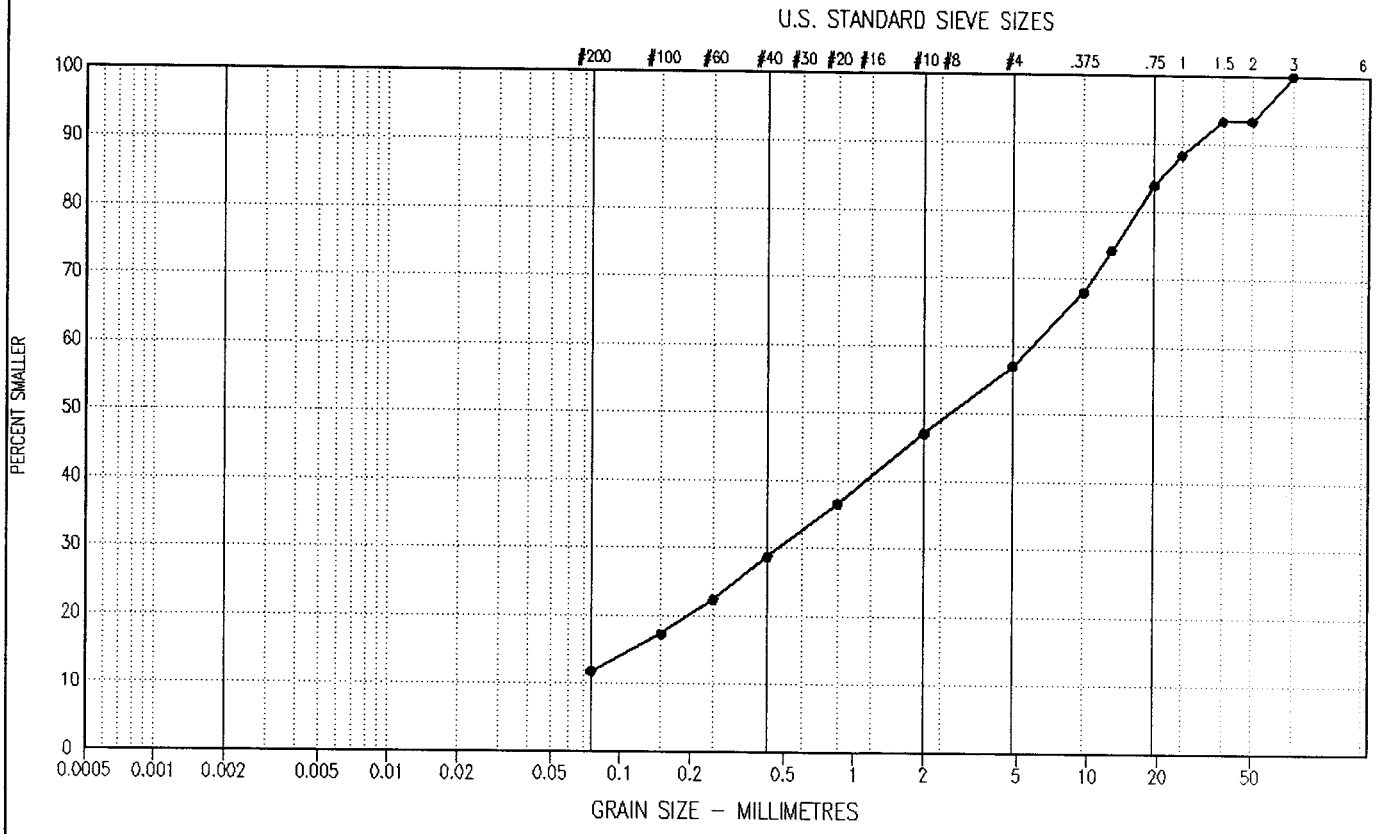
Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●——●	13563-TP1	1.80 – 2.00	12	45	43	120.3	0.8	SP-SM

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	TEST PIT NO: 13563-TP2
ARCTIC GOLD & SILVER	DRILL: 225 CAT HOE	PROJECT NO: 0201-98-13563
CARCROSS, YT	UTM ZONE: 8 N6666200 E515600	ELEVATION:

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SILT & SAND & GRAVEL – PUSHED DEBRIS
					ORGANICS
					SAND & GRAVEL – trace to some silt, loose, damp, brown, cobble 6" – 12"
1.0	■	5			
					– less silt, med. dense, greyish brown
2.0	■	6	GW-GM		
					– saturated, free water
3.0	■	7			END OF TESTPIT @ 3.0 m
4.0					
5.0					
6.0					
7.0					
8.0					

■ STANDARD PENETRATION ■ 10 20 30 40

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

DEPTH(ft) 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0

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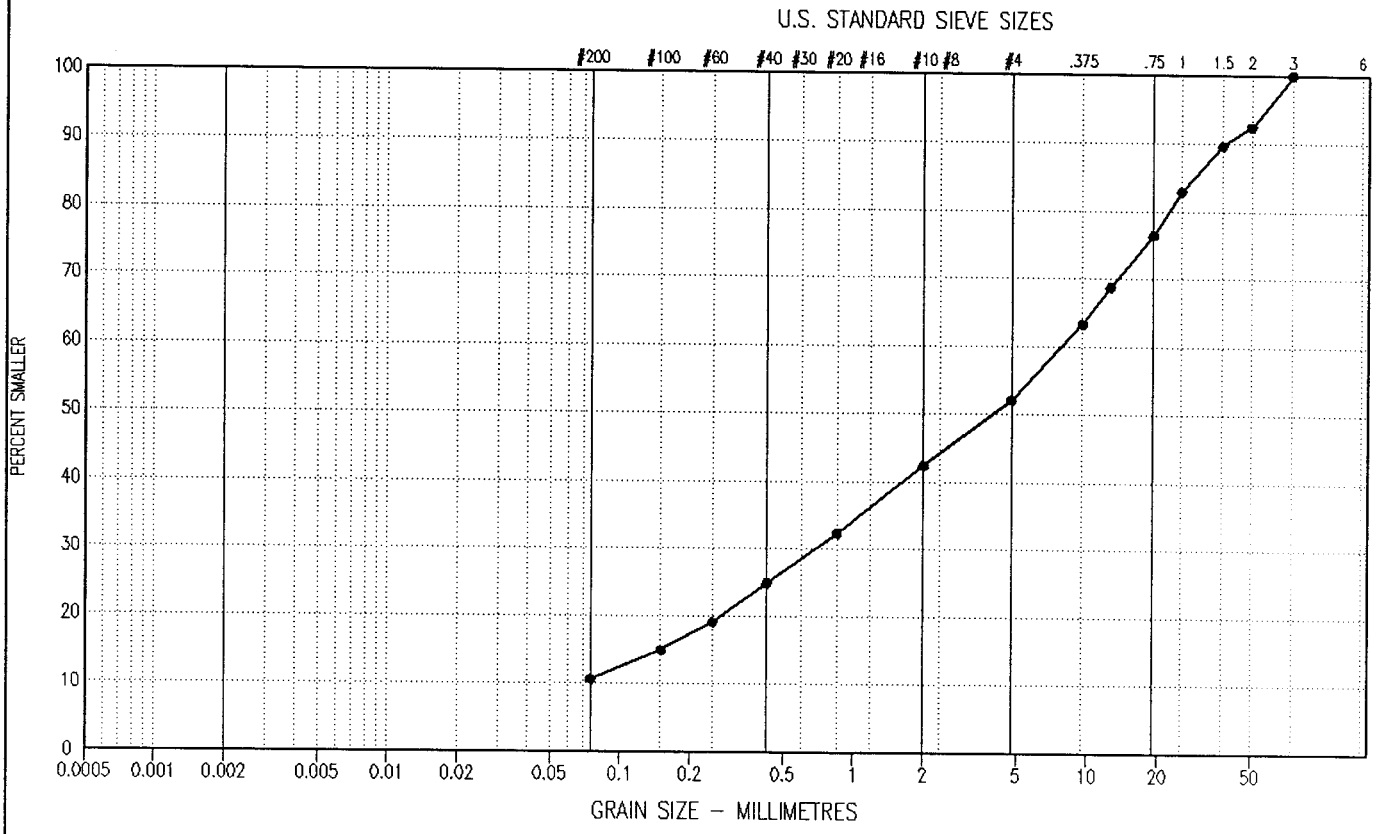
LOGGED BY: CPC	COMPLETION DEPTH: 3 m
REVIEWED BY: MEB	COMPLETE: 98/10/08
Fig. No:	Page 1 of 1

98/10/27 10:52AM (YUKON-T8)

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●——	13563-TP2	1.80 – 2.00	11	41	48	126.9	1.0	GW-GM

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	TEST PIT NO: 13563-TP3
ARCTIC GOLD & SILVER	DRILL: 225 CAT HOE	PROJECT NO: 0201-98-13563
CARCROSS, YT	UTM ZONE: 8 N6666200 E515600	ELEVATION:

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					ORGANICS, VISIBLE BOULDERS (0.4 m dia)
	■	8			SILT – gravelly, some sand, loose oxidation staining, damp, brown, cobble 6" to 12"
1.0	■	9			SAND & GRAVEL – some silt, med. dense, damp, brownish grey
2.0	■	10			
					– more silt, moist – large boulders (2" dia) – moist to wet
3.0	■	11			
					– some silt to silty – water seepage
4.0	■	12			
	■	13			
5.0					END OF TESTPIT @ 4.8 m
6.0					
7.0					
8.0					

■ STANDARD PENETRATION ■ 10 20 30 40

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

DEPTH(ft) 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0

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Whitehorse, Yukon

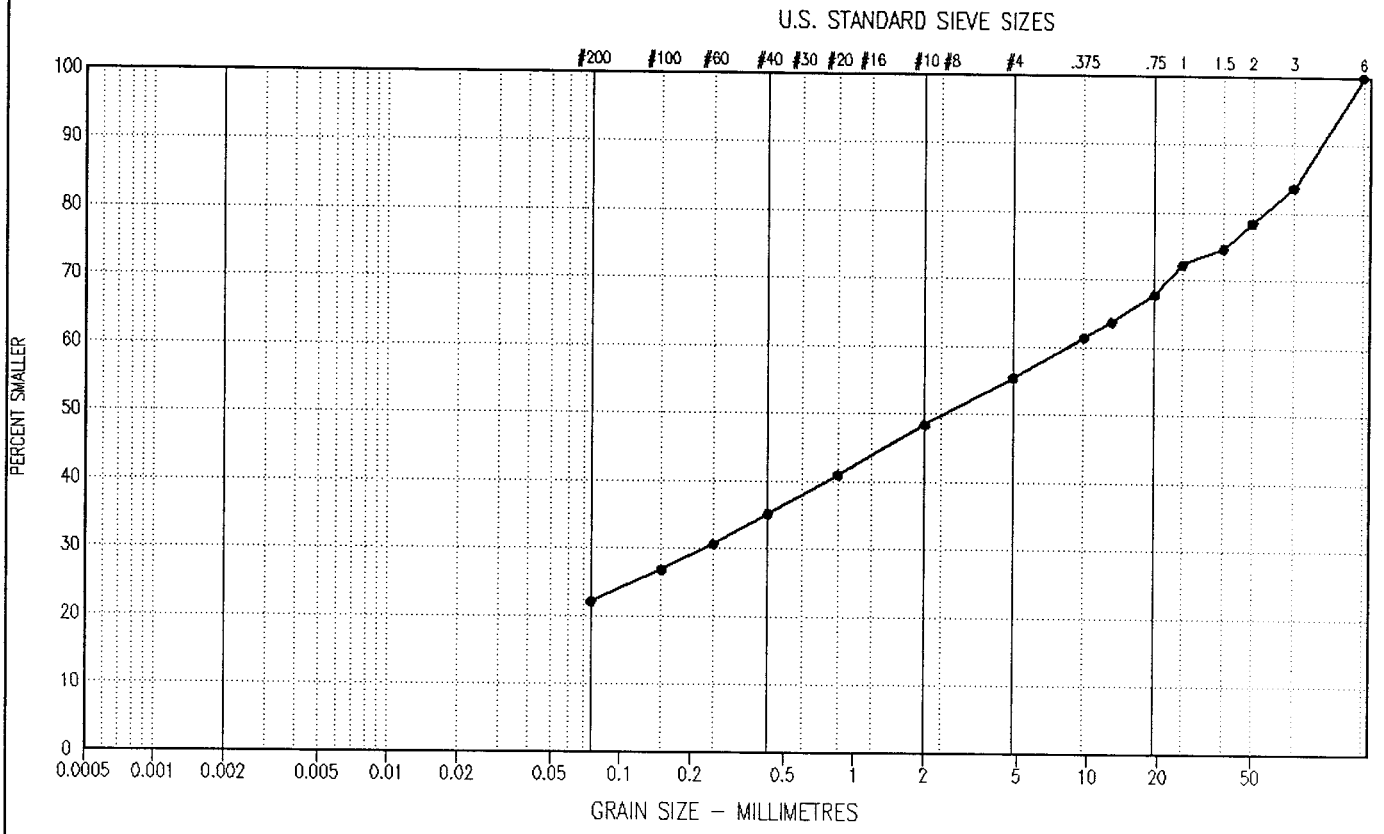
LOGGED BY: CPC	COMPLETION DEPTH: 4.8 m
REVIEWED BY: MEB	COMPLETE: 98/10/08
Fig. No:	Page 1 of 1

98/10/27 11:23AM (YUKON-T8)

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●	13563-TP3	2.80 – 3.00	22	33	45	–	–	

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	TEST PIT NO: 13563-TP4
ARCTIC GOLD & SILVER	DRILL: 225 CAT HOE	PROJECT NO: 0201-98-13563
CARCROSS, YT	UTM ZONE: 8 N6666200 E515600	ELEVATION:

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION	STANDARD PENETRATION 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	PERCENT GRAVEL 20 40 60 80 / PERCENT SAND 20 40 60 80 / PERCENT SILT OR FINES 20 40 60 80 / PERCENT CLAY 20 40 60 80	DEPTH(ft)
0.0					SAND – gravelly, trace of silt, loose, damp to moist, brownish cobbles (6" to 12")			0.0
					– odd boulder (2' dia)			
1.0	■	14						2.0
								4.0
					– moist to wet			
2.0 ▼	■	15						6.0
					– water seepage			▼
								8.0
					– more silt, wet			
3.0	■	16						10.0
								12.0
	■	17						
4.0					END OF TESTPIT @ 4.0 m Note: 3m North of existing cut face which is 2.0 m light			14.0
								16.0
5.0								18.0
								20.0
6.0								22.0
								24.0
7.0								26.0
8.0								

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: CPC	COMPLETION DEPTH: 4 m
REVIEWED BY: MEB	COMPLETE: 98/10/08
Fig. No:	Page 1 of 1

98/10/27 11:24AM (YUKON-T8)

SITE INVESTIGATION	CLIENT: STEFFEN, ROBERTSON & KIRSTEN INC	TEST PIT NO: 13563-TP5
ARCTIC GOLD & SILVER	DRILL: 225 CAT HOE	PROJECT NO: 0201-98-13563
CARCROSS, YT	UTM ZONE: 8 N6666200 E515600	ELEVATION:

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					FILL – debris, larger boulders near surface (2'dia)
1.0	■	18			SILT – gravelly, some sand, loose, damp, brown, cobble 6" to 12" dia
2.0	■	19			SAND – gravelly, trace of silt, med–dense, moist, brown
					– more silt, moist to wet
3.0 ▼	■	20			– water seepage – dense
4.0	■	21			
5.0					END OF TESTPIT @ 4.9 m
6.0					
7.0					
8.0					

■ STANDARD PENETRATION ■
10 20 30 40

PLASTIC M.C. LIQUID
10 20 30 40

■ PERCENT GRAVEL ■
20 40 60 80

● PERCENT SAND ●
20 40 60 80

▲ PERCENT SILT OR FINES ▲
20 40 60 80

◆ PERCENT CLAY ◆
20 40 60 80

DEPTH(ft)
0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: CPC	COMPLETION DEPTH: 4.9 m
REVIEWED BY: MEB	COMPLETE: 98/10/08
Fig. No:	Page 1 of 1

98/10/27 11:24AM (YUKON-T8)

APPENDIX D:

PERMEABILITY TEST RESULTS

APPENDIX B
Metallurgical Test Results

CESL Engineering
1636 West 75th Avenue, Vancouver, BC, Canada V6P 6G2 Tel.: (604) 264-5500/5610 Fax (604) 264-5555 E-mail: cesl@cesl.com

November 10, 1998

Stefffen Robertson and Kirsten (Canada) Inc.
Suite 800, 580 Hornby Street
Vancouver, B.C.
V6C 3B6

Attention: Mr. Jason Smolensky

Please find the enclosed results of cyanidation leach extraction. The 72 hour leach extration resulted in an extraction of 70% of contained gold. Further evaluation of the samples is recommended to determine the economics of processing the tailings. Reprocessing the tailings may extract enough gold to off set the neutralization cost of acidic tailings.

Please call if you need further info.

Sohan Basra

Sohan Basra

SRK - PWGSC

TEST: Cyanide Leach CN -1
SAMPLE: 1.5-2.0 m 3.0 kg
GRIND: N/A

I) METALLURGICAL BALANCE

PRODUCT	WEIGHT (g)	ASSAY Au (g/t)	ASSAY Ag (g/t)	DISTRIBUTION Au (%)	DISTRIBUTION Ag (%)
72 hr sol'n	887.1	1.15	69.8	68.5	67.7
Residue	410.9	1.14	71.8	31.5	32.3
CALC HEAD		3.62	222.5	100.0	100.0
ASSAY HEAD		3.51	239.0		

II) TEST CONDITIONS

SAMPLE (Time, Hrs)	pH	[NaCN] (g/L)	CUMULATIVE CONSUMPTION NaCN (kg/t)	CUMULATIVE CONSUMPTION Ca(OH)2 (kg/t)
Sol'n 0	11.3	5.00	0.00	0.0
3	11.0	N/A	N/A	48.7
23	10.7	N/A	N/A	48.7
72	10.2	1.00	7.58	48.7

Initial pH of Slurry: 2.1

Conditions maintained throughout leach:

Solids : 31.7 %
[NaCN] : N/A

SRK - PWGSC

TEST: Cyanide Leach CN -2
SAMPLE: BH COMP. (BH3+BH5+BH7+BH8)
GRIND: N/A

I) METALLURGICAL BALANCE

PRODUCT	WEIGHT (g)	ASSAY Au (g/t)	ASSAY Ag (g/t)	DISTRIBUTION Au (%)	DISTRIBUTION Ag (%)
72 hr sol'n	855.4	0.71	40.9	75.1	74.5
Residue	411.6	0.49	29.1	24.9	25.5
CALC HEAD		1.97	114.1	100.0	100.0
ASSAY HEAD		1.70	121.0		

II) TEST CONDITIONS

SAMPLE (Time, Hrs)	pH	[NaCN] (g/L)	CUMULATIVE CONSUMPTION NaCN (kg/t)	CUMULATIVE CONSUMPTION Ca(OH)2 (kg/t)
Sol'n 0	11.3	5.00	0.00	0.0
3	10.7	N/A	N/A	32.2
23	10.6	N/A	N/A	33.4
72	10.4	0.90	7.85	33.4

Initial pH of Slurry: 1.9

Conditions maintained throughout leach:

Solids : 32.5 %
[NaCN] : N/A

CESL

EBA Engineering Consultants Ltd.

CONSTANT HEAD PERMEABILITY TEST — **ARCTIC GOLD & SILVER TAILINGS**

Job Number: 0201-13563
Test Hole: TP2 Depth: 1.8-2.0 m

Date: 98-11-05
Test No: P-1

Time	Buret (cc)	Elap. (min)	Outflow (cc)
8:15	21.5	0	0.0
8:16	30.0	1	8.5
8:17	38.5	2	17.0
8:18	47.0	3	25.5
8:19	55.5	4	34.0
8:20	64.0	5	42.5
8:21	72.0	6	50.5
8:22	80.0	7	58.5
8:23	88.0	8	66.5
8:24	96.0	9	74.5

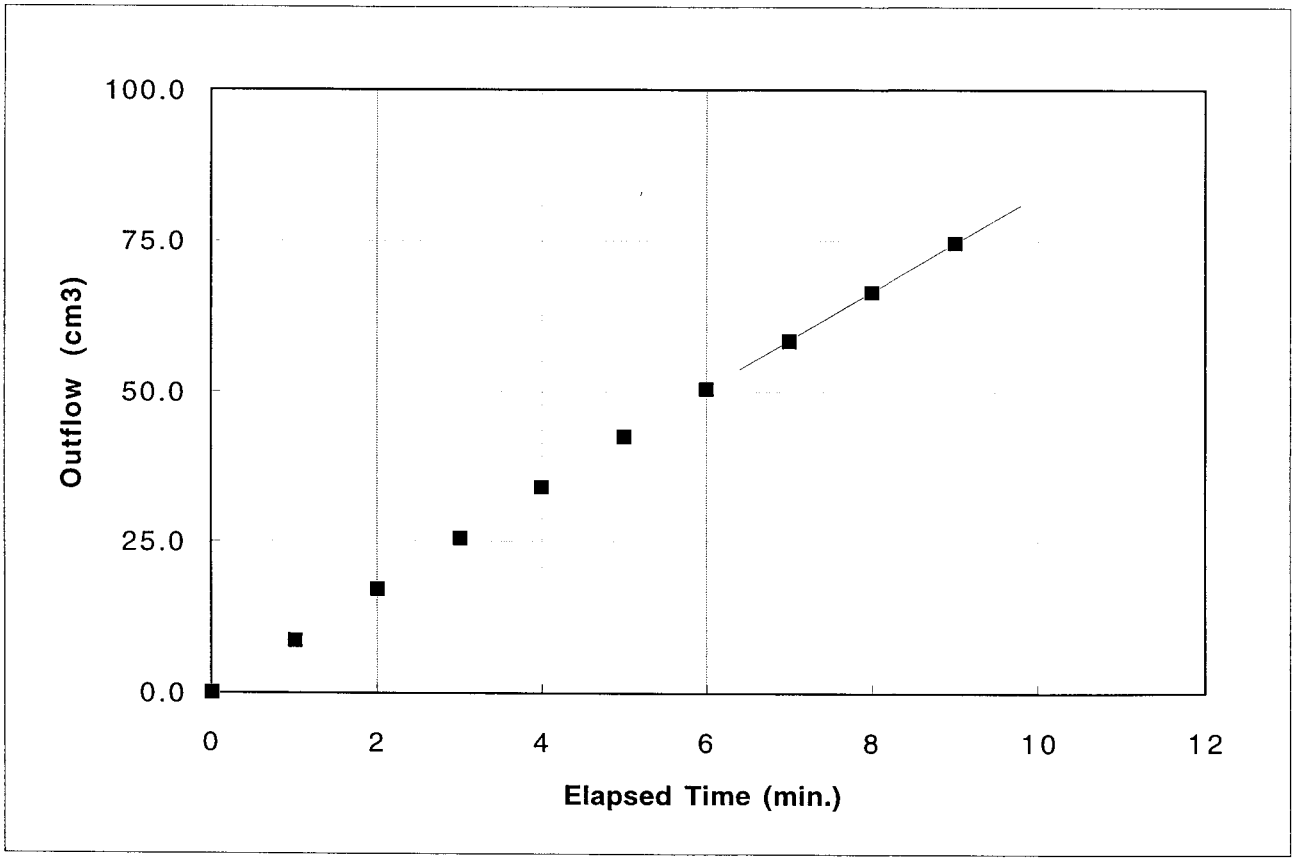
Diameter= 101.2 mm
Height= 116.7 mm

Volume= 938.69 cm3

Head Diff.= 0.063 psi

Q= 0.133 cm3/sec
i= 0.38
A= 80.44 cm2

K= 4.37E-03 cm/sec

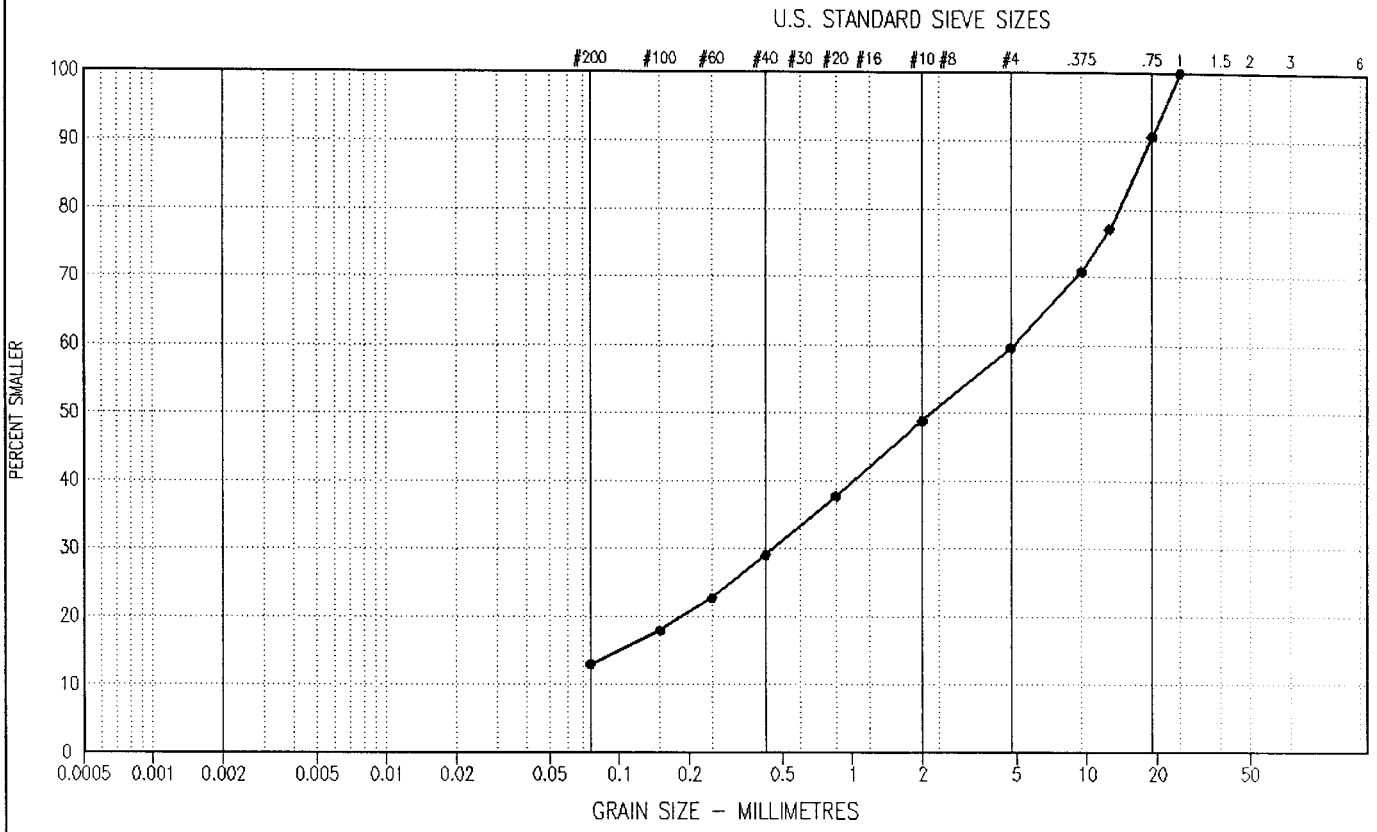


EBA Engineering

grain size for P-1

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (ft)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●—●	SCREEN(6)	0.00	13	47	41	161.4	1.5	SM

Project: 0201-98-13563 Date Tested: 98/10/22 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering Consultants Ltd.

