MN-082

Assessment of Abandoned Yukon Mine Sites

Tinta Hill #82

Prepared for
Public Works and Government Services Canada

February 1997
GV206.01

Consultants in Groundwater, Property Contamination and Environmental Management

GeoViro Engineering Ltd.

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1.0 INTRODUCTION AND BACKGROUND

Several abandoned exploration and development mine sites in the Yukon, including the Tinta Hill site have been identified and previously investigated under the Arctic Environmental Strategy Action on Waste program by the Department of Indian Affairs and Northern Development (DIAND) Technical Services. In 1996, Public Works and Government Services Canada retained GeoViro Engineering Ltd. (GeoViro) to further investigate specific sites identified by DIAND as requiring additional investigations and to determine appropriate remedial actions to close the sites in a safe and environmentally acceptable fashion. This report outlines the site investigation, findings and recommendations for the Tinta Hill abandoned mine/exploration site.

1.1 Location

The Tinta Hill abandoned mine/exploration site is located on the southwest slope of Granite Mountain approximately 44 km northwest of the community of Carmacks, Yukon (Figure 1.1). The site is located at a latitude of 62° 17' 37"N and longitude 136° 58' 33"W, at an elevation of 1200 to 1225 metres above sea level (Figure 1.2).

1.2 Overview of Site Development

The following outlines the work history of the site as presented in the previous assessment report by DIAND Technical Services, 1994.

1930 - 1932	Trenching and shallow shafts.
1937	Restaked by W. Teare as Tenderfoot claims.
1940	Tenderfoot claims restaked and explored with two shafts, 15 and 11 m deep, and a 16 m adit.
1959	Restaked as May and June claims by Conwest Exploration Ltd. who trenched and drilled 5 holes (410m) in 1960.
1966	Restaked as Tinta claims by Canex Placer who completed grid soil sampling and an electromagnetic survey.
1968	Property optioned to Silgold Mines Ltd. who transferred option to Coin Canyon Mines Ltd. between 1969-1972 who then performed soil sampling and dozer trenching.
1970	Canol Metals Mining Ltd. tied on Sno, etc. claims.
1973	Re-optioned by Exeter Mines Ltd. who completed 25 drill holes (1684.6m), dozer trenching, soil sampling, electromagnetic survey and added more claims.
1975	Exeter Mines changed names to Tinta Hill Mines Ltd.

1976	Geochemical surveys and drilling of 3 holes (313.6m).
1979	The claims reverted to Placer Development Ltd. and were optioned by a joint venture between Silver Tusk Mines Ltd. and Panther Mines Ltd.
1980-1981	Drifting and crosscutting (516m) was completed in the No. 1 adit as well as another 457m in the No. 2 adit.
1986	Trenching.
1987	International Consolidated Platinum Ltd. performed trenching under a joint venture agreement.
1988	Mill city Gold Mining Corporation optioned the property, performed prospecting, and drilled 8 holes (1150m).
1989	Silver Tusk performed road work.
1991	Trenching.

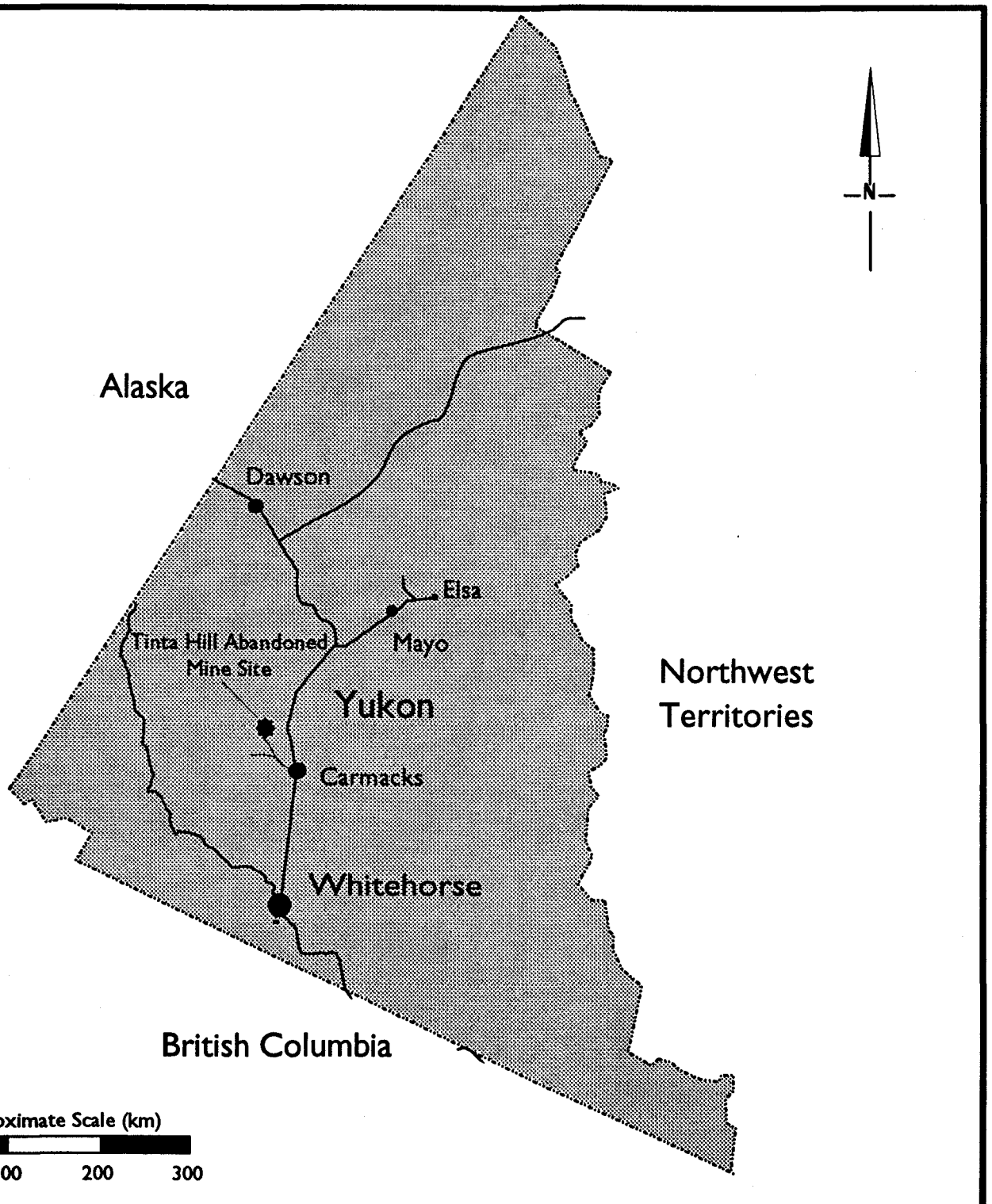
Roads, trails and exploration workings are shown in the airphoto presented as Figure 1.3.

