

Assessment of Abandoned Yukon Mine Sites

Peso #62

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Services Canada

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GV206.01

*Consultants in
Groundwater,
Property
Contamination
and
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Management*



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1.0 INTRODUCTION AND BACKGROUND

Several abandoned exploration and development mine sites in the Yukon, including the Peso 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 Peso abandoned mine site.

1.1 Location

The Peso abandoned mine site is located at latitude 64° 00' 38"N and longitude 135° 57' 56"W, approximately 48 km north of the community of Mayo, in the central Yukon (Figure 1.1). The site is located approximately 5 km west of Dublin Gulch at an elevation of approximately 1300 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, 1994.

1910-1916	Staked as Independence 1-8 by J. Alverson and G. Huffman. A 4.9 m shaft was sunk in 1912 and trenched until 1916.
1949, June	Restaked as Peso claims by Alverson and C.D. Poll.
1950	Dozer trenching completed.
1951-1952	Claims optioned by A.W. Johnston and J.W. Powelson.
1960	Claims optioned by Tanar Gold Mining Ltd. who transferred the claims to a new company, Peso Silver Mines Ltd. in 1961.
1961-1962	Peso completed 381 m of drifting and cross-cutting, 874.8 m of drilling from 16 holes, extensive trenching and 11.3 m of cross-cutting on the Rex vein.
1963	Charter Oil Co. Ltd. purchased a major interest in Peso and completed approximately 1067 m of underground development and 1067 m of underground drilling from 35 holes.
1972	36 claims on the north side of the Peso property were optioned to Alaskex Mining Corp. Ltd. who completed 127.4 m of drilling from 2 holes on the No. 1 vein.
1977	Peso partially restaked the No. 1 vein as MIC claims, and dozer trenched the Rex and Peso groups.
1978	H claims were added.

- 1979 Alaskex Mining Corp. Ltd. was changed to Rex Silver Mines Ltd.
- 1980 Partially restaked as Mole claims by a joint venture between Canada Tungsten Mining Corp. and Queenstake Resources Ltd.
- 1981, June P. Howard staked Colleen claims to the north of the old working and optioned them briefly to Mattagami Lake Mines Ltd. who completed preliminary mapping and sampling.
- 1985, Aug. M.J. Moreau tied on Pierre claims.
- 1986 The Pierre claims were explored with hand trenching and the Peso and Rex claims were purchased at a sheriff's sale.
- 1988-1989 More Pierre claims were added.
- 1990, Aug. Moreau restaked the Mole, Peso, Rex and Pierre claims.
- 1991, June Aurum Geological Consultants Inc. conducted a small sampling and evaluation program.
- 1991, Aug. B. Harris surrounded the property with a large block of West claims.

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 Peso site, as provided by Indian and Northern Affairs Canada, Mayo Mining District are provided in Table I-1.

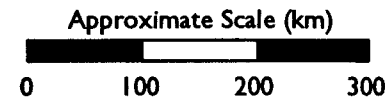
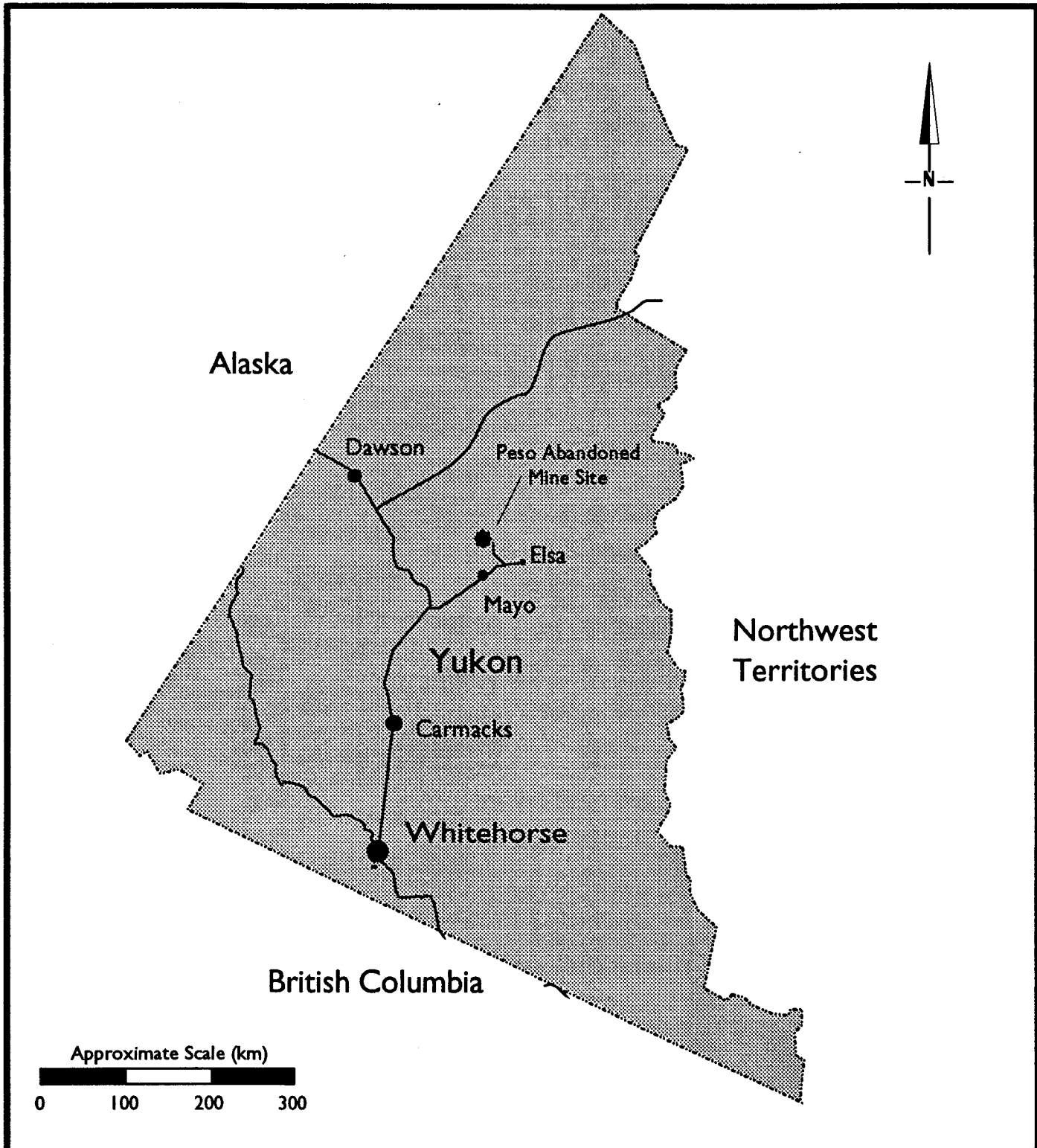
**TABLE I-1
 ACTIVE CLAIMS IN AREA OF PESO ABANDONED MINE SITE**


Claim Name	Claim Number	Expiry Date	Owner
Peso	1-2, 11-12	97/08/21	M.J. Moreau
Pierre	1-12, 33	96/11/13	M.J. Moreau
Mole	1-6, 14-18	96/11/13	M.J. Moreau
West	9-12, 16-27, 36, 37, 40, 42, 44, 46, 48, 50, 60, 360	96/10/01	Ivanhoe Goldfields Ltd.
West	196, 197, 209, 220, 271, 331-334, 343-346, 361, 362, 369, 370	97/10/01	Ivanhoe Goldfields Ltd.
West	41, 43, 45, 47, 49, 51, 61, 67-78, 85-88, 92-103, 122-131, 145-155, 166, 320, 322, 323-330, 335-342, 347-358, 363-368	2000/10/01	Ivanhoe Goldfields Ltd.
West	175, 184, 185, 194, 195, 206-208, 218, 219, 229-234, 243-246, 255-258, 267-270, 272, 281-285, 294-297, 319, 321	2001/10/01	Ivanhoe Goldfields Ltd.

The information provided indicates that several of the Pierre and Rex claims formerly held by M.J. Moreau and the West claims formerly held by H600 Holdings Ltd. have not been renewed. Details of all claims in the area of the Peso site are provided in Appendix A.

1.3 Site Access

The site is accessible by asphalt and dirt roads from Mayo and Dublin Gulch. Dublin Gulch is accessed by travelling north from Mayo on Highway 2 for approximately 35 to 40 km then heading northwest on the South McQuesten dirt road for approximately 40. The road to Dublin Gulch is maintained and generally in good condition during the non winter months as there are placer mine operations and a mine camp (prefeasibility mine site study camp) in the Dublin Gulch area. The Peso site is then accessed by travelling approximately 4 km west of Dublin Gulch on an old dirt road. The location of the access road from Dublin Gulch and road condition could not be ascertained since the site was accessed by helicopter during this investigation, however, anecdotal information from personnel working in the Dublin Gulch area suggest that the site can be accessed on this road with four wheel drive or all terrain vehicles.



 GeoViro Engineering Ltd.	TITLE Peso Mine Site Location	
	PROJECT Yukon Abandoned Mine Sites	
CLIENT Public Works and Government Services, Canada	September, 1996	Project GV206.01
	Figure I.1	

