

Assessment of Abandoned Yukon Mine Sites

Mount Haldane #37

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 Mount Haldane 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 Mount Haldane abandoned mine site.

1.1 Location

The Mount Haldane abandoned mine site is located at a latitude of 63° 51' 39"N and longitude of 135° 52' 56"W, approximately 30 km north of the community of Mayo, in the central Yukon (Figure 1.1). The site is located on the west side of Mount Haldane at an elevation of approximately 1200 m 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, 1993.

1915	Claims first staked as Lookout, etc. by A. Johnson and J.V. Smith.
1916-1918	The south (Middlecoff) zone was explored by surface trenching and two short adits. In 1918, A. Johnson drove a short adit on the Johnson zone about 457 m north of the Middlecoff zone.
1919	Claims optioned to Yukon Silver-Lead Mining Co. Ltd. which drove a third adit and shipped 24.7 tonnes in 1920.
1944	Restaked by E. Bleiler and M. Ewing as Middlecoff claims.
1952	Claims optioned to Lookout Mountain Ltd.
1964	Claims optioned to Silver Titan Mining Ltd. who added DB, May, Ted, etc. claims and conducted geochemical sampling, trenching, and adit rehabilitation and found the Main zone about 457 m north of the Johnson zone.
1966	Property transferred to Haldane Silver Mining Ltd. The Middlecoff and Johnson zones were explored by 701 m of overburden drilling, 487.7 m of drifting, and 533.4 m of underground drilling.
1968	Paramount Mining Ltd. acquired control of Haldane Silver Mining Ltd.

1978	M.H. Ewing optioned the Middlecoff claims to Barry Way who added Gopher, etc. claims and performed grid soil sampling. The property was also examined briefly by a group called Cortin Project.
1980-1985	Ewing trenched and optioned the property to Barandium Resources Ltd.
1988	Trenching was completed.
1989	Road construction, prospecting, and line cutting was completed.
1990	Barandium changed its name to IGC International Gulf Corporation.
1991	The claims were returned to Ewing.

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

Claim Status

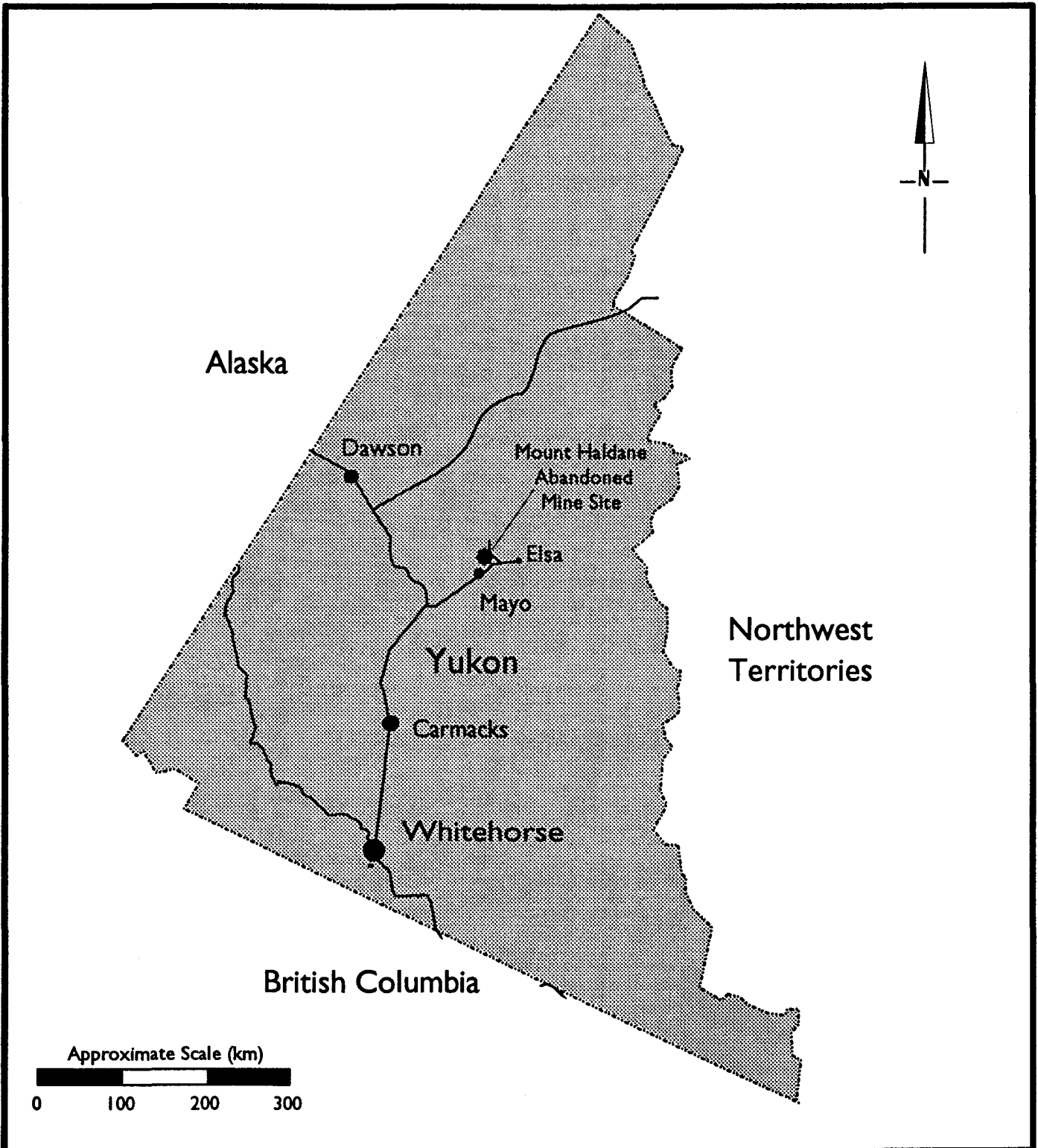
The status of active claims (dated September 7, 1996) in the area of the Mount Haldane site, as provided by Indian and Northern Affairs Canada, Mayo Mining District are shown in Table 1-1.

TABLE 1-1
ACTIVE CLAIMS IN AREA OF MOUNT HALDANE ABANDONED MINE SITE

Claim Name	Expiry Date	Owner
Middlecoff	April 9, 1997	Richard Ewing
Gopher	April 9, 1997	Richard Ewing
Lowell	April 9, 1997	Richard Ewing
John	April 9, 1997	Richard Ewing
Jo	April 9, 1997	Richard Ewing
Whistler	April 9, 1997	Richard Ewing
Ricky	April 9, 1997	Richard Ewing
Dawn	April 9, 1997	Richard Ewing

1.3 Site Access

The site is accessible from the community of Mayo by asphalt and dirt roads. The site is reached by travelling north from Mayo on Highway 2 for approximately 25 km then heading northwest on a dirt trail located just north of the Halfway Lakes. The trail is followed for approximately 15 to 20 km along the south and southwest side of the mountain. Much of the trail can be travelled by a two-wheel drive vehicle; however, the final several kilometres to the site require a four-wheel drive or all-terrain vehicle to reach the site. The trail crosses several minor intermittent streams and debris flows.



GeoViro Engineering Ltd.