Claim Status

The most recent claims belonged to Silver Tusk Mines Ltd. and expired August, 1992. This information was obtained August, 1996, from Indian and Northern Affairs Canada, Whitehorse.

1.3 Site Access

The site is accessible by dirt roads from the community of Carmacks. The site may be accessed with a four-wheel drive or all terrain vehicle from the Mount Freegold road. If heavier machinery is required on-site, a small caterpillar may be required to repair sections of the roadway.



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CLIENT
Public Works and Government Services, Canada

TITLE
Tinta Hill Mine Site Location

PROJECT
Yukon Abandoned Mine Sites

September, 1996	Project GV206.01	Figure 1.1

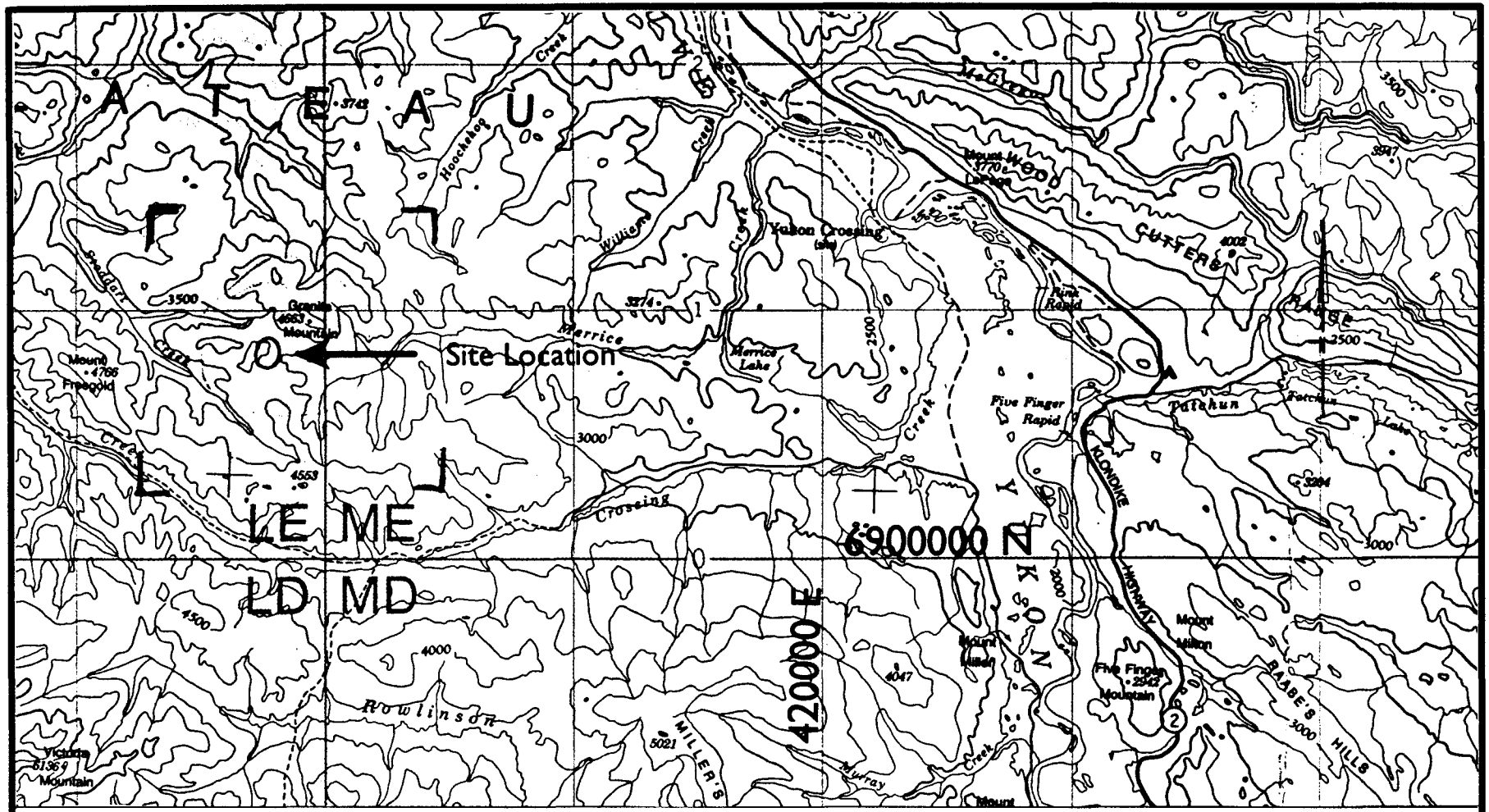


Figure after Department of Energy, Mines and Resources, 1990, NTS sheet 115 I edition 4
"Carmacks, Yukon Territory", Scale 1:250,000., Contour Interval 500 feet.

GeoViro Engineering Ltd.	TITLE: Regional Topography, Tinta Hill Abandoned Mine Site	
CLIENT: Public Works and Government Services Canada	PROJECT: Yukon Abandoned Mine Sites	
September, 1996	Project: GV206.01	Figure 1.2

GeoViro Engineering Ltd.

TITLE
Tinta Hill Abandoned Mine Site Air Photo

CLIENT
Public Works and Government Services, Canada

PROJECT
Yukon Abandoned Mine Sites

September, 1996	Project GV206.01	Figure 1.3

2.0 PURPOSE AND SCOPE OF WORK

The key objectives of the assessment were to identify specific environmental and human safety risks and provide recommendations and Class "D" cost estimates for remediation or mitigation of risks. The assessment of the site was completed in three phases. Phase I involved reviewing available site information. Phase 2 comprised the site investigation and sample collection by the project team. Phase 3 comprised the preparation of this assessment report with recommendations for remediation and mitigation.

Phase I - Data Collection and Review

After authorisation to proceed, relevant site information was obtained, reviewed and an investigation plan developed with team members required for site investigation.

Phase 2 - Site Investigation and Sample Collection

The site investigation identified and assessed existing or potential safety and environmental risks on the site. The site investigation team comprised senior personnel with backgrounds in geological engineering, geotechnical engineering and environmental chemistry. The investigation at the Tinta Hill site included an assessment of

- physical properties of soil, slope stability, and the potential for erosion;
- non-hazardous site debris to determine disposal options;
- potential or actual environmental pathways and receptors;
- structures and hazardous materials for demolition; and
- surface water quality.