MOISTURE - DENSITY RELATIONSHIP

ASTM D698, D1557, or D2049

PROJECT: Arctic Gold & Silver Tailings

PROJECT NO.: 0201-98-13563

CLIENT: Steffen, Robertson & Kersten (Can.) Inc.

DESCRIPTION: SAND & GRAVEL (screened past 25mm) - brown

SAMPLE LOCATION: TP2 1.8-2.0m

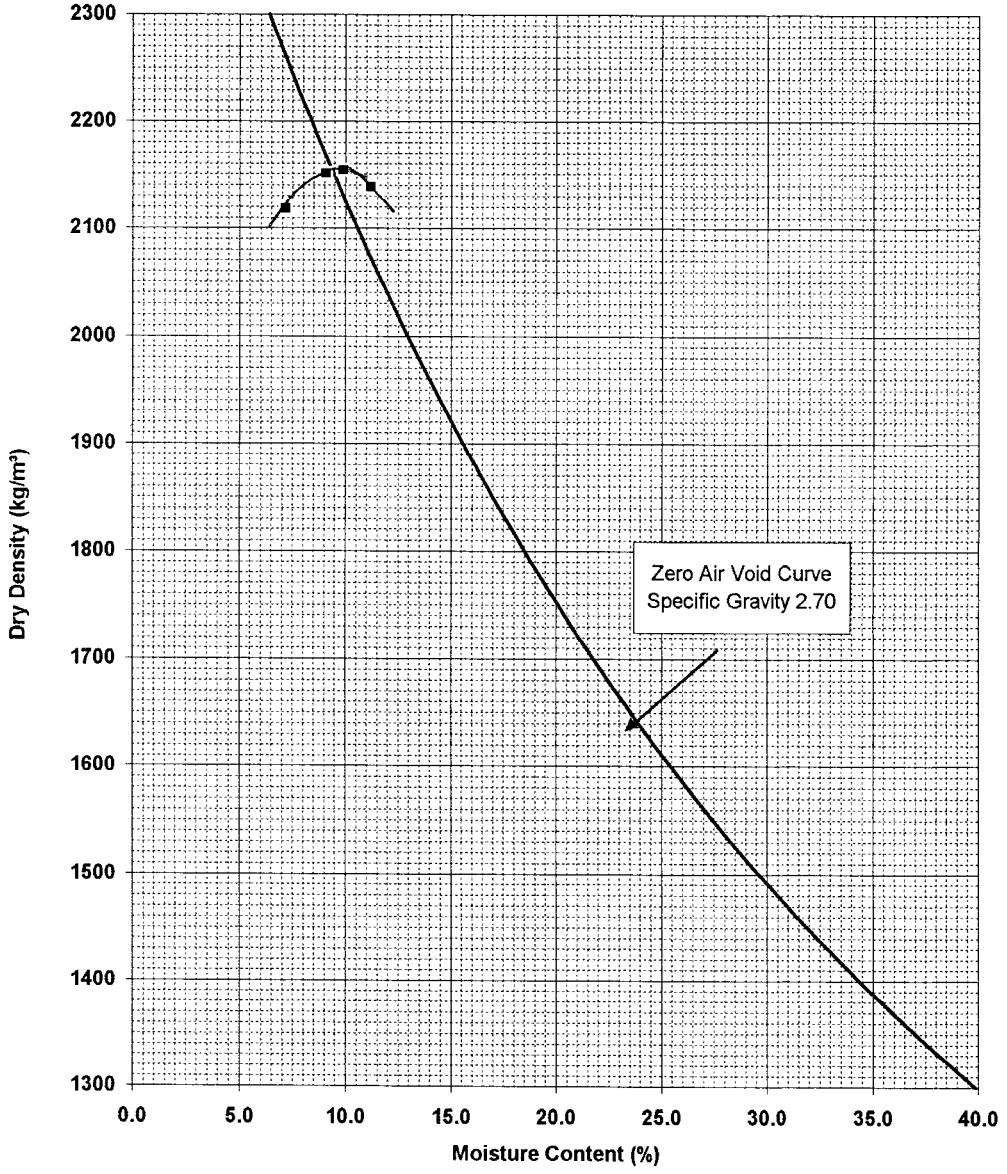
SAMPLE NUMBER: 5520.2

DATE TESTED: 98/11/03

MOISTURE CONTENT (as received): 7.2%

MAXIMUM DRY DENSITY: 2155

OPTIMUM MOISTURE CONTENT: 9.9%



STANDARD PROCTOR

ASTM D698

Hammer Mass: 2.494 kg

Hammer Drop: 304.8 mm

Number of Layers: 3

Number of Blows/Layer: 25

Diameter of Mould: 101.4 mm

Height of Mould: 116.3 mm

Mould Volume: 0.000938 m³

Compactive Effort: 593.5 kJ/m³

REVIEWED BY:

_____ P.Eng.

REMARKS: _____

eba

EBA Engineering Consultants Ltd.

CONSTANT HEAD PERMEABILITY TEST — **ARCTIC GOLD & SILVER TAILINGS**

Job Number: 0201-13563
Test Hole: TP3 Depth: 2.8-3.0 m

Date: 98-11-05
Test No: P-2

Time	Buret (cc)	Elap. (min)	Outflow (cc)
13:00	18.0	0	0.0
13:01	28.0	1	10.0
13:02	38.0	2	20.0
13:03	48.0	3	30.0
13:04	58.0	4	40.0
13:05	68.0	5	50.0
13:06	78.0	6	60.0
13:07	88.0	7	70.0
13:08	98.0	8	80.0

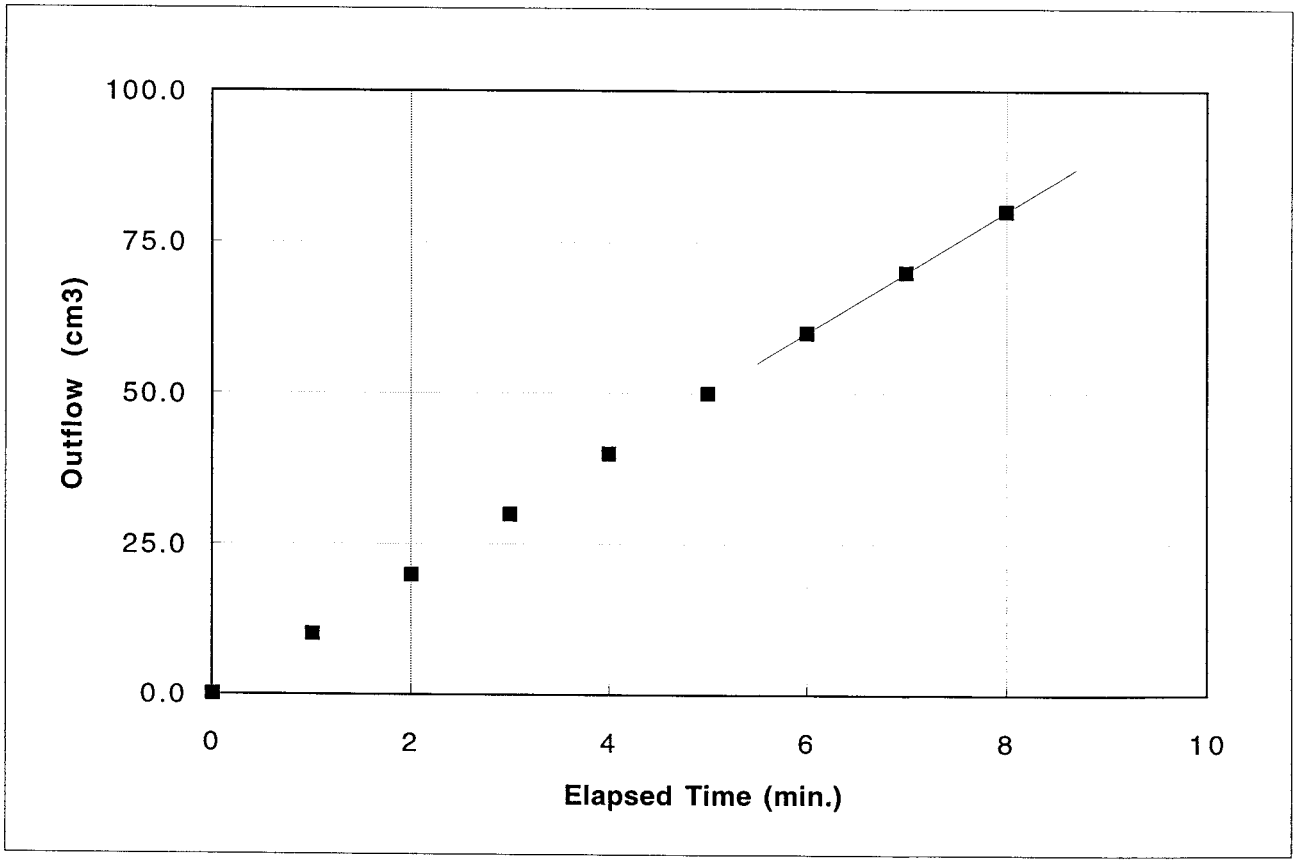
Diameter= 101.2 mm
Height= 116.7 mm

Volume= 938.69 cm3

Head Diff.= 0.063 psi

Q= 0.167 cm3/sec
i= 0.38
A= 80.44 cm2

K= 5.44E-03 cm/sec

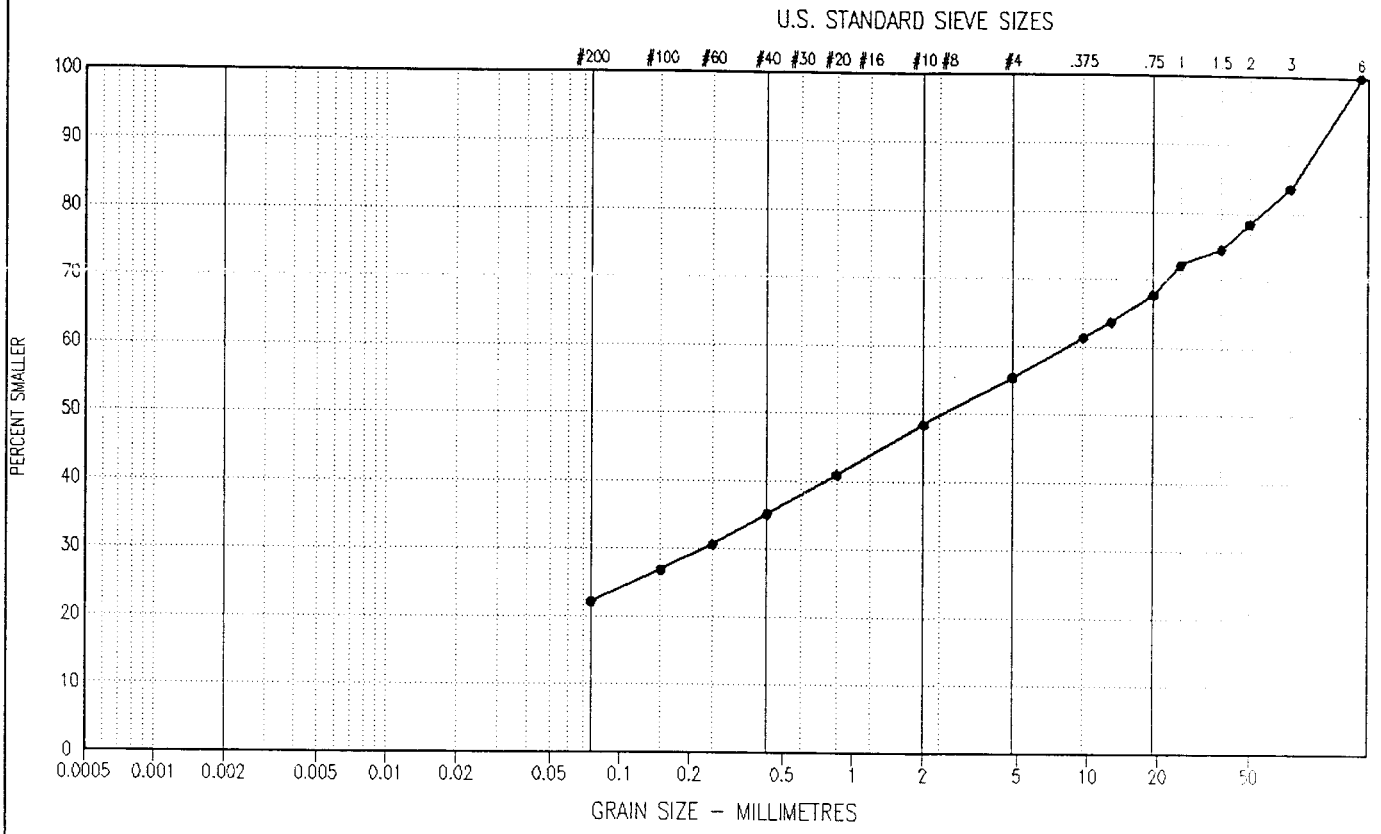


EBA Engineering

grain size for "P-2"

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●	13563-TP3	2.80 – 3.00	22	33	45	–	–	

Project: 0201-98-13563 Date Tested: 98/10/20 BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering Consultants Ltd.

MOISTURE - DENSITY RELATIONSHIP

ASTM D698, D1557, or D2049

PROJECT: Arctic Gold & Silver Tailings

PROJECT NO.: 0201-98-13563

CLIENT: Steffen, Robertson & Kersten (Can.) Inc.

DESCRIPTION: SAND & GRAVEL (screened past 25mm) - brown

SAMPLE LOCATION: TP3 2.8-3.0 m

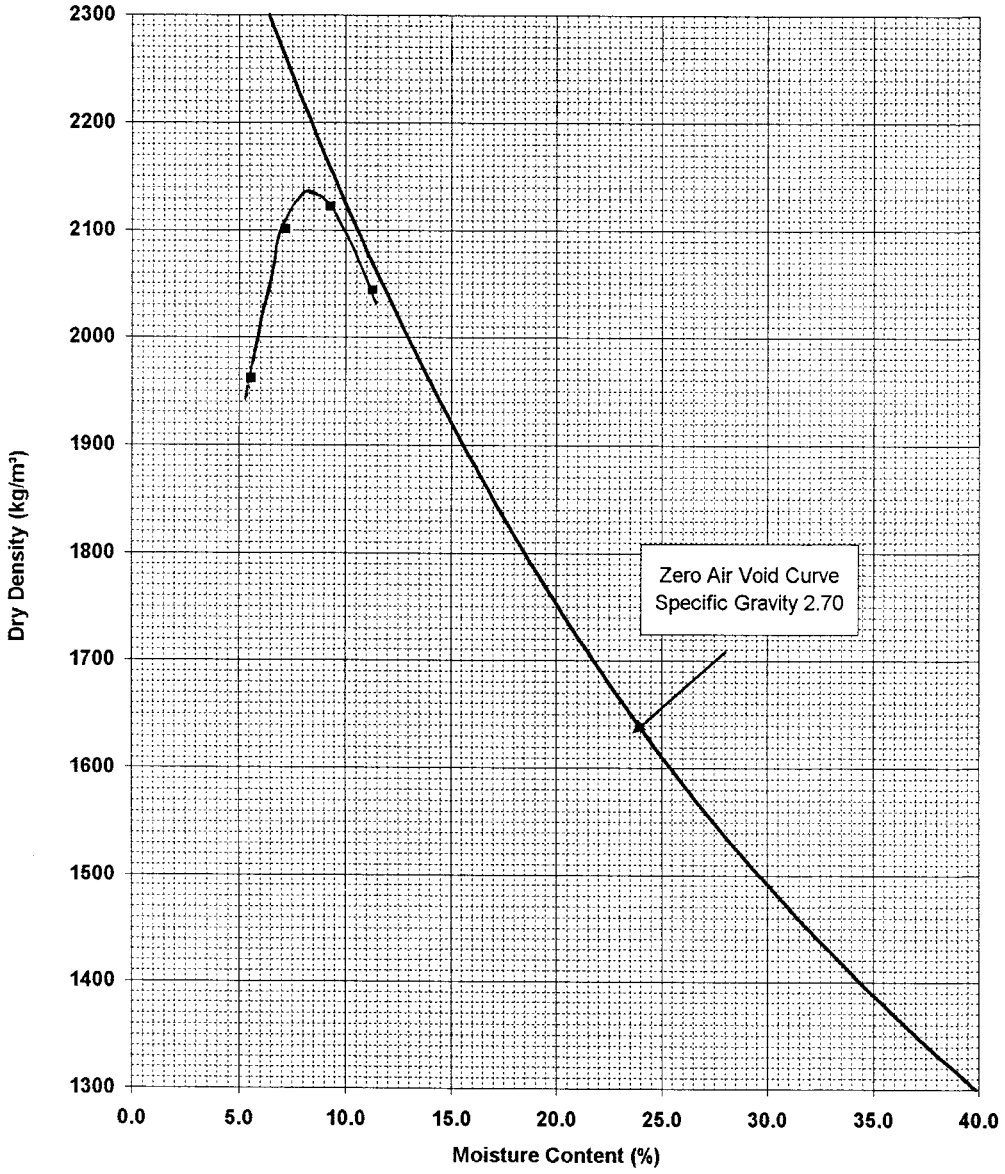
SAMPLE NUMBER:

DATE TESTED: 98/11/04

MOISTURE CONTENT (as received):

MAXIMUM DRY DENSITY: 2135

OPTIMUM MOISTURE CONTENT: 8.2%



STANDARD PROCTOR

ASTM D698

Hammer Mass: 2.494 kg

Hammer Drop: 304.8 mm

Number of Layers: 3

Number of Blows/Layer: 56

Diameter of Mould: 152.3 mm

Height of Mould: 116.5 mm

Mould Volume: 0.00212 m³

Compactive Effort: 590.3 kJ/m³

REVIEWED BY:

_____ P.Eng.

REMARKS: _____

EBA Engineering Consultants Ltd.

CONSTANT HEAD PERMEABILITY TEST — **ARCTIC GOLD & SILVER TAILINGS**

Job Number: 0201-13563
Test Hole: 1/3 TP1 Depth: 0.8-1.0 m
2/3 TP1 1.8-2.0 m

Time	Buret (cc)	Elap. (min)	Outflow (cc)
15:31	15.5	0	0.0
15:32	20.5	1	5.0
15:33	25.5	2	10.0
15:34	30.0	3	14.5
15:35	34.5	4	19.0
15:36	39.0	5	23.5
15:37	43.5	6	28.0
15:38	48.0	7	32.5
15:39	52.5	8	37.0
15:40	57.0	9	41.5
15:41	61.5	10	46.0
15:42	66.0	11	50.5
15:43	70.5	12	55.0

Date: 98-11-05
Test No: P-3

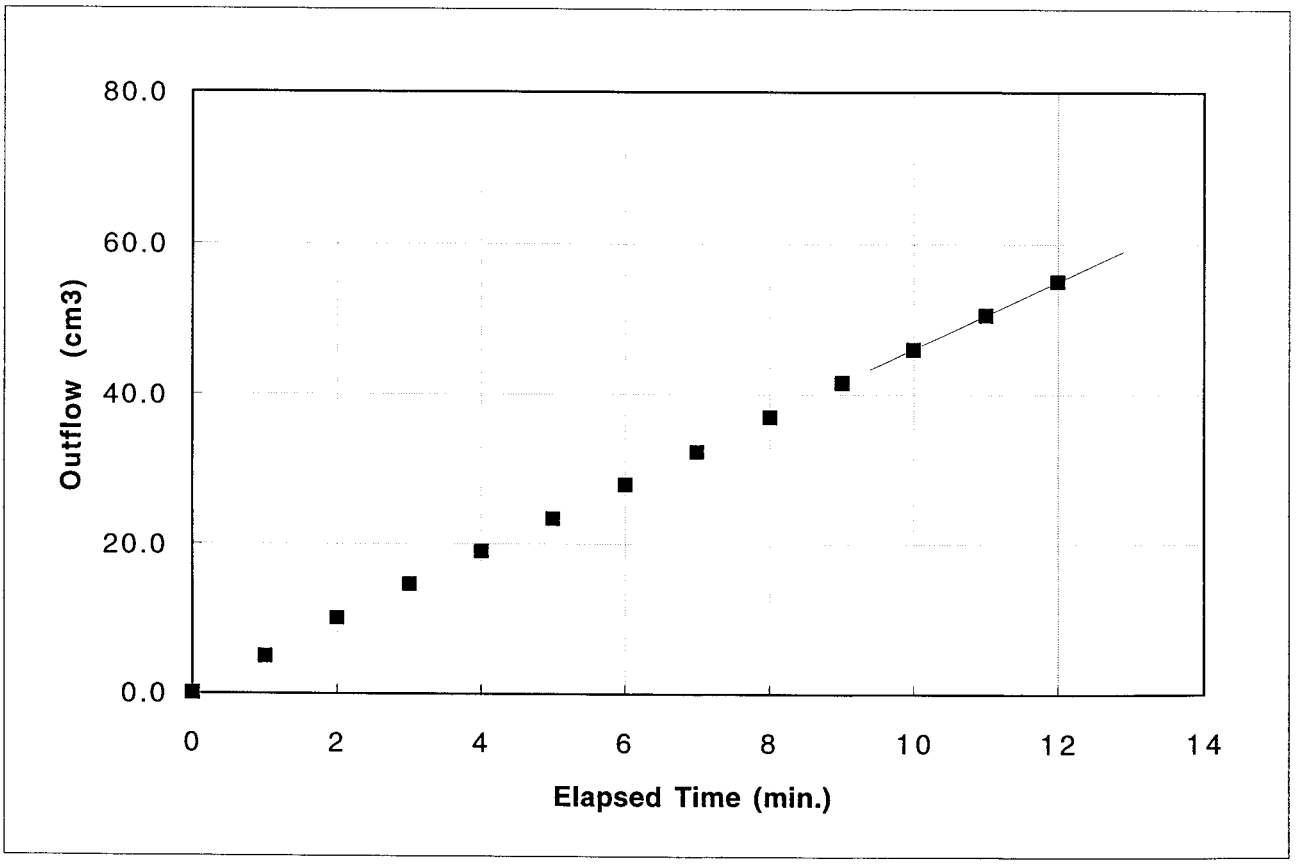
Diameter= 101.2 mm
Height= 116.7 mm

Volume= 938.69 cm3

Head Diff.= 0.063 psi

Q= 0.075 cm3/sec
i= 0.38
A= 80.44 cm2

K= 2.46E-03 cm/sec

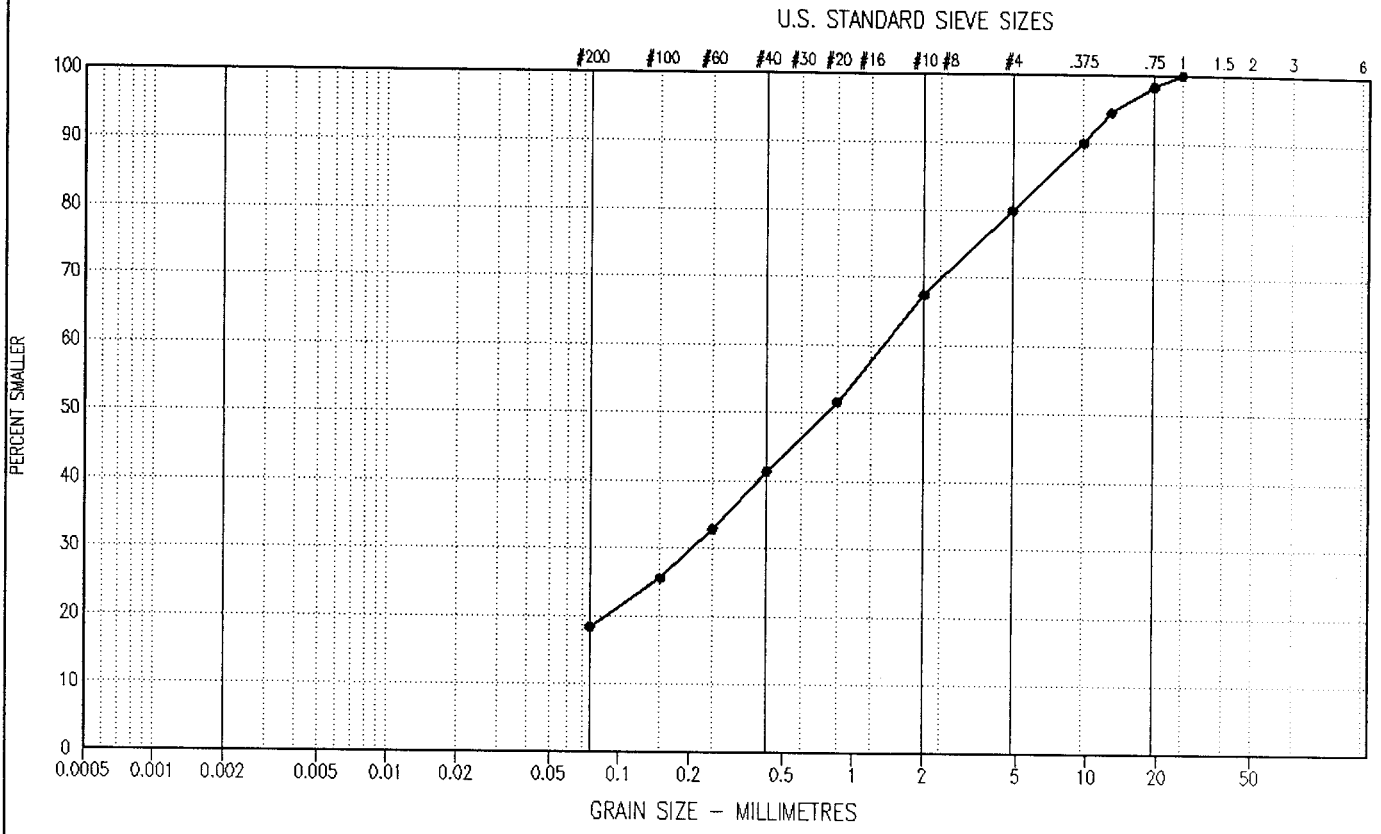


EBA Engineering

grain size for " P-3

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (ft)	DESCRIPTION			Cu	Cc	U.S.C
			CLAY & SILT %	SAND %	GRAVEL %			
●	COMP(1&2)	0.00	18	62	20	–	–	

Project: 0201-98-13563

Date Tested: 98/10/22

BY: MS

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering Consultants Ltd.