TITLE

Mt. Haldane Abandoned Mine Site Location

PROJECT

Yukon Abandoned Mine Sites

CLIENT

**Public Works and
Government Services,
Canada**

September, 1996

Project GV206.01

Figure 1.1

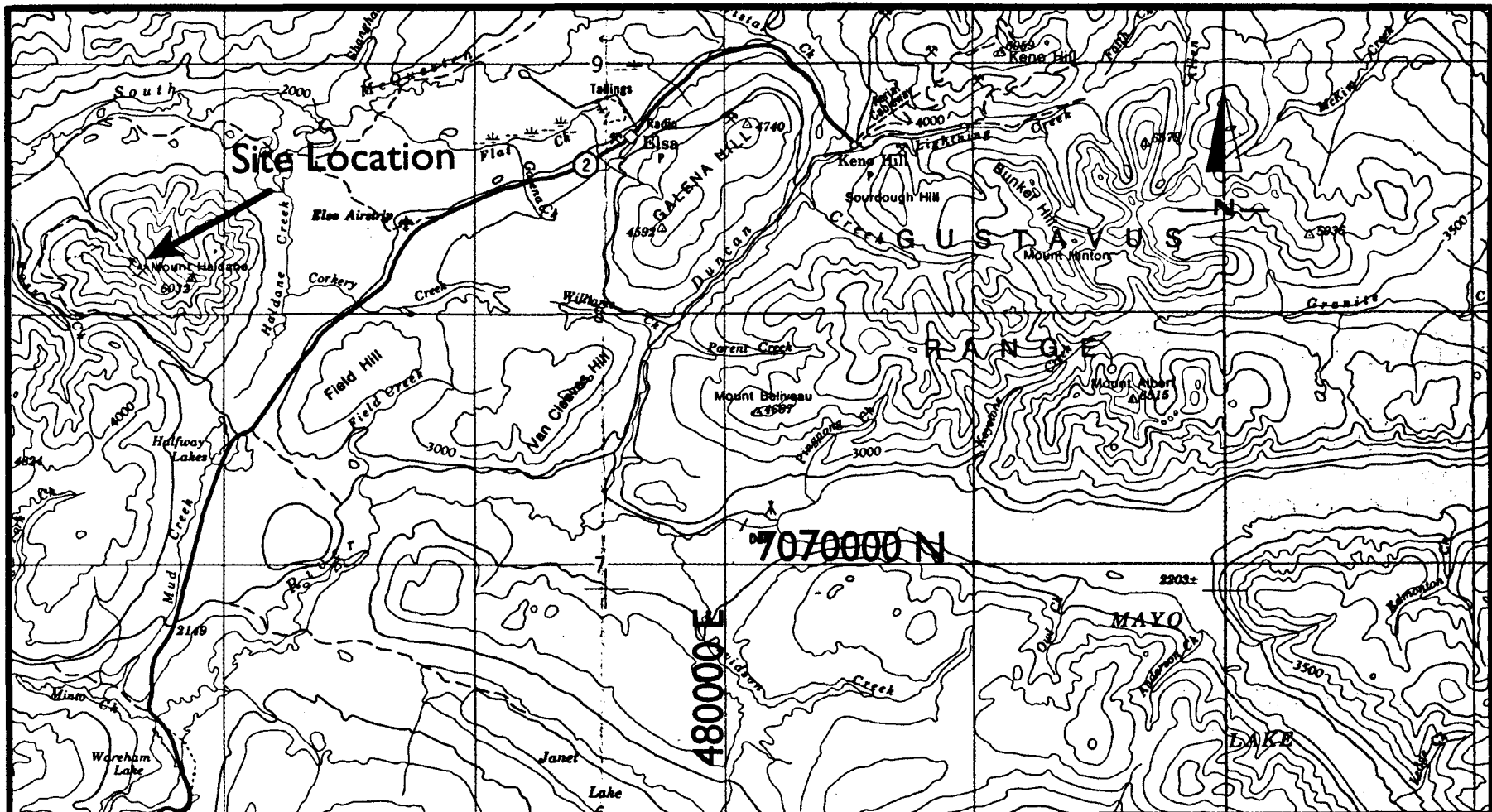



Figure after Department of Energy, Mines and Resources, 1971, NTS sheet 105 M edition 3 "Mayo, Yukon Territory", Scale 1:250,000., Contour Interval 500 feet.

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



GeoViro Engineering Ltd.

TITLE

Mount Haldane Abandoned Mine Site Air Photo

PROJECT

Yukon Abandoned Mine Sites

CLIENT

Public Works and
Government Services,
Canada

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 site assessment was completed in three phases. Phase 1 involved compiling and reviewing available site information then developing the detailed investigation plan. 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 1 - Data Collection and Review

After authorisation to proceed, 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 on-site investigation identified and assessed existing or potential safety and environmental risks. The site investigation team comprised senior personnel with backgrounds in geological engineering and environmental chemistry. The investigation included an assessment of

- waste rock to assess potential ARD conditions;
- three open adits to identify closure requirements;
- physical properties of soil, slope stability, and potential for erosion;
- nonhazardous site debris to determine disposal options;
- surface water quality;
- potential or actual environmental pathways and receptors;
- building structures and hazardous building materials for demolition;
- barrel contents for petroleum products to determine disposal or incineration options;
- borrow sources for mitigation purposes; and
- appropriate landfill locations, if required for long term placement of wastes.

The site was photographed (selected photographs provided in Appendix A) and a detailed site plan completed indicating the location of all sources of contamination, buildings, mine openings and workings, site debris, surface water bodies, environmentally sensitive receiving bodies, and sample locations.

Phase 3 - Reporting

Findings from the Phase 1 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 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, January, 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 in 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 Mayo 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:

Mine Openings were inspected, measured and documented to identify closure requirements.

Trenches and Excavations were inspected and slope stability assessed.

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

Hazardous Materials were inventoried and sampled for analyses.

Buildings and 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, water and drum sampling methods are provided in Appendix B.

Quality Assurance (QA) is a set of procedures for ensuring that 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;
- regular maintenance and cleaning of field equipment.

4.0 ENVIRONMENTAL SETTING

4.1 Mineralisation

The Mount Haldane vein system contains three main mineralised zones, named from north to south, Middlecoff, Johnson and Main. These veins appear to be part of a single, many branching north trending transverse type vein fault cutting the Mississippian Keno Hill quartzite formation. The Middlecoff zone contains erratic lenses of galena, sphalerite and minor tetrahedrite. The major commodities identified at the site comprise silver, lead and zinc.

4.2 Climate

Temperature and precipitation data for Mayo, provided by Environment Canada Climatic Data Services, have been used for the Mount Haldane site. The climate of the area is characterised by moderate rainfall and seasonal temperature extremes. Average monthly temperatures vary from -26.9 °C in January to 15.6 °C in July. Since the site is at a higher elevation than Mayo, the mean temperatures at the site may be slightly different, i.e. slightly lower average in the summer. The average annual precipitation for Mayo is 318 mm. Based on our experience at other sites in this area, precipitation will vary with elevation. Our past experience suggests that an average annual precipitation of 500 to 600 mm may be more accurate for a site at this elevation. The four driest months are January to April.

4.3 Vegetation

The site is covered by thick vegetation comprised predominantly of alder, willow and black spruce. Almost all of the existing trails on-site, easily identified on the 1968 airphoto (Figure 1.3), are now heavily overgrown.

4.4 Fish and Wildlife Resources

A study of fish and wildlife resources was not within the scope of this project. The only surface water identified on-site was a creek that bisected the site and discharges to South McQuesten River several kilometres to the northwest. According to Yukon Renewable Resources there is no specific fisheries data for the intermittent stream that flows through the site. The South McQuesten River, however, is of high fisheries value and known to support populations of arctic grayling, northern pike, slimy sculpin and provides spawning and rearing habitat for chinook salmon. Other incidental species that have been documented in the South McQuesten River include whitefish, longnose sucker, burbot and the occasional inconnu. Wildlife observed during the site investigation included small rodents and grouse.

4.5 Site Topography, Drainage and Soils

The site lies within the watershed of South McQuesten Creek and its tributaries. South McQuesten creek is located approximately 6 km northwest of the site and approximately 600 m lower in elevation. The site is located at the base of a small gulch that slopes moderately to the northwest towards South McQuesten Creek.

The general area was glaciated during the Pleistocene period. Due to the steep slopes in the vicinity of the mine site, little glaciated material remains. The majority of the site comprises colluvium and bedrock along the slopes and coarse talus and landslide material along the base of the gulch near the main camp site.

Surface water was present at the base of the gulch to the north and south of the camp site. Upgradient of the camp site the water disappeared into the ground and re-surfaces a few hundred meters downgradient of the camp site. The surface water was present in the narrow areas of the gulch and absent in the camp area where the gulch has a broader base due to being infilled with talus and landslide material. Surface water likely appears in the drainage course near the camp site during times of high surface water runoff.