The site was photographed and a detailed site plan completed, showing the location of structures, water bodies, mine workings, site debris, and sample locations. The photos are located in Appendix A and the site layout is shown in Figure 5.1.

Phase 3 - Reporting

Findings from the Phase I and Phase 2 investigations are compiled in this report in accordance with the "Generic Site Assessment Report Format" provided in the request for standing offer. The report includes recommendations to remediate and mitigate environmental and safety risks identified. Recommendations are based on, and comply with, applicable federal and/or territorial criteria and guidelines. A Class "D" cost estimate to complete remedial work is provided in a separate document. Site plans have been prepared in AutoCAD format.

3.0 SITE ASSESSMENT METHODOLOGY

3.1 Assumptions and Limitations

The assessment was limited to the area specifically developed or occupied for mine exploration or mining purposes and immediately-adjacent areas. Roadways to the mine site were not included in the assessment.

The assumption and limitations that apply are listed below:

- information provided in DIAND Technical Services Assessment Report, March 1994 is accurate;
- investigations were limited to surficial observations;
- soil conditions, volumes and areas, were based on surficial observations; and
- hydrogeologic conditions are inferred and based on generally accepted principals of groundwater flow.

3.2 Assessment Criteria

The regulatory framework for managing contaminated sites includes the use of criteria/guidelines to determine the extent and severity of site contamination and to provide numerical concentrations for investigation and remediation of sites. The Canadian Council of Ministers of the Environment (CCME) and B.C. Environment, Lands and Parks, (BCELP) have developed criteria/guidelines for managing contaminated sites. The site is federally controlled, therefore, the CCME Interim Remediation Criteria are used to assess the severity of contamination and the need for further investigation or remediation. Where numerical concentrations are not established for specific contaminants in the CCME criteria the numerical concentrations provided in the BCELP "Criteria for Managing Contaminated Sites in B.C." are used. Both the CCME and BCELP have developed very similar assessment and remediation criteria for soil for agricultural, residential, parkland, commercial and industrial sites. Criteria have also been established for water for the protection of aquatic life, irrigation, livestock watering and drinking water.

For the purpose of assessing the severity of contamination and the requirement for completing remediation at this abandoned mine site, contaminant concentration is soil and water samples are compared to the commercial/industrial criteria for soil and the aquatic life criteria for water.

BCELP has established petroleum hydrocarbon criteria for contaminated sites. The hydrocarbon classes are incorporated as "substances" with corresponding remediation standards. The substance classes are:

VPH - volatile petroleum hydrocarbons (C_5 - C_9)
LEPH - light extractable petroleum hydrocarbons (C_{10} - C_{18})
HEPH - heavy extractable petroleum hydrocarbons (C_{19} - C_{32})

3.3 Methods

3.3.1 Background Information

Available background information collected and reviewed during the first phase of work included

- historical land use and mine development information provided in DIAND report;
- land claim status provided by Whitehorse Mining District;
- infrastructures;
- site location and access;
- area mineralisation and geology;
- climatic data; and
- topographic maps and aerial photography;

3.3.2 Site Assessment Components

The site assessment was conducted to identify existing or potential safety and environmental risks. The assessment included the following components:

Trenches and Excavations were inspected and slope stability assessed.

Non-Hazardous Site Debris was inventoried during a site reconnaissance.

Structures were inspected for hazardous materials, construction and material details; measured; and assessed for stability.

3.3.3 Sampling Methods and Quality Assurance

Our sample collection and handling protocols follow currently acceptable CCME and American EPA practices. Soil and water samples were placed in laboratory prepared glass and plastic containers. A clean pair of disposable vinyl gloves was used to handle each set of samples. All sampling equipment was cleaned between the collection of each sample to prevent cross-contamination. All samples were placed in coolers under a chain-of-custody procedure. To ensure the integrity of the analytical information, all sample numbers and requested analyses were recorded on the field site plan and on a multiple copy chain-of-custody form that accompanied each cooler.

Soil and water sampling methods are provided in Appendix B.

Quality Assurance (QA) is a set of procedures for ensuring that the analytical results are accurately representative of field conditions. A complete QA program includes both a field and laboratory component. The project laboratories (CanTest and Chemex) complete national and in-house quality control programs on an on-going basis. In addition to the laboratory's quality programs the following measures were implemented:

- chain-of-custody procedures and forms;
- a sample labelling and location identification plan;
- use of laboratory prepared sample containers; and
- regular maintenance and cleaning of field equipment.

4.0 ENVIRONMENTAL SETTING

4.1 Mineralisation

Exploration at the site was centred about a vertical shear zone cutting Triassic Klotassin quartz diorite. Minor gold, silver, lead, zinc and copper values are reported to have been associated with a shear-controlled sulphide vein containing galena, sphalerite and minor amounts of tetrahedrite and chalcopyrite mineralisation.

4.2 Climate

Temperature and precipitation data for Carmacks, provided by Environment Canada Climatic Data Services, have been used for the Tinta Hill site. The climate of the area is characterised by moderate rainfall and seasonal temperature extremes. Average monthly temperatures vary from -28.6 °C in January to 14.8 °C in July. Since the site is at a higher elevation than Carmacks, the mean temperatures at the site may be slightly different, i.e. slightly lower average in the summer. The average annual precipitation for Carmacks is 276.7 mm. Based on our experience at other sites in this area, precipitation will vary with elevation. The Tinta Hill site may experience greater precipitation than Carmacks. Approximately 66% of the total annual precipitation falls as rainfall with almost 90% of the rainfall occurring from June to September.

4.3 Vegetation

The site is located near the tree line. Black spruce are sparse (Photo 1 and 2, Appendix A) and willow shrubs are abundant. Little or no vegetation is being re-established in trenches and excavations (Photo 3, Appendix A). The site is mantled by a very thin layer of topsoil that is underlain by granular rocky material with no organic content; therefore, disturbed areas will not re-vegetate easily.

4.4 Fish and Wildlife Resources

A study of fish and wildlife resources was not within the scope of this project. No surface water bodies other than minor intermittent creeks and groundwater seeps were identified on the exploration site. The nearest creeks (Stoddart and Merrice) are more than 2 km from the site. Yukon Renewable Resources reports no information on the upper reaches of both these creeks that drain into the Yukon River. The lower gradient section of Stoddart Creek at the confluence with the Yukon River (approximately 40 km from the site), is considered to have significant fisheries value. No wildlife was observed during the site investigation, however, bear claw marks were noted on an abandoned trailer. Parks Canada lists grizzlies, marmots, and caribou as common species found in this area.