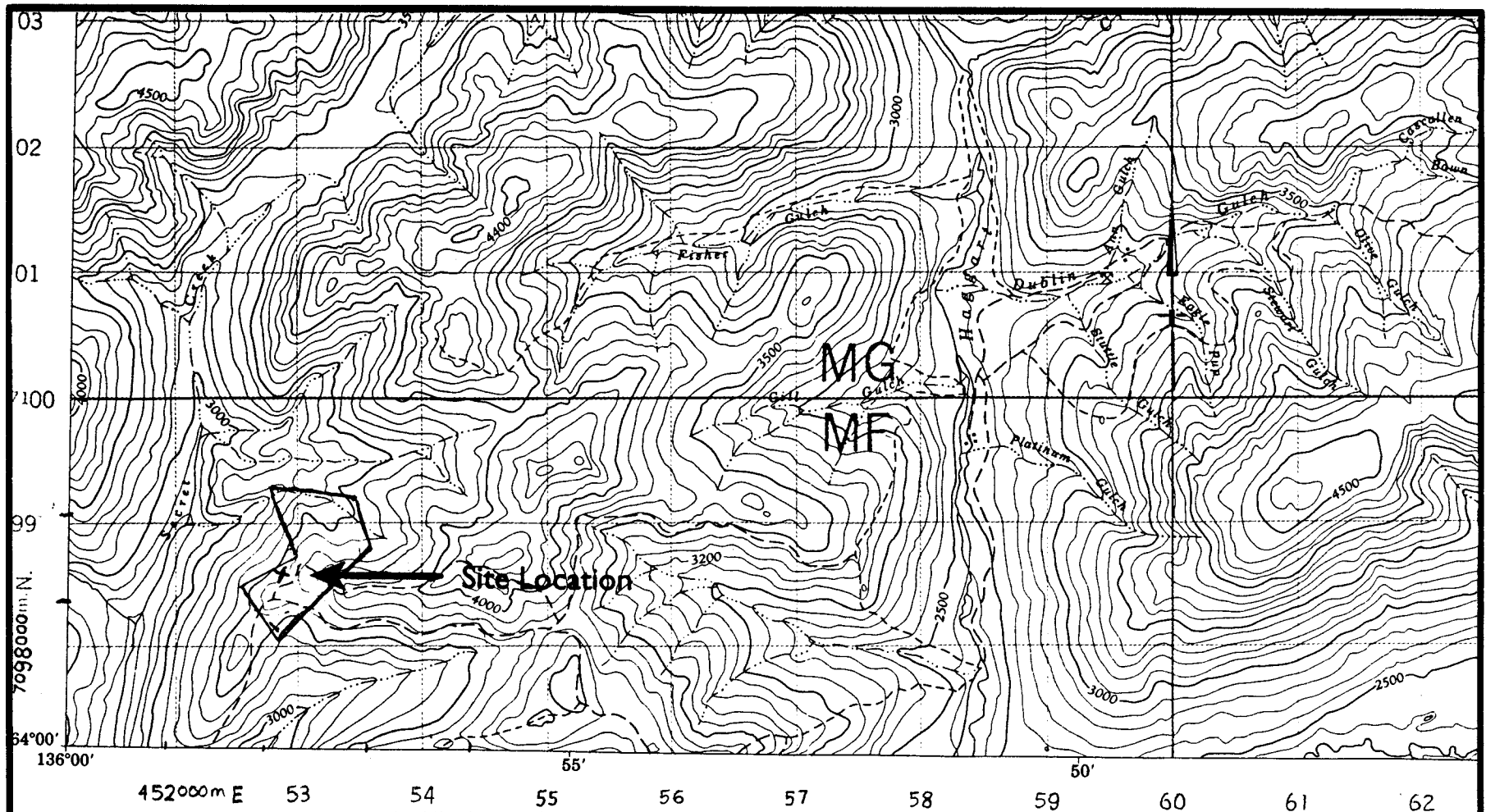



Figure after Department of Energy, Mines and Resources, 1971, NTS sheet 106 D/4 edition 2
 "Dublin Gulch, Yukon Territory", Scale 1:50,000., Contour Interval 100 feet.

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



GeoViro Engineering Ltd.

CLIENT

Public Works and
Government Services,
Canada

TITLE

Peso Abandoned Mine Site Air Photo

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 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 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, environmental chemistry and geotechnical mine engineering. The investigation included an assessment of

- the waste rock piles and excavation areas to assess ARD conditions;
- two mine openings to identify closure requirements;
- physical properties of soil, slope stability, and potential for erosion;
- nonhazardous site debris to determine disposal options;
- surface water;
- 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 and a detailed site plan completed, showing the location of all sources of contamination, buildings, mine openings and workings, site debris, waste rock piles, surface water bodies, springs, 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 accessible off-site environmental resources potentially affected by site activities. Access roadways to mine sites 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 are based on surficial observations;
- hydrogeologic conditions are inferred and based on experience at similar sites and generally accepted principals of groundwater flow regimes; and
- BC guidelines for contaminated site and acid rock drainage are used in the absence of specific Yukon criteria.

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 (C₅ - C₉)
- LEPH - light extractable petroleum hydrocarbons (C₁₀ - C₁₈)
- HEPH - heavy extractable petroleum hydrocarbons (C₁₉ - C₃₂)

Interim Policy for Acid Rock Drainage at Mine Sites

The Province of British Columbia Ministry of Energy, Mines and Petroleum Resources have developed a series of working policies and technical initiatives to deal with acid rock drainage. The document "Interim Policy for Acid Rock Drainage at Mine Sites" July 1993 (IPARD) is the first attempt by the Ministry to present those roles and guidelines as a comprehensive working policy. We refer to this document for regulatory guidance in the absence of Yukon specific policies or guidelines for acid rock drainage.

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 on the site. The assessment included the following components:

The **waste rock** disposal area was inspected and the following tasks completed:

- collection of surface and near surface soil samples of the waste rock and adjacent soil;
- testing soil pH;

- mapping and logging area to determine aerial extent, volume and slopes; and
- inspection of adjacent vegetation for signs of stress.

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

Trenches and Excavations were inspected, areas estimated 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 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;
- collection of duplicate samples in the field and analyses of samples; and
- regular maintenance and cleaning of field equipment.

4.0 ENVIRONMENTAL SETTING

4.1 Mineralisation

Veins cutting quartzite and schist of the late Proterozoic to Early Cambrian Hyland Group are the target areas mined at Peso. The veins are typically, highly sheared, chloritic, narrow many branching vein-faults. The mineralised sections contain quartz, carbonates and the sulphides; pyrite, tetrahedrite, galena and sphalerite.

The major commodities identified at the site comprise silver, lead and zinc. Antimony is identified as a minor commodity.

4.2 Climate

Temperature and precipitation data for Mayo, provided by Environment Canada Climatic Data Services, have been used for the Peso 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. The Peso site will likely experience 500 to 600 mm of precipitation. Over 50% falls during the months of June, July, August and September. 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 to 8 m. Almost all of the trails on-site that are easily identified on the airphoto (Figure 1.3) dated 1968 are now heavily overgrown. The only evidence of stressed vegetation occurs below the waste rock pile below Adit I (Photo I, Appendix C).

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 were identified near the areas of mining at the site. Tributaries of Secret Creek are located approximately 1 km downslope of Adit I and the waste rock pile (main mine site working). The most northerly exploration trenches and excavations are located in close proximity to headwaters of one creek tributary. Yukon Renewable Resources had no specific fisheries data for Secret Creek and its tributaries, however, some fisheries resources may be present because this creek flows into Haggart Creek which flows into the

South McQuesten River, both of which are considered to be of significant fisheries value. Haggart Creek is known to contain arctic grayling and northern pike. Wildlife observed during the site investigation included small rodents and grouse.

4.5 Site Topography, Drainage and Soils

The main portion of the site lies within the watershed of Secret Creek and its tributaries. Secret Creek is located approximately 1 km west of the site and approximately 400 m lower in elevation. The main mine area is located along the top and west flank of a north south ridge. The site slopes moderately to steeply to the west towards Secret Creek.

The general area was extensively glaciated during the Pleistocene period. Thus, the majority of the site is mantled with till or till-like material comprised of silt to gravel and rock. The depth of the unconsolidated material is unknown and likely varies from a few metres to several meters as evident in many of the trenches. A small exploration excavation was completed at the northeast portion of the exploration area at a lower elevation and in the immediate vicinity of a creek tributary. This area is infilled with unconsolidated glacial and alluvial deposits.

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.

Since the site is located near the upper reaches of a ridge, 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 main mine 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 horizontal and downward direction until it discharges at topographic low areas, that occur as creeks and rivers in this area. Discharge may also occur locally on the lower and middle slopes below the site and at the base of the rock pile 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 no evidence of near surface groundwater in the mine area during the site reconnaissance. The amount of recharge to the ground will depend on the hydrogeologic character of the surficial soils and upper bedrock zone.

Since the site is located near a topographic high point along a ridge, a groundwater divide will occur where the groundwater on the west side of the ridge will flow to the west and to the east on the east side of the

ridge. The main mine workings are located on the west side of the ridge and therefore, groundwater potentially impacted by these former operations is inferred to migrate towards the west, discharging several hundred metres to the west near Secret Creek and its tributaries.

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, flow velocity or 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 portion of the site, where most of the workings occurred, is located at the west end of the site. Trenching has occurred in a linear arrangement to the northeast and secondary trails lead to small exploration and surface workings to the north. 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.

5.1 Buildings, Infrastructure, and Equipment

The buildings, infrastructure and equipment on-site provided are those identified during the site reconnaissance of September 12, 1996. Several buildings, in various states of deterioration, are present in the main area of mine workings. 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

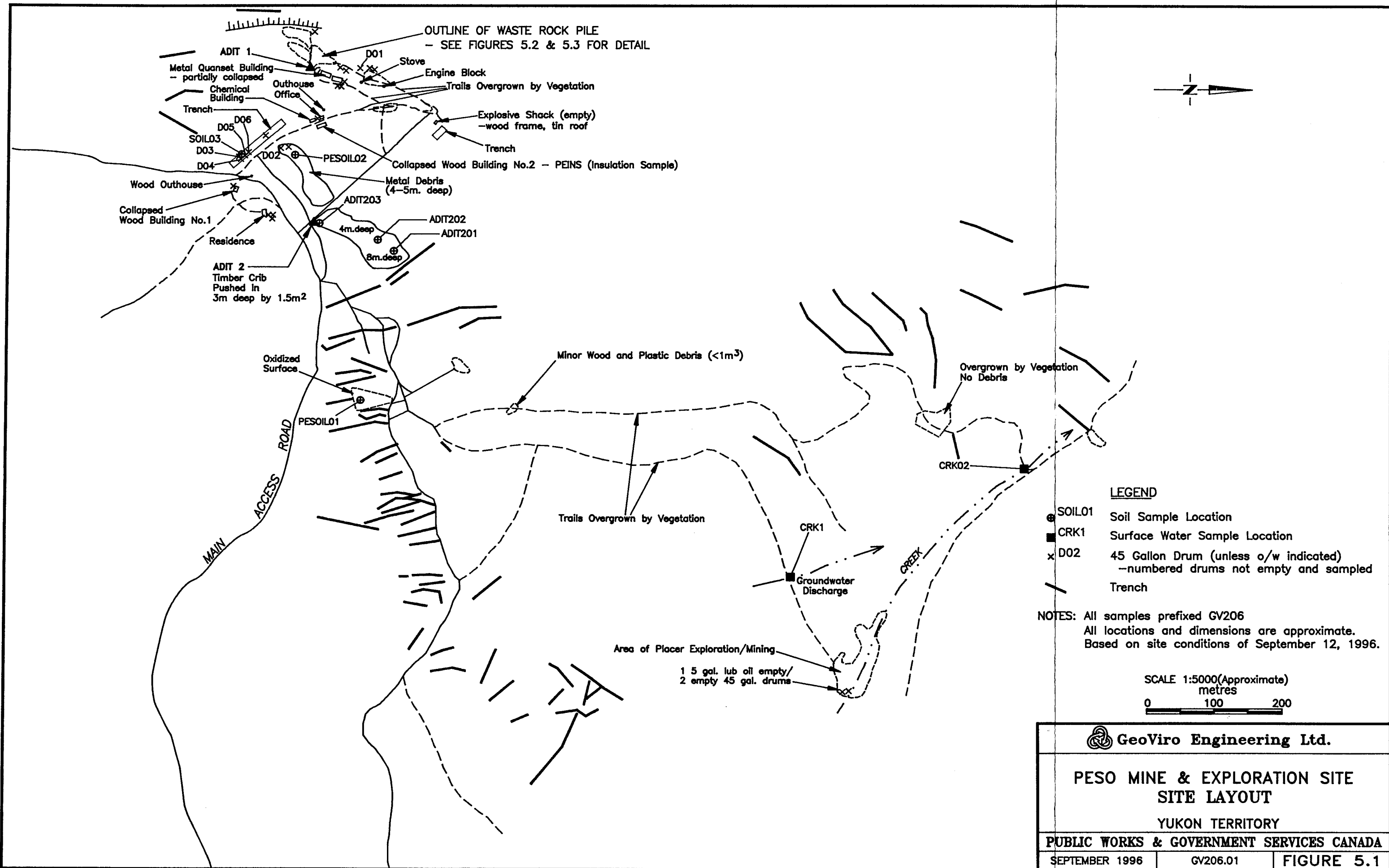
Seven buildings and two outhouses were identified during the site reconnaissance. This section details the building locations, sizes, construction materials and debris within the buildings. A name provided for each buildings is given based our best interpretation of the building's use or current state.