4.6 Hydrogeology

A detailed investigation 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.

The site is located in a small gulch several hundred metres higher in elevation than significant surface water bodies. A small creek is present along the base of the gulch where at the time of the investigation water flowed above the site disappearing into the ground approximately 500 m north of the camp site and reappeared in the creek approximately 500 m below the camp site. The mining and exploration areas (along the steep walls of the gulch) are inferred to be located in a groundwater recharge area. The base of the gulch where the camp site and creek are located are located in a groundwater recharge and discharge area depending on the seasonal fluctuation of groundwater levels.

Recharge to the groundwater regime 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 towards and discharge to the creek in the centre of the gulch. Discharge may also occur locally on the slopes 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. Groundwater seepage was observed from the lower south adit at the time of the site visit.

The rate of groundwater flow through the groundwater bearing medium will depend on the amount of recharge to the aquifer and the hydraulic conductivity of the aquifer bearing medium. The hydraulic conductivity of the bedrock in this area is most dependent on the fracture network in the rock and is expected to be low. No attempt has been made to estimate the depth to groundwater or flow velocity and volume.

4.7 Permafrost

No evidence of permafrost was encountered during the site reconnaissance. However, permafrost was encountered in the Dublin Gulch area at similar elevations during other studies by GeoViro. Thus, permafrost may be encountered in areas of this site.

5.0 SITE DESCRIPTION AND FINDINGS

The main camp site is located at the base of the gulch. Two adits are present a short distance away from the camp area on the south slope of the gulch and one other adit and several areas of trenching are located along the north slope of the gulch. The main roadways, trails, trenching and excavations are identified on the airphoto (Figure 1.3) and the site layout highlighting significant site workings and structures is provided in Figure 5.1. Photo 1, Appendix A was taken from the air on the day of the site visit and shows several of the structures in the camp area and the mine workings on the south slope.

5.1 Buildings, Infrastructure, and Equipment

The buildings, infrastructure and equipment discussed in this section are those identified during the site reconnaissance of September 9, 1996. Several buildings, in various states of deterioration, are present. No buildings or structures were identified in the outlying exploration areas. Location of buildings, equipment and debris are shown on Figure 5.1.

5.1.1 Buildings

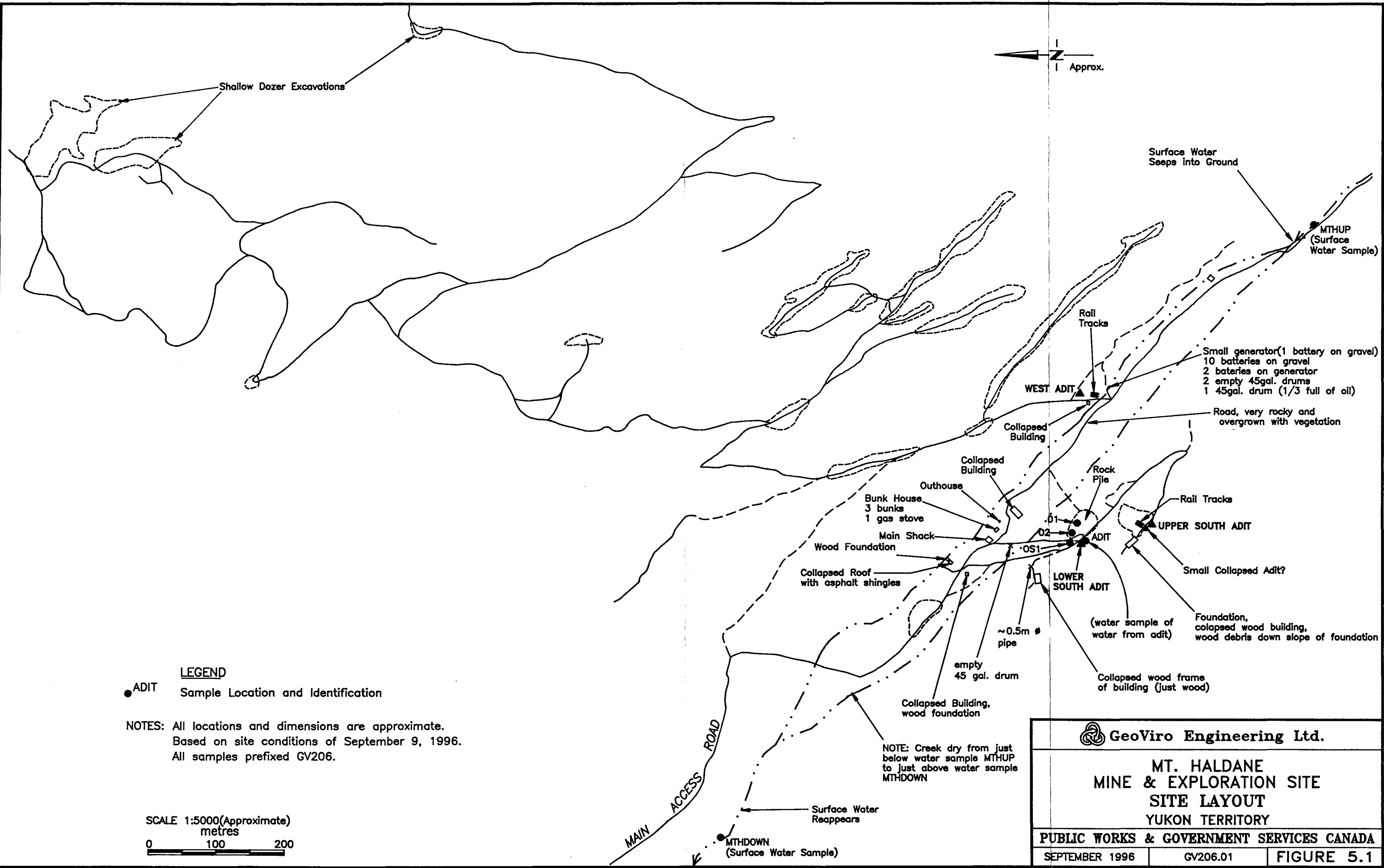
Eight buildings, many of which are collapsed, and one outhouse were identified during the site reconnaissance. This section details the building locations, sizes, construction materials and debris within the buildings. Names provided for each buildings are given based our best interpretation of use.

Main Building

The main building is located at the base of the gulch and appear either much newer than the other buildings or of much better construction (Photos 1 and 2, Appendix A). This building is in good condition except some of the floor boards are weakening. The building is constructed of wood with dimensions of 8.5 x 7.4 m. The building was virtually empty of debris with the exception of a wood burning stove. In its current condition, this building would be suitable as a resting area or emergency shelter, however, may pose a small hazard with additional deterioration.

Bunk House

The bunk house (Photos 1 and 3, Appendix A) is located 12 m east of the main building. The 6.2 x 3.7 m wood building contains fibreglass insulation. Debris found in the building consists of three bunks and one gas stove. The building is in fair condition; however, floor boards are deteriorating. A wooden outhouse is located near the northeast corner of this building.




LEGEND
 ● ADIT Sample Location and Identification

NOTES: All locations and dimensions are approximate.
 Based on site conditions of September 9, 1996.
 All samples prefixed GV206.

SCALE 1:5000 (Approximate)
 metres
 0 100 200

NOTE: Creek dry from just below water sample MTHUP to just above water sample MTHDOWN

 GeoViro Engineering Ltd.		
MT. HALDANE MINE & EXPLORATION SITE SITE LAYOUT YUKON TERRITORY		
PUBLIC WORKS & GOVERNMENT SERVICES CANADA		
SEPTEMBER 1996	GV206.01	FIGURE 5.1

Collapsed Wood Buildings West of Main Building

Two collapsed wood buildings (Photos 1, 4 and 5, Appendix A) are located on either side of the roadway approximately 40 m west of the main building. The building on the south side of the roadway is constructed of wood and has dimensions of 4.6 x 4 m. The building on the north side of the road is also constructed of wood with asphalt roof shingles and is 5 x 3.7 m. There was no evidence of any building materials other than wood and asphalt shingles.