4.5 Site Topography, Drainage and Soils

The site covers several square kilometres on the south slope of Granite Mountain. The slope is moderate over most of the site and gets steeper on the south side of the site. The site is situated in the watershed of either Stoddart or Merrice Creek and their tributaries.

The site is mantled by a very thin layer of organic soil (<10 cm) that is underlain by coarse granular and rocky material. The airphoto suggests that till-like or more clay-like material may be present in nearby areas to the east of the site.

4.6 Hydrogeology

Assessment of the hydrogeological characteristics of the site was not within the scope of this project. However, groundwater characteristics can be inferred with some degree of confidence, based on site location, topography and our experience at other similar sites in this area.

Since the site is located near the upper reaches of a mountain, several hundred metres higher in elevation than significant surface water bodies, the area is inferred to be located in a groundwater recharge area. Recharge to the groundwater regime in the area of the site will occur primarily from precipitation. A portion of the precipitation will infiltrate the ground, migrate downward to the groundwater table, located some distance below surface, and then flow in a horizontal and downward direction until it discharges at topographic low areas, that occur as creeks in this area. Discharge may also occur locally on the site in the form of seeps and springs where low permeability barriers to flow such as till, permafrost, or tight bedrock force upward movement of groundwater. There was evidence of groundwater discharge on a trail.

4.7 Permafrost

No evidence of permafrost was encountered during the site reconnaissance. However, permafrost may be encountered in areas of this site.

5.0 SITE DESCRIPTION AND FINDINGS

The main roadways, trails, trenching and excavations are identified on the airphoto (Figure 1.3). The site layout highlighting significant site workings, structures and debris are provided in Figure 5.1.

5.1 Buildings, Infrastructure, and Equipment

No buildings or infrastructure, other than an abandoned trailer and very little debris, were identified during the site reconnaissance on September 11, 1996.

5.1.1 Abandoned Trailer

The abandoned trailer is lying on its side and is located west of the site. The trailer has a steel base, wood frame and chip board walls (Photo 4, Appendix A). Most of the roof was covered with asphalt shingle material. The trailer is approximately 2.4 m wide and 3.5 m long. The trailer contained approximately 1 m^3 of wood waste.

A fibrous insulation was present in the walls. A sample of the insulation (GV206THINS) was collected and analysed for asbestos content. The results of the analysis (Table C1, Appendix C) indicate that the insulation does not contain asbestos.

5.1.2 Infrastructure (Excavations and Trenches)

Trenches and excavations are located in the exploration area. Some of these are shown in Photos 1, 2 and 3, Appendix A. Photo 3 is typical of the trenches along the northern portion of the site. The excavated material is very sandy to rocky in nature, and the excavations are generally shallow. The slopes do not show signs of deep-seated instability, nor do they appear to present a significant health and safety issue.

A soil sample was collected from the base of one of the trenches (GV206THSOIL1, Figure 5.1) and analysed for total metal concentrations. The results of the analysis indicate that the sample does not contain any significantly high concentrations of the metals tested. None of the metal concentrations in the sample exceed the CMCS remediation criteria for commercial or industrial sites. The complete results are provided in Table C2, Appendix C, and the laboratory report is provided in Appendix D.

Erosion and slope instability was noted along the road cut along the steep bank on the south side of the site. Photo 7, Appendix A, shows a section of the road where erosion has occurred.

5.2 Non-Hazardous Materials

Due to the size of the site and density of the shrubs, it was difficult to identify all abandoned pieces of equipment and debris. We covered the majority of the site by foot and did leave the trails and roads on a regular basis to identify as much material as possible within our time limitations. Very little debris other than the abandoned trailer and its contents were identified on-site. A small amount of wood waste (Photo 5, Appendix A) and a few articles of metal debris (Photo 6, Appendix A) are present at the clearings in the central portion of the site. A wood crate is adjacent to the trench located on the northeast corner of the site. Excluding the trailer, there is less than a few cubic metres of debris on site and most of this is wood.

5.3 Hazardous Material

No hazardous materials were identified during the site reconnaissance.