MOISTURE - DENSITY RELATIONSHIP

ASTM D698, D1557, or D2049

PROJECT: Arctic Gold & Silver Tailings

PROJECT NO.: 0201-98-13563

CLIENT: Steffen, Robertson & Kersten (Can.) Inc.

DESCRIPTION: SAND & GRAVEL (screened past 25mm) - brown

SAMPLE LOCATION: 1/3 TP1 0.8-1.0m, 2/3 TP1 1.8-2.0m

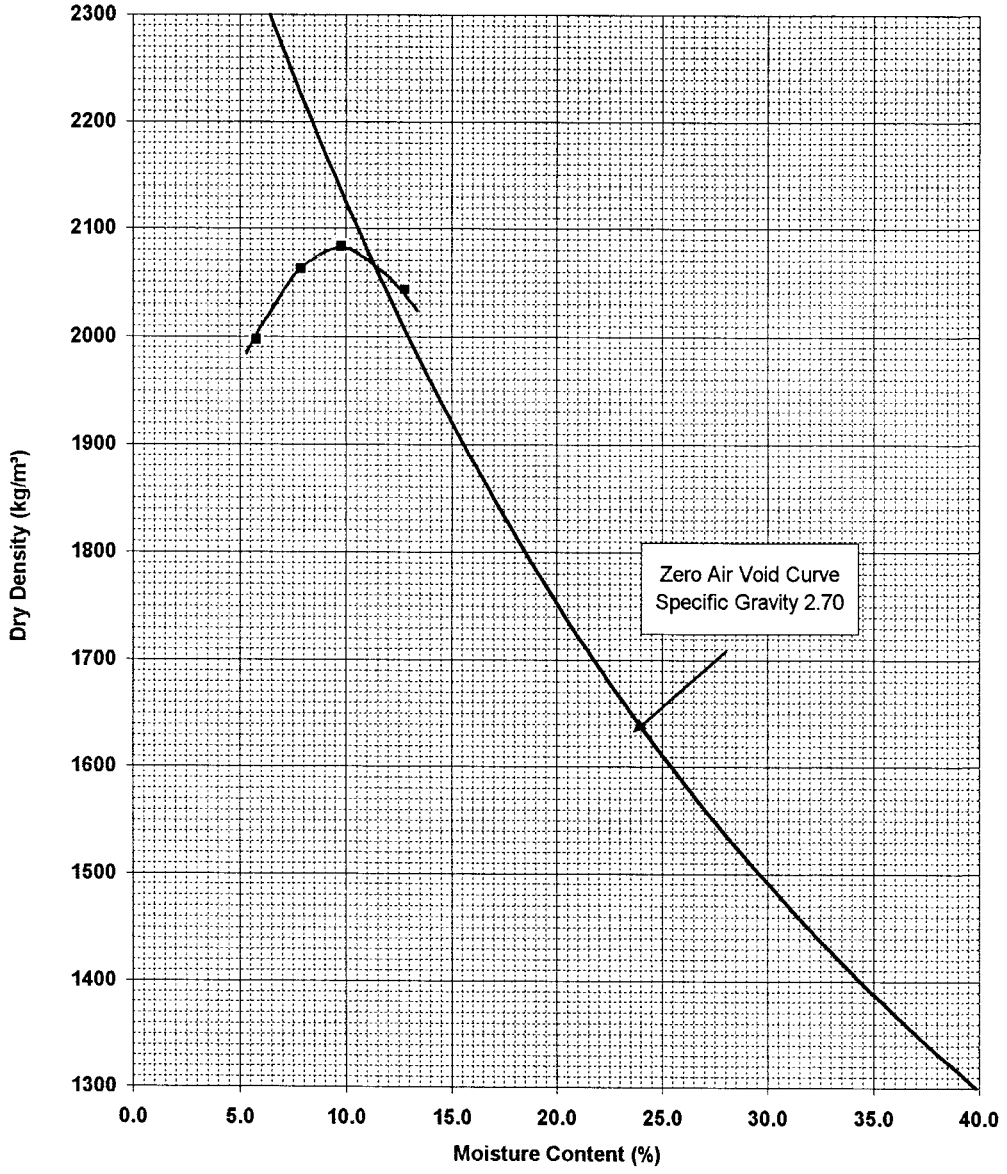
SAMPLE NUMBER: 5520.1

DATE TESTED: 98/11/03

MOISTURE CONTENT (as received): 5.8%

MAXIMUM DRY DENSITY: 2085

OPTIMUM MOISTURE CONTENT: 9.8%



STANDARD PROCTOR

ASTM D698

Hammer Mass: 2.494 kg

Hammer Drop: 304.8 mm

Number of Layers: 3

Number of Blows/Layer: 25

Diameter of Mould: 101.4 mm

Height of Mould: 116.3 mm

Mould Volume: 0.000938 m³

Compactive Effort: 593.5 kJ/m³

REVIEWED BY:

_____ P.Eng.

REMARKS: _____

APPENDIX C
Water and Soil Chemistry Results

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

analytical
service
laboratories
ltd.

FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date: October 29, 1998

ASL File No. J8584

Report On: Arctic Gold & Silver / Venus
Water & Soil Analysis

Report To: **Public Works & Gov't Serv. Env.**
Environmental Services
#1000 - 9700 Jasper Ave.
Edmonton, AB
T5J 4E2

Attention: **Mr. Mike Nahir**

Received: September 15, 1998

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Heather A. Ross, B.Sc. - Project Chemist
Miles Gropen, B.Sc. - Project Chemist

cc: Mr. Michael Royle -
Steffen, Robertson and Kirsten
Vancouver, B.C.

RESULTS OF ANALYSIS - Water[1]

File No. J8584

		AGS-98 MW1D	AGS-98 MW2	AGS-98 MW3	AGS-98 MW4	AGS-98 MW5
		98 09 10	98 09 10	98 09 10	98 09 10	98 09 10
Physical Tests						
Conductivity	(umhos/cm)	260	3310	245	-	3940
Total Dissolved Solids		331	4330	309	-	5970
Hardness	CaCO3	124	1180	86.3	1760	778
pH		7.49	5.79	7.34	-	3.66
Dissolved Anions						
Sulphate	SO4	22	2550	18	-	4590

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.

RESULTS OF ANALYSIS - Water[1]

File No. J8584

	V-98 MW1	V-98 MW2S	V-98 MW2D	V-98 MW3S	V-98 MW3D
	98 09 11	98 09 11	98 09 11	98 09 11	98 09 11
Physical Tests					
Conductivity (umhos/cm)					
Total Dissolved Solids					
Hardness CaCO3					
pH					
Dissolved Anions					
Sulphate SO4					

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.

RESULTS OF ANALYSIS - Water[1]

File No. J8584

		AGS-98 MW1D	AGS-98 MW2	AGS-98 MW3	AGS-98 MW4	AGS-98 MW5
		98 09 10	98 09 10	98 09 10	98 09 10	98 09 10
Dissolved Metals						
Aluminum	D-Al	0.029	0.37	0.029	0.88	130
Antimony	D-Sb	<0.2	<0.2	<0.2	<1	<0.4
Arsenic	D-As	0.025	0.8	0.042	20.3	88
Barium	D-Ba	0.05	0.03	0.12	0.07	<0.02
Beryllium	D-Be	<0.005	<0.005	<0.005	<0.03	0.02
Boron	D-B	<0.1	<0.1	<0.1	<0.5	<0.2
Cadmium	D-Cd	<0.0002	0.008	0.0004	0.004	1.7
Calcium	D-Ca	37.3	352	24.9	455	187
Chromium	D-Cr	<0.001	<0.001	<0.001	<0.001	0.012
Cobalt	D-Co	<0.02	0.68	<0.02	1.8	0.93
Copper	D-Cu	0.001	0.03	0.002	<0.001	1.47
Iron	D-Fe	0.04	664	<0.03	3150	1290
Lead	D-Pb	<0.001	<0.001	<0.001	<0.05	0.135
Lithium	D-Li	<0.02	0.07	<0.02	<0.1	0.16
Magnesium	D-Mg	7.5	72.4	5.9	152	75.3
Manganese	D-Mn	0.110	68.2	0.187	163	23.4
Mercury	D-Hg	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	D-Mo	<0.03	<0.03	<0.03	<0.2	<0.06
Nickel	D-Ni	<0.05	0.28	<0.05	0.7	0.6
Selenium	D-Se	<0.0005	0.0008	<0.01	<0.01	<0.01
Silver	D-Ag	<0.0001	0.0004	<0.0001	0.002	0.0007
Sodium	D-Na	4	39	14	12	19
Thallium	D-Tl	<0.2	<0.2	<0.2	<1	<0.4
Vanadium	D-V	<0.03	<0.03	<0.03	<0.2	0.08
Zinc	D-Zn	<0.005	16.6	<0.005	35.5	29.7

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.

RESULTS OF ANALYSIS - Water[1]

File No. J8584

	V-98 MW1	V-98 MW2S	V-98 MW2D	V-98 MW3S	V-98 MW3D
	98 09 11	98 09 11	98 09 11	98 09 11	98 09 11
Dissolved Metals					
Aluminum D-Al					
Antimony D-Sb					
Arsenic D-As					
Barium D-Ba					
Beryllium D-Be					
Boron D-B					
Cadmium D-Cd					
Calcium D-Ca					
Chromium D-Cr					
Cobalt D-Co					
Copper D-Cu					
Iron D-Fe					
Lead D-Pb					
Lithium D-Li					
Magnesium D-Mg					
Manganese D-Mn					
Mercury D-Hg					
Molybdenum D-Mo					
Nickel D-Ni					
Selenium D-Se					
Silver D-Ag					
Sodium D-Na					
Thallium D-Tl					
Vanadium D-V					
Zinc D-Zn					

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.

RESULTS OF ANALYSIS - Water[1]

File No. J8584

	V-98 DP1-TD	V-98 DP2-TD	V-98 DP2-TS
	98 09 11	98 09 11	98 09 11
Dissolved Metals			
Arsenic D-As			

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. J8584

		AGS-98 TS-C1 98 08 29	AGS-98 TS-C2 98 08 29	AGS-98 TS-C3 98 08 29	V-98 DPH-TD-TS1 98 08 29	AG2 98 08 29
Physical Tests						
Moisture	%	10.8	14.7	13.4		5.5
Total Metals						
Aluminum	T-Al	-	-	-		-
Antimony	T-Sb	-	-	-		-
Arsenic	T-As	541	208	7		16100
Barium	T-Ba	-	-	-		-
Beryllium	T-Be	-	-	-		-
Bismuth	T-Bi	-	-	-		-
Cadmium	T-Cd	-	-	-		-
Calcium	T-Ca	-	-	-		-
Chromium	T-Cr	-	-	-		-
Cobalt	T-Co	-	-	-		-
Copper	T-Cu	-	-	-		-
Iron	T-Fe	-	-	-		-
Lead	T-Pb	-	-	-		-
Lithium	T-Li	-	-	-		-
Magnesium	T-Mg	-	-	-		-
Manganese	T-Mn	-	-	-		-
Mercury	T-Hg	<0.005	<0.005	0.016		0.052
Molybdenum	T-Mo	-	-	-		-
Nickel	T-Ni	-	-	-		-
Phosphorus	T-P	-	-	-		-
Potassium	T-K	-	-	-		-
Selenium	T-Se	-	-	-		-
Silver	T-Ag	-	-	-		-
Sodium	T-Na	-	-	-		-
Strontium	T-Sr	-	-	-		-
Thallium	T-Tl	-	-	-		-
Tin	T-Sn	-	-	-		-
Titanium	T-Ti	-	-	-		-
Vanadium	T-V	-	-	-		-
Zinc	T-Zn	-	-	-		-

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. J8584

		AG3	AG5	AG12	AG13	AG23
		98 08 29	98 08 29	98 08 29	98 08 29	98 08 29
Physical Tests						
Moisture	%	4.5	17.9	18.6	15.5	11.7
Total Metals						
Arsenic	T-As	7690	15900	250	3.9	37600
Mercury	T-Hg	0.033	0.050	0.014	0.012	0.088

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. J8584

		AG17
		98 08 29
Physical Tests		
Moisture	%	31.5
Total Metals		
Arsenic	T-As	33600
Mercury	T-Hg	0.207

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

Appendix 1 - QUALITY CONTROL - Replicates

File No. J8584

Sediment/Soil[1]	V-98 DPH-TD-TS1 98 08 29	V-98 DPH-TD-TS1 QC # 133813
Total Metals		
Aluminum	T-Al	
Antimony	T-Sb	
Arsenic	T-As	
Barium	T-Ba	
Beryllium	T-Be	
Bismuth	T-Bi	
Cadmium	T-Cd	
Calcium	T-Ca	
Chromium	T-Cr	
Cobalt	T-Co	
Copper	T-Cu	
Iron	T-Fe	
Lead	T-Pb	
Lithium	T-Li	
Magnesium	T-Mg	
Manganese	T-Mn	
Molybdenum	T-Mo	
Nickel	T-Ni	
Phosphorus	T-P	
Potassium	T-K	
Selenium	T-Se	
Silver	T-Ag	
Sodium	T-Na	
Strontium	T-Sr	
Thallium	T-Tl	
Tin	T-Sn	
Titanium	T-Ti	
Vanadium	T-V	
Zinc	T-Zn	

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

Appendix 1 - QUALITY CONTROL - Replicates

File No. J8584

Sediment/Soil[1]		AG5	AG5
		98 08 29	QC # 133071
Physical Tests			
Moisture	%	17.9	17.9
Total Metals			
Mercury	T-Hg	0.050	0.032

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

Appendix 1 - QUALITY CONTROL - Replicates

File No. J8584

Water[1]		**AGS-98 MW5** 98 09 10	**AGS-98 MW5** QC # 133070
Physical Tests			
Total Dissolved Solids		5970	6170
Hardness	CaCO3	778	766
Dissolved Metals			
Aluminum	D-Al	130	128
Antimony	D-Sb	<0.4	<0.4
Arsenic	D-As	88	87
Barium	D-Ba	<0.02	0.03
Beryllium	D-Be	0.02	0.02
Boron	D-B	<0.2	<0.2
Cadmium	D-Cd	1.7	1.5
Calcium	D-Ca	187	185
Chromium	D-Cr	0.012	0.013
Cobalt	D-Co	0.93	0.91
Copper	D-Cu	1.47	1.46
Iron	D-Fe	1290	1280
Lead	D-Pb	0.135	0.125
Lithium	D-Li	0.16	0.16
Magnesium	D-Mg	75.3	74.1
Manganese	D-Mn	23.4	23.1
Mercury	D-Hg	<0.00005	<0.00005
Molybdenum	D-Mo	<0.06	<0.06
Nickel	D-Ni	0.6	0.6
Silver	D-Ag	0.0007	0.0006
Sodium	D-Na	19	18
Thallium	D-Tl	<0.4	<0.4
Vanadium	D-V	0.08	0.09
Zinc	D-Zn	29.7	29.4

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Conventional Parameters in Water

These analyses are carried out in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 19th Edition 1995 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000A), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 19th Edition 1995 published by the American Public Health Association. A cold-oxidation procedure involving bromine monochloride is used, followed by instrumental analysis by cold-vapour atomic absorption spectrophotometry (CVAAS).

Moisture

This analysis is carried out gravimetrically by drying the sample at 103 C for a minimum of three hours.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050B or Method 3051, published by the United States Environmental Protection Agency (EPA). The sample is manually homogenized and a representative subsample of the wet material is weighed. The sample is then digested by either hotplate or microwave oven using a 1:1 ratio of nitric acid and hydrochloric acid. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000A) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

End of Report

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

analytical
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laboratories
ltd.

FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date:	October 29, 1998
ASL File No.	J8427
Report On:	ICP001.07.01/.02 Soil & Water Analysis
Report To:	**Public Works & Gov't Serv. Env.** Environmental Services #1000 - 9700 Jasper Ave. Edmonton, AB T5J 4E2
Attention:	**Mr. Mike Nahir**
Received:	September 9, 1998

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Heather A. Ross, B.Sc. - Project Chemist
Miles Gropen, B.Sc. - Project Chemist

cc: Mr. Michael Royle -
Steffen, Robertson and Kirsten
Vancouver, B.C.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. J8427

		P-2	P-3	P-4	P-5	P-6
Physical Tests						
Moisture	%	68.8	73.0	87.3	87.1	90.3
Total Metals						
Arsenic	T-As	25100	31300	83	9480	16400
Mercury	T-Hg	0.110	0.115	0.030	0.033	0.046

< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. J8427

		P-7	P-8
Physical Tests			
Moisture	%	89.8	67.4
Total Metals			
Arsenic	T-As	804	21
Mercury	T-Hg	0.041	0.024

< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Water[1]

File No. J8427

		D-1	D-3	T-1	T-2	P-1
Total Metals						
Aluminum	T-Al	0.028	-	0.065	0.037	0.022
Antimony	T-Sb	<0.2	-	<0.2	<0.2	<0.2
Arsenic	T-As	0.0006	-	0.0025	0.0074	0.0016
Barium	T-Ba	0.01	-	<0.01	<0.01	<0.01
Beryllium	T-Be	<0.005	-	<0.005	<0.005	<0.005
Boron	T-B	<0.1	-	<0.1	<0.1	<0.1
Cadmium	T-Cd	<0.0002	-	<0.0002	<0.0002	<0.0002
Calcium	T-Ca	17.8	-	8.74	9.31	8.61
Chromium	T-Cr	<0.001	-	<0.001	<0.001	<0.001
Cobalt	T-Co	<0.02	-	<0.02	<0.02	<0.02
Copper	T-Cu	<0.001	-	<0.001	<0.001	<0.001
Iron	T-Fe	<0.03	-	0.36	0.77	0.67
Lead	T-Pb	<0.001	-	<0.001	<0.001	<0.001
Lithium	T-Li	<0.02	-	<0.02	<0.02	<0.02
Magnesium	T-Mg	3.8	-	2.1	2.3	2.0
Manganese	T-Mn	<0.005	-	0.010	0.043	0.032
Mercury	T-Hg	<0.00005	-	<0.00005	<0.00005	<0.00005
Molybdenum	T-Mo	<0.03	-	<0.03	<0.03	<0.03
Nickel	T-Ni	<0.05	-	<0.05	<0.05	<0.05
Selenium	T-Se	<0.0005	-	<0.0005	<0.0005	<0.0005
Silver	T-Ag	<0.0001	-	<0.0001	<0.0001	<0.0001
Sodium	T-Na	2	-	<2	<2	2
Thallium	T-Tl	<0.2	-	<0.2	<0.2	<0.2
Vanadium	T-V	<0.03	-	<0.03	<0.03	<0.03
Zinc	T-Zn	<0.005	-	<0.005	<0.005	<0.005
Dissolved Metals						
Arsenic	D-As	0.0006	0.0005	0.0017	0.0034	0.0012
Mercury	D-Hg	<0.00005	<0.00005	<0.00005	-	<0.00005

< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.

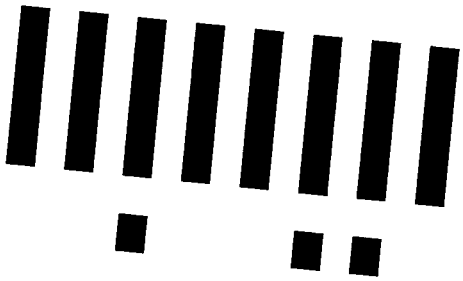
RESULTS OF ANALYSIS - Water[1]

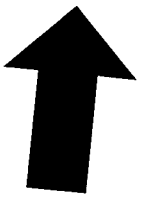
File No. J8427

P-2

Dissolved Metals		
Arsenic	D-As	0.0028
Mercury	D-Hg	<0.00005

< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except where noted.





A4

Simplex mode
Mode Recto
Simplex-Modus
Modo símplex
Modo simplex

METHODOLOGY

File No. J8427

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Moisture

This analysis is carried out gravimetrically by drying the sample at 103 C for a minimum of three hours.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050B or Method 3051, published by the United States Environmental Protection Agency (EPA). The sample is manually homogenized and a representative subsample of the wet material is weighed. The sample is then digested by either hotplate or microwave oven using a 1:1 ratio of nitric acid and hydrochloric acid. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000A) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 19th Edition 1995 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000A), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 19th Edition 1995 published by the American Public Health Association. A cold-oxidation procedure involving bromine monochloride is used, followed by instrumental analysis by cold-vapour atomic absorption spectrophotometry (CVAAS).

End of Report

APPENDIX D
Report by
Laberge Environmental Services

Laberge
ENVIRONMENTAL SERVICES

P.O. BOX 5111
WHITEHORSE, YT
Y1A 4S3

OFFICE PHONE (867) 668-6838
CELL PHONE (867) 668-1043
FAX (867) 667-6956

September 22, 1998

Daryl Hockley, P. Eng.
Steffen Robertson and Kirsten (Canada) Inc
Suite 800 - 580 Hornby Street
Vancouver, B.C.
V6C 3B6

Dear Daryl:

Re: **Surface Water and Lake Sediment Sampling at the Abandoned Mill Site on the Arctic Gold and Silver Property**

Please find enclosed the details regarding the above sampling program. Underhill will be forwarding the map to you, I believe today. As the entire lake was not delineated, we could only plot five (5) of the lake sediment sites with any degree of accuracy. We apologize for this and have also included a photo enlargement of the unnamed lake with the actual site locations indicated on the photo. We hope this will help in future repeat sampling.

If you have any questions or we can be of further assistance to you, please contact us at your convenience.

Yours truly,

Bonnie Burns
Laberge Environmental Services

c.c. Brett Hartshorne, Waste Management, INAC

Laberge
ENVIRONMENTAL SERVICES

P.O. BOX 5111
WHITEHORSE, YT
Y1A 4S3

OFFICE PHONE (867) 668-6838
CELL PHONE (867) 668-1043
FAX (867) 667-6956

SURFACE WATER AND LAKE SEDIMENT SAMPLING

AT

ARCTIC GOLD AND SILVER MINE'S ABANDONED MILL SITE

Prepared for:

STEFFEN ROBERTSON AND KIRSTEN (CANADA) INC.

Prepared by:

LABERGE ENVIRONMENTAL SERVICES

September 1998

SCOPE OF WORK

Steffen Robertson and Kirsten (SRK) is presently conducting a site assessment with associated clean up, for Public Works and Government Services Canada on the abandoned Arctic Gold and Silver Mine's mill site. It was SRK's understanding that Indian and Northern Affairs Canada (INAC) would supply field support for tasks 2 (surface water sampling) and 6 (lake sediment samples). Due to time constraints, INAC could not complete this work and contracted Laberge Environmental Services (LES) to collect the appropriate samples in early September.