Residence

The residence (Photo 2, Appendix C) is located along the top portion of the ridge on the south side of the site. The residence is standing and appears in fair shape with the exception of some rotting floor boards. The building is 10 m long and 6 m wide with a 1.5 m wide outside deck on the south side. The building has a wood frame and plywood walls with styrofoam insulation. The ceiling and roof are wood and the floor is tiled. The building was virtually empty of debris and there was no evidence of asbestos-containing material.

Collapsed Wood Building No. 1

This collapsed former buildings (Photo 3, Appendix C) is located approximately 50 m southwest of the residence building. The collapsed wood structure covers an area of 7.5 x 5.3 m. There was no evidence of any materials other than wood, however, other materials may be present within the collapsed structure that could not be investigated due to the hazardous state of the building.



Collapsed Wood Building No. 2

This collapsed wood building (Photo 4, Appendix C) is located on the north side of the trail opposite from the chemical and office buildings. The dimension of the wood structure is approximately 11 x 4.5 m. Significant amounts of a fibrous insulation was mixed in with the wood debris. A sample of the insulation (GV206PEINS) was collected and analysed for asbestos content. The results of the analysis (Table D1, Appendix D) indicate that the insulation does not contain asbestos. Laboratory reports are provided in Appendix E.

Chemical Building

The chemical building (named because of the presence of approximately five broken Amyl Alcohol bottles and used chemical bottles) is constructed of wood with asphalt shingles on the roof and walls (Photo 4, Appendix C). The building dimension is 8.6 x 3.7 m and the structure is in fair condition, however, floor boards are rooting and may collapse when walked on. Debris within the building consists of one-gas furnace, several bagged soil and rock samples, magazines, wood tables and broken glass (Photo 5, Appendix C).

Office

The office building (Photo 4, Appendix C) is adjacent to the chemical building. The wood building consists of a sleeping area, an office-type area and a small porch. The building dimension is 3.5 x 3.7 m with a 2 x 2 m porch. Debris in the building consists of 4-empty paint cans, a metal box spring, a wooden desk and several books and paper debris. The building structure is in fair condition, however, floor boards are deteriorating.

Explosive Shack

The explosives shack (named because of explosive sign on outside of building) is located approximately 230 m north of the main adit and waste rock pile (Photo 6, Appendix C). The building dimension is 5 x 3 m. The building is constructed of wood with a tin roof. The building is empty and there was no evidence of explosives, asbestos or other debris within or outside the building.

Quonset

The 10.5 x 6.7 m metal quonset (Photos 7 and 8, Appendix C) is located approximately 30 m north of the main adit. The areas around the building, and trails leading to the building are heavily vegetated. The quonset is partially collapsed and poses a safety risk as the remainder will likely collapse some time in the

future. The building was used as the main storage area for site equipment and materials. Debris in the building consists of 3-engine blocks, approximately 200-core boxes, cement bags, chains, wheels, gears and several empty 20 litre and 200 litre barrels. In addition to the debris, approximately 2 kilos of tartaric acid was present.

Outhouses

Two wooden outhouses were identified on-site. One located near the residence was tipped over and the other was situated outside the office building.

5.1.2 Infrastructure (Excavations and Trenches)

Several excavations and trenches of various dimensions are located throughout the property as shown in Figure 1.3 (airphoto) and Figure 5.1. These excavations range from very surficial (less than 1 m deep) to several metres deep (up to 5 m) and over 100 m in length. Little vegetation has established itself in these excavations as the soil is very granular to rocky with little or no organic content.

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

Several samples of the soil were collected from the base of excavations and analysed for metal, paste pH and ABA. We believe these samples to represent native soil conditions in these areas. The results of the analysis are provided in Table 5-1 and the laboratory report is provided in Appendix E.

**TABLE 5-1
 EXCAVATION/TRENCH SOIL SAMPLE RESULTS**

SAMPLE # (locations shown on Figure 5.1)	Field Paste pH	Lab Paste pH	S(T) %	S(SO ₄) %	AP	NP	Net NP	NP/AP
GV206PEADIT201	5.5	3.97	0.15	NA	4.7	-1.0	-5.7	<0.1
GV206PEADIT203	5.7	4.84	0.10	NA	3.1	-0.4	-3.6	<0.1
GV206PADIT203 (duplicate)	6.0	4.74	0.06	NA	1.9	-0.1	-1.9	<0.1
GV206PESOIL01		3.69	0.84	NA	26.3	-3.1	-29.3	<0.1
GV206PESOIL02		3.79	0.48	NA	15.0	-1.9	-16.9	<0.1

NA - sample with S(T) < 1% not assayed for S (SO₄). AP calculation assumes S (SO₄)=0.

AP = acid potential in tonnes CaCO₃ equivalent per 1000 tonnes of material.

NP = neutralisation potential in tonnes CaCO₃ equivalent per 1000 tonnes of material.

Net NP = net neutralisation potential = tonnes CaCO₃ equivalent per 1000 tonnes of material.

Based on the ABA assessment criteria (Appendix F), the results presented in Table 5-1 suggest that although the Adit and excavation soil samples do not have the acid generating potential of the waste rock pile materials, they are more likely to be acid generating than acid consuming.

5.2 Non-Hazardous Materials

For a site with a working history dating back to 1910, there is not a large amount of debris detectable at surface. Due to the dense vegetation it would be 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 regularly to identify as much material as possible. 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.

Much of the equipment and debris is contained in and around the metal quonset near Adit 1. This material comprises 3-engine blocks, approximately 200-core boxes, cement bags, chains, wheels, gears and several empty 20 litre and 200 litre barrels. There is approximately 10 to 15 m³ of material in this area (Photo 8, Appendix C).

A old stove and engine block is located north of Adit 1 along north-south trending trail that leads to the explosive shack. A few drums were also located off the side of this trail including drum D01 that was approximately half full of lubricating oil.

Small amounts (1 to 2 m³) of metal and glass debris were located on the north side of the residence and in the trench near drum D02. A minor amount of plastic and a few small cans were located in a small clearing along the north-south trending trail several hundred metres east of the main mine site area.

In the vicinity of Adit 1 and the waste rock pile, there are several timbers, wood waste, approximately 20 m of rail track, a rail car and several lengths of plastic pipe.

5.3 Hazardous Material

Hazardous material identified include the contents of the six drums (D01 to D06) and a few kilos of tartaric acid. The tartaric acid is not a regulated waste but should be removed from the site and disposed of properly.

Approximately 20 to 25 - 200 litre drums and several 20 litre pails were identified throughout the site. The 20 litre pails and most of the drums are empty, however, six drums contained from approximately 10 litres to 100 litres of fuel or oil. The location of the drums are shown on Figure 5.1. Drums that were not

empty are designate D01 to D06 and the empty drums are represented only by the symbol outlined in the map legend. Samples of the liquid content in the six drums were collected and the results and quantities for each drum are provided in Table 5-2. Most drums are located in the main mine site area and are easily accessed. Two drums and one pail (all empty) are located in the exploration area along the creek tributary at the far northeast portion of the site. This area can only be accessed by foot or air as the trail leading to this area is completely overgrown and very boggy in areas.

A surficial soil sample was collected in the area where drums D03 to D06 are present. The sample was analysed and the results (Table D2, Appendix D) indicate there are no detectable concentration of light and heavy extractable petroleum hydrocarbons (LEPH and HEPH) in the sample, therefore no leakage is apparent from these drums.

The results of the analyses indicate a high concentration of total organic halogens are present in the sample collected from Drum D01. The contents of this drum are considered to be hazardous and the liquid cannot be burned on-site, but rather requires removal and disposal at a special waste handling facility. Additional analyses of the sample from D01 indicate that there are no detectable concentrations of polychlorinated biphenyls (PCB) in the sample. Results of the drum sampling are provided in Table 5-2 and the laboratory reports are provided in Appendix E.

The samples collected from drums 03 and 06 (samples GV206PED03 and GV206PED06) were analysed for metal concentrations. The results of the analyses indicate that the metal concentrations in the two samples are within the allowable levels for fuel in uses other than for Cement Kilns provided in Part 6, Section 41 of the B.C. Waste Management Act, Special Waste Regulations. The metal results are provided in Table D3, Appendix D.

TABLE 5-2
DRUM SAMPLE RESULTS

Drum Identification	Approximate Volume in Litres	Total Organic Halogens (TOX) ug/g	Suspected Liquid
D01	100	14,460 (no PCBs detected)	lubricating oil
D02	15	9	gasoline/water
D03	15	4 (comp. of D03 and D04)	?
D04	15		jet fuel
D05	15	6 (comp. of D05 and D06)	regular gasoline
D06	60		regular gasoline

5.4 Surface Water

Two surface water samples were collected during the reconnaissance of the most northerly portion of the exploration area several hundred metres from the main mine site area. One sample (CRK1, Figure 5.1) was collected from a small stream of water that occurred as a groundwater seep. This sample was collected in a topographic depression where the area was boggy. The second sample (CRK02, Figure 5.1) was collected from a tributary that discharges to Secret Creek approximately 1.2 km to the west.

The water samples were analysed for general chemistry and metal concentrations. The results are provided in Tables D4 and D5, Appendix D. Laboratory reports are provided in Appendix E. The results indicate that the aluminum and copper concentrations in both samples and the iron concentration in CRK1 exceed the criteria for the protection of aquatic life. All other metal concentrations are below the criteria. The pH of 5.92 in the tributary sample is slightly acidic. Based on the topographic layout of the site, these samples should not be affected by the main mine workings and the results likely indicate background conditions for this area. Further testing of creeks and their tributaries in this area would be required to confirm this observation.