Collapsed Wood Building (Shed)

This collapsed wooden building (Photos 1 and 6, Appendix A) is located approximately 60 m east of the main building. The dimensions of this former structure are estimated to be 18 x 4.5 m. The remains of the roof contain asphalt shingles. The size of the building suggests that it was formerly a storage building. The presence of debris under the structure could not be verified or assessed.

Collapsed Wood Building by Mine Adits

A collapsed wood structure is present by each of the three adits located during the site reconnaissance.

Lower South Adit - The collapsed wood structure is located a few metres northwest of this adit.

Upper South Adit - The collapsed wood structure (Photos 1 and 7, Appendix A) is located approximately 30 m west of this adit. Most debris is spread out over an area of 10 x 10 m and some is spread out down the slope to the north. A landslide has occurred above this former building and may account for the debris torrent below the building. An estimated 10 to 20 m³ of non-hazardous debris is present in this area. Galvanised sheet metal and nails sticking out of wood debris make this area a minor safety hazard.

North Adit - The collapsed wood structure (4.5 x 4 m) is located southwest of this adit. The building is of wood construction with asphalt roofing shingles (Photo 8, Appendix A).

5.1.2 Infrastructure (Excavations and Trenches)

A few trenches of various dimensions are located on the north slope of the gulch. The airphoto suggests that most excavation and trench exploration occurred on the north slope of the gulch above the north adit. The locations are shown in Figures 1.3 (airphoto) and Figure 5.1. Vegetation is established in the trenches close to the base of the gulch, while little vegetation occurs in the trenches at higher elevations.

The excavations and trenches are generally shallow and the slopes of do not show signs of deep-seated instability, nor do they appear to present a health and safety issue.

5.2 Non-Hazardous Materials

Due to the heavy vegetation it was difficult to identify all abandoned pieces of waste 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 limitation. The location of much of the equipment and debris found is shown on Figure 5.1. Details of this material is provided below and, where the material is deemed to be hazardous, further information is provided in Section 5.3.

A list and approximate location of site debris follows:

- one - 200 litre drum (empty) by dry creek bed south of main building (Photo 9, Appendix A);
- two - 200 litre drums (empty) by old drill and generator;
- abandoned generator and drill unit east of north adit (Photo 10, Appendix A);
- several small cans (empty) and metal debris by old drill and generator and upper south adit;
- large diameter pipe, 5 m long, west of lower south adit;
- rail tracks by upper south and north adits;
- steel pipes sticking out of ground by north adit;
- galvanised sheet metal and metal debris by upper south adit and building;
- wood waste and asphalt shingles by collapsed buildings;
- wood waste and timber scattered throughout site;
- fibreglass insulation in bunk house;
- one wood stove (main bld.) and one gas stove (bunk house); and
- three metal bunks in bunk house.

5.3 Hazardous Material

Hazardous materials identified include the contents in the drum by the old drill and several lead-acid batteries.

Approximately 75 litres of oil is present in the 200 litre drum located by the old drill and generator. A sample of the liquid was collected (GV206MTHOIL) and analysed for concentrations of total organic halogens (TOX), polychlorinated biphenyls (PCB) and metals. The results of the analyses indicate 37 mg/kg of total organic halogens and non-detectable concentrations of PCBs are present in the oil sample. The PCB and metal results are shown in Tables C1 and C2, Appendix C, laboratory reports are provided in Appendix D. The results of the analyses indicate that none of the parameters tested (TOX, PCB and

metals) exceed the allowable levels for fuel as provided in Part 6, Section 41 of the B.C. Waste Management Act, Special Waste Regulations.

A surficial soil sample (GV206MTH04) was collected, from a stained area measuring 5 x 8 m, adjacent to the old drill. The sample was analysed and the results (Table C3, Appendix C) indicate there are no detectable concentrations of light extractable petroleum hydrocarbons (LEPH) and 2900 mg/kg of heavy extractable petroleum hydrocarbons (HEPH) in the sample. This stained soil does not appear to represent a significant risk to human health or the environment.

Up to 15 lead-acid batteries are located in the vicinity of the old drill and generator. The batteries were found on abandoned pieces of equipment and the ground. One battery was identified near the collapsed wood shed.

5.4 Surface Water

Two surface water samples and one adit seep sample were collected during the site visit. The seep sample (GV206MTHADIT) was collected from water flowing at surface that was discharging from the lower south adit. The two surface water samples were collected from the creek flowing along the base of the gulch. One sample was collected upgradient of the mine site (GV206MTHUP), before the surface water disappeared below talus, and the other downgradient of the mine site (GV206MTHDOWN), after the water resurfaced in the creek. The samples were analysed for general chemistry and total metal concentrations. Results are shown in Tables C4 and C5, Appendix C. The laboratory reports are shown in Appendix D.

The results indicate that no metals concentrations in the creek samples exceed the criteria for the protection of aquatic life. The cadmium and selenium concentrations in the adit sample exceed the aquatic life criteria. All other metal concentrations in the adit sample are below the criteria. The general chemistry of the samples suggests that the adit and downgradient creek samples are more basic and higher in dissolved solids than the creek sample collected upgradient from the mine site. The results suggest that there is no significant acid generation from the native rock and that the water quality in the creek downgradient of the site is not detrimentally impacted.

5.5 Waste Rock Disposal Area

5.5.1 General Description/Layout

A small area near the lower south adit appears to be waste rock material. The waste rock covers an area of approximately 75 m², with an average depth of approximately 2.5 m. We estimate approximately 200 to 300 m³ of rock at this location. The near surface material of the rock pile is comprised of brown sand and silt with rock. The location of the waste rock area is shown in Figure 5.1. The waste rock area is shown in photos I and II in Appendix A.

During the site visit, there was no evidence of stressed vegetation in and around the rock pile, nor was there evidence of seepage along the toe. Soil with vegetation was observed on top of the rock pile.

5.5.2 Analytical Results/Chemistry

Three soil samples were collected from the rock pile and analysed on-site for paste pH and in the laboratory for metal concentrations. The results of the on-site analysis indicate the three samples have paste pHs ranging from 6.1 to 7.2. A groundwater sample seeping from the lower south adit had a field pH of 7.3 and a laboratory measured pH of 7.17.

Two of the samples (01 and 03) were analysed for total metals by the project laboratory. These results suggest that the soil samples contain high concentrations relative to the CMCS criteria for arsenic (351 & 680 ppm), cadmium (48.1 and 41.6 ppm), selenium (26.1 & 42 ppm), silver (126 ppm), and zinc (2150 & 3140 ppm). These concentrations likely represent background concentrations in the mined rock. The results of the analysis are presented in Table C6, Appendix C and the laboratory report in Appendix D.

The results of field observations and measurements suggest that the rock pile is not significantly impacting site surface water, groundwater or vegetation.

5.6 Mine Openings

Three mine openings were identified during the site reconnaissance. The adit locations are shown in Figure 5.1 and are identified as the:

- lower south adit - located on south slope approximately 100 m south of main building and adjacent to waste rock pile;
- upper south adit - located approximately 80 m further up slope from the lower south adit; and
- north adit - located on north slope approximately 300 meter south east of camp.

The lower south adit (Photos 12, Appendix A) is mostly collapsed and supported by timber extending horizontally into the slope face. The adit is up to 1 m wide but would be difficult to access. The depth of the adit could not be determined. This adit may present a minor safety hazard.

The upper south adit (Photos 13 and 14, Appendix A) entrance is about 2 m wide at the base, approximately 0.75 m high, and is supported by wood cribbing. Once inside the entrance, the adit opens into a larger area where there is another doorway approximately 3 m into the hill. The adit likely leads further into the hill from the doorway. The ease of access to this adit is identified as being a safety hazard.

The north adit (Photo 15, Appendix A) entrance is collapsed and, therefore, presents a very minor safety hazard.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Health and Safety

Upper South Adit - To reduce the safety hazard, the portal entrance should be closed. If earth moving equipment is mobilised to the site, the portal can be buried with benign rock or soil. If no earth moving equipment is mobilised on-site, a rock drill can be brought in with a light truck to drill blast holes in the rock around the portal. A qualified blaster could then charge the holes and collapse the entrance to the adit.