METHODS, DESCRIPTIONS AND DISCUSSION

Surface Water Sampling

A total of six (6) sites were sampled for various parameters on September 6th and 7th, 1998. At each site, samples to be analyzed for total dissolved solids, alkalinity, acidity and sulphates were collected in new one litre plastic bottles. Samples to be analyzed for mercury were collected in 100 mL clean glass bottles and preserved with potassium dichromate and sulphuric acid. Samples to be analyzed for total metals were collected in 100 mL new plastic bottles and preserved with nitric acid. The dissolved metals samples were filtered in the field using a hand operated pump with disposable nalgene filter kits (filter pore size 0.45 microns) and placed into new 100 mL plastic bottles. The filtered samples were preserved with nitric acid. All sample bottles, disposable filter kits and vials of preservative were supplied by INAC.

In-situ measurements were taken at each site. Conductivity and temperature were determined with an Orion conductivity meter model 126. Dissolved oxygen readings were obtained using an Orion oxygen meter model 820 and pH measurements were taken with an Accumet pH meter.

Instantaneous discharge was measured at each site where possible. An area with a uniform cross section was chosen and the velocity and depth were measured using a Price type meter and top setting wading rod. Ten or more readings were taken across the profile of the stream. Total discharge was calculated as the sum of these individual discharges (area x velocity). Where the stream morphology did not permit the use of this equipment, discharge was visually estimated.

Photographs and notes on the riparian vegetation were taken at each site. Each site was flagged and labelled.

Table One provides site descriptions, observations and in-situ results at each of the six sites.

TABLE ONE

IN-SITU RESULTS AND OBSERVATIONS AT ARCTIC GOLD AND SILVER

Site	D-1	D-3	P-1	P-2	T-1	T-2
Site Description	Diversion ditch near NW corner of tailings	Diversion ditch near road to mine	Inflow to unnamed lake	In unnamed lake adjacent to discharge point in zone of influence.	Tank Cr at outlet of unnamed lake	Tank Cr 350 m d/s of AG&S in canyon
Date, 1998	Sept 6	Sept 6	Sept 6	Sept 6	Sept 7	Sept 7
pH	7.42	7.36	6.83	7.10	7.52	7.69
Conductivity (uS/cm)	111.6	87.1	60.5	71.1	64.6	68.3
Temp °C	7.1	10.5	9.0	9.1	8.6	7.8
Dissolved Oxygen (mg/L)	9.4	9.8	8.2	10.5	10.7	11.1
Dissolved Oxygen (%)	91	105	82	108	107	110
Flow (litres/second)	1 to 2 (e)	2 to 3 (e)	15 (e)	-	-	122.3
Riparian Vegetation	U.S.: white spruce, balsam fir, L.S.: willows, dwarf birch, shrubby cinqfoil, crowberry, lowbush cranberry, G.C.: grasses equisetum,sphagnum moss.	U.S.: pine, white spruce, L.S.: willows, labrador tea, shrubby cinqfoil, G.C. grasses, fireweed, equisetum, various forbs, knickaknick, sphagnum moss	Flooded habitat of willows and sedges	-	U.S.: none, L.S.: willows, alder, G.C.: grasses, equisetum, fireweed	U.S.: balsam fir, pine, white spruce, willows, L.S.: willows, crowberry, G.C.: sphagnum moss, grasses, equisetum
Comments	undefined channel, trickle which frequently goes underground, areas where it daylights has small pools of standing water and ground is spongy.	sampled in small reach where daylights, goes underground and could not be located between here and D-2.	channel is poorly defined but flow is evident.	there was no direct flow in the discharge channel, sampled directly in front of channel and between the 2 survey posts	several individual flows due to beaver dam, sampled where there was majority of flow, no active flow through existing culvert.	sampled at beginning of canyon, bank height 1.2 m, avg width 2m substrate comprised mainly of cobbles, few fines.

(e) = estimated U.S. = upper story L.S. = lower story G.S. = ground cover

Lake Sediment Sampling

A single grab sediment sample was collected from seven (7) sites in the unnamed lake using a petite ponar dredge supplied by INAC. Sample locations were to be recorded using GPS or compass triangulation. The GPS which INAC loaned to LES for this study was an older model which required long periods of time (up to 30 minutes) to obtain a reading. This was of very little use in a bobbing boat in the lake therefore sample sites were positioned using the survey control points established on land as much as possible. Five of these sites (P-2 to P-6) have been plotted on the map prepared by Underhill. All of the lake sites are plotted on the enclosed 8 x 10 aerial photograph.

Accompanying the grab samples, sediment cores were also to be collected. INAC provided LES with a soil probe for this purpose. This instrument was limited in its use however, being restricted to the shallower areas. Consequently, core samples were collected at P-2 and P-3 only.

Sediment site descriptions and observations are presented in Table Two.

RECOMMENDATIONS

It is recommended that core sampling be conducted in late winter / early spring (March) using appropriate equipment. This would provide a stable platform to work from and would allow locations to be properly mapped. This sampling could coincide with INAC's core sampling of Tank Creek at Bennett Lake.

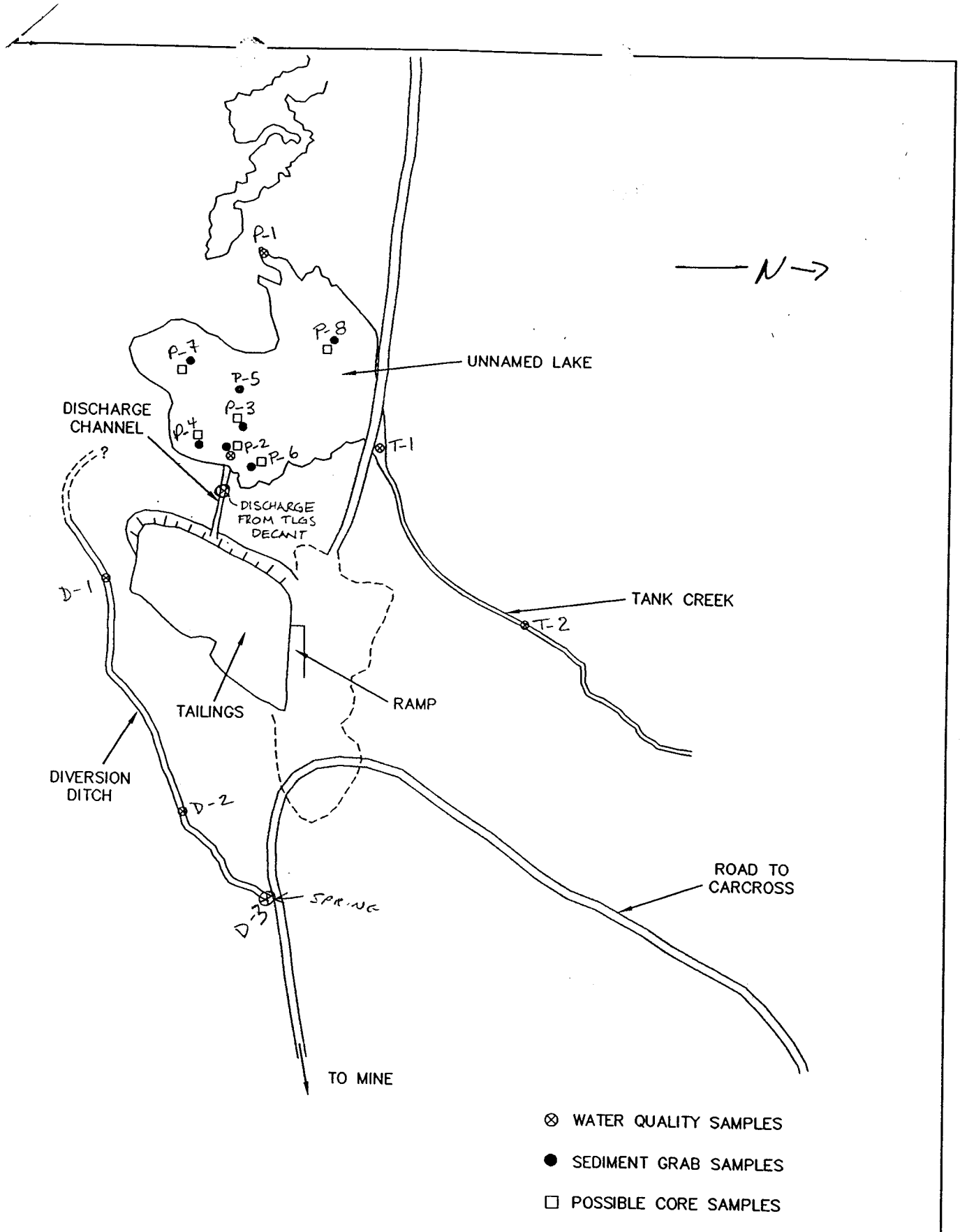
ATTACHMENTS

Accompanying this document are photographs of the various sites. There is an 8 x 10 enlargement of the lake showing the lake sediment sample locations. Underhill will be forwarding the map to SRK under separate cover.

TABLE TWO

SEDIMENT SAMPLING IN THE UNNAMED LAKE, SEPT 6, 1998

Site #	Site Description	Matrix	Depth (m)	Comments
P-1	Inflow to unnamed lake	water	-	see Table One
P-2	Below discharge ditch	water grab - sediment core (P2A, P2B, P2C)	0.95	layer of rust coloured precipitate on muddy substrate
P-3	In direct line with P-2 and discharge ditch	grab - sediment core (P3A, P3B)	1.7	layer of rust coloured precipitate on muddy substrate
P-4	To the west of P-3	grab - sediment	2.2	layer of rust coloured precipitate on muddy substrate
P-5	In direct line with P-3, P-2 and discharge ditch	grab - sediment	2.1	at the outer edge of rust coloured plume, short vegetative growth on substrate
P-6	East of P-5	grab - sediment	1.8	within rust coloured plume, short vegetative growth on substrate
P-7	North of P-4 in mid section of bay	grab - sediment	2.4	difficult to obtain sample due to thick vegetative growth on substrate
P-8	Southeast of beaver lodge	grab - sediment	2.1	managed to get a sediment sample altho there is a great deal of aquatic plant growth in this area



STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

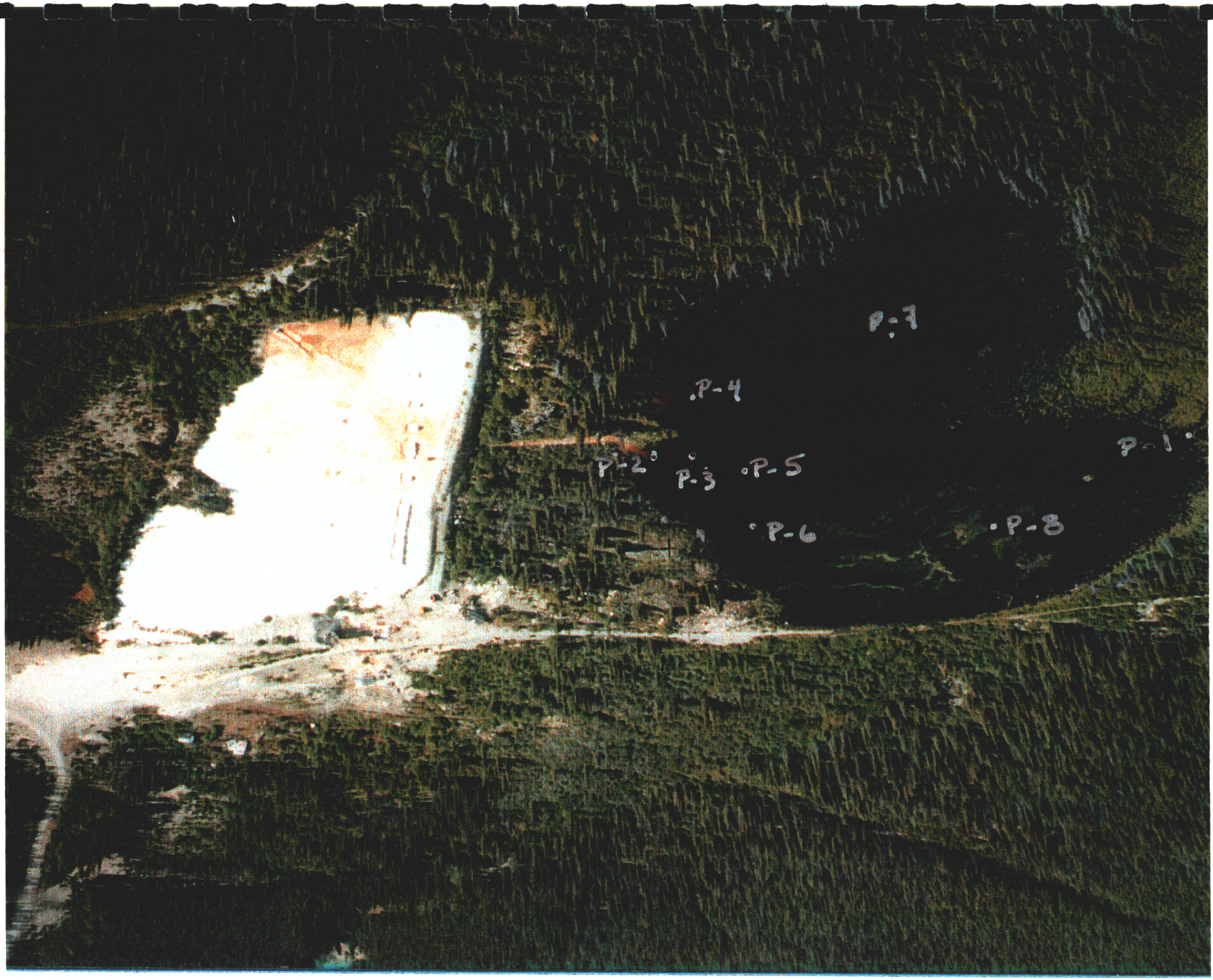
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

ARCTIC GOLD AND SILVER

SAMPLE LOCATIONS

PROJECT NO.	DATE	APPROVED	FIGURE
1CP001.06	AUG. 1998		1

FILE REF: LOCATION.DWG


P-7
P-4
P-1
P-2
P-3
P-5
P-6
P-8

#19, 4078 4th Ave. Whitehorse, Yukon
P.O. Box 5111
Y1A 4S3 Phone (867) 668 6838
Fax (867) 667 6956

Laberge Environmental Services

Fax

To: Jason **From:** Ken Nordin

Fax: (604) 687- 5532 **Pages:**

Phone: (604) 681-4169 **Date:** 12/10/98

Re: AG&S sediment samples **CC:**

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Jason,

The following are approximate:

Total length of cores at sample stations P-3 and P-2 were 30 cm.

The thickness of the orange coloured surface material was very shallow. In the samples at P-2 (closest to the drain outlet) the thickness was about 2.5 cm. At P-3, furthest from the drain, the thickness was only about one cm.

Judging from the disturbance of the bottom by the sampler at other areas within the orange stain footprint, the thickness appeared to be very shallow. Once the sediment had settled, we could see from the remains each sample site that the stained sediment layer was like a thin film overlaying the grey coloured soils underneath.

Hope this helps, but it would be good to check out the original cores if they were stored, or any notes made by Daryl Hawkley when he received the core samples.

APPENDIX E

Laboratory Tests Results from Landfill Area

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

analytical
service
laboratories
ltd.

FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date: December 4, 1998

ASL File No. K1302

Report On: Water and Soil Analysis
(Arctic Sold/Silver and Venus)

Report To: **Public Works & Gov't Serv. Env.**
Environmental Services
#1000 - 9700 Jasper Ave.
Edmonton, AB
T5J 4E2

Attention: **Mr. Mike Nahir**

Received: November 10, 1998

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Heather A. Ross, B.Sc. - Project Chemist
Miles Gropen, B.Sc. - Project Chemist

RESULTS OF ANALYSIS - Sediment/Soil[1,2,3]

File No. K1302

		AGS-LF-S1 98 11 05 14:30	AGS-LF-S2 98 11 05 14:30
Physical Tests			
Moisture	%	22.6	28.4
pH		5.31	6.17
Total Metals			
Antimony	T-Sb	<20	<20
Arsenic	T-As	122	126
Barium	T-Ba	130	155
Beryllium	T-Be	<0.5	0.5
Cadmium	T-Cd	0.7	1.9
Chromium	T-Cr	37	53
Cobalt	T-Co	6	10
Copper	T-Cu	16	73
Lead	T-Pb	56	<50
Mercury	T-Hg	0.020	0.015
Molybdenum	T-Mo	<4	<4
Nickel	T-Ni	12	24
Selenium	T-Se	<0.1	0.1
Silver	T-Ag	2	<2
Tin	T-Sn	<10	<10
Vanadium	T-V	63	81
Zinc	T-Zn	68	263

< = Less than the detection limit indicated.
Split samples were split at ASL as per the client's instructions.
[1]Results are expressed as milligrams per dry kilogram except where noted.
[2]EPH = Extractable Petroleum Hydrocarbons.
[3]HEPH & LEPH = Heavy and Light Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil[1,2,3]

File No. K1302

	AGS-LF-S1 98 11 05 14:30	AGS-LF-S2 98 11 05 14:30
Halogenated Volatiles		
Bromodichloromethane	<0.01	<0.01
Bromoform	<0.01	<0.01
Carbon Tetrachloride	<0.01	<0.01
Chlorobenzene	<0.01	<0.01
Chloroethane	<0.01	<0.01
Chloroform	<0.01	<0.01
Chloromethane	<0.01	<0.01
Dibromochloromethane	<0.01	<0.01
1,2-Dichlorobenzene	<0.01	<0.01
1,3-Dichlorobenzene	<0.01	<0.01
1,4-Dichlorobenzene	<0.01	<0.01
1,1-Dichloroethane	<0.01	<0.01
1,2-Dichloroethane	<0.01	<0.01
cis-1,2-Dichloroethylene	<0.01	<0.01
trans-1,2-Dichloroethylene	<0.01	<0.01
1,1-Dichloroethylene	<0.01	<0.01
Dichloromethane	<0.2	<0.3
1,2-Dichloropropane	<0.01	<0.01
cis-1,3-Dichloropropylene	<0.01	<0.01
trans-1,3-Dichloropropylene	<0.01	<0.01
1,1,1,2-Tetrachloroethane	<0.01	<0.01
1,1,2,2-Tetrachloroethane	<0.01	<0.01
Tetrachloroethylene	<0.01	<0.01
1,1,1-Trichloroethane	<0.01	<0.01
1,1,2-Trichloroethane	<0.01	<0.01
Trichloroethylene	<0.01	<0.01
Trichlorofluoromethane	<0.01	<0.01
Vinyl Chloride	<0.01	<0.01
Non-halogenated Volatiles		
Benzene	<0.01	<0.01
Ethylbenzene	<0.01	<0.01
Styrene	<0.01	<0.01
Toluene	<0.01	<0.01
meta- & para-Xylene	<0.01	<0.01
ortho-Xylene	<0.01	<0.01

< = Less than the detection limit indicated.
Split samples were split at ASL as per the client's instructions.
[1]Results are expressed as milligrams per dry kilogram except where noted.
[2]EPH = Extractable Petroleum Hydrocarbons.
[3]HEPH & LEPH = Heavy and Light Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil[1,2,3]

File No. K1302

	AGS-LF-S1 98 11 05 14:30	AGS-LF-S2 98 11 05 14:30
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	<0.01	<0.01
Acenaphthylene	<0.01	<0.01
Anthracene	<0.01	<0.01
Benz(a)anthracene	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01
Benzo(b)fluoranthene	<0.01	<0.01
Benzo(g,h,i)perylene	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.01
Chrysene	<0.01	<0.01
Dibenz(a,h)anthracene	<0.01	<0.01
Fluoranthene	<0.01	<0.01
Fluorene	<0.01	<0.01
Indeno(1,2,3-c,d)pyrene	<0.01	<0.01
Naphthalene	<0.01	<0.01
Phenanthrene	<0.01	<0.01
Pyrene	<0.01	<0.01
Polychlorinated Biphenyls		
Total Polychlorinated Biphenyls	0.40	<0.05
Extractables		
EPH (C10-18)	<200	<200
EPH (C19-31)	<200	342
LEPH	<200	<200
HEPH	<200	342

< = Less than the detection limit indicated.
Split samples were split at ASL as per the client's instructions.
[1]Results are expressed as milligrams per dry kilogram except where noted.
[2]EPH = Extractable Petroleum Hydrocarbons.
[3]HEPH & LEPH = Heavy and Light Extractable Petroleum Hydrocarbons.

METHODOLOGY File No. K1302

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 19th Edition 1995 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000A), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Moisture

This analysis is carried out gravimetrically by drying the sample at 103 C for a minimum of three hours.

pH in Soil

This analysis is carried out in accordance with procedures described in "Soil Sampling and Methods of Analysis" (CSSS). The procedure involves mixing the air-dried sample with deionized/distilled water. The pH of the solution is then measured using a standard pH probe. A one to two ratio of sediment to water is used for mineral soils and a one to ten ratio is used for highly organic soils.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050B or Method 3051, published by the United States Environmental Protection Agency (EPA). The sample is manually homogenized and a representative subsample of the wet material is weighed. The sample is then digested by either hotplate or microwave oven using a 1:1 ratio of nitric acid and hydrochloric acid. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000A) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

Volatile Organic Compounds in Sediment/Soil

This analysis is based on United States Environmental Protection Agency Methods 5030, 5035 and 8260. The procedure involves a purge and trap extraction of the volatile compounds and subsequent analysis by capillary column gas chromatography with mass selective detection.

Polycyclic Aromatic Hydrocarbons in Sediment/Soil

This analysis is carried out using a procedure adapted by ASL from U.S. EPA Methods 3500, 3630, and 8270 (Publ. #SW-846 3rd ed., Washington, DC 20460). The procedure involves a microwave assisted extraction with dichloromethane followed by a clean-up using silica gel column chromatography. This clean-up procedure has been found to effectively remove aliphatic and heterocyclic hydrocarbons which could potentially interfere with the analysis. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection.

Polychlorinated Biphenyls in Sediment

This analysis is carried out using a procedure adapted from EPA Method 8082 (Publ. # SW-846 3rd ed., Washington, DC 20460). The procedure involves a solid-liquid extraction of the sample with hexane/acetone and back extraction with water. The hexane extract is cleaned and analysed by capillary column gas chromatography with electron capture detection.

Extractable Hydrocarbons in Sediment/Soil

This analysis is carried out using procedures adapted from U.S. EPA Methods 3500/8015 (Publ. # SW-846 3rd ed., Washington, DC 20460) and British Columbia Ministry of Environment, Lands and Parks Method for "Extractable Petroleum Hydrocarbons in Soil by GC/FID" (January 1996) The procedure involves a hexane/acetone solvent extraction followed by analysis of the extract by capillary column gas chromatography with flame ionization detection. Results are not corrected for Polycyclic Aromatic Hydrocarbons (PAHs) for Extractable Petroleum Hydrocarbon (LEPH/HEPH)

purposes.

Light and Heavy Extractable Petroleum Hydrocarbons in Soil

These results are calculated by subtracting selected Polynuclear Aromatic Hydrocarbon results from Extractable Petroleum Hydrocarbon results. To calculate LEPH, the individual results for naphthalene and phenanthrene are subtracted from EPH(C10-18). To calculate HEPH, the individual results for benz(a)anthracene, benzo(b)]fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and pyrene are subtracted from EPH(C19-31).