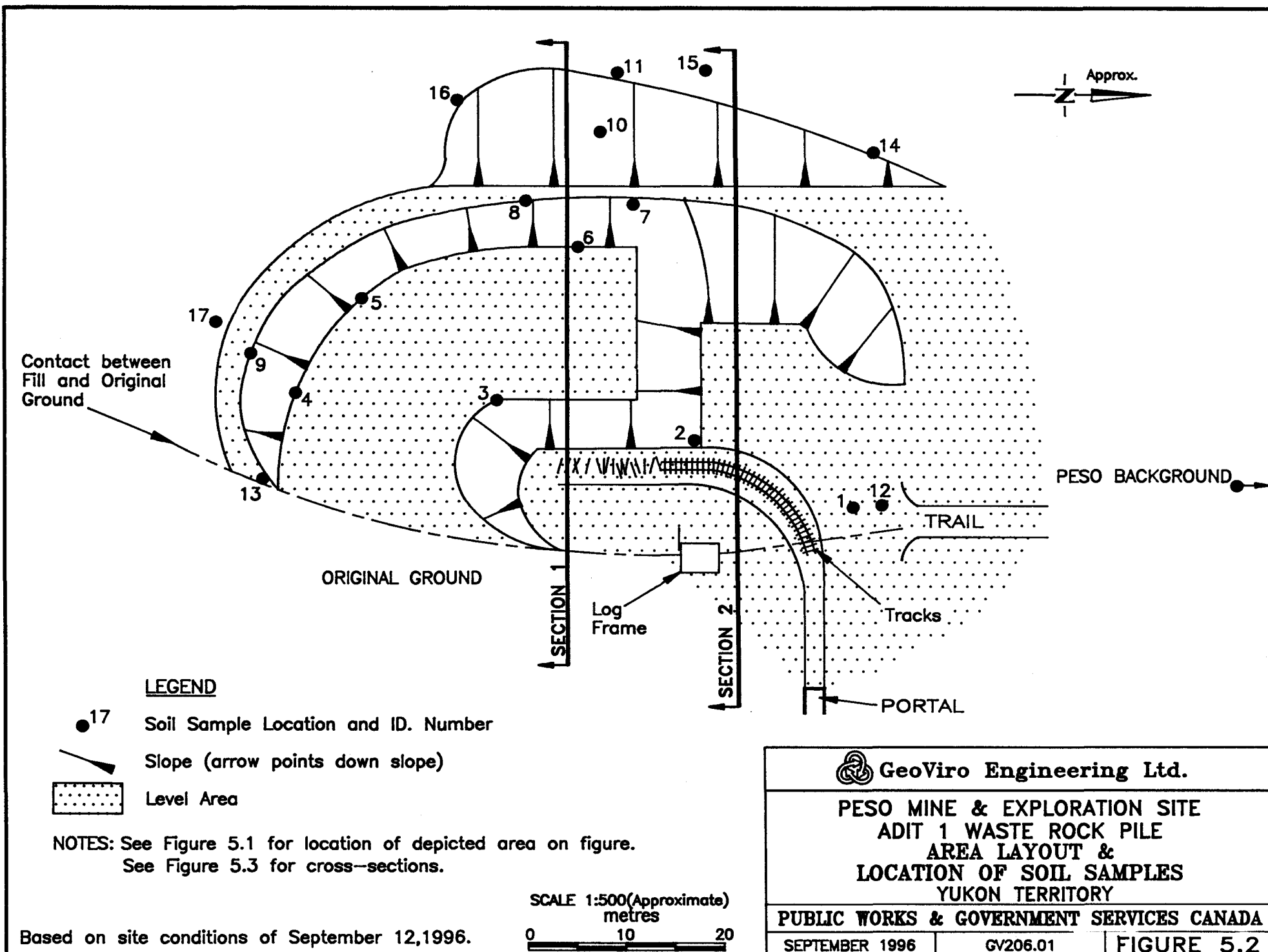
5.5 Waste Rock Disposal Area

5.5.1 General Description/Layout

There is approximately 9,500 m³ of waste rock at the west extremity of the site below Adit 1. This material covers an area of approximately 0.4 ha. The layout of the waste rock area is shown in Figure 5.2. Schematic cross sections of the waste rock are shown in Figure 5.3. The waste rock area is shown in photos 12, 13 and 14 in Appendix C.

From a visual inspection, the waste rock is a sand with some silt and gravel, and with a trace of cobbles and boulders. The individual particles are soft, angular, and platy - typical of the chloritic schist in the area. The waste rock appears to have been placed in three lifts about 5 to 12 m thick. Each lift has a face at its angle of repose (about 1.3h:1v or 37 degrees) and is separated from the higher lift by a bench varying in width from 2 to 15 m. The original ground is moderately steep, with an average slope estimated at 3h:1v (18 degrees).

There was no evidence of surface slumping or slope failure, nor was there evidence of concentrated seepage along the toe. There was some surface ravelling and fines washing from the slopes, but this did not appear to be degrading the stability of the mass.



Contact between
Fill and Original
Ground

PESO BACKGROUND

ORIGINAL GROUND

SECTION 1

Log
Frame

SECTION 2

TRAIL

Tracks

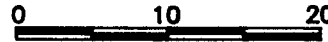
PORTAL

LEGEND

- 17 Soil Sample Location and ID. Number
- ▾ Slope (arrow points down slope)
- ▨ Level Area

NOTES: See Figure 5.1 for location of depicted area on figure.
See Figure 5.3 for cross-sections.

SCALE 1:500 (Approximate)
metres



Based on site conditions of September 12, 1996.

GeoViro Engineering Ltd.

**PESO MINE & EXPLORATION SITE
ADIT 1 WASTE ROCK PILE
AREA LAYOUT &
LOCATION OF SOIL SAMPLES
YUKON TERRITORY**

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

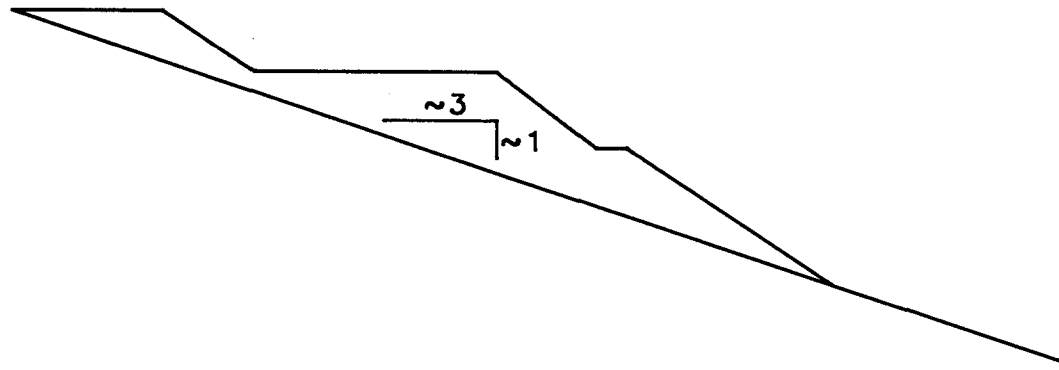
SEPTEMBER 1996

GV206.01

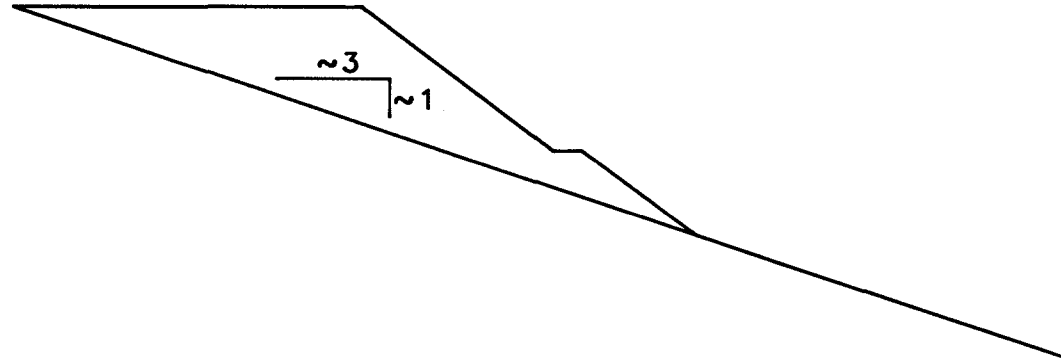
FIGURE 5.2

SECTION 1

← WESTERLY



SECTION 2



NOTES: See Figure 5.2 for location of cross-sections.



 **GeoViro Engineering Ltd.**

**PESO MINE & EXPLORATION SITE
ADIT 1 WASTE ROCK PILE
SCHEMATIC CROSS-SECTIONS**

YUKON TERRITORY

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

SEPTEMBER 1996

GV206.01

FIGURE 5.3

5.5.2 Analytical Results/Chemistry

Sixteen near surface samples of the waste material and one sample at a depth of about 0.9 m were collected. Selected samples were analysed in the field for pH and in the laboratory for metal concentrations, pH and acid base accounting (ABA). The ABA results are shown in Table 5-3 and the metal concentrations in soil samples are provided in Table D6, Appendix D. Laboratory reports are provided in Appendix E.

**TABLE 5-3
WASTE ROCK PILE SAMPLE RESULTS**

SAMPLE # (locations shown on Figure 5.2)	Field Paste pH	Lab Paste pH	S(T) %	S(SO ₄) %	AP	NP	Net NP	NP/AP
PESO BACKGROUND topsoil	5.2	4.81	0.03	NA	0.9	-1.4	-2.3	<0.1
GV206PADI-1	3.6	4.04	1.79	0.41	43.0	-1.1	-44.1	<0.1
GV206PADI-2		3.34	0.81	NA	25.3	-6.3	-31.6	<0.1
GV206PADI-3	3.3	2.97	1.38	0.46	28.8	-9.1	-38.0	<0.1
GV206PADI-5	5.9	3.09	1.2	0.68	16.1	-6.6	-22.7	<0.1
GV206PADI-7 3FT.	2.9	1.90	13	1.21	368	-26	-394	<0.1
GV206PADI-14	2.3	3.02	0.33	NA	10.3	-6.4	-16.7	<0.1
GV206PADI-15		3.33	0.15	NA	4.7	-5.8	-10.4	<0.1
GV206PADI-16		4.01	0.17	NA	5.3	-1.0	-6.3	<0.1
GV206PADI-17 (native soil)		5.02	0.07	NA	2.2	0.1	-2.1	<0.1

NA - sample with S(T) <1% not assayed for S (SO₄). AP calculation assumes S (SO₄)=0.
AP = acid potential in tonnes CaCO₃ equivalent per 1000 tonnes of material.
NP = neutralisation potential in tonnes CaCO₃ equivalent per 1000 tonnes of material.
Net NP = net neutralisation potential = tonnes CaCO₃ equivalent per 1000 tonnes of material.

5.5.3 Discussion of Results

A summary of the acid base accounting process and interpretation of ABA test results is provided in Appendix F. The following provides a brief interpretation of the results of the ABA test results for the waste rock material sampled at the Peso site.

Acid base accounting is a static test that can only be used to indicate whether or not there is the potential to generate net acidity at some unknown time in the future. The ABA test should only be used as an initial screening technique to assess the potential for acid rock drainage and not as a means to predict actual field geochemistry or waste rock drainage/groundwater quality.

The predictive ability of acid base accounting is generally considered to be reliable when the net acid production potential is greater than 20 kg H₂SO₄ per tonne (acid producing) or less than -20 kg H₂SO₄ per tonne (non acid producing). As can be seen from the results presented in Table 5-3 above, five (5) of the eight (8) waste rock pile samples were found to exhibit a NET NP of less than -20 tonnes CaCO₃ equivalent per 1000 tonnes of material (i.e. +20 kg H₂SO₄ per tonne). The waste rock samples analysed would be considered to be strong candidates for acid production.

Samples with ratios of more than 4:1 would be considered acid consuming, while samples with ratios of less than 1:1 would be considered acid producing. Between these ratios, samples would be neither clearly acid producing or consuming. Under this type of assessment criteria all the waste rock pile samples collected from the Peso abandoned mine site would be considered to be acid generating. The acid generating potential of the Peso background and native soil sample is uncertain.

It is important to recognise that samples collected for acid base accounting should be representative of the type of mineralisation and quantity of material being investigated and that samples should be obtained at depth within non-weathered horizons. The importance of obtaining samples at depth, in relatively unoxidized zones was demonstrated by sample GV206PAD 1-7. This sample was collected at 3 ft below ground surface (bgs) and exhibited the highest acid generating potential (-394 tonnes CaCO₃ equivalent per 1000 tonnes of material), by a significant margin. (Note: the scope of work precluded the collection of subsurface rock waste samples).

Paste pH measures the immediate acidity or basic characteristics of the material and may be indicative (at levels less than or equal to pH 4) that acid generation has been initiated or occurred prior to measurement. As can be seen from the paste pH results in Table 5-3, a majority of the samples collected already appear to be generating acid.

The overall results suggest that the waste rock pile has a high potential for producing acid drainage (assuming the results of analysis are representative of all materials contained within the waste rock pile). Low paste pH results and visual observations of phytotoxic distress in vegetation currently growing below the waste rock pile at Adit 1, indicate that acid production has already started.