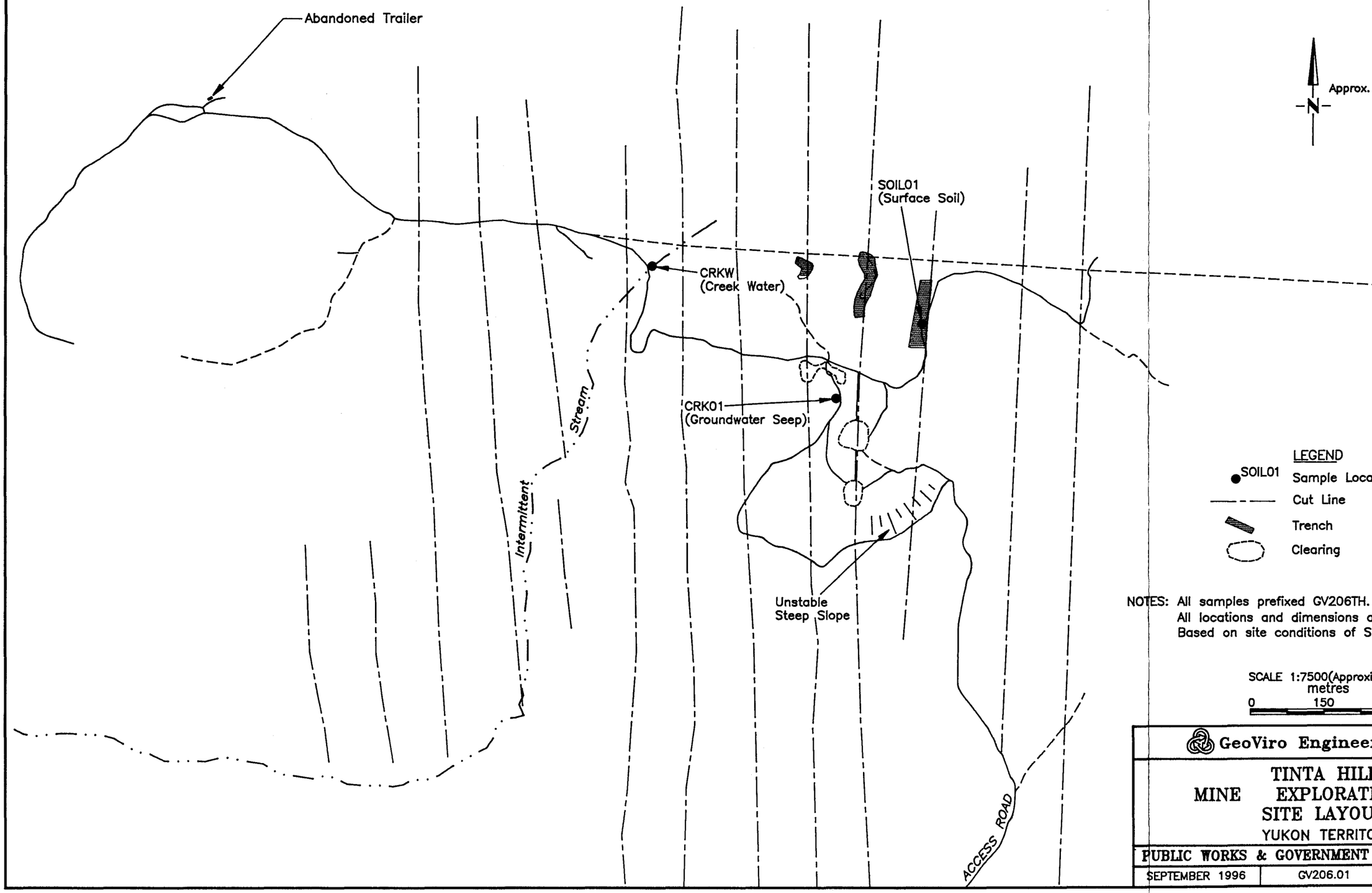
5.4 Surface Water

Two water samples were collected during the reconnaissance of the site. One sample (CRKW, Figure 5.1) was collected from a small intermittent creek in a shallow gully west of the site. The other sample (CRK01, Figure 5.1, Photo 8) was collected from a groundwater seep that was running down a roadway in the central portion of the site.

The water samples were analysed for metal concentrations and general chemistry. The results are provided in Tables C3 and C4, Appendix C. Laboratory reports are provided in Appendix D. The results indicate that the general chemistry of the samples is acceptable. The aluminum and copper concentrations in both samples exceed the criteria for the protection of aquatic life, but are below the criteria for drinking water. All other metal concentrations are below the aquatic life criteria. The airphoto (Figure 1.3) suggests that there has been no site activity upgradient of where the creek sample west of the site was collected, therefore this sample likely represents background conditions.

5.5 Mine Openings

Shafts and adits were reported as being completed in the early 1930s and 1940 as well as crosscutting in a No. 1 and No. 2. Adit in 1980 and 1981. However, no shafts or adits were found during our site reconnaissance. No shafts and adits were found during the 1993 site visit by DIAND staff.



NOTES: All samples prefixed GV206TH.
All locations and dimensions are approximate.
Based on site conditions of September 11, 1996.

SCALE 1:7500(Approximate)
metres
0 150 300

GeoViro Engineering Ltd.

TINTA HILL MINE EXPLORATION SITE SITE LAYOUT

YUKON TERRITORY

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

SEPTEMBER 1996	GV206.01	FIGURE 5.1

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Health and Safety

No health and safety issues were identified at the site. No action is required

6.2 Environmental Risks

No environmental risks or significant sources of contamination were identified at the site. No action is required.

6.3 Aesthetic Concerns

Aesthetic concerns arise from the distribution of a very small amount of metal and wood debris, the abandoned trailer, and areas where vegetation has been cleared.

A contractor can collect the debris and trailer and haul it off-site for disposal in a proper landfill at Carmacks.

Areas cleared of vegetation should be left to re-vegetate naturally, even though this will take several years to accomplish.

All mitigative work should be completed in a fashion that will minimise additional damage to the existing vegetation. A Class "D" cost estimate to complete the work is provided under separate cover.

7.0 STANDARD LIMITATIONS

This report was prepared for the exclusive use of Public Works and Government Services Canada and it's representatives. The findings and conclusions documented in this report have been prepared for specific application to this project and have been developed in a manner consistent with that level of care and skill normally exercised by members of the environmental science and engineering profession currently practising under similar conditions in the area.

The report is based on data and information collected during a single site investigation conducted by GeoViro Engineering Ltd. personnel. The report is based solely on the conditions of the site at the time of the field investigations.

Conditions between sample locations may vary. Some potential remains for the presence of unknown, unidentified, or unforeseen surface and subsurface contamination. Further evidence of such potential site contamination would require additional surface and subsurface exploration and testing.

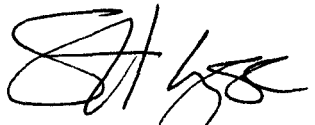
Some conclusions of this report are based on a comparison of chemical analytical results to criteria currently provided by CCME and BCELP. In the event that these criteria are changed, amended, or replaced, GeoViro Engineering Ltd. should be requested to re-evaluate the conclusions of this report, and provide amendments as required.

If new information is developed in future work (which may include excavations, borings, or other studies), GeoViro Engineering Ltd. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

Respectively submitted

GeoViro Engineering Ltd.

David E. Karwandy, P.Eng.
Project Manager



Stuart Wyse, Ph.D.
Senior Review

APPENDIX A

SITE PHOTOGRAPHS

APPENDIX A
LIST OF PHOTOGRAPHS

Photo 1: View of the site from the air, looking to the northwest.

Photo 2: View of central portion of the site from the air, looking to the northeast.

Photo 3: Trench at northeast corner of site, looking south.

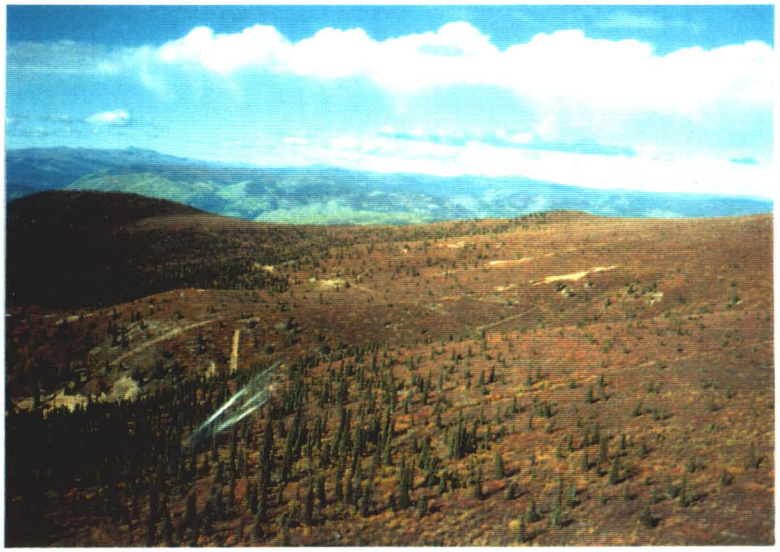
Photo 4: Trailer west of site.