End of Report

APPENDIX

HYDROCARBON DISTRIBUTION REPORTS

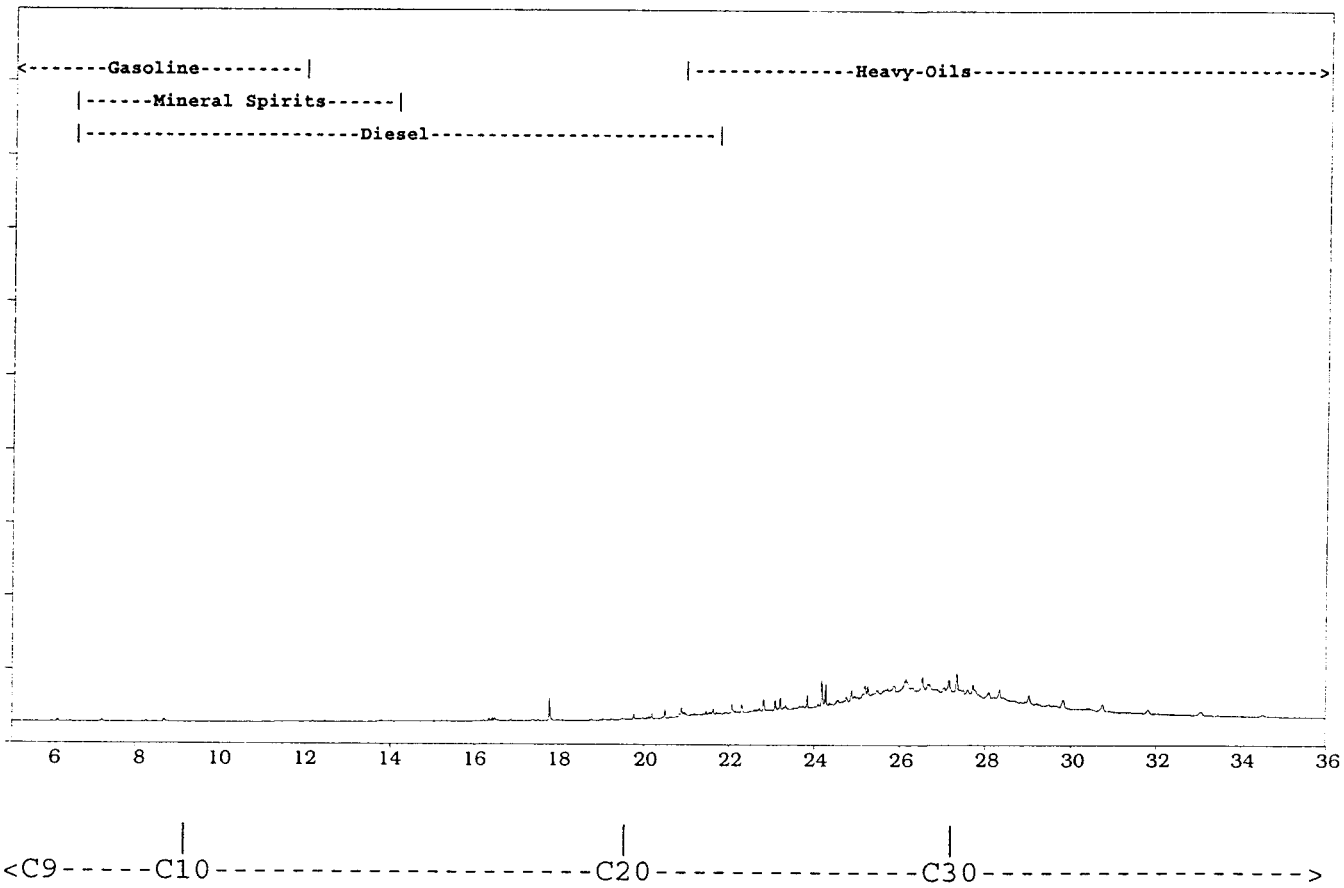
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: **K1302-T--10** AGS-LF- S2

Sample acquired: NOV 17, 1998 23:54:21 Sequence File: TEHNOV17

File Name: C:\TEH\NOV17\TEHNOV17.27R , Sample Name: K1302-T--10 98 11 05 14:30

Chromatogram Scale: 50.0 millivolts



ASL Sample ID: K1302-T--10* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.2
C10-C19	(beg-nC10 to beg-nC20)	3.3
C20-C30	(beg-nC20 to beg-nC31)	37.7
C31-C40	(beg-nC31 to beg-nC41)	58.7

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amounts of hydrocarbon product present in the ranges specified. Percent values are relative to the sum of all chromatographic peaks between the retention times of the alkanes n-C9 and n-C40, and are based solely on the areas of those peaks.

APPENDIX

CHAIN OF CUSTODY FORMS

[redacted]AIN[redacted]F C[redacted]STO[redacted] / A[redacted]ALY[redacted]CAL[redacted]REQUEST[redacted]FORM[redacted]

[redacted]988 T[redacted]reet [redacted]
Vancouver, BC
Canada V5L 1K5
TEL: (604) 253-4188
TOLL FREE: (800) 665-0243
FAX: (604) 253-6700

Specialists in Environmental Chemistry

ASL analytical service laboratories ltd.

CLIENT: Public Works and Government Services Canada

ADDRESS: 1000 9700 Ave Jasper Ave Alta T5J 4E2

CONTACT: Michael Aleksic

TELEPHONE: (403) 497-3802 FAX: (403) 497-3842

PROJECT NAME/NO.: (E89) 0581-98-13609

QUOTE / P.O. NO.:

DATE SUBMITTED: 98/11/09 ASL CONTACT: Heather Ross

[redacted] ANALYSIS REQUESTED [redacted] PA[redacted] 1 O[redacted]

FOR LAB USE ONLY

LAB USE ONLY	SAMPLE IDENTIFICATION	Y	M	D	TIME COLLECTED	MATRIX	BETX / VPH	VOC / VPH	EPH	PAH	LEPH / HEPH	MO+G / SWOG	Metals - PL, RL, CL, IL / AL (S)	Metals - AW / DW (W)	Dissolved Arsenic					NOTES
1	VE98-WQ-1A	98	11	06	9:45 AM	Water									✓					
2	VE98-WQ-2A	98	11	06	11:45 AM										✓					
3a/b	VE98-WQ-3A	98	11	06	10:15 AM										✓					
4	VE98-WQ-4A	98	11	06	11:30 AM										✓					
5a/b	VE98-WQ-5	98	11	07	5:40 PM										✓					
6	VE98-WQ-1B	98	11	06	9:50 AM										✓					
7	VE98-WQ-2B	98	11	06	11:50 AM										✓					
	~~VE98-WQ-3B~~	~~98~~	~~11~~	~~06~~	~~10:30 AM~~															
8	VE98-WQ-4B	98	11	06	10:35 AM	V									✓					
					: AM PM															
9	AGS-LF-S1	98	11	05	?:30 PM	SOIL		✓		~~✓~~	✓		✓			✓				
10	AGS-LF-S2		"		?:35 PM			✓		~~✓~~	✓		✓			✓				
11	AGS-LF-S3		↓		?:30 PM	↓														
					: AM PM															
					: AM PM															
					: AM PM															

TURN AROUND REQUIRED:

☒ ROUTINE (7 - 10 WORKING DAYS)

☐ RUSH (SPECIFY DATE): ____________

SPECIAL INSTRUCTIONS:

- COULD YOU SPLIT SAMPLES VE98-WQ-5 AND COMPLETE TESTING ON BOTH SPLIT SAMPLES ← VE98-WQ-5
- ALL SAMPLES WILL HAVE TO BE FILTERED

SAMPLE CONDITION UPON RECEIPT:

☐ FROZEN

☐ COLD

☐ AMBIENT

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
P. Cowan	DATE 98/11/09 TIME 11:00		DATE TIME
	DATE TIME		DATE 98/11/10 TIME

Customized - British Columbia, CSR

REPORT COPY

/home/grps/qc/DOCS/*/FORMS/ChnCstdy.r03
GLP
SOP02.04.06
TSSP02.04.03

APPENDIX F
Test Pit Log and Laboratory Test Results for Borrow Source Near Carcross

December 18, 1998

EBA File: 0201-98-13604

PWGSC - Environmental Services
1000 - 9700 Jasper Avenue
Edmonton, Alberta
T5J 4E2

Attention: Mr. Michael Nahir, P.Eng, M.Eng.
Senior Environmental Engineer

Subject: Impervious Borrow Material Study
Carcross Area, Yukon

Subsequent to your discussions with Mr. Mike Billowits and Mr. Richard Trimble of this office, an in-house geotechnical study has been completed to delineate possible sources of impervious soils for use as capping over the Arctic Gold & Silver tailings pond.

This letter describes EBA's data acquisition process, the sites identified and a summary of the geotechnical conditions and development constraints for each of the potential sites listed.

1.0 GEOTECHNICAL DATA SEARCH

From the EBA project initiation sheet database, a list of all Carcross area projects was retrieved. Of the close to 50 projects completed in the Carcross area, six projects were identified as studies suitable for the delineation of a borrow source for fine grained soil. The files for these six projects were pulled and studied, resulting in a short list of two sites. Details for each site are presented in the following sections.

2.0 POTENTIAL SITES

The three main factors for site selection were proximity to Montana Mountain, site accessibility, and most importantly, the existence of lacustrine soils with sufficient silt and clay content to ensure soil permeabilities in the 10^{-7} to 10^{-8} m/s range.

Two sites were identified. Both are within hauling distance of Montana Mountain and both have highway access. The first site identified is the area surrounding the Carcross Gun Club. This site is located on the west side of the South Klondike Highway approximately 5 km north of Carcross. This is the area which has been identified as the site of the new Carcross Sewage Disposal site and pre-design work is currently on-going.

The second site is located at km 50.7 of the Tagish Road (approximately 5 km from Carcross as well). This site is now utilized as the new Carcross Dump.

2.1 New Carcross Lagoon Site

The site has been described as a relatively flat lacustrine plain which is confined between the incised channel and adjacent wetlands of the Watson River to the west and the steeply ascending slopes of Caribou Mountain to the east. The south boundary is formed by an irregular series of bedrock highs which form the north edge of the recently constructed Watson River Subdivision. Access into the site is along the Gun Club access road at the south end and there is also a site access to the railroad near the north end of the site.

The general statigraphy of the site reveals two distinct layers of glaciolacustrine soils. The upper zone of surficial soils consists of sediments deposited in a shallow lake environment and consists of sandy silt interbedded with lenses of silty sand. The underlying soils consist of fairly homogeneous silty clays which are wet to saturated and very soft.

The thickness of the surficial silty soils ranges from 1.8 m to 4.3 m. The soils become wet and soft below 1.5 m and would be susceptible to softening during periods of rainfall or disturbance by construction traffic.

Constant head testing on recompacted samples indicate hydraulic conductivities between 10^{-7} and 10^{-8} m/s. Recently completed Guelph Permeameter testing of the near surface soils has also indicated hydraulic conductivities in the same range.

Attached to this letter is Appendix A, which contains relevant geotechnical information for this site.

2.2 km 50.7 Tagish Road Dump Site

The km 50.7 Dump Site is the second site considered to be acceptable as a fine material borrow source area. The site is triangular in shape with two bedrock ridges forming the east and west sides of the site while being bordered by the Tagish Road to the south. The area is cleared with a well constructed access road into the trench currently being utilized for solid waste disposal.

Soil conditions within the saddle of this site are described in existing EBA studies as lacustrine silt over silt till, underlain by bedrock.

Soil permeabilities within the lacustrine silt soils were measured as 2.2×10^{-8} m/s in a 1987 study completed by EBA. Rainfall retention in the initial trench excavated at the dump site confirms the impervious nature of the soils at this site.

Geotechnical information for this site is presented as Appendix B, also attached.

3.0 LAND TENURE

Both areas have land tenure issues which are in the process of being resolved. The lagoon site requires resolution of First Nations interests, Block Land Transfer (BLT) issues and Spot Land Transfers from the federal government. For the km 50.7 Dump Site, BLT issues are expected to be resolved this winter.

4.0 RECOMMENDATIONS FOR FURTHER WORK

Conversations with personnel responsible for development in both areas have suggested that cooperation between interested parties is going to be required. For instance, there is the possibility that additional material may be required for berm construction at the lagoon site, necessitating the need for a borrow area on or near site and YTG personnel have stated an interest in discussing possible advantages for trench enlargement at the km 50.7 Dump Site.

As such, this report should be considered preliminary until some of the conflicts associated with these two sites are sorted out. Once achieved, recommendations for additional quantity determinations at specific areas within the sites listed can be presented.

We trust this report satisfies your present requirements. If clarification of any of the information presented above is required, please contact the undersigned.

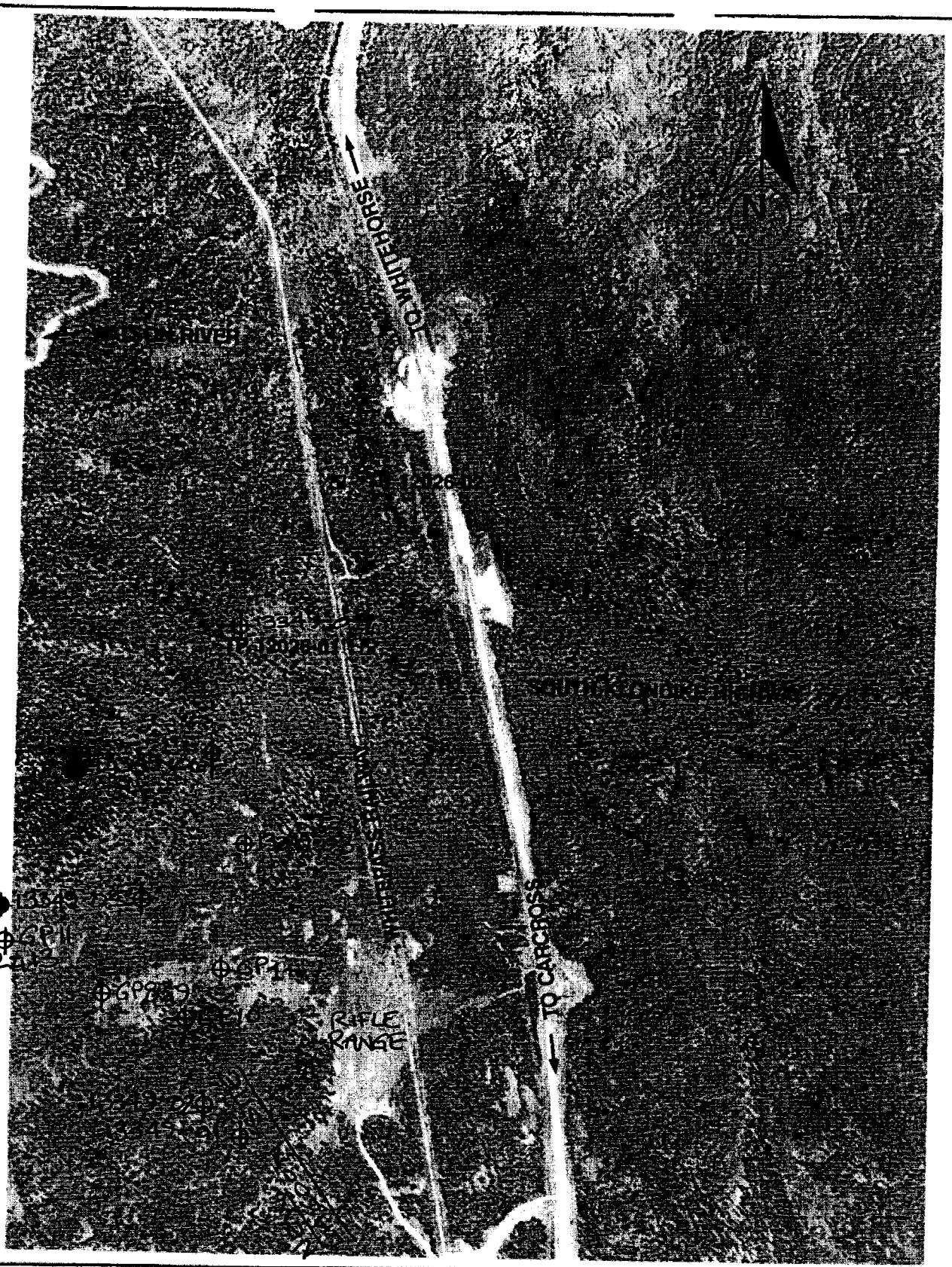
Yours truly,
EBA Engineering Consultants Ltd.

Myles C. Plaunt, C.E.T.
Engineering Technologist

J. Richard Trimble, P.Eng.
Project Director, Yukon Region
Whitehorse Office Manager

APPENDIX A

New Lagoon Site Geotechnical Information

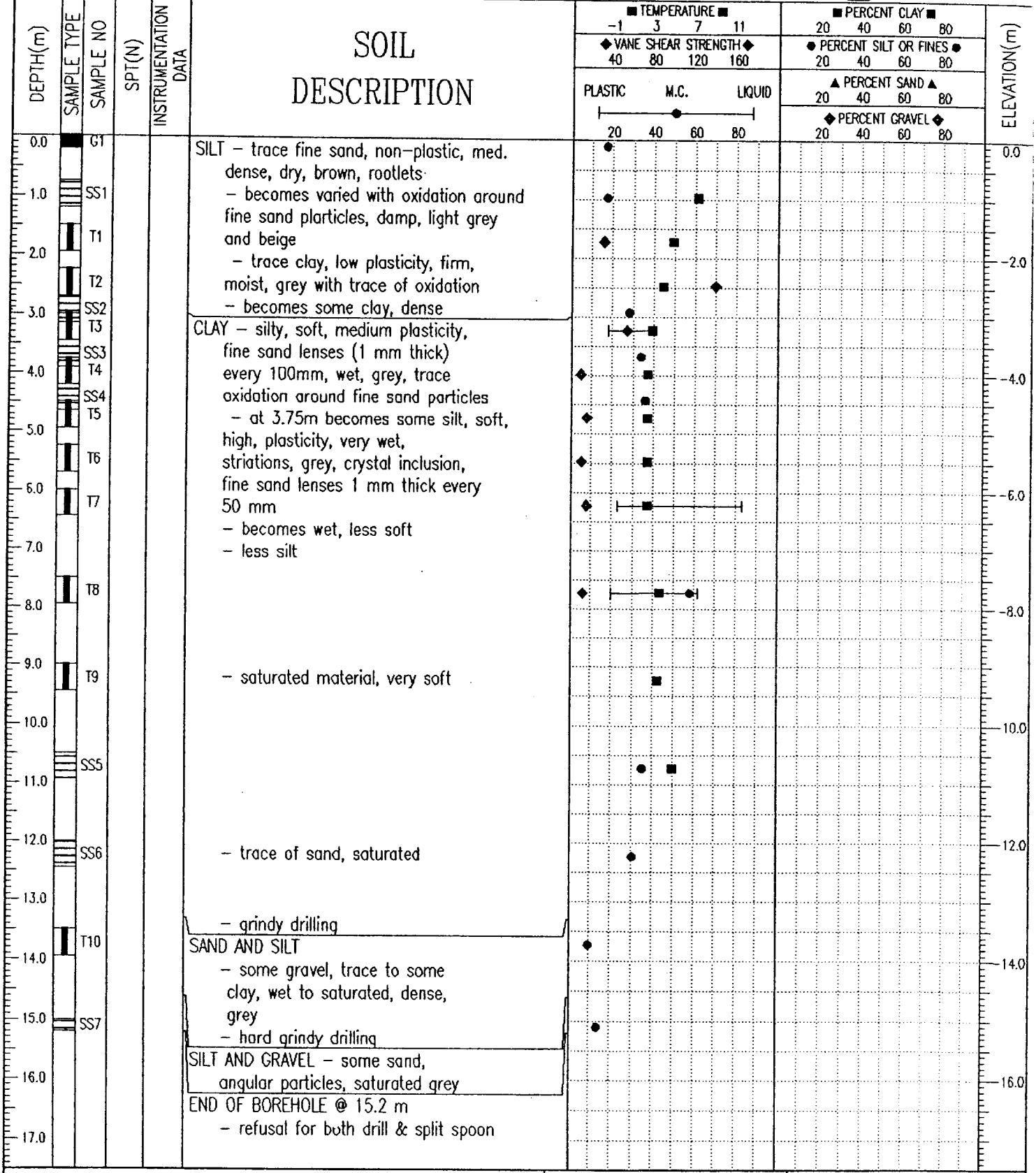


EBA Engineering Consultants Ltd.			PROJECT GEOTECHNICAL STUDY ~~BIG ROCK DUMP SITE~~
CLIENT ~~GOVERNMENT OF YUKON~~			TITLE **SITE PLAN SHOWING** TESTHOLE ~~TESTPIT~~ **LOCATIONS** IN PROPOSED LAGOON AREA
DATE **95-09-18**	DWN **MCP**	CHKD	DWG NO. **FIGURE 1** ~~0201-95-12020~~

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH1
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Hollow Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION:

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | SHEBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



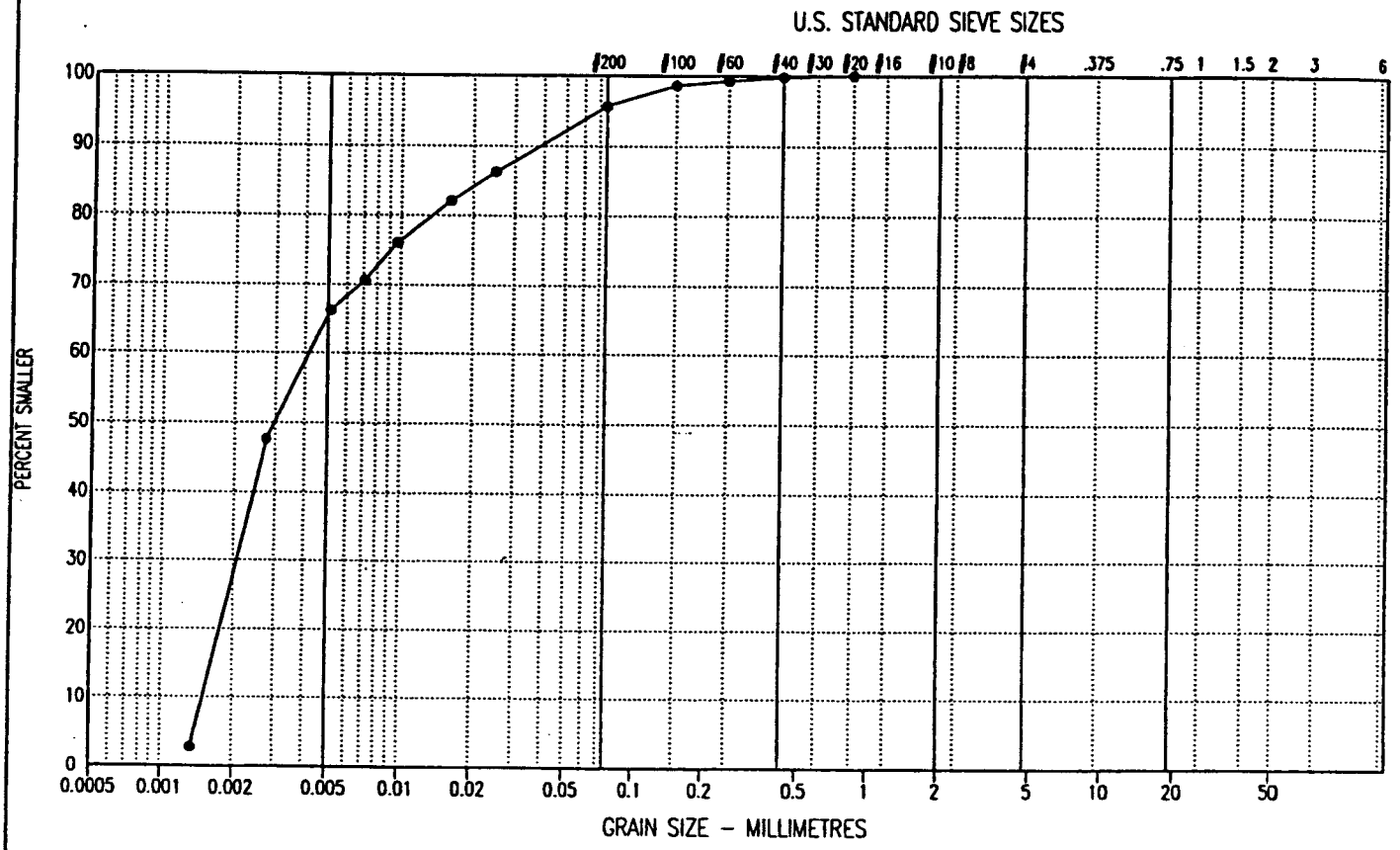
EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 15.2 m
	REVIEWED BY: JRT	COMPLETE: 98/09/11
	Fig. No:	Page 1 of 1

98/12/09 03:53PM (WELL17)

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C
			CLAY %	SILT %	SAND %	GRAVEL %			
●——●	T3/BH1	3.00 – 3.45	65.2	30.4	4.4	0.0	2.8	0.7	

Project: 0201-13349

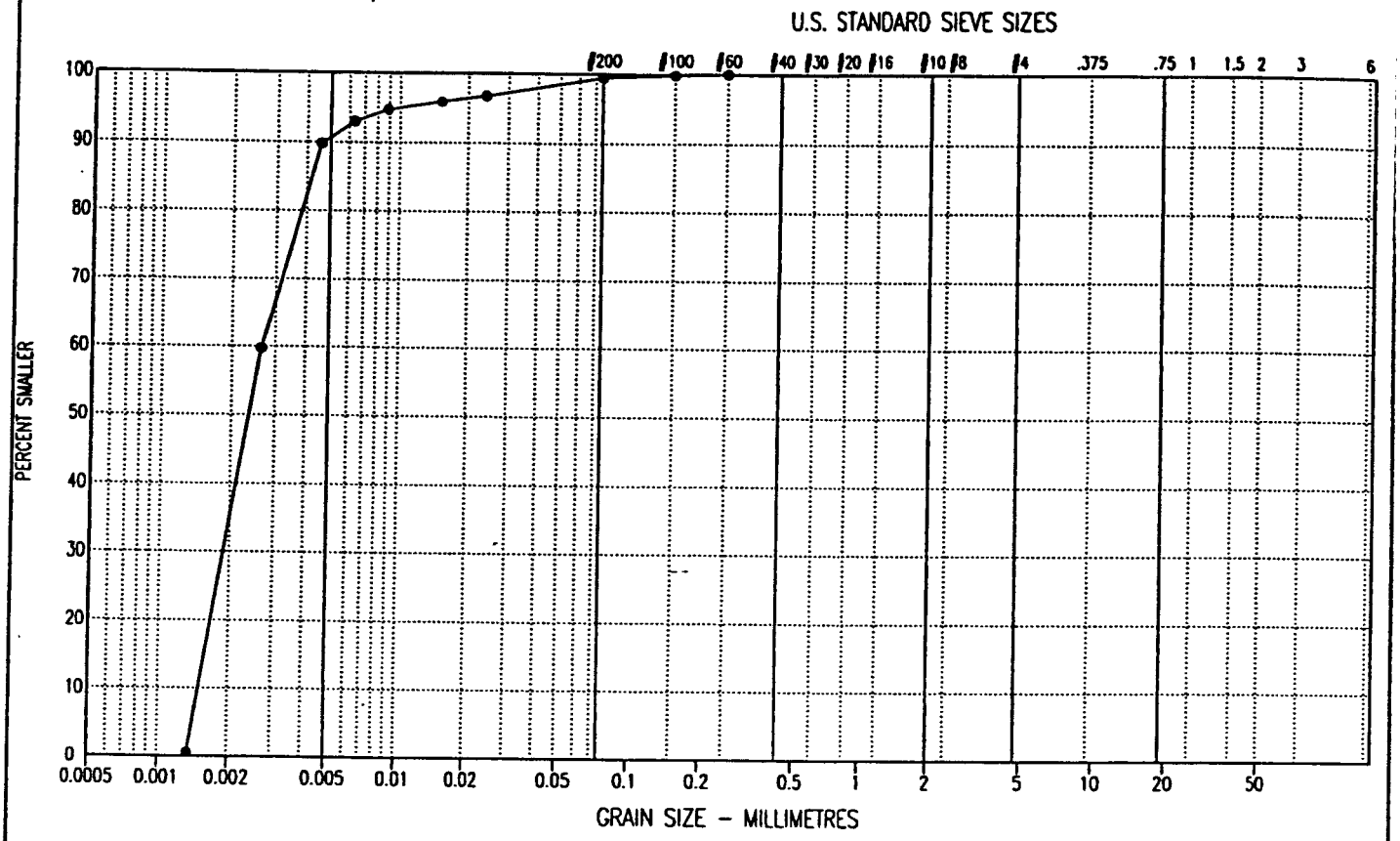
Date Tested: 98/10/14 BY: SK

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C
			CLAY %	SILT %	SAND %	GRAVEL %			
●—●	T7/BH1	6.00 – 6.45	90.5	8.9	0.6	0.0	1.7	1.0	