Lower South and North Adits - A few cubic metres of fill from nearby both these openings can be used to block the entrances and eliminate any safety hazard.

Buildings - Several buildings on-site are in various states of deterioration. The main and bunk buildings are standing and in fair condition. The other buildings noted are collapsed and present a hazard to people that may walk on or near the structures. The floor boards on the standing buildings are slightly deteriorating and in the future may pose a health and safety hazard to people entering the buildings. All buildings should be demolished to prevent a future health and safety issues. If the buildings are to remain in place, signs should be posted to possibly reduce the liability to the property owner.

Land Slides - Evidence of recent landslides in the vicinity of the upper and lower adits along the south slope suggests that failure may be a result of mining activities (road cuts, adit work). Future work that may require road work, clearing trails, or removal of vegetation will increase the risk of additional slides. Any work that may be completed in this area of the site should be done in a way that minimises any impact to the current site conditions. Small trucks should be used if debris is to be collected from the upper south adit and the stability of nearby slopes should be assessed prior to using explosives to close any adits.

6.2 Environmental Risks

Drum Contents - The approximate 75 litres of liquid in the drum at the old drill should be flared on-site.

Lead acid batteries should be collected and taken off site for proper disposal.

6.3 Aesthetic Concerns

Aesthetic concerns arise from the distribution of metal and wood debris, buildings, and cleared vegetation from excavation and trenching work.

Buildings are constructed largely of wood. The buildings can be left in place or levelled and combustible material burned. Burning of material at this site may be difficult due to the dense vegetation at the base of the gulch where most debris and material is situated. Creating a buried landfill may also prove difficult due to the absence of a thick layer of unconsolidated material near the base of the gulch and the presence of a nearby water body that may be impacted. If burning is not suitable, the wood debris on-site should be collected and stored above ground in one dedicated location.

Metal debris including empty drums, stoves, pipes, bunks, pails etc. should be collected and buried on-site at a suitable distance from the creek that is located at the base of the gulch.

Class "D" cost estimates are provided in a separate document.

7.0 STANDARD LIMITATIONS

This report was prepared for the exclusive use of Public Works and Government Services Canada and its 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.

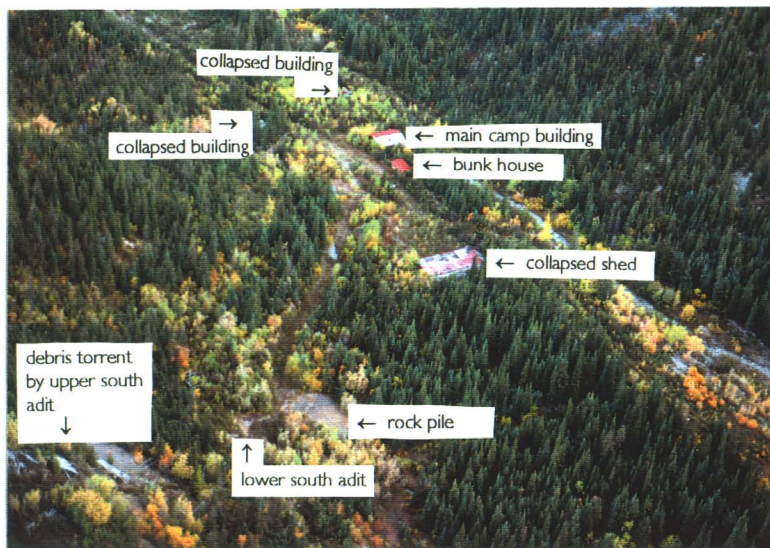

David E. Karwandy, P.Eng.
Project Manager


Stuart Wyse, Ph.D.
Senior Review

APPENDIX A
SITE PHOTOGRAPHS

**APPENDIX A
LIST OF PHOTOGRAPHS**

- Photo 1: View of camp site and south slope from the air.
- Photo 2: Main camp building.
- Photo 3: Bunk house.
- Photo 4: Collapsed wood building west of camp on north side of roadway.
- Photo 5: Collapsed wood building west of camp on south side of roadway
- Photo 6: Collapsed shed building.
- Photo 7: Debris and collapsed wood building near upper south adit.
- Photo 8: Collapsed wood building near north adit.
- Photo 9: Partially full drum at old drill and generator area.
- Photo 10: Old drill and generator.
- Photo 11: Rock pile.
- Photo 12: Lower south adit showing discharge water.
- Photo 13: Upper south adit entrance.
- Photo 14: Upper south adit inside entrance.
- Photo 15: North adit, collapsed.



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APPENDIX B
SAMPLING METHODS

APPENDIX B SAMPLING METHODS

Drum Content Sampling

Drum contents were sampled using clean glass capillary tubes. The glass tubes were inserted into the drum, and uppermost open tip was sealed to maintain the sample within the tube as it was extracted from the drum or pail. The sample was then drained into 40-ml laboratory prepared glass vial and placed in a cooler for storage and shipment to the project laboratory. The sampling procedure was repeated until a sufficient volume of sample was collected in the vial. A new tube was used for each drum.

Soil Sampling

Small handdug excavations were completed in areas where 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 container, 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 HNO₃ added for preservation. Water analysed for general chemistry was placed in 1 litre plastic containers.

APPENDIX C
ANALYTICAL TABLES

TABLE CI
PCB CONCENTRATIONS IN PRODUCT SAMPLE
ENVIRONMENTAL ASSESSMENT MINE SITE 37 AT MT. HALDANE
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
 mg/L

Sample No.	Detection Level	GV206MTHOIL
Date sampled		9-Sep-96
Arochlor 1242	0.7	<
Arochlor 1248	0.7	<
Arochlor 1254	0.7	<
Arochlor 1260	0.7	<

Analyses by Caritest Laboratory, Vancouver, B.C.

TABLE C2
 METAL CONCENTRATIONS IN PRODUCT SAMPLES
 ENVIRONMENTAL ASSESSMENT MINE SITE 37 AT MT. HALDANE
 PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
 mg/kg (ppm)

Sample No.	GV206MTHOIL	Detection
Date sampled	9-Sep-96	Limits
Location		
Aluminum	<	2
Antimony	<	2
Arsenic	<	3
Barium	1.6	0.01
Beryllium	<	0.06
Boron	0.6	0.1
Cadmium	<	0.2
Calcium	1.7	0.1
Chromium	<	0.3
Cobalt	<	0.2
Copper	<	0.2
Iron	42	0.3
Lead	<	0.8
Magnesium	0.2	0.01
Manganese	0.18	0.03
Molybdenum	<	0.4
Nickel	<	0.3
Phosphorus	113	4
Silver	<	0.3
Sodium	<	1
Strontium	0.02	0.01
Tin	<	0.3
Titanium	<	0.06
Vanadium	<	0.1
Zinc	2	0.2
Zirconium	<	0.2

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

< = less than the detection limit

TABLE C3
LEPH AND HEPH IN SOIL SAMPLES
ENVIRONMENTAL ASSESSMENT MINE SITE 37 AT MT. HALDANE
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
mg/kg

Sample No.	CMCS Criteria for Soil			Detection	GV206MTHOS1	GV206MTH04
	AL	PL/RL	CL/IL	Limit		
Date sampled					9-Sep-96	9-Sep-96
Location					below lower S adit	old drill rig
Depth (m)					0-0.1	0-0.1
LEPH	1000	1000	2000	250	<	<
HEPH	1000	1000	5000	250	<	2900

< = Less than detection limit

* numerical concentrations from the Criteria for Managing Contaminated Sites in B.C.