Photo 5: Wood debris in clearing.

Photo 6: Metal and wood debris in clearing. Trench noted in Photo 3 in the upper right corner of the photo.

Photo 7: Road and slope erosion on south side of the site.

Photo 8: Groundwater seepage along roadway where sample CRK01 was collected.



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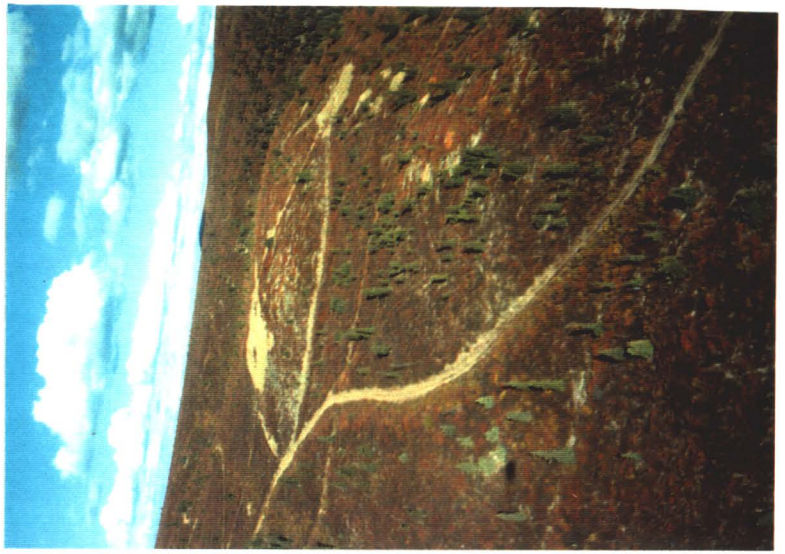

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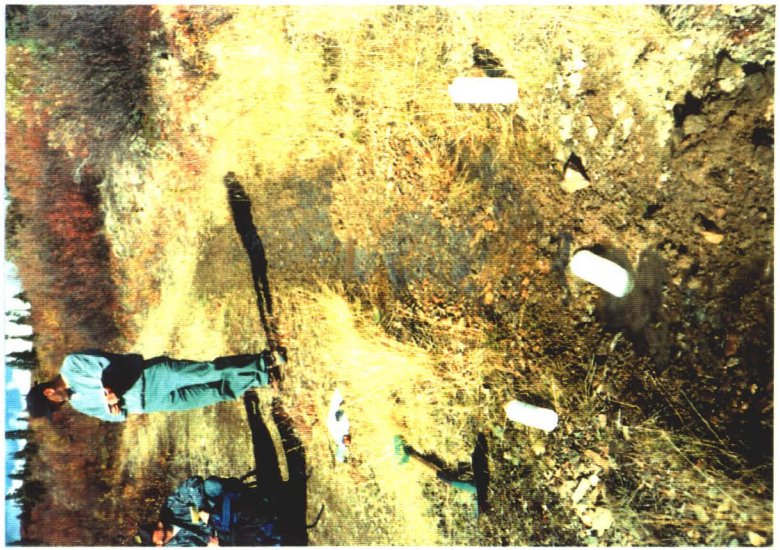

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APPENDIX B

SAMPLING METHODS

APPENDIX B
SAMPLING METHODS

Soil Sampling

Small hand dug excavations were completed in areas were near surface soil samples were to be collected. Excavations were completed using either a shovel or trowel, depending on the depth of the excavation and the volume of soil required.

Soil conditions were logged, noting colour/weathering, rock composition, particle size and distribution. Photographs of sample locations were taken and the location of the sample with a specific identification number were recorded on a site plan and in the field log book. The sample container was also identified with the sample location.

Soil samples were collected from the walls of the excavations using a clean stainless steel trowel. Samples collected for hydrocarbon analysis were placed in 250 ml laboratory prepared glass containers with teflon lids. Where the soil was to be analysed for metals and acid base accounting (ABA), approximately 2 kg of the soil was placed in plastic zip-lock bags. Soil samples were placed in coolers for storage and shipment to the project laboratory.

Water Sampling

Samples were collected from surface streams, creeks and groundwater seeps on and adjacent to the property. Water samples were collected by placing a clean 500 ml plastic contain, preservative free, facing upstream, ensuring that the sample was not contaminated by disturbed sediment, debris and other floating material. The water collected in the plastic container was then poured into the sample containers. The sample containers were placed in coolers for storage and shipment to the project laboratory.

Water analysed for hydrocarbon concentrations was placed in a 1 litre amber glass container. Surface water (sediment free) analysed for total metals was placed in a 500 ml plastic container complete with HNO_3 added for preservation. Water analysed for general chemistry was placed in 1 litre plastic containers.

APPENDIX C

ANALYTICAL TABLES

TABLE C1
ASBESTOS FIBER IDENTIFICATION - ABANDONED TRAILER
ENVIRONMENTAL ASSESSMENT MINE SITE 82 AT TINTA HILL
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Sample No.	GV206THINS
Date sampled	11-Sep-96
Asbestos Type	none
Asbestos Content	<
Other fiber ID	glass fiber
Other fiber content	80-99
Filler	1-20

Results expressed as % volume fiber found / submitted (% vol / vol)

< = Less than detection limit of 1% (%vol / vol)

Analysis completed by CanTest Laboratory, Vancouver, B.C.

TABLE C2
METAL CONCENTRATIONS IN SOIL SAMPLES
ENVIRONMENTAL ASSESSMENT MINE SITE 82 AT TINTA HILL
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
mg/kg (ppm)

Sample No.	CCME AL	CCME PL/RL	CCME CL/IL	DETECTION LIMITS	GV206THSOIL1
Date sampled					11-Sep-96
Depth (m)					surface
Moisture (%)				0.01	10.6
Antimony	20	20	40	10	<
Arsenic	20	30	50	30	<
Barium	750	500	2000	0.1	106
Beryllium	4	4	8	1	<
Cadmium	3	5	20	0.25	<
Chromium	750	250	800	2	13
Cobalt	40	50	300	1	6
Copper	150	100	500	1	116
Lead	375	500	1000	1	32
Mercury	0.8	2	10	0.001	0.08
Molybdenum	5	10	40	4	5
Nickel	150	100	500	2	7
Selenium	2	3	10	3	<
Silver	20	20	40	2	<
Tin	5	50	300	5	<
Vanadium	200	200	-	0.5	32
Zinc	600	500	1500	1	35
Aluminum				10	11200
Boron				0.5	11
Calcium				1	1500
Iron				2	24200
Magnesium				0.1	2560
Manganese				0.2	108
Phosphorus				20	1710
Sodium				5	507
Strontium				0.1	60.1
Titanium				0.3	108

AL - Agricultural PL/RL - Parkland/Residential CL/IL - Commercial/Industrial

Analyses completed by Cantest Laboratory, Vancouver, B.C.