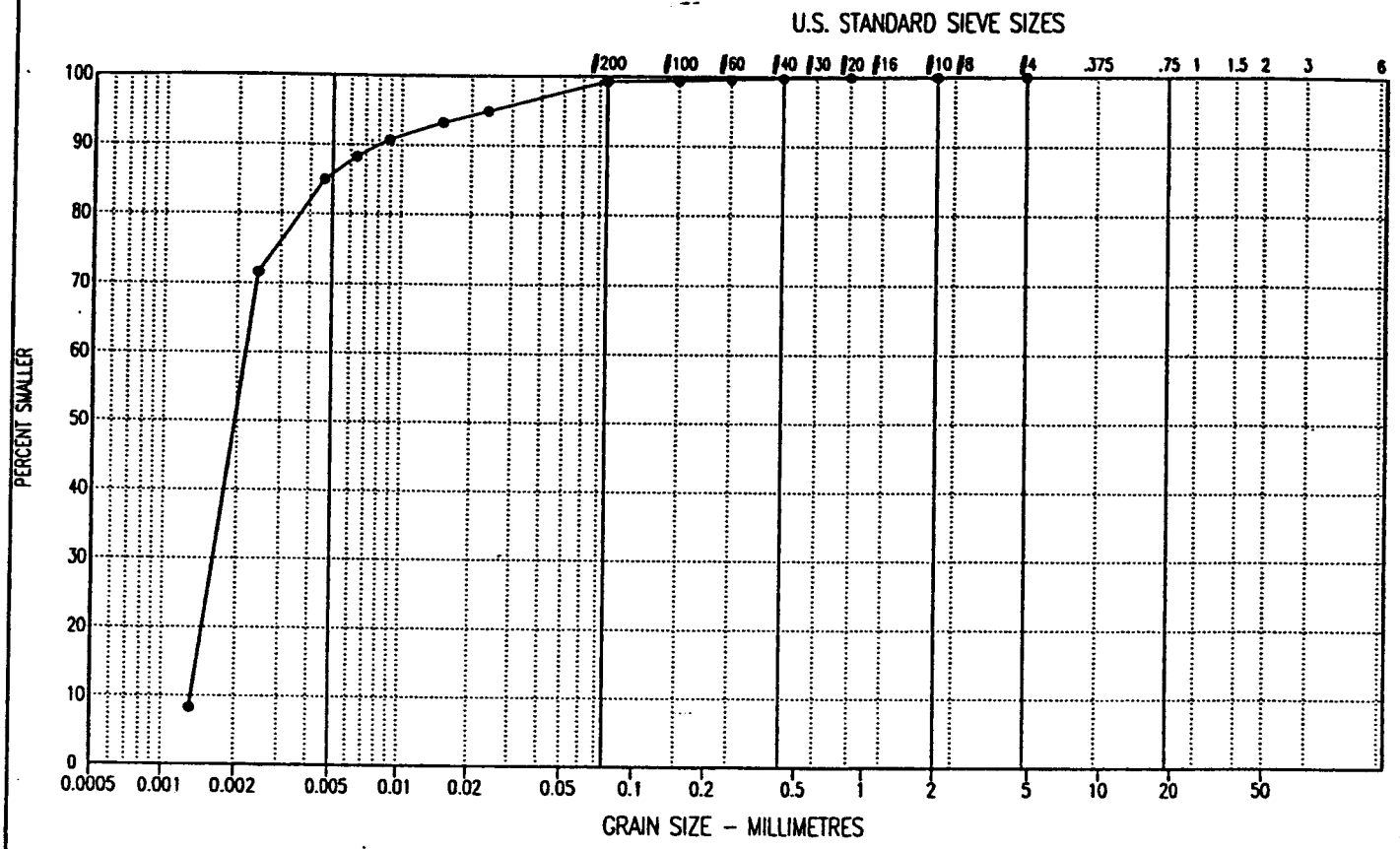
Project: 0201-13349 Date Tested: 98/10/14 BY: SK

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C
			CLAY %	SILT %	SAND %	GRAVEL %			
●——●	T8/BH1	7.50 – 7.95	85.6	13.6	0.8	0.0	1.7	1.0	

Project: 0201-13349

Date Tested: 98/10/14 BY: SK

Tested in accordance with ASTM D422 unless otherwise noted.

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH2
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Hollow Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION:

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPLIT SP. | CRREL BARREL | SHEBY TUBE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

SOIL DESCRIPTION

TEMPERATURE -1 3 7 11 | VANE SHEAR STRENGTH 40 80 120 160 | PLASTIC M.C. LIQUID 10 20 30 40 | PERCENT CLAY 20 40 60 80 | PERCENT SILT OR FINES 20 40 60 80 | PERCENT SAND 20 40 60 80 | PERCENT GRAVEL 20 40 60 80

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	INSTRUMENTATION DATA	SOIL DESCRIPTION
0.0					ORGANICS – damp, dark brown
1.0					SILT – trace of fine sand, non-plastic, med. dense, damp brown
					– becomes dense, some oxidation, damp, light grey to brown
2.0		T11			
		SS8			
3.0					– smoother drilling
		T12			– some clay, low plasticity, very soft, wet to saturated, brown
4.0		SS9			
5.0		T13			CLAY – trace of sand, high plasticity, soft, saturated, grey
6.0		SS10			
7.0					
8.0		SS11			
9.0		SS12			
10.0					SAND AND CLAY, –some gravel, grindy drilling
11.0					END OF BOREHOLE @ 10.5 m
12.0					
13.0					
14.0					
15.0					
16.0					
17.0					

ELEVATION(m): 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0

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Whitehorse, Yukon

LOGGED BY: MEB	COMPLETION DEPTH: 10.5 m
REVIEWED BY: JRT	COMPLETE: 98/09/12
Fig. No:	Page 1 of 1

98/12/09 03:40PM (WELL17)

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH3
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 683.5 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						ORGANICS – dry, dark brown
						SILT – some sand, loose, non-plastic, dry, light brown
1.0						
		20				
2.0						– trace of sand, moist
						– clayey, trace of sand, low plasticity, soft, moist, grey
		21				
3.0						
4.0						
5.0						CLAY – some silt, med-plasticity, soft, moist to wet, grey
		22				
6.0						END OF BOREHOLE @ 6.0 m
7.0						

STANDARD PENETRATION 20 40 60 80

PLASTIC M.C. LIQUID 10 20 30 40

PERCENT GRAVEL 20 40 60 80

PERCENT SAND 20 40 60 80

PERCENT SILT OR FINES 20 40 60 80

PERCENT CLAY 20 40 60 80

INSTRUMENTATION DATA

ELEVATION(m): 683.0, 681.0, 679.0, 677.0

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Whitehorse, Yukon

LOGGED BY: CPC	COMPLETION DEPTH: 6 m
REVIEWED BY: MEB	COMPLETE: 98/09/11
Fig. No:	Page 1 of 1

98/11/24 10:58AM (YUKON-7)

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH4
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 684 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION(m)
0.0						ORGANICS – dry, dark brown	684
						SILT – some sand, loose, non-plastic, dry, light brown	
1.0							
		17					
2.0							682.(
						– clayey, trace of sand, low plasticity, soft, moist to wet, grey	
		18					
3.0							
4.0							680.(
5.0							
		19					
6.0						END OF BOREHOLE @ 6.0 m	678.(
7.0							

■ STANDARD PENETRATION ■ 20 40 60 80

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

INSTRUMENTATION DATA

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: CPC	COMPLETION DEPTH: 6 m
	REVIEWED BY: MEB	COMPLETE: 98/09/11
	Fig. No:	Page 1 of 1

98/11/24 10:58AM (YUKON-7)

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH5
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 683.2 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	STANDARD PENETRATION 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	PERCENT GRAVEL 20 40 60 80 / PERCENT SAND 20 40 60 80 / PERCENT SILT OR FINES 20 40 60 80 / PERCENT CLAY 20 40 60 80	INSTRUMENTATION DATA	ELEVATION(m)
0.0						ORGANICS – dry, dark brown				683.
						SILT – some sand, loose non-plastic, dry, light brown to orangy brown				
1.0										
		9								
						CLAY – some silt, trace to sand, low plasticity, soft, moist to wet, grey				
2.0										681.(
		10								
3.0						– med-plasticity, soft, wet to saturated				
4.0										679.(
		11								
5.0										
		12								
6.0						END OF BOREHOLE @ 6.0 m				677.(
7.0										

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Whitehorse, Yukon

LOGGED BY: CPC	COMPLETION DEPTH: 6 m
REVIEWED BY: MEB	COMPLETE: 98/09/11
Fig. No:	Page 1 of 1

98/11/24 10:58AM (YUKON-7)

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH6
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 683.3 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	STANDARD PENETRATION 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	PERCENT GRAVEL 20 40 60 80 / PERCENT SAND 20 40 60 80 / PERCENT SILT OR FINES 20 40 60 80 / PERCENT CLAY 20 40 60 80	INSTRUMENTATION DATA	ELEVATION(m)
0.0						ORGANICS – dry, dark brown				683.
						SILT – some sand, loose, non-plastic, dry to humid, brownish grey				
1.0										
		13								
2.0						– trace of sand, trace of clay, low-plasticity, soft, oxidation staining,moist, grey				681.(
		14								
3.0										
4.0										
		15				CLAY – some silty to silty, med. plasticity, soft, moist to wet, grey				679.(
5.0										
		16								
6.0						END OF BOREHOLE @ 6.0 m				677.(
7.0										

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: CPC	COMPLETION DEPTH: 6 m
	REVIEWED BY: MEB	COMPLETE: 98/09/11
	Fig. No:	Page 1 of 1

98/11/24 10:59AM (YUKON-7)

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH7
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 682.5 m

SAMPLE TYPE: GRAB SAMPLE | NO RECOVERY | STANDARD PEN. | 75 mm SPOON | CRREL BARREL

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						ORGANICS – dry, dark brown
						SILT – some sand, loose, non-plastic, dry, light brown to brown
1.0		6				– stiffer drilling – trace of sand, trace of clay, low plasticity, firm, damp
2.0						CLAY – some silt, med. plasticity, soft, moist, light brown
3.0		7				– moist to wet
4.0						
5.0						GRAVEL – sandy, silty, sub-angular clasts, moist to wet, orangy brown
6.0		8				END OF BOREHOLE @ 6.0 m
7.0						

STANDARD PENETRATION 20 40 60 80

PLASTIC M.C. LIQUID 10 20 30 40

PERCENT GRAVEL 20 40 60 80

PERCENT SAND 20 40 60 80

PERCENT SILT OR FINES 20 40 60 80

PERCENT CLAY 20 40 60 80

INSTRUMENTATION DATA

ELEVATION(m): 682.5, 680.0, 678.0, 676.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: CPC	COMPLETION DEPTH: 6 m
	REVIEWED BY: MEB	COMPLETE: 98/09/11
	Fig. No:	Page 1 of 1

98/11/24 10:59AM (YUKON-7)

GEOTECHNICAL INVESTIGATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	BOREHOLE NO: 13349-BH8
PROPOSED SEWAGE LAGOON	DRILL: CME 750 c/w Solid Stem Auger	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 682.3 m

SAMPLE TYPE: GRAB SAMPLE; NO RECOVERY; STANDARD PEN.; 75 mm SPOON; CRREL BARREL

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0						ORGANICS – dry, dark brown
						SILT – some sand, non-plastic loose, dry to humid, brown
1.0						
		2				
2.0						
						– trace of sand, med. dense, oxidation staining, low plasticity, soft, damp, greyish brown
3.0		3				
4.0						CLAY – some silt, med. plasticity, soft, damp, grey
		4				
5.0						– moist
		5				
6.0						END OF BOREHOLE @ 6.0 m
7.0						

STANDARD PENETRATION 20 40 60 80

PLASTIC M.C. LIQUID 10 20 30 40

PERCENT GRAVEL 20 40 60 80

PERCENT SAND 20 40 60 80

PERCENT SILT OR FINES 20 40 60 80

PERCENT CLAY 20 40 60 80

INSTRUMENTATION DATA

ELEVATION(m): 682.0, 680.0, 678.0, 676.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: CPC	COMPLETION DEPTH: 6 m
REVIEWED BY: MEB	COMPLETE: 98/09/11
Fig. No:	Page 1 of 1

98/11/24 10:59AM (YUKON-7)

GEOTECHNICAL EVALUATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	TEST PIT NO: 13349-GP10
PROPOSED SEWAGE LAGOON	BACKHOE: CASE 580D rubber tired	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 683.8 m

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					ORGANICS (TYPICAL FOREST FLOOR) – silty, non-plastic, loose, damp, beige
					SILT – trace of fine sand, firm, non-plastic, light grey and orange (oxidation), damp,
1.0	■	7			SAND – some silt, fine grained sand sizes, medium dense, poorly graded damp, light grey and orange (oxidation throughout)
					SILT – some clay, firm, low plasticity, moist, light grey with orange (oxidation throughout), traces of decayed organic inclusions, tiny rootlets (vertical) holes (1/2 mm diameter) with extensive oxidation around holes
2.0					
	■	8			
3.0					– becomes soft and wet
					– still very oxidized with rootlet holes
4.0					
					– still very oxidized with rootlet holes
	■	9			
5.0					END OF TESTPIT @ 4.8 m NOTE: Guelph Permemeter test performed: – GP10 @ depth of 2.8 m

■ STANDARD PENETRATION ■ 10 20 30 40
◆ TEMPERATURE ◆ −1 3 7 11
PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80
● PERCENT SAND ● 20 40 60 80
▲ PERCENT SILT OR FINES ▲ 20 40 60 80
◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 683.0, 681.0, 679.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 4.8 m
	REVIEWED BY: JRT	COMPLETE: 98/10/08
	Fig. No:	Page 1 of 1

98/11/25 08:06AM (YUKON-TS)

GEOTECHNICAL EVALUATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	TEST PIT NO: 13349-GP11
PROPOSED SEWAGE LAGOON	BACKHOE: CASE 580D rubber tired	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 682.7 m

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SILT AND ORGANICS – roots, topsoil damp, brown
					SILT – dense, non-plastic, dry, light grey, rootlets
					SAND – trace of silt, fine grained sand sizes, dense, poorly graded, damp, light brown with oxidation (mottled) – becomes fine to medium grained, no silt @ 0.3 m – becomes very fine grained, trace of silt, light grey @ 0.5 m – becomes fine to medium grained, mottled, moist @ 0.6 m
1.0					– becomes rust coloured, wet @ 1.25 m – 5 cm thick silt len @ 1.3 m – very fine sand starts (some silt) @ 1.35 m – becomes dark grey @ 1.48 m
					SILT – some fine grained sand, non-plastic, firm, wet, dark grey
2.0					CLAY – some silt, medium plasticity, firm, wet, dark grey
					END OF TESTPIT @ 2.3 m NOTE: Guelph Permemeter test performed: – GP11 @ depth of 2.25 m
3.0					
4.0					

■ STANDARD PENETRATION ■ 10 20 30 40
◆ TEMPERATURE ◆ -1 3 7 11
PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80
● PERCENT SAND ● 20 40 60 80
▲ PERCENT SILT OR FINES ▲ 20 40 60 80
◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m)
682.7
680.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 2.3 m
	REVIEWED BY: JRT	COMPLETE: 98/10/09
	Fig. No:	Page 1 of 1

98/11/25 08:07AM (YUKON-T3)

GEOTECHNICAL EVALUATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	TEST PIT NO: 13349-GP12
PROPOSED SEWAGE LAGOON	BSCKHOE: CASE 580D rubber tired	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 682.4 m

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					ORGANIC AND SILT – roots, topsoil, damp, brown
					SILT – non-plastic, stiff, damp, light brown, rootlets
					SAND – fine to medium grained, trace of silt, poorly graded, dense, damp, light brown with rust mottled appearance
1.0	■	10			SILT – clayey, stiff, low plasticity, moist, beige and grey (no sign of tiny holes or rust coloured oxidation)
2.0	■	11			CLAY AND SILT (VARVED) – alternating silt and clay layers (typically 2 mm silt layers, 1 mm thick clay layers) low plasticity, stiff, moist, grey (clay) and beige (silt), film of oxidation between layers
					END OF TESTPIT @ 2.3 m
					NOTE: Not dark grey like other clay deposit encountered where GP10 test was conducted
					NOTE: Guelph Permemeter test performed: – GP12 @ depth of 2.25 m – GP13 @ depth of 1.2 m
3.0					
4.0					

■ STANDARD PENETRATION ■ 10 20 30 40
◆ TEMPERATURE ◆ -1 3 7 11
PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80
● PERCENT SAND ● 20 40 60 80
▲ PERCENT SILT OR FINES ▲ 20 40 60 80
◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m)
682.0
680.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 2.3 m
	REVIEWED BY: JRT	COMPLETE: 98/10/09
	Fig. No:	Page 1 of 1

98/11/25 08:07AM (YUKON-T3)

PRELIMINARY SITE INVESTIGATION	CLIENT: YTG – ENGINEERING & DEVELOPMENT	TEST PIT NO: 12026-01
PROPOSED BIG ROCK DUMP SITE	EXCAVATOR: RUBBER TIRED BACKHOE	PROJECT NO: 0201-95-12026
CARCROSS, YUKON	UTM ZONE: 8 N6674850 E515500	ELEVATION:

SAMPLE TYPE: GRAB SAMPLE; NO RECOVERY; STANDARD PEN.; 75 mm SPLIT SP.; CRREL BARREL; NW CORE

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

SOIL DESCRIPTION

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	WELL INSTALLATION	SOIL DESCRIPTION
0.0					MOSS GROUND COVER AND ORGANIC ROOT MAT
		1			SAND – silty, trace of organics, rootlets throughout, sand is medium to coarse grained from 0.1 to 0.4 m, damp, compact (est.), light olive brown
1.0		2			SILT – sandy, fine grained, uniform, moist, firm, mottled brown with grey
2.0		3			– siltier with trace of clay, becoming wet to saturated between 2.0 and 3.0 m
3.0		4			
					SILT – trace to some clay, saturated, firm, dark grey – water table measured at 3.7 m on 95-08-16; approximately 28 hours after installation
4.0		5			
5.0					END OF TESTPIT @ 4.6 m – standpipe installed to 4.6 m
6.0					

■ STANDARD PENETRATION ■ 10 20 30 40

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ GROUND ICE DESCRIPTION ◆ 20 40 60 80

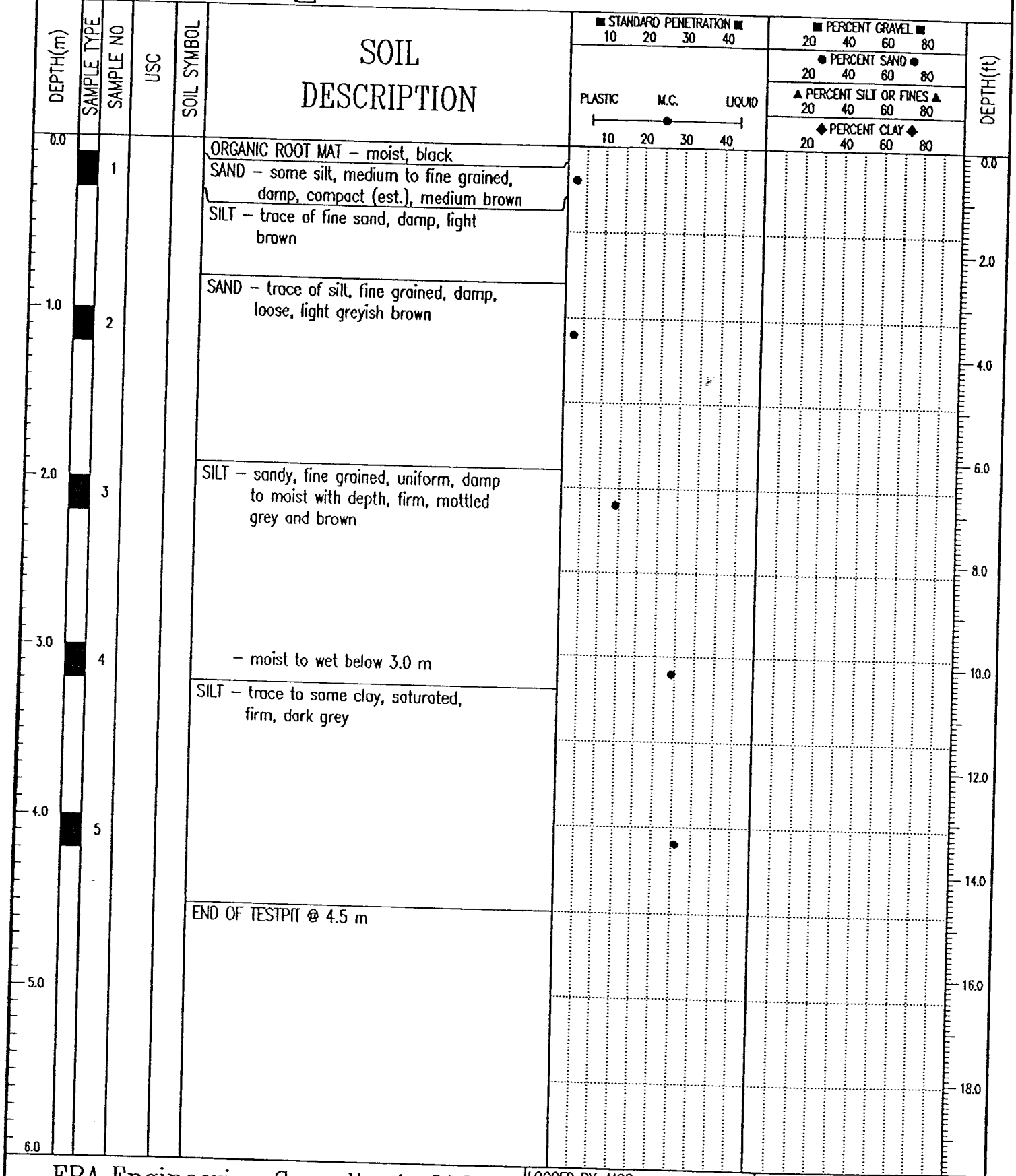
DEPTH(ft): 0.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MCP REVIEWED BY: MCP Fig. No:	COMPLETION DEPTH: 4.6 m COMPLETE: 95/09/15 Page 1 of 1

95/09/20 09:15AM (WELL76.0)

PRELIMINARY SITE INVESTIGATION	CLIENT: YTG – ENGINEERING & DEVELOPMENT	TEST PIT NO: 12026-02
PROPOSED BIG ROCK DUMP SITE	EXCAVATOR: RUBBER TIRED BACKHOE	PROJECT NO: 0201-95-12026
CARCROSS, YUKON	UTM ZONE: 8 N6675250 E515350	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY



ORGANIC ROOT MAT – moist, black

SAND – some silt, medium to fine grained, damp, compact (est.), medium brown

SILT – trace of fine sand, damp, light brown

SAND – trace of silt, fine grained, damp, loose, light greyish brown

SILT – sandy, fine grained, uniform, damp to moist with depth, firm, mottled grey and brown

– moist to wet below 3.0 m

SILT – trace to some clay, saturated, firm, dark grey

END OF TESTPIT @ 4.5 m

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MCP	COMPLETION DEPTH: 4.5 m
	REVIEWED BY: MCP	COMPLETE: 95/09/15
	Fig. No:	Page 1 of 1

95/09/20 09:16AM (YUKON-T6)

Summary

Test Number	Permeability Data (cm/sec)	Description of Location	Depth of Test (m)	Soil Type	My Guess
GP3	8.793E-05	grassy area, near weather station	0.55	Silt (with rootlet holes)	2.3E-04
GP7	5.496E-05	grassy area, near weather station	3.00	Silt (with rootlet holes)	1.4E-04
GP9	5.006E-07	willows, hummocky, just west of BH93-C	1.35	Clay (dark grey in colour)	1.0E-06
GP11	5.216E-07	willows, hummocky, just south of BH92-1A	2.25	Clay (dark grey in colour)	1.0E-06
GP12	2.217E-07	spruce forest and willows, just west of BH98-7	2.25	Clay (varved)	5.6E-07
GP13	2.128E-06	spruce forest and willows, just west of BH98-7	1.20	Clay, silty (not varved)	4.2E-06