Once the potential for acid generation has been established a more detailed evaluation involving kinetic and geochemical testing of representative samples and groundwater characterisation is normally performed to predict the rate, duration and quantity of acid formation. This information would then be used to select the most appropriate waste management and environmental control measures. Whether or not it would be cost effective to perform this type of study when it appears that the preliminary ABA data and field observations indicate that the site is currently, or will generate acid at some time in the future, is difficult to say.

5.6 Mine Openings

Two mine openings were identified during the site reconnaissance. One is located next to the waste rock (Adit 1) and the other (Adit 2) is located at the southwest end of the major trench marked on Figure 5.1.

Adit 1 (Photos 9 and 10, Appendix C) opening is approximately 2 m² and extends well into the hill. It is not possible to see the end of the drift from the portal. Historic records suggest that the drift could be about 1500 m long; this roughly corresponds with the volume of waste rock on the surface. The portal itself is made of wood cribbing and is starting to decay and collapse. A few boards are nailed across the portal. This site has been identified as being a safety hazard.

Adit 2 (Photo 11, Appendix C) is a near vertical shaft about 1.2 m square. It is filled to within a few metres of the surface with soil and presents only a minor safety hazard as is.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Health and Safety

Adit 1 - To reduce the hazard, the portal should be closed. If earth moving equipment is mobilised to the site to rework the waste rock pile, the portal can be buried with benign rock or soil. If there will be no earth moving equipment 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.

Adit 2 - with very little work and a few cubic metres of adjacent soil, this opening could be completely filled and all safety hazards eliminated.

Buildings on-site are in various state of deterioration. The quonset and collapsed wood building No. 2 are currently unstable. The remaining buildings are either fully collapsed or still standing. The floor boards on some of the buildings are rotting and pose a current or future health hazard. All buildings should be levelled to reduce the risk present from these structures. Combustible non-hazardous materials should be burned on-site and non-combustible non-hazardous materials should be landfilled on-site.

Trenches and Excavations on-site vary in depth from less than a metre to several metres. The slopes of the trenches do not show signs of deep-seated instability and do not appear to present a significant health and safety issue from this perspective. These excavations, however, are accessible to motorised vehicles and may pose a safety risk to occupants of vehicles that could unexpectedly drive over the edges.

6.2 Environmental Risks

Waste Rock Pile - None of the possible options to reduce the production and emission of acidic seepage would be particularly easy to implement at this site. Generally, a low-permeability cap and surface water diversion to reduce migration of water through the waste rock is the most practical. This cap could be made from fine-grained soil or from a synthetic liner. There is not an obvious source of fine-grained material nearby to borrow. The site has a thin (less than 1 m) layer of coarse colluvium or glaciated material over weathered schist. Neither of these materials would produce the low permeability typically specified for a liner. A synthetic liner would provide the low permeability but generally requires a protective soil covering to host the revegetation and to protect the delicate geomembrane from long-term damage. The surficial colluvium would be adequate for this cover.

In either case the surface of the waste rock would have to be re-graded to provide a smooth surface with sufficient flat slopes to allow equipment to operate. For a soil liner, the slope has to be sufficiently flat to

place and compact the soil. For a synthetic liner, the slope has to be sufficiently flat to place the cover layer without damaging the geomembrane. Usually slopes have to be flattened to about 3h:1v, but in this case, that is the slope of the ground beneath the waste rock. To re-slope the surface of the waste rock to achieve a workable slope would significantly increase the footprint of the existing pile.

A less expensive and less effective alternative would be to utilise the relatively soft and fine-grained nature of the waste rock itself to reduce infiltration. After regrading the slopes to 2h:1v so a dozer can operate on the slopes, sufficient lime could be tilled into the top 300 mm of the waste rock to allow grasses and native shrubs to grow. The tilled surface of the waste rock would then be compacted with a dozer to lower the permeability and, hence the surface infiltration. Finally, the area could be seeded to minimise surface erosion.

Drum Contents - Drum D01 contains approximately 100 L of a heavy oil that is contaminated with high concentrations of organic halogens. This liquid/oil is likely a 9.2 or 9.1 classification under the B.C. special waste legislation and will require shipment and destruction at a special waste handling facility (Swan Hill, Alberta). Wastes which contain halogenated organic compounds in total concentrations greater than or equal to 1,000 ug/g are prohibited from disposal in a secure landfill or long term storage facility and require destruction. The remaining drums (D02 to D06) contain gasoline, jet fuel and water with low concentrations of organic halogens and metals. The contents of drums D02 to D06 should be flared on-site and the drums landfilled on-site.

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, other than the quonset, are constructed largely of wood. The combustible building materials should be burned on-site. The quonset should be levelled and landfilled.

Non-hazardous metal debris including empty drums, stoves, quonset building, etc. should be landfilled on-site.

Vegetation is rapidly establishing itself in previously disturbed and cleared areas and no action is recommended to vegetate barren areas.

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.

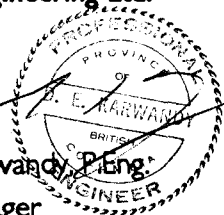
Some conclusions of this report are based on a comparison of chemical analytical results to criteria currently provided by CCME and BCCLP. In the event that these criteria are changed, amended, or replaced, GeoViro Engineering Ltd. should be requested to re-evaluate the conclusions of this report, and 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. Karwan, P.Eng.
Project Manager



Stuart Wyse, Ph.D.
Senior Review

APPENDIX A

MINE CLAIMS

1996/10  Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

We are able to confirm the status of the following claims:

Claim Name	Claim No.	Grant No.	Expiry Date	Registered Owner	% Ownd
Pierre	1 - 4	YA77744 - YA77747	1990/08/09	M. J. Moreau	100
	5 - 12	YA77748 - YA77755	1989/08/09	M. J. Moreau	100
	23 - 38	YA83351 - YA83368	1988/04/08	M. J. Moreau	100
	73 - 88	YA83393 - YA83408		M. J. Moreau	100
Pierre No.	93 - 98	YA83409 - YA83412		M. J. Moreau	100
	13 - 22	Y802095 - Y802104	1990/03/02	M. J. Moreau	100
Rex	1 - 8	Y802241 - Y802248	1990/07/15	M. J. Moreau	100
Mole	1 - 6	Y802249 - Y802254		M. J. Moreau	100
	13 - 18	Y802255 - Y802260		M. J. Moreau	100
Pierre	23 - 84	Y802878 - Y802937	1989/10/07	M. J. Moreau	100
	5 - 12	Y803338 - Y803345	1990/10/25	M. J. Moreau	100
	41 - 58	Y803346 - Y803363		M. J. Moreau	100
	23 - 40	Y803364 - Y803381	1990/10/27	M. J. Moreau	100
REX	59 - 84	Y803382 - Y803407	1990/10/30	M. J. Moreau	100
	1 - 8	Y803721 - Y803728	1994/08/03	M. J. Moreau	100
PIERRE	27	Y803729	1994/08/08	M. J. Moreau	100
	29	Y803730		M. J. Moreau	100
	31	Y803731		M. J. Moreau	100
	76	Y803732	1994/08/07	M. J. Moreau	100
	77	Y803733		M. J. Moreau	100
	79	Y803734		M. J. Moreau	100
	81	Y803735		M. J. Moreau	100
Pierre	33	Y803746	1996/11/13	M. J. Moreau	100
Mole	15 - 18	Y803747 - Y803750		M. J. Moreau	100
	1 - 6	Y803787 - Y803792		M. J. Moreau	100
Peso	14	Y803794		M. J. Moreau	100
	1 - 2	Y803795 - Y803796	1997/08/21	M. J. Moreau	100
Pierre	11 - 12	Y803797 - Y803798		M. J. Moreau	100
	1 - 12	Y803799 - Y803810	1996/11/13	M. J. Moreau	100
WEST	9 - 12	Y818778 - Y818779	1996/10/01	Ivanhoe Goldfields Ltd.	100
	13 - 15	Y818780 - Y818782	1991/08/29	H8000 Holdings Ltd.	100
	16 - 27	Y818783 - Y818794	1996/10/01	Ivanhoe Goldfields Ltd.	100
	36 - 37	Y818803 - Y818804		Ivanhoe Goldfields Ltd.	100
	38 - 39	Y818805 - Y818808	1992/08/29	H8000 Holdings Ltd.	100
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	44	Y818811	1996/10/01	Ivanhoe Goldfields Ltd.	100
	45	Y818812	2000/10/01	Ivanhoe Goldfields Ltd.	100
	46	Y818813	1996/10/01	Ivanhoe Goldfields Ltd.	100
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	49	Y818816	2000/10/01	Ivanhoe Goldfields Ltd.	100
	50	Y818817	1996/10/01	Ivanhoe Goldfields Ltd.	100
	51	Y818818	2000/10/01	Ivanhoe Goldfields Ltd.	100
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	145 - 155	Y818912 - Y818922	2000/10/01	Ivanhoe Goldfields Ltd.	100
	163 - 165	Y818930 - Y818932	1992/08/29	H8000 Holdings Ltd.	100
	168	Y818933	2000/10/01	Ivanhoe Goldfields Ltd.	100
	175	Y818942	2001/10/01	Ivanhoe Goldfields Ltd.	100
	184 - 185	Y818951 - Y818952		Ivanhoe Goldfields Ltd.	100
194 - 195	Y818981 - Y818982		Ivanhoe Goldfields Ltd.	100	
198 - 197	Y818983 - Y818984	1997/10/01	Ivanhoe Goldfields Ltd.	100	
208 - 208	Y818973 - Y818975	2001/10/01	Ivanhoe Goldfields Ltd.	100	
209	Y818976	1997/10/01	Ivanhoe Goldfields Ltd.	100	
218 - 219	Y818985 - Y818986	2001/10/01	Ivanhoe Goldfields Ltd.	100	
220	Y818987	1997/10/01	Ivanhoe Goldfields Ltd.	100	
229 - 234	Y818998 - Y819001	2001/10/01	Ivanhoe Goldfields Ltd.	100	
243 - 246	Y819010 - Y819013		Ivanhoe Goldfields Ltd.	100	
255 - 258	Y819022 - Y819025		Ivanhoe Goldfields Ltd.	100	
267 - 270	Y819034 - Y819037		Ivanhoe Goldfields Ltd.	100	
271	Y819038	1997/10/01	Ivanhoe Goldfields Ltd.	100	
272	Y819039	2001/10/01	Ivanhoe Goldfields Ltd.	100	

We are able to confirm the status of the following claims:

Claim No.	Indian and Northern Affairs Canada	Aloues indiennes et du Nord Canada	Expiry Date	Registered Owner	% Ownd
281 - 285		YB19048 - YB19052		Ivanhoe Goldfields Ltd.	100
284 - 297		YB19061 - YB19064		Ivanhoe Goldfields Ltd.	100
298 - 306		YB19065 - YB19073	1991/08/29	H6000 Holdings Ltd.	100
309		YB19076	1992/08/29	H6000 Holdings Ltd.	100
318		YB19086	2001/10/01	Ivanhoe Goldfields Ltd.	100
320		YB19087	2000/10/01	Ivanhoe Goldfields Ltd.	100
321		YB19088	2001/10/01	Ivanhoe Goldfields Ltd.	100
322		YB19089	2000/10/01	Ivanhoe Goldfields Ltd.	100
323 - 330		YB19780 - YB19787		Ivanhoe Goldfields Ltd.	100
331 - 334		YB19788 - YB19791	1997/10/01	Ivanhoe Goldfields Ltd.	100
335 - 342		YB19792 - YB19799	2000/10/01	Ivanhoe Goldfields Ltd.	100
343 - 346		YB19800 - YB19803	1997/10/01	Ivanhoe Goldfields Ltd.	100
347 - 358		YB19804 - YB19815	2000/10/01	Ivanhoe Goldfields Ltd.	100
359		YB19816	1995/10/01	Ivanhoe Goldfields Ltd.	100
360		YB19817	1996/10/01	Ivanhoe Goldfields Ltd.	100
361 - 362		YB19818 - YB19819	1997/10/01	Ivanhoe Goldfields Ltd.	100
363 - 368		YB19820 - YB19826	2000/10/01	Ivanhoe Goldfields Ltd.	100
369 - 370		YB19828 - YB19827	1997/10/01	Ivanhoe Goldfields Ltd.	100

Indian and Northern
Affairs CanadaAffaires indiennes
et du Nord Canada

Mayo Mining District

*Box 10*Our file: *Make reference**Mayo, YT, Y0B 1M0**(403) 996- 2256**Fax: (403) 996-2617*

FAX TRANSMISSION COVER SHEET

Date: *October 7, 1996***To:** *David Karwandy - GeoViro Engineering Ltd.***Fax:** *(604)689-5708***Subject:** *Peso Mine Site***Sender:** *David G. Wiebe*

YOU SHOULD RECEIVE 3 PAGE(S), INCLUDING THIS COVER SHEET. IF YOU DO NOT RECEIVE ALL THE PAGES, PLEASE CALL (403) 996- 2256.