AL - Agricultural PL - Urban Park RL - Residential CL - Commercial IL - Industrial

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

TABLE C4
 GENERAL CHEMISTRY IN WATER SAMPLES
 ENVIRONMENTAL ASSESSMENT MINE SITE 37 AT MT. HALDANE
 PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Date sampled Location	units	CMCS		GV206MTHADIT 9-Sep-96 adit seepage	GV206MTHUP 9-Sep-96 creek upgradient	GV206MTHDOWN 9-Sep-96 creek downgradient	Detection Limit
		Aquatic Life Numeric Criteria	Drinking Water				
pH		6.5-9.0*	6.5-8.0*	7.17	4.83	6.49	
Conductivity	uS/cm			375	78	183	1
True Color	CU			<	<	<	5
Turbidity	NTU			0.32	0.34	0.32	0.1
Hardness (CaCO3)	mg/L			188	34	80	1
Total Dissolved Solids	mg/L		<=500*	310	58	140	10
Bicarbonate (HCO3)	mg/L			137	21.7	44.5	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	0.22	<	<	0.05
Chloride	mg/L		250	<	<	<	0.2
Nitrate and Nitrite	mg/L			0.15	0.38	0.38	0.05
Nitrate	mg/L	40	10	0.15	0.38	0.38	0.05
Nitrite	mg/L	0.02 to 0.06 varies with Chloride	3.2	<	<	<	0.002
Sulphate	mg/L	100	500	82	16	48	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 C5
 CONCENTRATIONS OF METALS IN WATER SAMPLES
 ENVIRONMENTAL ASSESSMENT MINE SITE 37 AT MT. HALDANE
 PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
 ug/L (ppb)

Sample No.	CCME Aquatic Life	Detection Limits	GV206MTHADIT	GV206MTHUP	GV206MTHDOWN
Date sampled			9-Sep-96	9-Sep-96	9-Sep-96
Location			adit seepage	creek upgradient	creek downgradient
Aluminum	5-100**	5	7	7	7
Antimony	-		<	<	<
Arsenic	50		5	30	3
Barium	-		2	21	31
Beryllium	-		<	<	<
Boron		5	53	22	21
Cadmium	0.2-1.8*	0.2	4.2	<	<
Calcium	-	10	66,600	11,800	28,300
Chromium	2-20		<	<	<
Cobalt	-		<	<	<
Copper	2.4*		<	<	<
Iron	300	30	<	<	<
Lead	1.7*		<	<	<
Magnesium	-	50	5,222	960	2,350
Manganese	-		22	<	<
Mercury	0.1	0.05	<	<	<
Molybdenum	-		<	2	<
Nickel	25-150*		3	<	<
Phosphorus	-	400	<	<	<
Potassium	-	10	310	140	180
Selenium			9	<	<
Silicon	-	100	5,700	4,700	3,600
Silver	0.1	0.10	<	<	<
Sodium	-	100	400	1,000	400
Strontium	-		150	26	96
Tellurium	-		<	<	<
Thallium	-	0.1	<	<	<
Thorium	-	0.5	<	<	<
Tin	-		<	<	<
Titanium	-		<	<	<
Uranium	-	0.5	0.8	<	<
Vanadium	-		<	<	<
Zinc	30	5	140	<	<
Zirconium	-		<	<	<

* - 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.

TABLE C6
METAL CONCENTRATIONS IN SOIL SAMPLES
ENVIRONMENTAL ASSESSMENT MINE SITE 37 AT MT. HALDANE
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
mg/kg (ppm)

Sample No.	CCME			DETECTION LIMITS	GV206MTH01	GV206MTH03
	AL	PL/RL	CL/IL		9-Sep-96 surface	9-Sep-96 surface
Date sampled				0.01	9.7	11.5
Depth (m)						
Moisture (%)						
Antimony	20	20	40	10	<	20
Arsenic	20	30	50	30	351	680
Barium	750	500	2000	0.1	9	49
Beryllium	4	4	8	1	<	<
Cadmium	3	5	20	0.25	48.1	41.6
Chromium	750	250	800	2	22	45
Cobalt	40	50	300	1	1	14
Copper	150	100	500	1	201	251
Lead	375	500	1000	1	4580	11200
Mercury	0.8	2	10	0.001	0.42	1.2
Molybdenum	5	10	40	4	<	<
Nickel	150	100	500	2	18	53
Selenium	2	3	10	3	26.1	42
Silver	20	20	40	2	21	126
Tin	5	50	300	5	34	38
Vanadium	200	200	-	0.5	35	97
Zinc	600	500	1500	1	2150	3140
Aluminum				10	8500	21300
Boron				0.5	23	39
Calcium				1	520	8270
Iron				2	53400	93000
Magnesium				0.1	3820	8270
Manganese				0.2	23600	30400
Phosphorus				20	1190	3080
Sodium				5	<	23
Strontium				0.1	18	44
Titanium				0.3	3	28

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

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

< = less than the detection limit

exceeds the CL/IL criteria

APPENDIX D
LABORATORY REPORTS

Analysis Report

CANTEST

CanTest Ltd

REPORT ON: Analysis of Water and Soil Samples

Professional
Analytical
Services

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

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

Att'n: Mr. David Karwandy

CHAIN OF CUSTODY: 17781
PROJECT NAME: MTH
PROJECT NUMBER: GV200.01

NUMBER OF SAMPLES: 7

REPORT DATE: October 17, 1996

DATE SUBMITTED: September 19, 1996

GROUP NUMBER: 6091919

SAMPLE TYPE: Water and Soil

TEST METHODS:

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.

Extractable Petroleum Hydrocarbons in Water/Soil (LEPH/HEPH-GNS) - analysis was performed using a draft DCM extraction-GC/FID procedure specified by the B.C. MOELP. Compounds eluting between n-decane (n-C10) and n-nonadecane (n-C19) are defined as Light Extractable Petroleum Hydrocarbons (LEPH). Compounds eluting between n-nonadecane and n-dotriacontane (n-C32) are defined as Heavy Extractable Petroleum Hydrocarbons (HEPH). These results can be compared to Generic Numerical Standard (GNS) criteria. The results may or may not be corrected for specified PAH's, as noted on the report.

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.

(Continued)

CAN TEST LTD.


Richard S. Jomitz
Supervisor, Inorganic Testing

Page 1 of 6



REPORTED TO: GeoViro Engineering Ltd.

CANTEST

REPORT DATE: October 17, 1996

GROUP NUMBER: 6091919

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

Lead in Soil - analysis was performed using background-corrected Flame Atomic Absorption 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: 6091919

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	GV206MTHAD IT	GV206MTHUP	GV206MTHDO WN		
DATE SAMPLED:	Sep 9/96	Sep 9/96	Sep 9/96	DETECTION LIMIT	UNITS
CAN TEST ID:	609190086	609190088	609190089		
pH	7.17	4.83	6.49	-	pH units
Conductivity	375	78	183	1	μ S/cm
True Color	<	<	<	5	CU
Turbidity	0.32	0.34	0.32	0.1	NTU
Hardness CaCO3	188	34	80	1	mg/L
Total Dissolved Solids	310	58	140	10	mg/L
Bicarbonate Alkalinity HCO3	137	21.7	44.5	0.5	mg/L
Carbonate Alkalinity CO3	<	<	<	0.5	mg/L
Hydroxide Alkalinity OH	<	<	<	0.5	mg/L
Fluoride F	0.22	<	<	0.05	mg/L
Chloride Cl	<	<	<	0.2	mg/L
Nitrate and Nitrite N	0.15	0.38	0.38	0.05	mg/L
Nitrate N	0.15	0.38	0.38	0.05	mg/L
Nitrite N	<	<	<	0.002	mg/L
Sulphate SO4	82	16	48	1	mg/L