NOTE: SEE LOGS, FOLLOWING

GEOTECHNICAL EVALUATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	TEST PIT NO: 13349-GP1-4
PROPOSED SEWAGE LAGOON	EXCAVATOR: 225 CAT HOE	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 683.03 m

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					ORGANICS (Grass, Roots) – silty, dark brown, moist
	■	1			SILT (Cryoturbated for 0.3 m) – loose non-plastic, extensive layering (1 – 2 cm thick), damp, grey, rootlets – trace of fine sand, firm, non-plastic, no layering, damp, beige and light grey, rootlets (trace)
	■	2			
	■	3			SAND – trace of silt, fine grained sand sizes, medium dense, poorly graded, damp, grey with orange (oxidation), black decayed rootlet holes thoughout
1.0					END OF TESTPIT @ 1.0 m
					NOTE: Guelph Permemeter tests performed: – GP1 @ depth of 0.9 m – GP2 @ depth of 0.6 m – GP3 @ depth of 0.55 m – GP4 @ depth of 0.2 m
2.0					
3.0					
4.0					

■ STANDARD PENETRATION ■ 10 20 30 40

◆ TEMPERATURE ◆ −1 3 7 11

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 683.0, 681.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 1 m
	REVIEWED BY: JRT	COMPLETE: 98/10/07
	Fig. No:	Page 1 of 1

98/11/25 08:06AM (YUKON-13)

GEOTECHNICAL EVALUATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	TEST PIT NO: 13349-GP5-7
PROPOSED SEWAGE LAGOON	BACKHOE: CASE 580D Rubber Tired	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 683.03 m

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					SILT (CRYOTURBATED) – non-plastic, damp, layered, crumbly, grey, rootlets throughout
					– non-plastic, firm, humid, beige with orange oxidation and black decayed organic (rootlets) inclusion
1.0					FINE SAND – trace of silt, medium dense, poorly graded, layering (alternating fine graned lenses with fine to medium grained lenses), damp, grey with rust orange oxidation (more severe oxidation where medium grained sand occurs), decayed black organic inclusions to 0.8 m
					SILT – clayey, low plasticity, firm, layered, moist, grey with rust (oxidation) throughout, fine sand lenses (5 – 7 cm thick) noted between 1.38 – 1.45 m and 1.55 – 1.6 m
2.0					– becomes wet, sand lenses observed beyond 2.2 m were strictly fine sand and silt particles (1 mm thick) between silt layers, still very oxidized
3.0					CLAY – some silt, soft, medium plasticity, wet, dark grey
4.0					END OF TESTPIT @ 3.4 m NOTE: Guelph Permemeter tests performed: – GP5 @ depth 1.9 m – GP6 @ depth 2.4 m – GP7 @ depth 2.9 m

■ STANDARD PENETRATION ■ 10 20 30 40
◆ TEMPERATURE ◆ -1 3 7 11
PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80
● PERCENT SAND ● 20 40 60 80
▲ PERCENT SILT OR FINES ▲ 20 40 60 80
◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m) 683.0 681.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB REVIEWED BY: JRT Fig. No:
	COMPLETION DEPTH: 3.4 m COMPLETE: 98/10/08 Page 1 of 1

99/11/25 08:07AM (YUKON-T3)

GEOTECHNICAL EVALUATION	CLIENT: YUKON ENGINEERING SERVICES LTD.	TEST PIT NO: 13349-GP8-9
PROPOSED SEWAGE LAGOON	BACKHOE: CASE 580D Rubber Tired	PROJECT NO: 0201-98-13349
CARCROSS, YT	UTM ZONE: 8 N6674700 E515200	ELEVATION: 683.2 m

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					ORGANICS AND SILT – extensive roots (from willow bushes), black, damp
					SILT – trace of fine sand, non-plastic, firm, damp, light grey with orange oxidation throughout
		4			SAND – fine grained sand sizes, trace of silt, dense, poorly graded, damp, light grey
		5			– becomes fine to medium grained @ 0.53 m
1.0					– becomes fine grained @ 0.7 m
					SILT – some clay, firm, non-plastic, layered, moist, light grey with orange oxidation throughout
		6			CLAY – some silt, firm, medium plasticity, dense, ,moist, dark grey
					END OF TESTPIT @ 1.4 m
					NOTE: Guelph Permemeter tests performed: – GP8 @ depth of 0.25 m – GP9 @ depth of 1.35 m
2.0					
3.0					
4.0					

■ STANDARD PENETRATION ■ 10 20 30 40

◆ TEMPERATURE ◆ -1 3 7 11

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

ELEVATION(m): 683.0, 681.0

EBA Engineering Consultants Ltd. Whitehorse, Yukon	LOGGED BY: MEB	COMPLETION DEPTH: 1.4 m
	REVIEWED BY: JRT	COMPLETE: 98/10/08
	Fig. No:	Page 1 of 1

98/11/25 08:07AM (YUKON-T3)

APPENDIX B

km 50.7, Tagish Road Dump Site Geotechnical Information

APPENDIX D

SITE NO. 4 - CARCROSS

LOCATION:	km 50.7 (North Side) Tagish Road (approx. 3 km from Carcross)
VEGETATION:	Well vegetated with numerous large spruce trees up to 600 mm butt diameter.
SOIL CONDITIONS:	Lacustrine silt over sandy silt till over bedrock.
GROUNDWATER:	No water detected in any of the 9 holes drilled.
SOIL PERMEABILITY:	$k = 2.2 \times 10^{-6}$ cm/s at 4.5 m depth RELATIVE PERMEABILITY: Very low
BEDROCK:	The low ridge on the west side of the site appears to be bedrock cored (see Drawing No. 4604-D-2; however, the additional probe holes drilled during phase II have proven out a small area where bedrock is not shallower than 4.9 m.
PERMAFROST:	None detected
ACCESS:	Good access from a long straight section of the Tagish Road, and through an abandoned borrow area. A culvert will be required, and the road surface (if constructed of local materials) should be topped with 300 mm of compacted, well-graded gravel fill. A capping of 50 mm of 20 mm crushed traffic gravel will be sufficient for surfacing.

TRENCH EXCAVATION: A dozer will be able to complete the excavation down to 3.0 m. The logs indicate that excavation below 4.0 m may require a backhoe.

SITE DRAINAGE: The proposed dump is located on the east edge of a low bedrock cored ridge, sandwiched between it and another low ridge (not investigated) to the east. No evidence of surface drainage courses were visible, but the general slope of the land is towards the highway. The surface of the site is well drained.

COVER MATERIAL: The excavated soil will be acceptable as waste cover material, and will create a relatively impervious cover.

SITE DEVELOPMENT AND OPERATION: The location at km 50.7 appears to have good potential for a landfill. The landfill operations should be kept north of the power line with a buffer between the power line and the landfill site. Test holes to date have concentrated on the west portion of the site and indicate good sub-surface conditions in a limited band for a landfill operation.

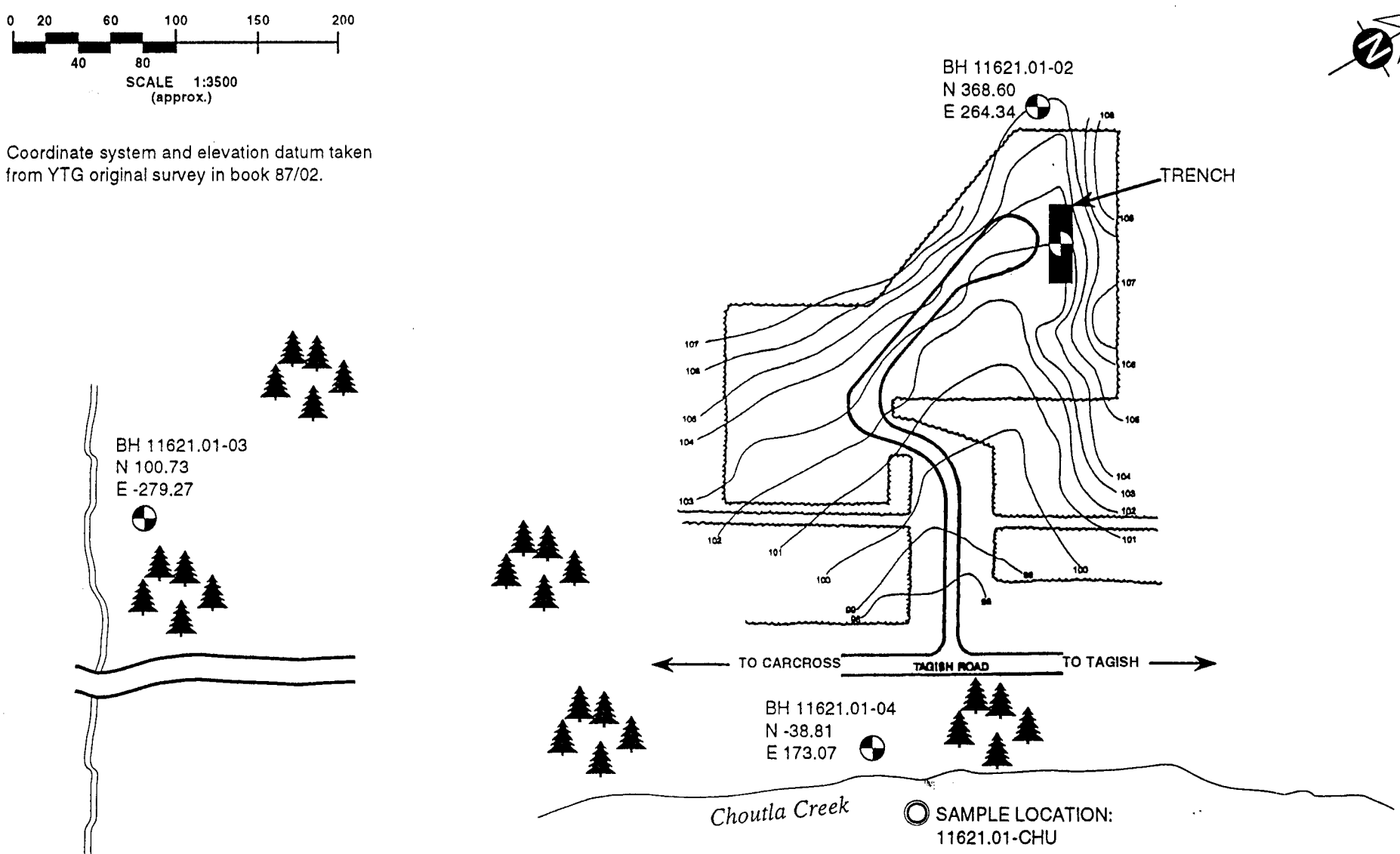
Possible further testing toward the easterly ridge (see attached drawing) should be undertaken with a rubber tired backhoe to determine the depth to bedrock and the possibility of shallower trenches.

From the preliminary field visit , it would seem reasonable to find an area for the faecal waste pond. Again this can only be sited when more soil data is known such that a landfill area can be best located.

Access to the site should be through the open borrow area and once across the power line the access road should turn to allow the natural buffer of trees to shield the site.

The block of land to dedicate for the site, if accepted, should include the portion between the power line and the road.

Site drainage does not appear to be a problem. The extra development costs in roadway and the limited proven area could result in further search in the area for an alternative site. Visual observations of ditch cuts along Highway No. 8 indicate several potential sites between km 50 and 52.



EBA Engineering Consultants Ltd.	PROJECT CARCROSS DUMP MONITORING WELLS Km 50.7 TAGISH ROAD, YUKON
CLIENT GOVERNMENT OF YUKON	TITLE LOCATION OF MONITORING WELLS
DATE 96.11.14 DWN CRE CHKD	FILE NO. 0221-96-11621.01 DWG 11621-01-01 REVISION 0

ALTERNATE WASTE DISPOSAL SITES	BOREHOLE No. SITE4-1	0201-4604
SITE No.4, HIGHWAY No. 8 (km 50.7) CARCROSS, YUKON	RELATIVE ELEVATION 0 (m) CME 750 c/w SOLID AUGERS	

SAMPLE TYPE ■ ▨ ☒ SPT ▤ GRAB ▥ ▦

DEPTH (m)	SOIL DESCRIPTION
0	PEAT(PT)—organic silt,moss and rootlets
.6	SILT(ML)—some clay,trace fine-grained sand,trace gravel;moist to wet; firm to stiff(est.);olive
1	—sandy,some gravel to gravelly; with occasional cobble;coarse to fine-grained gravel;damp; nonplastic
1.5	
2	
2.5	BEDROCK—shale;fractured
3	
3.5	
4	
4.5	
5	
5.5	END OF BOREHOLE 5.3 m
6	

SAMPLE

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18

PLASTIC LIMIT — WATER CONTENT(%) — LIQUID LIMIT

20 40 60 80

COMPRESSIVE STRENGTH

16 18 20 22

WET UNIT WEIGHT kN/m³

20 40 60 80

CLIENT: GOVERNMENT OF YUKON

DEPTH TO WATER: dry upon completion

EBA ENGINEERING CONSULTANTS LTD.
WHITEHORSE YUKON

COMPLETION DEPTH 5.3 m	COMPLETE 10:35 87-06-19
LOGGED BY MAV	DWG No.

ALTERNATE WASTE DISPOSAL SITES	BOREHOLE No. SITE4-2	0201-4604
SITE No.4, HIGHWAY No. 8 (km 50.7) CARCROSS, YUKON	RELATIVE ELEVATION 0 (m) CME 750 c/w SOLID AUGERS	

SAMPLE TYPE ■ ▨ ☒ SPT ▤ GRAB ▥ ▦

DEPTH (m)	SOIL DESCRIPTION
0	PEAT(PT)—organic silt,moss,rootlets
-.5	SILT(ML)—some gravel,some sand,trace clay:moist to wet:low plastic: olive brown
-1	SAND(SM)—gravelly,silty,trace clay;with occasional cobbles;damp to moist; compact to dense(est.);nonplastic dark olive brown
-1.5	
-2	
-2.5	BEDROCK—shale,fractured
-3	—auger refusal;move rig 2 m and attempt to penetrate past 2.7 m
-3.5	
-4	END OF BOREHOLE 3.8 m BOREHOLE TERMINATED DUE TO AUGER REFUSAL.
-4.5	
-5	
-5.5	
-6	

SAMPLE

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18

PLASTIC LIMIT — WATER CONTENT(%) — LIQUID LIMIT
20 40 60 80

COMPRESSIVE STRENGTH

16 18 20 22
WET UNIT WEIGHT kN/m³

20 40 60 80

CLIENT: GOVERNMENT OF YUKON

DEPTH TO WATER: dry upon completion

EBA ENGINEERING CONSULTANTS LTD.
WHITEHORSE YUKON

COMPLETION DEPTH 3.8 m	COMPLETE 11:45 87-06-19
LOGGED BY MAV	DWG No.

ALTERNATE WASTE DISPOSAL SITES	BOREHOLE No. SITE4–3	0201–4604
SITE No.4, HIGHWAY No. 8 (km 50.7) CARCROSS, YUKON	RELATIVE ELEVATION 0 (m) CME 750 c/w SOLID AUGERS	

SAMPLE TYPE ■ ▨ ☒ SPT ▤ GRAB ▥ ▥

DEPTH (m)	SOIL DESCRIPTION
0	PEAT(PT)–organic silt,moss,rootlets
.5	SILT(ML)–some clay,trace fine–grained sand:moist to wet:firm(est.): low plastic;olive –some gravel to gravelly
1	–gravelly,some sand;with occasional cobbles throughout; damp;compact to dense(est.); nonplastic
1.5	
2	
2.5	BEDROCK–shale,fractured
3	
3.5	
4	
4.5	
5	
5.5	END OF BOREHOLE 5.5 m BOREHOLE TERMINATED DUE TO AUGER REFUSAL.
6	

SAMPLE

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18

PLASTIC LIMIT — WATER CONTENT(%) — LIQUID LIMIT

20 40 60 80

COMPRESSIVE STRENGTH

16 18 20 22

WET UNIT WEIGHT kN/m³

20 40 60 80

CLIENT: GOVERNMENT OF YUKON

DEPTH TO WATER: dry upon completion

EBA ENGINEERING CONSULTANTS LTD.
WHITEHORSE YUKON

COMPLETION DEPTH 5.5 m	COMPLETE 12:45 87–06–19
LOGGED BY MAV	DWG No.

ALTERNATE WASTE DISPOSAL SITES

SITE No.4, HIGHWAY No. 8 (km 50.7)
CARCROSS, YUKON

BOREHOLE No. SITE4-4 | 0201-4604

RELATIVE ELEVATION 0 (m)

CME 750 c/w SOLID AUGERS

SAMPLE TYPE ■ ▨ ☒ SPT ▤ GRAB ▥ ▮ COMPRESSIVE STRENGTH

DEPTH (m)	SOIL DESCRIPTION
0	PEAT(PT)–organic silt,moss,and rootlets
	SILT(ML)–some clay,trace fine–grained sand;moist to wet;firm(est.); low plastic;olive grey
1	–clayey;thin laminae,wavy,non–parallel;firm to stiff(est.)
2	
3	–trace gravel and shale fragments; wet;olive grey
	–moisture content increasing with depth
4	–some clay;wet to saturated; olive
5	–gravelly,some sand
6	SAND(SP/SM)–gravelly,trace to some silt; with shale fragments throughout; moist;compact(est.);nonplastic; olive grey,with iron oxide staining
8	
	BEDROCK–shale;fractured
9	END OF BOREHOLE 9.1 m
	BOREHOLE TERMINATED DUE TO AUGER REFUSAL.
10	
11	
12	
13	
14	
15	
16	

SAMPLE

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52

PLASTIC LIMIT | WATER CONTENT(w) | LIQUID LIMIT

20 40 60 80

16 18 20 22
WET UNIT WEIGHT kN/m³

20 40 60 80

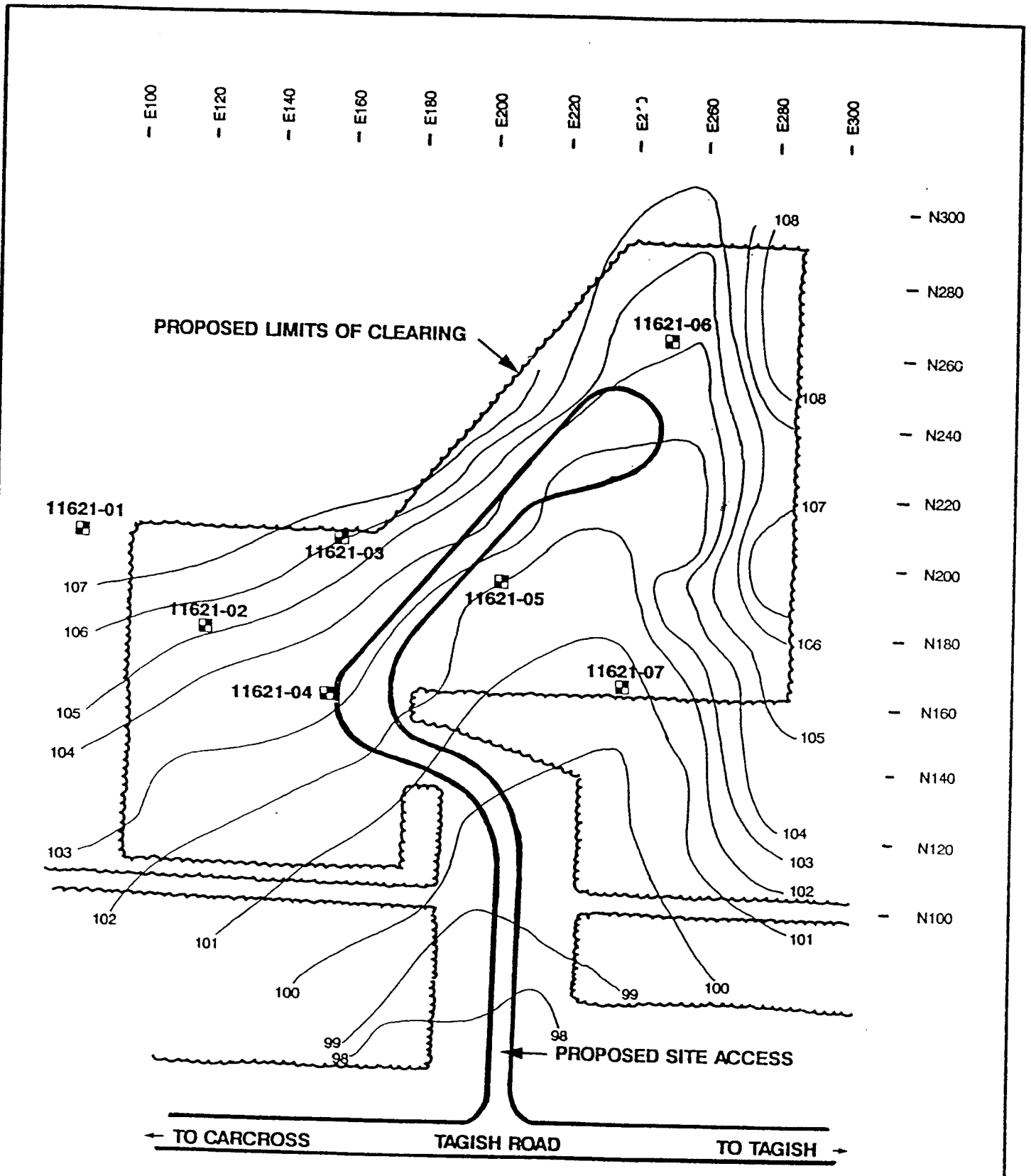
CLIENT: GOVERNMENT OF YUKON

DEPTH TO WATER: dry upon completion

EBA ENGINEERING CONSULTANTS LTD.
WHITEHORSE YUKON

COMPLETION DEPTH 9.1 m | COMPLETE 14:30 87-06-19

LOGGED BY MAV | DWG No.