Mr. Karwandy:

Attached list of quartz mineral claims, expiry dates and owners names as requested.

David Wiebe

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 hand dug 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
SITE PHOTOGRAPHS

APPENDIX C
LIST OF PHOTOGRAPHS

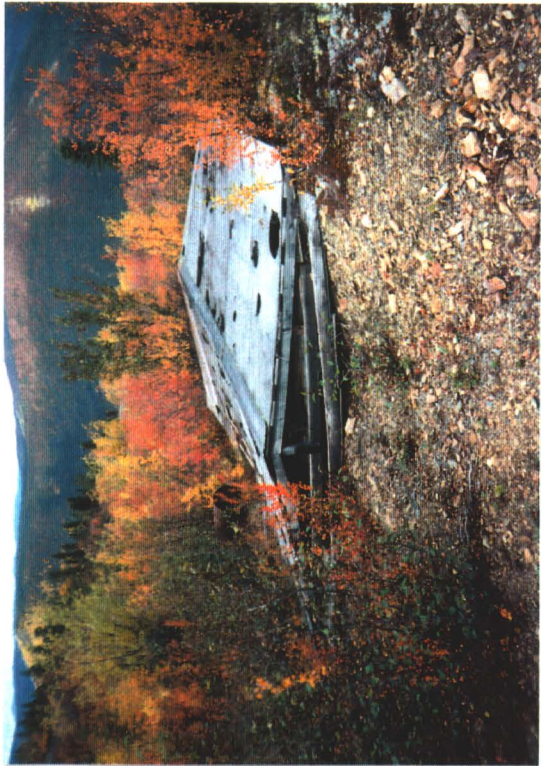
- Photo 1: Waste rock pile and stressed vegetation downgradient of pile.
- Photo 2: Residence building.
- Photo 3: Collapsed wood building No. 1.
- Photo 4: Aerial view of collapsed wood building No. 2, chemical and office buildings, quonset and waste rock pile.
- Photo 5: Inside chemical building.
- Photo 6: Explosive's shack.
- Photo 7: Quonset.
- Photo 8: Debris in Quonset.
- Photo 9: Adit 1 and rail track debris.
- Photo 10: Inside Adit 1 near entrance.
- Photo 11: Adit 2.
- Photo 12: Waste rock pile, viewed from above Adit 1.
- Photo 13: Waste rock pile, viewed from the south.
- Photo 14: Waste rock pile, viewed from below pile.



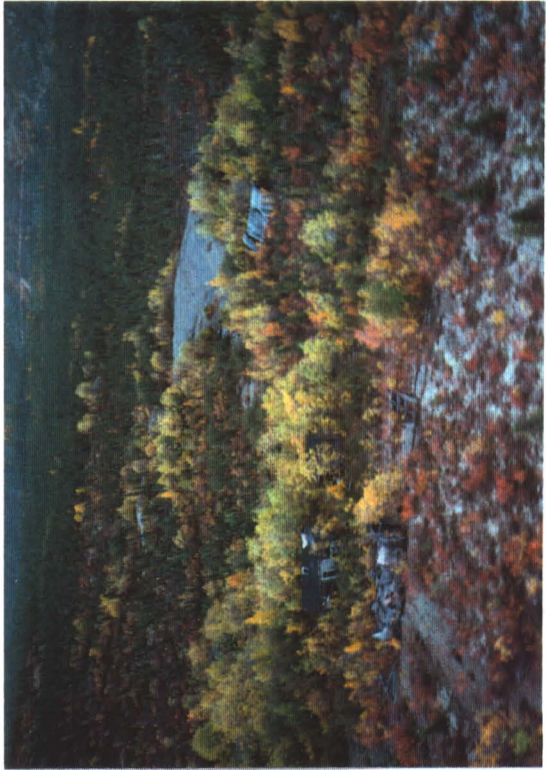
1



2



3



4



6



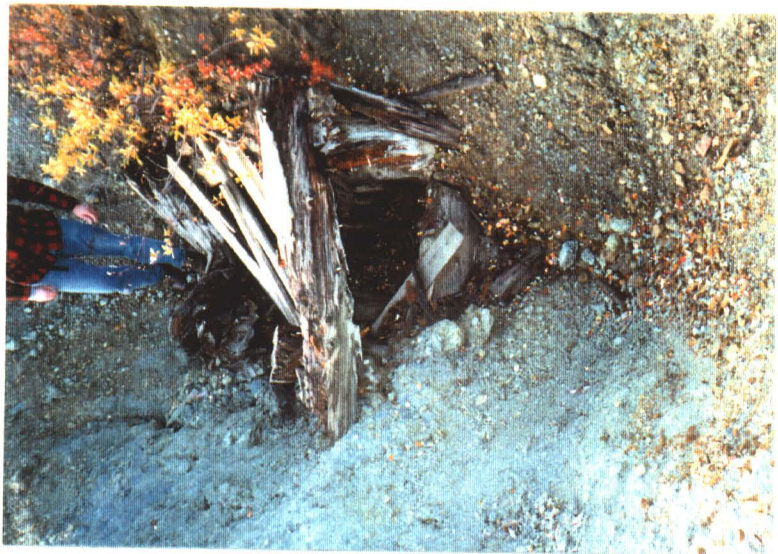
8



5



7



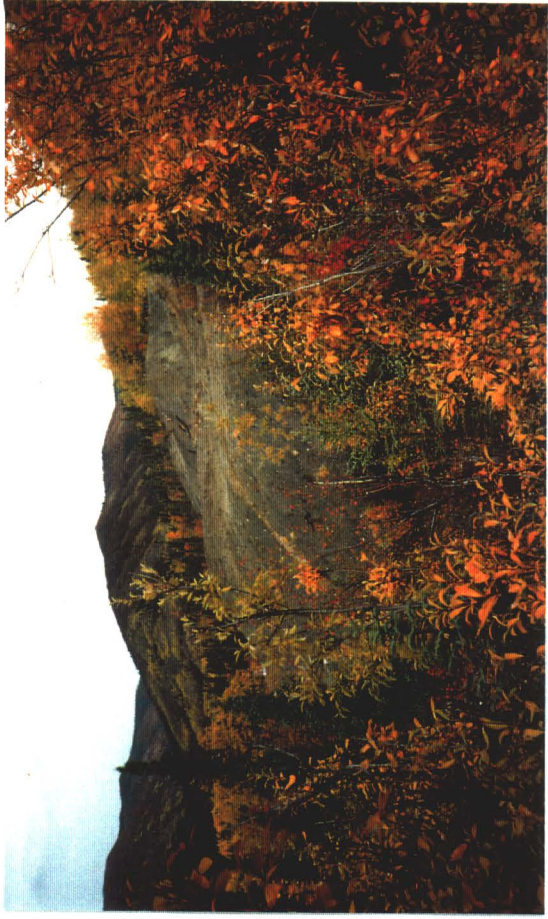
11

10

9



12



13



14

APPENDIX D
ANALYTICAL TABLES

TABLE D1
ASBESTOS FIBER IDENTIFICATION - COLLAPSED WOOD BUILDING NO. 2
ENVIRONMENTAL ASSESSMENT MINE SITE 62 AT PESO
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Sample No.	GV206PEINS
Date sampled	12-Sep-96
Asbestos Type	none
Asbestos Content	<
Other fiber ID	glass fiber
Other fiber content	60-80
Filler	20-40

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 D2
LEPH AND HEPH IN SOIL SAMPLES
ENVIRONMENTAL ASSESSMENT MINE SITE 62 AT PESO
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
mg/kg

Sample No.	CMCS Criteria for Soil			Detection	GV206PESOIL03
	AL	PL/RL	CL/IL	Limit	
Date sampled					12-Sep-96
Location					
Depth					surface
LEPH	1000	1000	2000	250	<
HEPH	1000	1000	5000	250	<

< = 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 D3
 METAL CONCENTRATIONS IN PRODUCT SAMPLES
 ENVIRONMENTAL ASSESSMENT AT MINE SITE 62 AT PESO
 PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
 mg/kg (ppm)

Sample No.	GV206PED03	GV206PED06	Detection Limits
Date sampled Location	12-Sep-96 drum 03	12-Sep-96 drum 06	
Aluminum	4.9	<	2
Antimony	<	<	2
Arsenic	<	<	3
Barium	0.07	0.02	0.01
Beryllium	<	<	0.06
Boron	2.9	0.1	0.1
Cadmium	<	<	0.2
Calcium	8.7	0.55	0.1
Chromium	<	<	0.3
Cobalt	<	<	0.2
Copper	0.7	0.4	0.2
Iron	1710	43	0.3
Lead	2	<	0.8
Magnesium	1.5	0.3	0.01
Manganese	6	0.17	0.03
Molybdenum	<	<	0.4
Nickel	<	<	0.3
Phosphorus	6	<	4
Silver	<	<	0.3
Sodium	10	<	1
Strontium	0.05	<	0.01
Tin	<	<	0.3
Titanium	0.09	<	0.06
Vanadium	<	<	0.1
Zinc	1.6	0.7	0.2
Zirconium	<	<	0.2

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

< = less than the detection limit

TABLE D4
 GENERAL CHEMISTRY IN WATER SAMPLES
 ENVIRONMENTAL ASSESSMENT MINE SITE 62 AT PESO
 PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Date sampled Location	units	CMCS		GV206PECRK01 12-Sep-96 groundwater seep	GV206PECRK02 12-Sep-96 creek tributary	Detection Limit
		Aquatic Life Numeric Criteria	Drinking Water			
pH		6.5-9.0*	6.5-8.0*	6.87	5.92	
Conductivity	uS/cm			15	37	1
True Color	CU			90	70	5
Turbidity	NTU			0.46	0.63	0.1
Hardness (CaCO ₃)	mg/L			4	14	1
Total Dissolved Solids	mg/L		<=500*	12	29	10
Bicarbonate (HCO ₃)	mg/L			3	5.9	0.5
Carbonate (CO ₃)	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
Nitrate and Nitrite	mg/L			<	<	0.05
Nitrate	mg/L	40	10	<	<	0.05
Nitrite	mg/L	0.02 to 0.06 varies with Chloride	3.2	<	<	0.002
Sulphate	mg/L	100	500	<	9.7	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 D5
 CONCENTRATIONS OF METALS IN WATER SAMPLES
 ENVIRONMENTAL ASSESSMENT MINE SITE 62 AT PESO
 PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
 ug/L (ppb)