< = less than the detection limit

TABLE C3
GENERAL CHEMISTRY IN WATER SAMPLES
ENVIRONMENTAL ASSESSMENT MINE SITE 82 AT TINTA HILL
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

	units	CMCS Aquatic Life Numeric Criteria	CMCS Drinking Water	GV206THCRKW	GV206THCRK01	Detection Limit
Date sampled				11-Sep-96	11-Sep-96	
Location				creek west of site	groundwater seep	
pH		6.5-9.0*	6.5-8.0*	6.81	6.67	
Conductivity	uS/cm			59	43	1
True Color	CU			20	20	5
Turbidity	NTU			0.27	22	0.1
Hardness (CaCO3)	mg/L			18	11	1
Total Dissolved Solids	mg/L		<=500*	50	40	10
Bicarbonate (HCO3)	mg/L			10.9	19.8	0.5
Carbonate (CO3)	mg/L			<	<	0.5
Hydroxide Alkalinity (OH)	mg/L			<	<	0.5
Fluoride	mg/L	0.2 to 0.3 varies with hardness	1.5	<	<	0.05
Chloride	mg/L		250	0.2	0.3	0.2
Nitrate and Nitrite	mg/L			0.11	0.39	0.05
Nitrate	mg/L	40	10	0.11	0.39	0.05
Nitrite	mg/L	0.02 to 0.06 varies with Chloride	3.2	<	<	0.002
Sulphate	mg/L	100	500	15	6.1	1

CMCS: Criteria for Managing Contaminated Sites in B.C., July 20, 1995.
* - CCME Interim Canadian Environmental Quality Criteria for Contaminated Sites
Analyses completed by CanTest Laboratory, Vancouver, B.C.
<1.0 = less than the detection limit indicated

Exceeds the Aquatic Life Criteria

TABLE C4
CONCENTRATIONS OF METALS IN WATER SAMPLES
ENVIRONMENTAL ASSESSMENT MINE SITE 82 AT TINTA HILL
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
ug/L (ppb)

Sample No.	CCME Aquatic Life	Detection Limits	GV206THCRKW	GV206THCRK01
Date sampled			11-Sep-96	11-Sep-96
Location			creek west of site	groundwater seep
Aluminum	5-100**	5	84	120
Antimony	-	1	<	<
Arsenic	50	1	<	12
Barium	-	1	21	19
Beryllium	-	1	<	<
Boron	-	5	<	36
Cadmium	0.2-1.8*	0.2	<	<
Calcium	-	10	5,500	3,140
Chromium	2-20	1	<	<
Cobalt	-	1	<	<
Copper	2-4*	1	6	470
Iron	300	30	<	170
Lead	1-7*	1	<	<
Magnesium	-	50	1,060	700
Manganese	-	1	<	2
Mercury	0.1	0.05	<	<
Molybdenum	-	1	2	21
Nickel	25-150*	1	<	<
Phosphorus	-	400	<	<
Potassium	-	10	670	830
Selenium	1	1	<	<
Silicon	-	100	16,000	17,800
Silver	0.1	0.1	<	<
Sodium	-	100	2,900	3,300
Strontium	-	1	43	37
Tellurium	-	1	<	<
Thallium	-	0.1	<	<
Thorium	-	0.5	<	<
Tin	-	1	<	<
Titanium	-	1	<	3
Uranium	-	0.5	<	<
Vanadium	-	1	<	<
Zinc	30	5	<	5
Zirconium	-	1	<	1

* - Guidelines change with hardness.

** - Guideline varies with pH, calcium, and dissolved organic carbon concentrations.

Analyses completed by CanTest Laboratory, Vancouver, B.C.

"<" - Less than detection limit indicated.

APPENDIX D

LABORATORY REPORTS

Analysis Report

CANTEST

CanTest Ltd

Professional
Analytical
Services

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

REPORT ON: Analysis of Water,Soil and Insulation Samples

REPORTED TO: GeoViro Engineering Ltd.
Suite 500
535 Thurlow Street
Vancouver, B.C.
V6E 3L2

Att'n: Mr. David Karwandy

CHAIN OF CUSTODY: 17774
PROJECT NAME: Tinta Hill
PROJECT NUMBER: GV206.01
P.O. NUMBER: GV 206.01

NUMBER OF SAMPLES: 4

REPORT DATE: October 17, 1996

DATE SUBMITTED: September 19, 1996

GROUP NUMBER: 6091917

SAMPLE TYPE: Water, Soil and Insulation

TEST METHODS:

Asbestos Fiber Identification - analysis was performed by Polarized Light Microscopy/Dispersion Staining in accordance with Workers' Compensation Board of British Columbia (WCB) Method No. 0205.

Conventional Parameters - analyses were performed using procedures based on those described in "British Columbia Environmental Laboratory Manual For the Analysis of Water, Wastewater, Sediment and Biological Materials" (1994 Edition), Province of British Columbia and "Standard Methods for the Examination of Water and Wastewater" 17th Edition, (1989) and 16th Edition (1985), published by the American Public Health Association.

Mercury in Water - analysis was performed using procedures based on Standard Methods for the Examination of Water and Wastewater section 3112 B, acid permanganate digestion , analysis using Cold Vapour Atomic Absorption.

Metals in Water - analysis was performed using Inductively Coupled Plasma Spectroscopy (ICP) or Graphite Furnace Atomic Absorption.

Metals in Water - analysis was performed using procedures based on U.S. EPA Method 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectroscopy (ICP/MS).

Cadmium in Soil - analysis was performed using background-corrected Flame Atomic Absorption Spectrophotometry.

Mercury in Soil - analysis was performed using Cold Vapour Atomic Absorption Spectrophotometry.

Lead in Soil - analysis was performed using background-corrected Flame Atomic Absorption

(Continued)

CAN TEST LTD.

Richard S. Jomitz
Supervisor, Inorganic Testing

CANTEST

Lead in Soil (continued)

Spectrophotometry.

Metals in Soil - Undried representative samples were digested with a mixture of nitric acid and hydrochloric acid-"Aqua Regia". Analysis was performed using Inductively Coupled Argon Plasma Spectroscopy (ICAP) or by specific techniques as described. Moisture was determined gravimetrically at 105 on a separate sample portion.