EBA Engineering Consultants Ltd.		PROJECT	**PROPOSED DUMP SITE km 50.7 - TAGISH ROAD**
CLIENT	**GOVERNMENT OF YUKON ENGINEERING AND DEVELOPMENT**	TITLE	**SITE PLAN SHOWING TESTPIT LOCATION**
DATE **95-10-23**	DWN **MCP** CHKD	DWG NO. **FIGURE 1**	**0201-11621**

PPOPOSED DUMP SITE	CLIENT: YTG – ENGINEERING & DEVELOPMENT	TEST PIT NO: 11621-05
km 50.7 TAGISH ROAD	TRACKED EXCAVATOR: NORTHWEST 35 DH	PROJECT NO: 0201-95-11621
CARCROSS, YUKON	UTM ZONE: 8 N6673200 E518550	ELEVATION: 102.50 (m)

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					TEA GROUND COVER AND ORGANIC ROOT MAT
					SILT – trace of fine sand, trace of clay, rootlets throughout, moist, medium brown
					SILT – trace of clay, trace of fine sand, moist, dense, light olive
1.0	■	1			
					SILT – some clay, moist to wet, dense, medium plastic, dark olive – thin parallel laminae
2.0	■	2			
3.0	■	3			– no slough throughout depth of testpit
4.0					
					END OF TESTPIT @ 4.5 m
5.0					

■ STANDARD PENETRATION ■ 10 20 30 40

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

◆ PERCENT CLAY ◆ 20 40 60 80

DEPTH(ft) 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: MCP	COMPLETION DEPTH: 4.5 m
REVIEWED BY: MCP	COMPLETE: 17/10/95
Fig. No:	Page 1 of 1

95/10/23 09:10AM (YUKON-TS)

PROPOSED DUMP SITE	CLIENT: YTG - ENGINEERING & DEVELOPMENT	TEST PIT NO: 11621-06
km 50.7 TAGISH ROAD	TRACKED ECAVATOR: NORTHWEST 35 DH	PROJECT NO: 0201-95-11621
CARCROSS, YUKON	UTM ZONE: 8 N6673450 E518560	ELEVATION: 104.50 (m)

SAMPLE TYPE ■ GRAB ⊘ NO RECOVERY

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	USC	SOIL SYMBOL	SOIL DESCRIPTION
0.0					TEA GROUND COVER AND ORGANIC ROOT MAT
					SILT – trace of fine sand, rootlets throughout, moist, medium brown
					SILT –some clay, moist, medium plastic, dense, medium to dark olive
1.0	■	1			
					– moisture content increases with depth
2.0	■	2			
3.0	■	3			
					– no slough throughout depth of testpit
4.0	■	4			
					– boulders at 4.3 m
5.0					END OF TESTPIT @ 4.8 m

■ STANDARD PENETRATION ■ 10 20 30 40

PLASTIC M.C. LIQUID 10 20 30 40

■ PERCENT GRAVEL ■ 20 40 60 80

● PERCENT SAND ● 20 40 60 80

▲ PERCENT SILT OR FINES ▲ 20 40 60 80

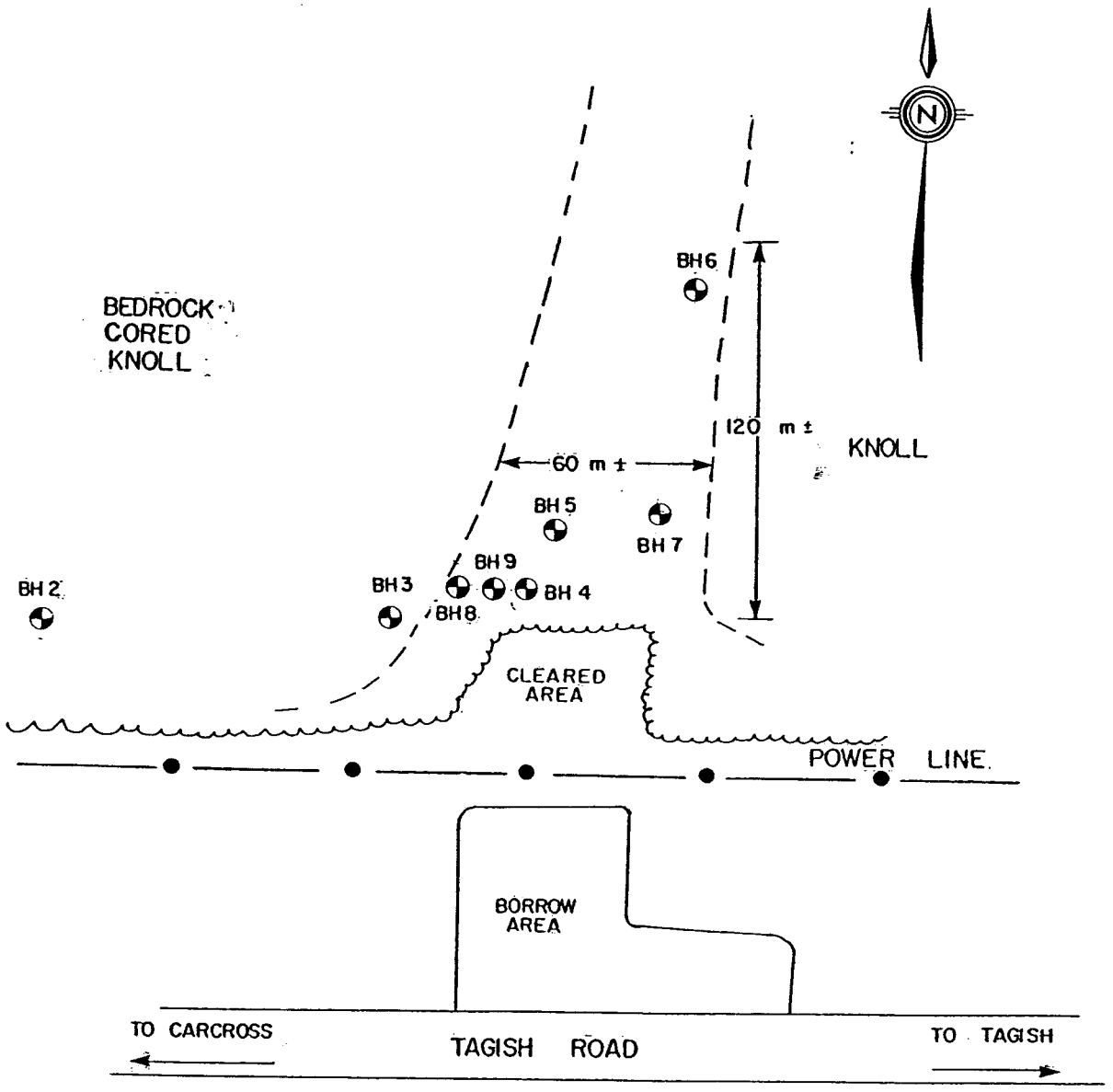
◆ PERCENT CLAY ◆ 20 40 60 80

DEPTH(ft) 0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

LOGGED BY: MCP	COMPLETION DEPTH: 4.8 m
REVIEWED BY: MCP	COMPLETE: 17/10/95
Fig. No:	Page 1 of 1

95/10/23 09:10AM (YUKON-TS)



PHASE I - BH 2,3,4
PHASE II - BH 5,6,7,8,9

NOTE: SKETCH PLAN ONLY - TOPOGRAPHIC FEATURES N.T.S.

APPROX. SCALE: 1:2500

EBA Engineering Consultants Ltd.	PROJECT: ALTERNATE WASTE DISPOSAL SITES CARCROSS, YUKON
CLIENT: GOVERNMENT OF YUKON (MUNICIPAL ENGINEERING)	TITLE: SKETCH PLAN SHOWING RELATIVE BOREHOLE LOCATIONS
DATE: 1987-08-20 / DWN / CHKD	DWG NO.: 4604-D-2 / 0201-4604

PROJECT: ALTERNATE WASTE DISPOSAL SITES	HOLE NO.: BH #4-6	PROJECT NO.: 0201-4604
LOCATION: Tagish, Yukon	SURFACE ELEVATION:	
	DRILL: CME 750 - Solid Shaft Auger	

SAMPLE TYPE: ■ THIN WALLED TUBE ☒ SPLIT SPOON ▤ DISTURBED ▧ NO RECOVERY ⊞ CORE ☐ OTHER

DEPTH (m.)	SOIL DESCRIPTION	UNIFIED SOIL CLASS.	SAMPLE	DEPTH (ft.)
0	SILT - some clay, trace of fine sand, rootlets, light grey	ML		1
1				2
				3
				4
	- olive grey			5
2				6
				7
				8
	SILT(TILL) - some clay, trace fine sand, trace gravel, subangular 6 mm diameter, olive grey	ML		9
3				10
				11
				12
4				13
				14
				15
5	END OF BOREHOLE			16
				17
				18
6				19
				20

WATER CONTENT-% : ●
PLASTIC LIMIT (W_P) — LIQUID LIMIT (W_L)
20 40 60 80

COMPRESSIVE STRENGTH
Unconfined..... ▲
Pocket Penetrometer..... △
TSF 1 2 3 4 5
kPa 100 200 300 400

WET UNIT $\frac{kN}{m^3}$ 16 18 20 22
WEIGHT-D P.C.F. 100 110 120 130 140 150
STANDARD PENETRATION: N- ■
20 40 60 80

eba

DEPTH TO WATER: NONE ON COMPLETION
DEPTH TO SLOUGH: NONE ON COMPLETION

COMPLETION DEPTH: 4.88 m	DATE DRILLED: 1987-08-19
LOGGED BY: R.J.P. Caron	DRAWING NO.:

This log is a compilation of subsurface conditions and soil or rock classification obtained from the field as well as from laboratory testing of samples from the borehole. Soil zones have been interpreted according to commonly accepted practice. The change from one zone to another, as indicated on the log, may be transitional and approximate in nature. Groundwater conditions refer only to those observed at the times and places indicated and they may vary with time, geologic conditions, and construction activity.

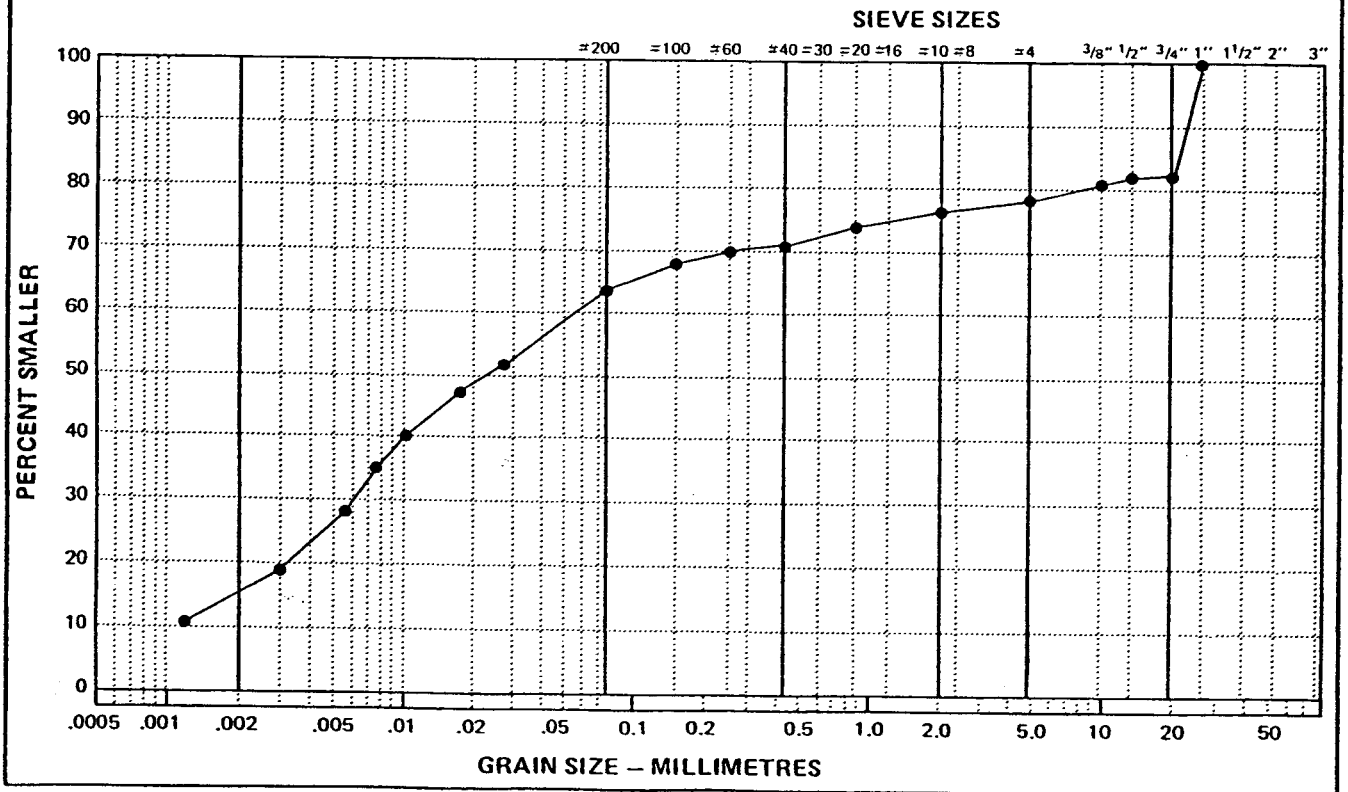
EBA Engineering Consultants Ltd.

PARTICLE - SIZE ANALYSIS OF SOILS

Project: Alternate Waste Disposal Sites
Carcross, Yukon
Project Number: 0201-4604
Date Tested: 1987-06-23
Borehole Number: #4 Site #4
Depth: 4.9 m - 5.4 m
Soil Description: SILT(ML)-gravelly, some sand
Cu:
Cc:
Natural Moisture Content: 21 %
Remarks:

SIEVE	PERCENTAGE PASSING
3"	
1 1/2"	
1"	100
3/4"	82
1/2"	82
3/8"	81
No. 4	78
No. 10	76
No. 20	74
No. 40	71
No. 60	70
No. 100	68
No. 200	64

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Tested in accordance with ASTM D422 unless otherwise noted.

PROJECT: ALTERNATE WASTE DISPOSAL SITES	HOLE NO.: BH#4-7	PROJECT NO.: 0201-4604
LOCATION: Tagish, Yukon	SURFACE ELEVATION:	
	DRILL: CME 750 - Solid Auger	

SAMPLE TYPE: ■ THIN WALLED TUBE ☒ SPLIT SPOON ▤ DISTURBED ▨ NO RECOVERY ⊞ CORE ☐ OTHER

DEPTH (m.)	SOIL DESCRIPTION	UNIFIED SOIL CLASS.	SAMPLE
0	SILT - someclay, trace fine sand, trace gravel, subangular, max. size 6 mm, olive grey	ML	
3	SILT(TILL) - some clay, trace fine sand, trace gravel subangular max. size 6 mm, olive grey	ML	
4	- sandier and gravellier		
5	END OF BOREHOLE		

DEPTH (ft.): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

WATER CONTENT-% : ●
PLASTIC LIMIT (W_P) — LIQUID LIMIT (W_L)
20 40 60 80

COMPRESSIVE STRENGTH
Unconfined..... ▲
Pocket Penetrometer..... Δ
TSF 1 2 3 4 5
kPa 100 200 300 400

WET UNIT $\frac{kN}{m^3}$ 16 18 20 22
WEIGHT-O P.C.F. 100 110 120 130 140 150

20 40 60 80
STANDARD PENETRATION: N- ■

DEPTH TO WATER: ▼
NONE ON COMPLETION
DEPTH TO SLOUGH: —
NONE ON COMPLETION

COMPLETION DEPTH: 5.03 m	DATE DRILLED: 1987-08-19
LOGGED BY: R.J.P Caron	DRAWING NO.:

This log is a compilation of subsurface conditions and soil or rock classification obtained from the field as well as from laboratory testing of samples from the borehole. Soil zones have been interpreted according to commonly accepted practice. The change from one zone to another, as indicated on the log, may be transitional and approximate in nature. Groundwater conditions refer only to those observed at the times and places indicated and they may vary with time, geologic conditions, and construction activity.

APPENDIX G

Further Details related to the Upgrade of the Road/Dam next to the Lake

APPENDIX G

FURTHER DETAILS RELATED TO THE UPGRADE OF THE ROAD/DAM NEXT TO THE LAKE

General

As part of the final closure of the site, the road/dam that separates the north end of the unnamed lake from Tank Creek will be modified to provide a higher level of safety against potential breaches of this structure. In particular, the structure would be lowered by as much as 2 m, an erosion protected spillway would be installed and any tailings exposed as a result of the lower lake level would be hauled to the tailings impoundment and covered with low permeability soil. This modification is required for both the "consolidate and cover" alternative and the "amend and reprocess" alternative.

Background Data

Although the bathymetric data for the unnamed lake is limited to last summer's in-lake sampling exercise by Laberge Environmental Services (Appendix D), the following conclusions can be drawn on the basis of topographic contours and airphotos (undated) taken at various times over the past 30 or so years (see attached figure showing the original location of Tank Creek and previous lake levels).

- Prior to mine development, the area presently occupied by the unnamed lake was a relatively flat, swampy lowland. Flow from the irregularly shaped lake west of the mine meandered eastward until it reached this swampy area, at which point the creek (Tank Creek) turned north, taking several "doglegs," as it flowed in an overall SSW to NNE direction.

- When the road to the pump house west of the mine was constructed, it interrupted the flow in Tank Creek, leading to the formation of a small lake.

- Photos taken when unnamed lake was small indicate that the ground east of Tank Creek is lower than ground to the west of the creek. Therefore, most of the water initially ponded immediately east of the Tank Creek thalweg, over an area about 20 to 30 m wide.

- As the lake level rose, probably because beavers plugged the two culverts through the access road, the west side of the lake shifted dramatically, indicating the terrain along this side of the lake is quite flat. Conversely, the east margin of the lake only shifted slightly to the east, indicating relatively steep ground on this side of the lake. This is supported by the above water topography in this area.

Based on our assessment of the Laberge results, the approximate extent of the in-lake tailings is 12,500 m^2, although a more accurate estimate would require further field work. Assuming that the bathymetry along the east side of the lake is the same as what is indicated by the topography immediately east of the lake, a drop of 1 m is likely to expose about 1500 m^2 along the east side of the lake, most of which may be covered by tailings. Assuming uniform slopes, a drop of 2 m would therefore expose about 3000 m^2 of the lake bed (and probably a large area of tailings).

Proposed Plan

The following plan is viewed as conceptual, but it is believed to represent a reasonable approach based on the philosophy of completing the modifications to the road/dam in a cost-effective, environmentally secure manner.

1. Early in the spring, before the freshet, excavate a trench in the road/dam that will lower the level of the lake by approximately 3 m. (this could be done using one or both of the existing culverts). As the top 2 m or so of the lake will likely be frozen, the risk of a large, uncontrolled release in conjunction with this action should be minimal. As the ice melts, it should flow slowly through the trench in a manner similar to what currently happens at the structure.

2. In the summer, after the ice has melted, a ground survey should be undertaken to obtain the topography of the "recently exposed" lake floor (i.e. to assist in the subsequent design analyses). Furthermore, a program of probing and sampling should be undertaken to confirm the extent, thicknesses and geochemistry of the exposed tailings.

3. In the area between the decant outfall and the area of spilled tailings, develop access to and along the lake shore that is suitable for haul trucks. The type access will depend on the season and type of trucks that are proposed. For instance, if this road is developed in summer, then gravel would likekly have to be hauled and dumped to develop road access along the lake shore. Conversely, if the work were

done in winter, little or no gravel would have to be placed to develop a trafficable surface. Truck selection will influence the quality of road development, i.e. Volvos would perform better over this terrain than conventional haul trucks.

4. Use a track-mounted Gradall excavator (maximum radius at groundline of about 9 m; less if the ground is sloping away) from the east edge of the lake, pull back the exposed tailings and dump them into a haul truck. It is likely that the tailings cover is very thin (i.e. typically less than 2 cm), everything down to the base of the old vegetative mat may have to be removed in order to achieve the removal of the tailings.

5. Haul the tailings to a pre-selected location on the surface of the tailings impoundment.

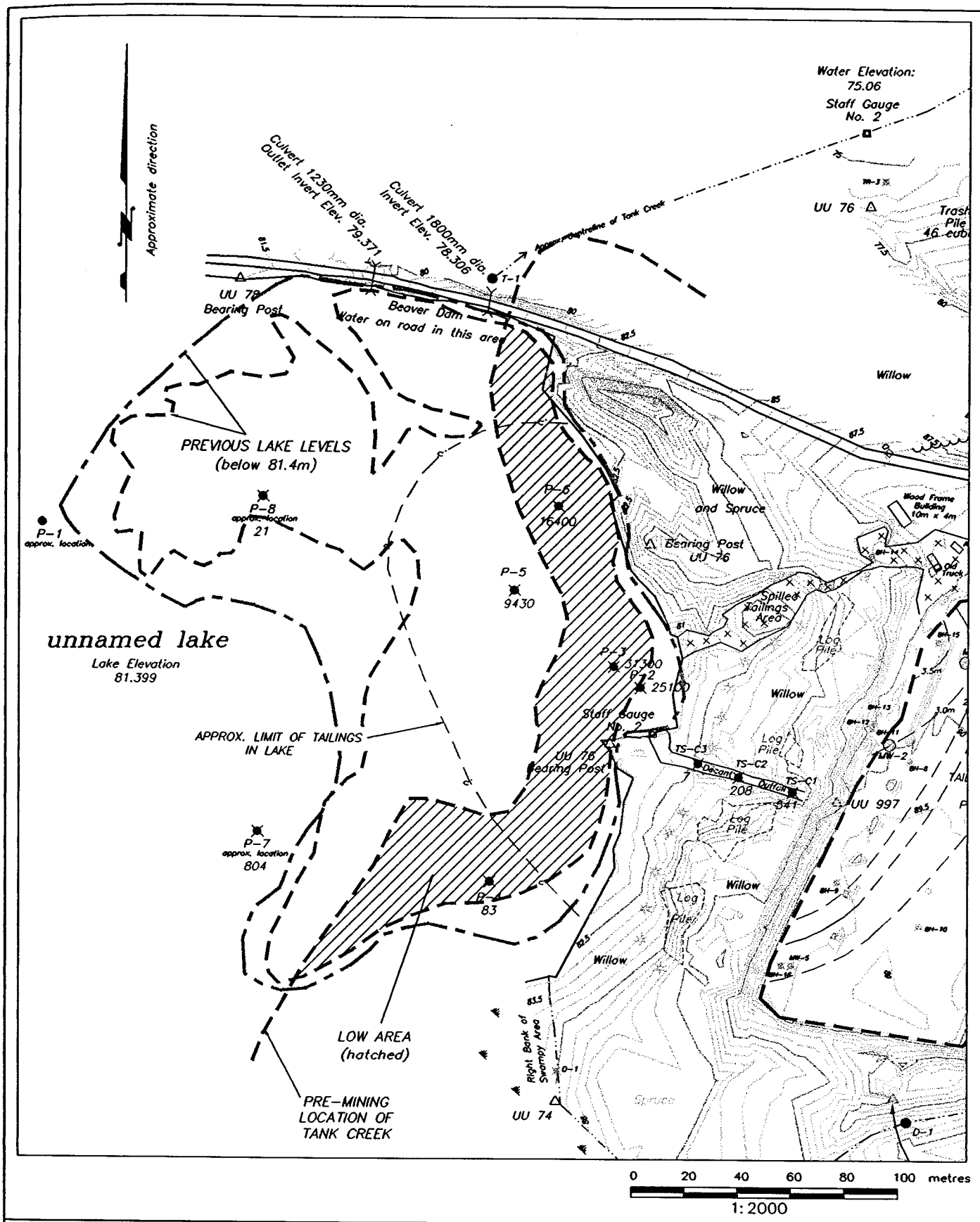
6. If steps 3 to 5 are done in the summer, then disposal of the tailings from the lake can proceed concurrent with the remediation of the tailings impoundment. Alternatively, if steps 3 to 5 are done in the winter following the reclamation of the tailings impoundment, then an area at or adjacent to the surface of the tailings impoundment (probably at the south end) would have to be reserved for the subsequent disposal of the lake tailings. Final covering of these tailings would be done when temperatures are suitable for compaction of the clay cover over the lake tailings.

7. The detailed design of the road/dam and its spillway would be done in conjunction with the data gathered when the lake level is lowered approximately 2 to 3 m. However, with the expectation that the structure will either be very low (i.e. about 1 to 2 m high) or removed entirely, the incremental cost of completing these works is expected to be relatively inexpensive when compared to the works required to maintain the lake at its current levels.

This scope assumes that the works associated with this structure do not elevate its status to that of a water dam, with all the formalities of investigation, design, construction control and monitoring that this would entail.

Estimated Costs

An estimate of the costs associated with this option is provided in the attached tables. If the removal of the tailings is done in the winter, then the cost is likely to be about $71,000. If the removal is done in the summer, the cost will be about $93,000, with the difference primarily arising from the need to develop a road along the east margin of the lake by placing filter fabric and granular fill about 1.5 m thick.



STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

ARCTIC GOLD AND SILVER

PREVIOUS LAKE LEVELS

PUBLIC WORKS AND
GOVERNMENT SERVICES CANADA

PROJECT NO.	DATE	APPROVED	FIGURE
1CP001.07.01	FEB. 1999		G-1

FILE REF: prev-lake-levels.dwg

Remediation of the unnamed lake
Preliminary Construction Cost Estimate
(with winter removal of the lake tailings)

Item	Description	Equipment/ Labour	Quantity	Units	Unit Rate	Cost
1	**Excavate trench in road and remove culverts**	excavator	16	hrs	$140	$2,240
		labourers	48	hrs	$50	$2,400
		pick-up	2	days	$55	$110
						$4,750
2	**Topography of lake bed and sampling of tailings**		1	lump	$8,000	$8,000
						$8,000
3	**Develop access to and along the east lake shore**	excavator	16	hrs	$140	$2,240
		dozer	16	hrs	$140	$2,240
						$4,480
4	**Remove exposed tailings** Pickup with Gradall, place in truck, haul to the tailings impoundment and dump in disposal area	excavator	40	hrs	$140	$5,600
		haul trucks	80	hrs	$65	$5,200
						$10,800
5	**Cover tailings from the lake** assume 100 m^2		30	m^3	$20	$600
						$600
6	**Upgrade the road/dam**[1]		2000	m^3	$20	$40,000
						$40,000
7	**Cut spillway**[2]	cut trench	50	m^3	$10	$500
		filter fabric	100	m^2	$3	$300
		rip rap	100	m^3	$20	$2,000
						$2,800
Total[3]						**$71,430**

Notes:
1. One of the largest costs is item 7, the upgrade of the road/dam. The details of this upgrade will depend on the results of the survey and sampling that are undertaken after the lake is lowered by 2 to 3 m.
2. The details of the spillway construction will also depend on the results of the survey and sampling that will be undertaken after the lake has been lowered.
3. This is the value used in Table 4.2 of the text. Contingencies and allowances for design are shown globally in Table 4.2.

Remediation of the unnamed lake
Preliminary Construction Cost Estimate
(with summer removal of the lake tailings)

Item	Description	Equipment/ Labour	Quantity	Units	Unit Rate		Cost
1	**Excavate trench in road and remove culverts**	excavator	16	hrs	$140	$2,240	
		labourers	48	hrs	$50	$2,400	
		pick-up	2	days	$55	$110	
							$4,750
2	**Topography of lake bed and sampling of tailings**		1	lump	$8,000	$8,000	$8,000
3	**Develop access to and along the east lake shore**	excavator	16	hrs	$140	$2,240	
		dozer	16	hrs	$140	$2,240	
		filter fabric	1200	m^2	$3	$3,600	
		gravel	1500	m^3	$12	$18,000	
							$26,080
4	**Remove exposed tailings** Pickup with Gradall, place in truck, haul to the tailings impoundment and dump in disposal area	excavator	40	hrs	$140	$5,600	
		haul trucks	80	hrs	$65	$5,200	
							$10,800
5	**Cover tailings from the lake** assume 100 m^2		30	m^3	$20	$600	$600
6	**Upgrade the road/dam**[1]		2000	m^3	$20	$40,000	$40,000
7	**Cut spillway**[2]	cut trench	50	m^3	$10	$500	
		filter fabric	100	m^2	$3	$300	
		rip rap	100	m^3	$20	$2,000	
							$2,800
Total[3]							**$93,030**

Notes:
1. One of the largest costs is item 7, the upgrade of the road/dam. The details of this upgrade will depend on the results of the survey and sampling that are undertaken after the lake is lowered by 2 to 3 m.
2. The details of the spillway construction will also depend on the results of the survey and sampling that will be undertaken after the lake has been lowered.
3. This is the value referenced in Table 4.2. Contingencies and allowances for design are shown globally in Table 4.2.