Sample No.	CCME	Detection	GV206PECRK01	GV206PECRK02
	Aquatic Life	Limits		
Date sampled			12-Sep-96	12-Sep-96
Location				
Aluminum	5-100**	5	360	240
Antimony	-	1	1	2
Arsenic	50	1	3	2
Barium	-	1	33	32
Beryllium	-	1	<	<
Boron	-	5	18	14
Cadmium	0.2-1.8*	0.2	<	<
Calcium	-	10	850	3,370
Chromium	2-20	1	<	<
Cobalt	-	1	1	<
Copper	2-4*	1	3	3
Iron	300	30	720	220
Lead	1-7*	1	<	<
Magnesium	-	50	330	1,460
Manganese	-	1	27	10
Mercury	0.1	0.05	<	<
Molybdenum	-	1	<	<
Nickel	25-150*	1	2	3
Phosphorus	-	400	<	<
Potassium	-	10	<	90
Selenium	1	1	<	<
Silicon	-	100	7,200	8,100
Silver	0.1	0.1	<	<
Sodium	-	100	300	500
Strontium	-	1	8	16
Tellurium	-	1	<	<
Thallium	-	0.1	<	<
Thorium	-	0.5	<	<
Tin	-	1	<	<
Titanium	-	1	2	1
Uranium	-	0.5	<	<
Vanadium	-	1	<	<
Zinc	30	5	8	7
Zirconium	-	1	2	2

* - 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 D6
METAL CONCENTRATIONS IN SOIL SAMPLES
ENVIRONMENTAL ASSESSMENT MINE SITE 62 AT PESO
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
mg/kg (ppm)

Sample No.	CCME			DETECTION LIMITS	Peso Backgd	PAD1-1	PAD1-3	PAD1-14	PAD1-15	PAD1-16	PAD1-17	PEADIT201	PEADIT203	PEADIT203 du	PESOIL01
	AL	PL/RL	CL/IL												
Date sampled					12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96	12-Sep-96
Location					20m North of Adit 1	Waste Rock Adit 1	Waste Rock Adit 1	below W.R. Adit 1	below W.R. Adit 1	below W.R. Adit 1	below W.R. Adit 1	trench base Adit 2	trench base Adit 2	trench base Adit 2	excavation base
Depth				0.01	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface
Moisture (%)					16.9	14.2	13.1	32.8	34.8	16.1	12.9	8	10.5	6.3	19.7
Antimony	20	20	40	10	50	4930	1540	314	190	43	364	7420	710	557	12600
Arsenic	20	30	50	30	135	6220	6900	3740	2370	235	641	54500	1590	1570	27400
Barium	750	500	2000	0.1	105	11	47	122	70	97	105	21	67	33	22
Beryllium	4	4	8	1	<	<	<	<	<	<	<	<	<	<	<
Cadmium	3	5	20	0.25	0.4	9.23	0.27	0.36	0.44	0.84	1.33	7.56	0.79	0.79	5.84
Chromium	750	250	800	2	20	24	8	18	14	16	17	3	8	6	5
Cobalt	40	50	300	1	7	20	2	5	6	8	8	1	1	1	1
Copper	150	100	500	1	54	382	252	103	89	61	81	175	23	41	214
Lead	375	500	1000	1	318	7190	2450	928	627	410	1410	4720	1720	2140	19500
Mercury	0.8	2	10	0.001	0.02	0.36	0.23	0.1	0.07	0.04	0.09	0.34	0.23	0.16	2.25
Molybdenum	5	10	40	4	<	<	<	<	<	<	<	<	<	<	<
Nickel	150	100	500	2	16	21	10	14	15	18	20	5	4	3	9
Selenium	2	3	10	3	<	<	<	<	<	<	<	21	<	<	196
Silver	20	20	40	2	<	<	<	9	<	<	<	7	7	3	10
Tin	5	50	300	5	<	<	24	9	7	<	8	56	33	26	353
Vanadium	200	200	-	0.5	24	20	15	22	22	23	23	5	8	7	6
Zinc	600	500	1500	1	87	1010	71	73	109	101	104	15	338	142	65
Aluminum				10	10900	7180	4190	7800	6250	8380	9430	988	2980	1650	2560
Boron				0.5	13	32	24	18	17	13	18	26	12	9	44
Calcium				1	579	590	507	444	315	955	1260	102	716	368	252
Iron				2	30300	65500	50700	37300	36200	27800	44800	45000	23900	17200	85400
Magnesium				0.1	3150	2170	53	2420	1370	2480	2780	74	43	21	21
Manganese				0.2	210	998	102	128	162	262	309	21	102	78	31
Phosphorus				20	952	1230	3330	1420	1290	1330	1520	1250	3600	1870	2140
Sodium				5	26	151	55	70	26	28	50	8	12	8	28
Strontium				0.1	10	46	301	34	21	16	34	7	347	173	66
Titanium				0.3	46	77	6.6	50	38	79	81	6	2.9	2.5	2.2

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

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

< = less than the detection limit

exceeds CL/IL criteria

APPENDIX E
LABORATORY REPORTS

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

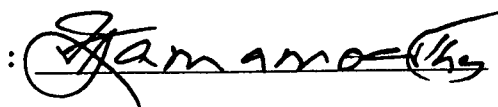
GEOVIRO ENGINEERING LTD.
STUART WYSE

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.

CHEMEX Labs Alberta Inc.

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

Sample Description : GV206PED01
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 : 96-07599-1
Chemex Project Number : GEOV010-0502
Sample Access :
Sample Matrix : OIL
Report Date : October 4, 1996
Analysis Date : September 26, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R E S U L T S	DETECTION LIMIT
Total Organic Halogens (TOX)		ug/g	14460.	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 : GV206PED01
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : GRAB
Sample Station Code : PESO

Chemex Worksheet Number : 96-07599-1
Chemex Project Number : GEOV010-0502
Sample Access :
Sample Matrix : OIL
Report Date : October 4, 1996

BATCH SPECIFIC QUALITY ASSURANCE REPORT

PARAMETER	DATE		QA/QC		MATRIX SPIKES				CALIBRATION CHECK		
	ANALYZED	BATCH	DUP	RECOV	CONTROL LIMITS		RECOV	CONTROL LIMITS			
	(DD-MM-YY)	NUM ANAL	Rr	%	LOWER	UPPER	%	LOWER	UPPER		
Total Organic Halogens (TOX)	26-09-96	1 DCF	N.A.	NOT APPLICABLE			100.1	80.0	120.0		

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

Sample Description : GV206PED02
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 : 96-07599-2
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	9.0	2.

CHEMEX Labs Alberta Inc.

Calgary : 2021 - 41st Avenue N.E., T2E 6P2, Telephone (403) 291-3077, FAX (403) 291-9488
Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

GEOVIRO ENGINEERING LTD.
ATTENTION : STUART WYSE
GV206.1

Sample Description : GV206PED02
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : GRAB
Sample Station Code : PESO

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

BATCH SPECIFIC QUALITY ASSURANCE REPORT

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

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Sample Description : GV206PED03/04

Sample Date & Time : N/A N/A

Sampled By :

Sample Type : COMPOSITE

Sample Received Date: September 25, 1996

Sample Station Code : PESO

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

Chemex Worksheet Number : 96-07599-3C

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	4.0	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 : GV206PED03/04
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : COMPOSITE
Sample Station Code : PESO

Chemex Worksheet Number : 96-07599-3C
Chemex Project Number : GEOV010-0502
Sample Access :
Sample Matrix : OIL
Report Date : October 4, 1996

BATCH SPECIFIC QUALITY ASSURANCE REPORT

PARAMETER	DATE ANALYZED (DD-MM-YY)	QA/QC BATCH NUM ANAL	DUP Rr	MATRIX SPIKES		CALIBRATION CHECK		
				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

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

Sample Description : GV206PED05/06

Sample Date & Time : N/A N/A

Sampled By :

Sample Type : COMPOSITE

Sample Received Date: September 25, 1996

Sample Station Code : PESO

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

Chemex Worksheet Number : 96-07599-4C

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	6.0	2.

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.
ATTENTION : STUART WYSE
GV206.1

Sample Description : GV206PED05/06
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : COMPOSITE
Sample Station Code : PESO

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

BATCH SPECIFIC QUALITY ASSURANCE REPORT


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


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 24, 1996
CHEMEX PROJECT NO. : GEOV010-0502-96-07815
CLIENT REFERENCE : GV206PED01
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 Inc.

GEOVIRO ENGINEERING LTD.
ATTENTION : STUART WYSE

GV206PED01

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 : GV206PED01
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : GRAB
Sample Received Date: October 21, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07815-1
Chemex Project Number : GEOV010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : October 24, 1996
Analysis Date : October 22, 1996

AROCLORS (PCBS) BY MODIFIED EPA METHOD 8081

COMPONENT	CONCENTRATION	UNIT	MDL
Aroclor 1016	< 0.2	mg/Kg	0.2
Aroclor 1221	< 0.2	mg/Kg	0.2
Aroclor 1232	< 0.2	mg/Kg	0.2
Aroclor 1242	< 0.2	mg/Kg	0.2
Aroclor 1248	< 0.2	mg/Kg	0.2
Aroclor 1254	< 0.2	mg/Kg	0.2
Aroclor 1260	< 0.2	mg/Kg	0.2
Aroclor 1262	< 0.2	mg/Kg	0.2
Aroclor 1268	< 0.2	mg/Kg	0.2

NOTES :

Results are reported in accordance with CCME guidelines, "Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites, Volume I". All results are corrected for blank levels.

MDL - Method detection level. - Calculated on the basis of the instrument detection level, the dilution used, and the weight of the sample.

() - Bracketed results are values below the reliable detection level, and are subject to reduced levels of confidence. The reliable detection level is twice the method detection level.

QA/QC SUMMARY

All samples were spiked with a component whose recovery was monitored to maintain analysis accuracy. Guidelines from SW846 for suggested surrogate recoveries for each matrix are shown below.

Surrogate Recovery : 102% LIQUID surrogate limits : 63% - 134%

CHEMEX Labs Alberta Inc.

GEOVIRO ENGINEERING LTD.
ATTENTION : STUART WYSE

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

GV206PED01

Sample Description : GV206PED01
Sample Date & Time : N/A N/A
Sampled By :
Sample Type : GRAB
Sample Received Date: October 21, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07815-1
Chemex Project Number : GEOV010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : October 24, 1996
Analysis Date : October 22, 1996

BATCH SPECIFIC QUALITY ASSURANCE REPORT

BATCH : 11 DATE : October 22, 1996 ANALYST:AAM	BLANK	DUPLICATE			MATRIX SPIKE			CALIBRATION CHECK		
	CONC.	CONC.1	CONC.2	RPD	RECOV	CONTROL LIMITS		RECOV	CONTROL LIMITS	
	mg/Kg	mg/Kg	mg/Kg	%	%	LOWER	UPPER	%	LOWER	UPPER
Aroclor 1016	< 0.2	< 0.2	< 0.2	0						
Aroclor 1221	< 0.2	< 0.2	< 0.2	0						
Aroclor 1232	< 0.2	< 0.2	< 0.2	0						
Aroclor 1242	< 0.2	< 0.2	< 0.2	0				108	74.	130.
Aroclor 1248	< 0.2	< 0.2	< 0.2	0						
Aroclor 1254	< 0.2	0.7	0.7	3	79	64.	130.			
Aroclor 1260	< 0.2	21.	20.	5				98	61.	120.
Aroclor 1262	< 0.2	< 0.2	< 0.2	0						
Aroclor 1268	< 0.2	< 0.2	< 0.2	0						

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

Attention: Mr. Dave Karwandy

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

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

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CANTEST

REPORTED TO: GeoViro Engineering Ltd.