Selenium in Soil - analysis was performed using Zeeman background-corrected Graphite Furnace Atomic Absorption Spectrophotometry.

TEST RESULTS:

(See following pages)

REPORTED TO: GeoViro Engineering Ltd.

REPORT DATE: October 17, 1996

GROUP NUMBER: 6091917

CANTEST

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:		GV206THCRKW	GV206THCRK01	DETECTION LIMIT	UNITS
DATE SAMPLED:		Sep 11/96	Sep 11/96		
CAN TEST ID:		609190049	609190050		
pH		6.81	6.67	-	pH units
Conductivity		59	43	1	µS/cm
True Color		20	20	5	CU
Turbidity		0.27	22	0.1	NTU
Hardness	CaCO3	18	11	1	mg/L
Total Dissolved Solids		50	40	10	mg/L
Bicarbonate Alkalinity	HCO3	10.9	19.8	0.5	mg/L
Carbonate Alkalinity	CO3	<	<	0.5	mg/L
Hydroxide Alkalinity	OH	<	<	0.5	mg/L
Fluoride	F	<	<	0.05	mg/L
Chloride	Cl	0.2	0.3	0.2	mg/L
Nitrate and Nitrite	N	0.11	0.39	0.05	mg/L
Nitrate	N	0.11	0.39	0.05	mg/L
Nitrite	N	<	<	0.002	mg/L
Sulphate	SO4	15	6.1	1	mg/L

µS/cm = microsiemens per centimeter
NTU = nephelometric turbidity units
< = Less than detection limit

CU = color units
mg/L = milligrams per liter

REPORTED TO: GeoViro Engineering Ltd.

REPORT DATE: October 17, 1996

GROUP NUMBER: 6091917

CANTEST

Metals Analysis in Water

CLIENT SAMPLE IDENTIFICATION:		GV206THCRKW	GV206THCRK01	DETECTION LIMIT	UNITS
SAMPLE PREPARATION:		DISSOLVED	DISSOLVED		
DATE SAMPLED:		Sep 11/96	Sep 11/96		
CAN TEST ID:		609190049	609190050		
Aluminum	Al	0.084	0.12	0.005	mg/L
Antimony	Sb	<	<	0.001	mg/L
Arsenic	As	<	0.012	0.001	mg/L
Barium	Ba	0.021	0.019	0.001	mg/L
Beryllium	Be	<	<	0.001	mg/L
Boron	B	<	0.036	0.005	mg/L
Cadmium	Cd	<	<	0.0002	mg/L
Calcium	Ca	5.50	3.14	0.01	mg/L
Chromium	Cr	<	<	0.001	mg/L
Cobalt	Co	<	<	0.001	mg/L
Copper	Cu	0.006	0.47	0.001	mg/L
Iron	Fe	<	0.17	0.03	mg/L
Lead	Pb	<	<	0.001	mg/L
Magnesium	Mg	1.06	0.70	0.05	mg/L
Manganese	Mn	<	0.002	0.001	mg/L
Mercury	Hg	<	<	0.05	µg/L
Molybdenum	Mo	0.002	0.021	0.001	mg/L
Nickel	Ni	<	<	0.001	mg/L
Phosphorus	PO4	<	<	0.4	mg/L
Potassium	K	0.67	0.83	0.01	mg/L
Selenium	Se	<	<	0.001	mg/L
Silicon	SiO2	16.0	17.8	0.1	mg/L
Silver	Ag	<	<	0.0001	mg/L
Sodium	Na	2.9	3.3	0.1	mg/L
Strontium	Sr	0.043	0.037	0.001	mg/L
Tellurium	Te	<	<	0.001	mg/L
Thallium	Tl	<	<	0.0001	mg/L
Thorium	Th	<	<	0.0005	mg/L
Tin	Sn	<	<	0.001	mg/L
Titanium	Ti	<	0.003	0.001	mg/L
Uranium	U	<	<	0.0005	mg/L
Vanadium	V	<	<	0.001	mg/L
Zinc	Zn	<	0.005	0.005	mg/L
Zirconium	Zr	<	0.001	0.001	mg/L

mg/L = milligrams per liter
< = Less than detection limit

µg/L = micrograms per liter

REPORTED TO: GeoViro Engineering Ltd.

REPORT DATE: October 17, 1996

GROUP NUMBER: 6091917

CANTEST

Asbestos Fiber Identification in Bulk Material

CLIENT SAMPLE ID	CAN TEST ID	ASBESTOS TYPE	ASBESTOS CONTENT	OTHER FIBER ID	OTHER FIBER CONTENT	FILLER
GV206THINS	609190052	none	<	glass fiber	80-99	1-20

Results expressed as % volume fibre found/submitted (% vol/vol)
< = Less than 1 percent (% vol/vol)

REPORTED TO: GeoViro Engineering Ltd.

REPORT DATE: October 17, 1996

GROUP NUMBER: 6091917

CANTEST

Metals Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:		GV206THSOIL1	DETECTION LIMIT	UNITS
DATE SAMPLED:		Sep 11/96		
CAN TEST ID:		609190054		
Moisture		10.6	0.01	%
Antimony	Sb	<	10	µg/g
Arsenic	As	<	30	µg/g
Barium	Ba	106	0.1	µg/g
Beryllium	Be	<	1	µg/g
Cadmium	Cd	<	0.25	µg/g
Chromium	Cr	13	2	µg/g
Cobalt	Co	6	1	µg/g
Copper	Cu	116	1	µg/g
Lead	Pb	32	1	µg/g
Mercury	Hg	0.08	0.001	µg/g
Molybdenum	Mo	5	4	µg/g
Nickel	Ni	7	2	µg/g
Selenium	Se	<	3	µg/g
Silver	Ag	<	2	µg/g
Tin	Sn	<	5	µg/g
Vanadium	V	32	0.5	µg/g
Zinc	Zn	35	1	µg/g
Aluminum	Al	11200	10	µg/g
Boron	B	11	0.5	µg/g
Calcium	Ca	1500	1	µg/g
Iron	Fe	24200	2	µg/g
Magnesium	Mg	2560	0.1	µg/g
Manganese	Mn	108	0.2	µg/g
Phosphorus	PO4	1710	20	µg/g
Sodium	Na	507	5	µg/g
Strontium	Sr	60.1	0.1	µg/g
Titanium	Ti	108	0.3	µg/g

% = percent
< = Less than detection limit

µg/g = micrograms per gram, on a dry weight basis.