μ S/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: 6091919

Metals Analysis in Water

CLIENT SAMPLE IDENTIFICATION:		GV206MTHAD	GV206MTHUP	GV206MTHD		
		IT		WN		
SAMPLE PREPARATION:		DISSOLVED	DISSOLVED	DISSOLVED		
DATE SAMPLED:		Sep 9/96	Sep 9/96	Sep 9/96		
CAN TEST ID:		609190086	609190088	609190089	DETECTION LIMIT	UNITS
Aluminum	Al	0.007	0.007	0.007	0.005	mg/L
Antimony	Sb	<	<	<	0.001	mg/L
Arsenic	As	0.005	0.030	0.003	0.001	mg/L
Barium	Ba	0.002	0.021	0.031	0.001	mg/L
Beryllium	Be	<	<	<	0.001	mg/L
Boron	B	0.053	0.022	0.021	0.005	mg/L
Cadmium	Cd	0.0042	<	<	0.0002	mg/L
Calcium	Ca	66.6	11.8	28.3	0.01	mg/L
Chromium	Cr	<	<	<	0.001	mg/L
Cobalt	Co	<	<	<	0.001	mg/L
Copper	Cu	<	<	<	0.001	mg/L
Iron	Fe	<	<	<	0.03	mg/L
Lead	Pb	<	<	<	0.001	mg/L
Magnesium	Mg	5.22	0.96	2.35	0.05	mg/L
Manganese	Mn	0.022	<	<	0.001	mg/L
Mercury	Hg	<	<	<	0.05	µg/L
Molybdenum	Mo	<	0.002	<	0.001	mg/L
Nickel	Ni	0.003	<	<	0.001	mg/L
Phosphorus	PO4	<	<	<	0.4	mg/L
Potassium	K	0.31	0.14	0.18	0.01	mg/L
Selenium	Se	0.009	<	<	0.001	mg/L
Silicon	SiO2	5.7	4.7	3.6	0.1	mg/L
Silver	Ag	<	<	<	0.0001	mg/L
Sodium	Na	0.4	1.0	0.4	0.1	mg/L
Strontium	Sr	0.15	0.026	0.096	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	<	<	<	0.001	mg/L
Uranium	U	0.0008	<	<	0.0005	mg/L
Vanadium	V	<	<	<	0.001	mg/L
Zinc	Zn	0.14	<	<	0.005	mg/L
Zirconium	Zr	<	<	<	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: 6091919

Extractable Petroleum Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CAN TEST ID	LEPH-uncorrected for PAH's	HEPH-uncorrected for PAH's
GV206MTHOS1	Sep 9/96	609190085	<	<
GV206MTH04	Sep 9/96	609190090	<	2900
DETECTION LIMIT UNITS			250 $\mu\text{g/g}$	250 $\mu\text{g/g}$

$\mu\text{g/g}$ = micrograms per gram, on a dry weight basis.

< = Less than detection limit

REPORTED TO: GeoViro Engineering Ltd.



REPORT DATE: October 17, 1996

GROUP NUMBER: 6091919

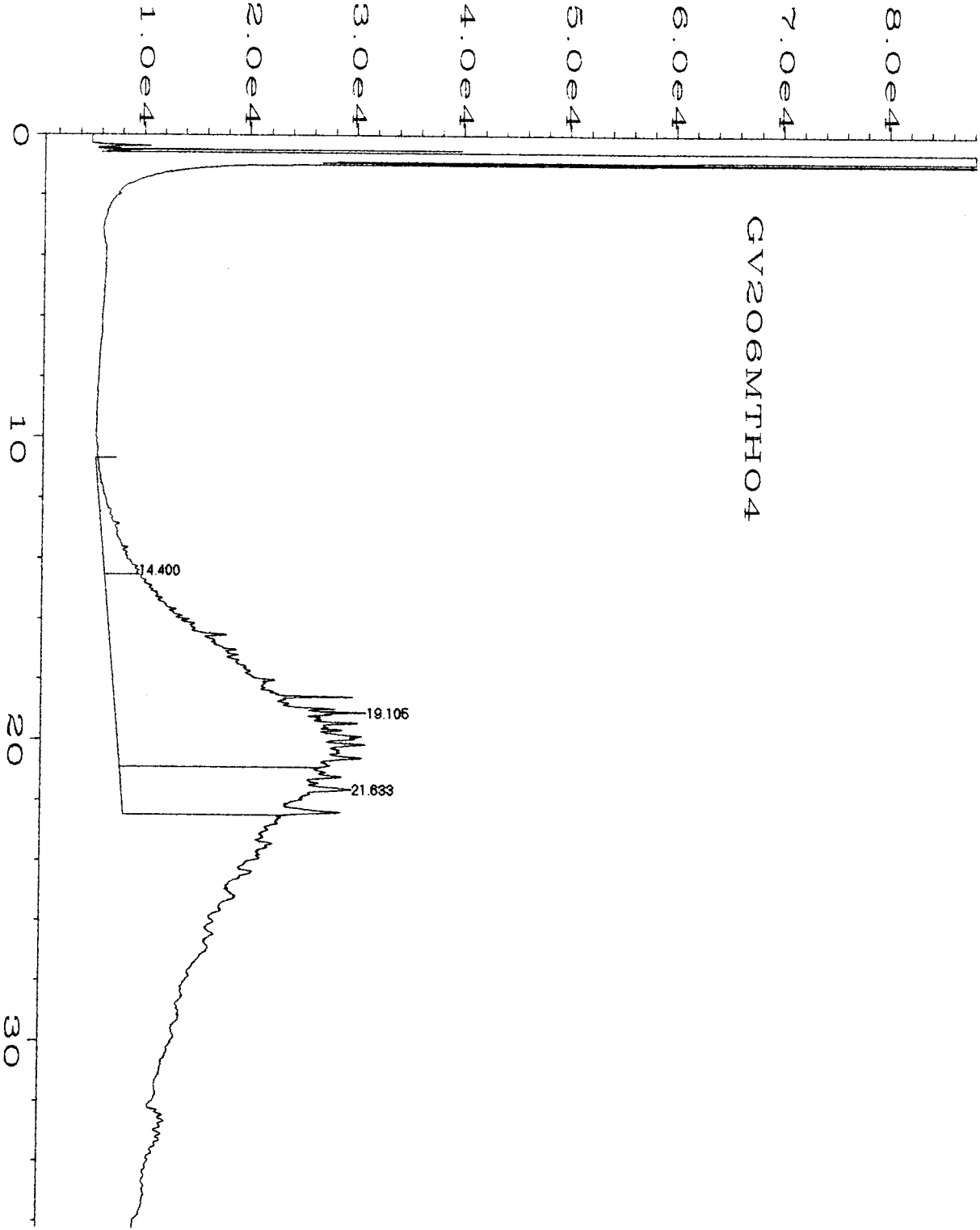
Metals Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:		GV206MTH01	GV206MTH03		
DATE SAMPLED:		Sep 9/96	Sep 9/96	DETECTION LIMIT	UNITS
CAN TEST ID:		609190091	609190092		
Moisture		9.7	11.5	0.01	%
Antimony	Sb	<	20	10	µg/g
Arsenic	As	351	680	30	µg/g
Barium	Ba	9	49	0.1	µg/g
Beryllium	Be	<	<	1	µg/g
Cadmium	Cd	48.1	41.6	0.25	µg/g
Chromium	Cr	22	45	2	µg/g
Cobalt	Co	1	14	1	µg/g
Copper	Cu	201	251	1	µg/g
Lead	Pb	4580	11200	1	µg/g
Mercury	Hg	0.42	1.2	0.001	µg/g
Molybdenum	Mo	<	<	4	µg/g
Nickel	Ni	18	53	2	µg/g
Selenium	Se	26.1	42.0	3	µg/g
Silver	Ag	21	126	2	µg/g
Tin	Sn	34	38	5	µg/g
Vanadium	V	35	97	0.5	µg/g
Zinc	Zn	2150	3140	1	µg/g
Aluminum	Al	8500	21300	10	µg/g
Boron	B	23	39	0.5	µg/g
Calcium	Ca	520	8270	1	µg/g
Iron	Fe	53400	93000	2	µg/g
Magnesium	Mg	3820	8270	0.1	µg/g
Manganese	Mn	23600	30400	0.2	µg/g
Phosphorus	PO4	1190	3080	20	µg/g
Sodium	Na	<	23	5	µg/g
Strontium	Sr	18	44	0.1	µg/g
Titanium	Ti	3	28	0.3	µg/g

% = percent
 < = Less than detection limit

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

user modified



Data File Name : C:\HPCHEM\FID\DATA\092396B\062F1901.D
Operator : RR
Instrument : FID
Sample Name : 609190090 40ML
Run Time Bar Code:
Acquired on : 24 Sep 96 10:08 AM
Report Created on: 24 Sep 96 04:17 PM
Page Number : 1
Vial Number : 62
Injection Number : 1
Sequence Line : 19
Instrument Method: TEHBAKE.MTH
Analysis Method : !TEH.MTH

Analysis Report

CANTEST

CanTest Ltd

Professional
Analytical
Services

REPORT ON: Analysis of Oil Samples

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

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Attention: Mr. Dave Karwandy

Fax: 604 731 2386

Tel: 604 734 7276

PROJECT NUMBER: GV206.01

1 800 665 8566

NUMBER OF SAMPLES: 6

REPORT DATE: November 22, 1996

DATE SUBMITTED: October 29, 1996

GROUP NUMBER: 7617K / 6103005

SAMPLE TYPE: Oil

TEST METHODS:

Metals in Oil - Samples were ashed @ 550°C. The residue was digested with nitric and hydrochloric acids. The resulting solutions were analyzed by Inductively Coupled Argon Plasma Spectrograph (ICAP).

TEST RESULTS:

See the following pages.

CANTEST LTD.


Richard S. Jornitz
Supervisor, Inorganic Testing

RSJ/wm

C:\CANTEST\INORGAN\REPORTS\GEOV7617.DOC



REPORTED TO: GeoViro Engineering Ltd.

REPORT DATE: November 22, 1996

GROUP NUMBER: 7617K / 6103005

TEST RESULTS:

CLIENT SAMPLE IDENTIFICATION:		GV206 MTH-OIL		
CANTEST ID:		7617K-3	UNITS	DETECTION LIMIT
Aluminum	Al	<	µg/g	2
Antimony	Sb	<	µg/g	2
Arsenic	As	<	µg/g	3
Barium	Ba	1.6	µg/g	0.01
Beryllium	Be	<	µg/g	0.06
Boron	B	0.6	µg/g	0.1
Cadmium	Cd	<	µg/g	0.2
Calcium	Ca	1.7	µg/g	0.1
Chromium	Cr	<	µg/g	0.3
Cobalt	Co	<	µg/g	0.2
Copper	Cu	<	µg/g	0.2
Iron	Fe	42	µg/g	0.3
Lead	Pb	<	µg/g	0.8
Magnesium	Mg	0.2	µg/g	0.01
Manganese	Mn	0.18	µg/g	0.03
Molybdenum	Mo	<	µg/g	0.4
Nickel	Ni	<	µg/g	0.3
Phosphorus	PO4	113	µg/g	4
Silver	Ag	<	µg/g	0.3
Sodium	Na	<	µg/g	1
Strontium	Sr	0.02	µg/g	0.01
Tin	Sn	<	µg/g	0.3
Titanium	Ti	<	µg/g	0.06
Vanadium	V	<	µg/g	0.1
Zinc	Zn	2.0	µg/g	0.2
Zirconium	Zr	<	µg/g	0.2

Results expressed as micrograms per gram (µg/g).

< = Less than

Analysis Report

CANTEST

CanTest Ltd

Professional
Analytical
Services

REPORT ON: Results of Testing

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

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

Att'n: Mr. Dave Karwandy

PROJECT NUMBER: GV206.01

NUMBER OF SAMPLES: 2

REPORT DATE: November 7, 1996

DATE SUBMITTED: October 29, 1996 - October 30, 1996

GROUP NUMBER: 6103005

SAMPLE TYPE: Oil

TEST METHODS:

Polychlorinated Biphenyls in Oil - analysis was using procedures based on U.S. EPA Methods 3580/8080, involving dilution, clean-up steps and analysis using GC/ECD. Aroclors 1242, 1248, 1254 and 1260 were included.

TEST RESULTS:

(See following page)

CAN TEST LTD.



Matthew Hartley, M.Sc.
Supervisor, Trace Organics

Page 1 of 2



REPORTED TO: GeoViro Engineering Ltd.



REPORT DATE: November 7, 1996

GROUP NUMBER: 6103005

Polychlorinated Biphenyls in Oil

CLIENT SAMPLE IDENTIFICATION:	GV206MTH-OIL	GV206HYD 17/18	
DATE SAMPLED:	Sep 9/96	Sep 10/96	
CAN TEST ID:	610300040	610220153	DETECTION LIMIT
Arochlor 1242	<	<	0.7
Arochlor 1248	<	<	0.7
Arochlor 1254	<	<	0.7
Arochlor 1260	<	<	0.7

Results expressed as milligrams per liter (mg/L)


< = Less than detection limit

CHEMEX Labs Alberta Inc.

Calgary : 2021 - 41st Avenue N.E., T2E 6P2, Telephone (403) 291-3077, FAX (403) 291-9468
Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

GEOVIRO ENGINEERING LTD.
STUART WYSE

DATE : October 4, 1996
CHEMEX PROJECT NO.: GEOV010-0502-96-07599
CLIENT REFERENCE : GV206
CLIENT JOB NO. :

Analytical Data Reviewed By : 

QA/QC Reviewed By : 

The above signatures indicate that the individuals identified have reviewed the enclosed documents.

NOTE : Soil samples and water samples (for stable parameters) will be retained for a period of 60 days after completion of analysis.
Retention beyond this period can be arranged for a fee.

CHEMEX Labs Alberta Inc. is accredited by both the Canadian Association for Environmental Analytical Laboratories and the Standards Council of Canada for specific parameters registered with the Association and the Council.

CHEMEX LABS Alberta METHOD SUMMARY

Total Organic Halides (TOX)

Subsamples of oil, solvent or solids are weighed directly onto a quartz sample boat and analysed. A pyrolysis/microcoulometric system is used to detect the content of organic halides (Cl, Br, I, but not F) as described in U.S. EPA methods 450.1 and 9020. Under furnace temperatures of 850-950 °C, all halogens are converted to HX and the resulting gases are fed into a titration cell through a sulphuric acid drying tube. The total halogen content is then determined by microcoulometric titration of silver ion and calculated as mg Cl and expressed in ppm or ppb as appropriate.

Detection limit: 0.5 ppm

Reference: Test Methods for Evaluating Solid Waste, SW-846; U.S. Environmental Protection Agency. Methods 9020A, 450.1.

Mitsubishi TOX -10 Analyzer Manual.

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Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

Sample Description : GV206MTH - OIL
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : GRAB
Sample Received Date: September 25, 1996
Sample Station Code : PESO

GEOVIRO ENGINEERING LTD.
ATTENTION : STUART WYSE
GV206.1
GV206

Chemex Worksheet Number : 96-07599-5
Chemex Project Number : GEOV010-0502
Sample Access :
Sample Matrix : OIL
Report Date : October 4, 1996
Analysis Date : October 2, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R E S U L T S	DETECTION LIMIT
Total Organic Halogens (TOX)		ug/g	37.0	2.

CHEMEX Labs Alberta Inc.

GEOVIRO ENGINEERING LTD.
ATTENTION : STUART WYSE
GV206.1

Calgary : 2021 - 41st Avenue N.E., T2E 6P2, Telephone (403) 291-3077, FAX (403) 291-9468
Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

Sample Description : GV206MTH - OIL
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : GRAB
Sample Station Code : PESO

Chemex Worksheet Number : 96-07599-5
Chemex Project Number : GEOV010-0502
Sample Access :
Sample Matrix : OIL
Report Date : October 4, 1996

BATCH SPECIFIC QUALITY ASSURANCE REPORT

PARAMETER	DATE	QA/QC	DUP	MATRIX SPIKES		CALIBRATION CHECK		
	ANALYZED (DD-MM-YY)	BATCH NUM ANAL		RECOV %	CONTROL LIMITS LOWER UPPER	RECOV %	CONTROL LIMITS LOWER UPPER	
Total Organic Halogens (TOX)	02-10-96	1 DCF	N.A.	NOT APPLICABLE		102.8	80.0	120.0