REPORT DATE: November 22, 1996

GROUP NUMBER: 7617K / 6103005

TEST RESULTS:

CLIENT SAMPLE IDENTIFICATION:		GV206 PED03	GV206 PED06		
CANTEST ID:		7617K-1	7617K-2	UNITS	DETECTION LIMIT
Aluminum	Al	4.9	<	µg/g	2
Antimony	Sb	<	<	µg/g	2
Arsenic	As	<	<	µg/g	3
Barium	Ba	0.07	0.02	µg/g	0.01
Beryllium	Be	<	<	µg/g	0.06
Boron	B	2.9	0.1	µg/g	0.1
Cadmium	Cd	<	<	µg/g	0.2
Calcium	Ca	8.7	0.55	µg/g	0.1
Chromium	Cr	<	<	µg/g	0.3
Cobalt	Co	<	<	µg/g	0.2
Copper	Cu	0.7	0.4	µg/g	0.2
Iron	Fe	1710	43	µg/g	0.3
Lead	Pb	2.0	<	µg/g	0.8
Magnesium	Mg	1.5	0.3	µg/g	0.01
Manganese	Mn	6.0	0.17	µg/g	0.03
Molybdenum	Mo	<	<	µg/g	0.4
Nickel	Ni	<	<	µg/g	0.3
Phosphorus	PO4	6	<	µg/g	4
Silver	Ag	<	<	µg/g	0.3
Sodium	Na	10	<	µg/g	1
Strontium	Sr	0.05	<	µg/g	0.01
Tin	Sn	<	<	µg/g	0.3
Titanium	Ti	0.09	<	µg/g	0.06
Vanadium	V	<	<	µg/g	0.1
Zinc	Zn	1.6	0.7	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

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

REPORT ON: Results of Testing
REPORTED TO: GeoViro Engineering Ltd.
Suite 500
535 Thurlow Street
Vancouver, B.C.
V6E 3L2
PROJECT NAME: GV206.01
P.O. NUMBER: GV206.01

NUMBER OF SAMPLES: 15

REPORT DATE: September 27, 1996

DATE SUBMITTED: September 24, 1996

GROUP NUMBER: 6092430

SAMPLE TYPE: Soil

TEST METHODS:

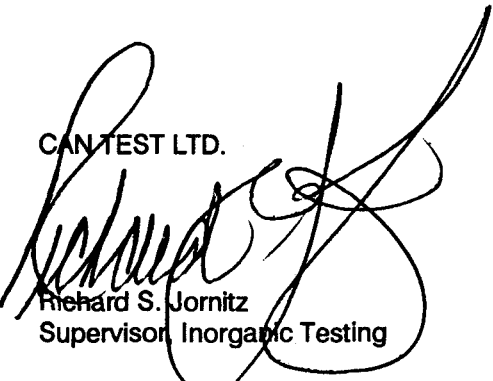
Sulphate Analysis - analysis was performed using acid digestion, precipitation as barium sulphate, and gravimetric analysis.

Sulphur - analysis was performed using a combustion technique with a Leco Induction Furnace

TEST RESULTS:

(See following page)

CANTEST LTD.


Richard S. Jornitz
Supervisor, Inorganic Testing



REPORTED TO: GeoViro Engineering Ltd.



REPORT DATE: September 27, 1996

GROUP NUMBER: 6092430

Conventional Parameters in Soil

CLIENT SAMPLE IDENTIFICATION:	CAN TEST ID	Sulphur S	Sulphate SO4
CESL 2630	609240115	0.03	-
CESL 2631	609240116	1.79	1.24
CESL 2632	609240117	0.81	-
CESL 2633	609240118	1.38	1.37
CESL 2634	609240119	1.2	2.05
CESL 2635	609240120	13.	3.64
CESL 2636	609240121	0.33	-
CESL 2637	609240122	0.15	-
CESL 2638	609240123	0.17	-
CESL 2639	609240124	0.07	-
CESL 2640	609240125	0.15	-
CESL 2641	609240126	0.10	-
CESL 2642	609240127	0.06	-
CESL 2643	609240128	0.84	-
CESL 2644	609240129	0.48	-
DETECTION LIMIT UNITS		0.01 %	10000 %

% = percent

Analysis Report

CANTEST

CanTest Ltd

REPORT ON: Analysis of Water, Soil and Insulation 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

Att'n: Mr. David Karwandy

Fax: 604 731 2386

Tel: 604 734 7276

CHAIN OF CUSTODY: 17775, 17777
PROJECT NAME: PESO
PROJECT NUMBER: GV206.01

1 800 665 8566

NUMBER OF SAMPLES: 15

REPORT DATE: October 17, 1996

DATE SUBMITTED: September 19, 1996

GROUP NUMBER: 6091920

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.

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).

(Continued)

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Richard S. Jornitz
Supervisor, Inorganic Testing

Page 1 of 9

REPORTED TO: GeoViro Engineering Ltd.

CANTEST

REPORT DATE: October 17, 1996

GROUP NUMBER: 6091920

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 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: 6091920

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:		GV206PECRK 1	GV206PECRK 02		
DATE SAMPLED:		Sep 12/96	Sep 12/96		
CAN TEST ID:		609190087	609190093	DETECTION LIMIT	UNITS
pH		6.87	5.92	-	pH units
Conductivity		15	37	1	μ S/cm
True Color		90	70	5	CU
Turbidity		0.46	0.63	0.1	NTU
Hardness	CaCO ₃	4	14	1	mg/L
Total Dissolved Solids		12	29	10	mg/L
Bicarbonate Alkalinity	HCO ₃	3.0	5.9	0.5	mg/L
Carbonate Alkalinity	CO ₃	<	<	0.5	mg/L
Hydroxide Alkalinity	OH	<	<	0.5	mg/L
Fluoride	F	<	<	0.05	mg/L
Chloride	Cl	<	<	0.2	mg/L
Nitrate and Nitrite	N	<	<	0.05	mg/L
Nitrate	N	<	<	0.05	mg/L
Nitrite	N	<	<	0.002	mg/L
Sulphate	SO ₄	<	9.7	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: 6091920

Metals Analysis in Water

CLIENT SAMPLE IDENTIFICATION:		GV206PECRK 1	GV206PECRK 02		
SAMPLE PREPARATION:		DISSOLVED	DISSOLVED		
DATE SAMPLED:		Sep 12/96	Sep 12/96		
CAN TEST ID:		609190087	609190093	DETECTION LIMIT	UNITS
Aluminum	Al	0.36	0.24	0.005	mg/L
Antimony	Sb	0.001	0.002	0.001	mg/L
Arsenic	As	0.003	0.002	0.001	mg/L
Barium	Ba	0.033	0.032	0.001	mg/L
Beryllium	Be	<	<	0.001	mg/L
Boron	B	0.018	0.014	0.005	mg/L
Cadmium	Cd	<	<	0.0002	mg/L
Calcium	Ca	0.85	3.37	0.01	mg/L
Chromium	Cr	<	<	0.001	mg/L
Cobalt	Co	0.001	<	0.001	mg/L
Copper	Cu	0.003	0.003	0.001	mg/L
Iron	Fe	0.72	0.22	0.03	mg/L
Lead	Pb	<	<	0.001	mg/L
Magnesium	Mg	0.33	1.46	0.05	mg/L
Manganese	Mn	0.027	0.01	0.001	mg/L
Mercury	Hg	<	<	0.05	µg/L
Molybdenum	Mo	<	<	0.001	mg/L
Nickel	Ni	0.002	0.003	0.001	mg/L
Phosphorus	PO4	<	<	0.4	mg/L
Potassium	K	<	0.09	0.01	mg/L
Selenium	Se	<	<	0.001	mg/L
Silicon	SiO2	7.2	8.1	0.1	mg/L
Silver	Ag	<	<	0.0001	mg/L
Sodium	Na	0.3	0.5	0.1	mg/L
Strontium	Sr	0.008	0.016	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	0.002	0.001	0.001	mg/L
Uranium	U	<	<	0.0005	mg/L
Vanadium	V	<	<	0.001	mg/L
Zinc	Zn	0.008	0.007	0.005	mg/L
Zirconium	Zr	0.002	0.002	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: 6091920

Asbestos Fiber Identification in Bulk Material

CLIENT SAMPLE ID	CAN TEST ID	ASBESTOS TYPE	ASBESTOS CONTENT	OTHER FIBER ID	OTHER FIBER CONTENT	FILLER
GV206PEINS	609190094	none	<	glass fiber	60-80	20-40

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: 6091920

Extractable Petroleum Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CAN TEST ID	LEPH-uncorrected for PAH's	HEPH-uncorrected for PAH's
GV206PESOIL03	Sep 12/96	609190095	<	<
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: 6091920

Metals Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:		PESO BACKGROUND	GV206PAD1-3	GV206PAD1-3	GV206PAD1-14		
DATE SAMPLED:		Sep 12/96	Sep 12/96	Sep 12/96	Sep 12/96		
CAN TEST ID:		609190096	609190097	609190098	609190099	DETECTION LIMIT	UNITS
Moisture		16.9	14.2	13.1	32.8	0.01	%
Antimony	Sb	50	4930	1540	314	10	µg/g
Arsenic	As	135	6220	6900	3740	30	µg/g
Barium	Ba	105	11	47	122	0.1	µg/g
Beryllium	Be	<	<	<	<	1	µg/g
Cadmium	Cd	0.40	9.23	0.27	0.36	0.25	µg/g
Chromium	Cr	20	24	8	18	2	µg/g
Cobalt	Co	7	20	2	5	1	µg/g
Copper	Cu	54	382	252	103	1	µg/g
Lead	Pb	318	7190	2450	928	1	µg/g
Mercury	Hg	0.02	0.36	0.23	0.10	0.001	µg/g
Molybdenum	Mo	<	<	<	<	4	µg/g
Nickel	Ni	16	21	10	14	2	µg/g
Selenium	Se	<	<	<	<	3	µg/g
Silver	Ag	<	<	<	9	2	µg/g
Tin	Sn	<	<	24	9	5	µg/g
Vanadium	V	24	20	15	22	0.5	µg/g
Zinc	Zn	87	1010	71	73	1	µg/g
Aluminum	Al	10900	7180	4190	7800	10	µg/g
Boron	B	13	32	24	18	0.5	µg/g
Calcium	Ca	579	590	507	444	1	µg/g
Iron	Fe	30300	65500	50700	37300	2	µg/g
Magnesium	Mg	3150	2170	53	2420	0.1	µg/g
Manganese	Mn	210	998	102	128	0.2	µg/g
Phosphorus	PO4	952	1230	3330	1420	20	µg/g
Sodium	Na	26	151	55	70	5	µg/g
Strontium	Sr	10	46	301	34	0.1	µg/g
Titanium	Ti	46	77	6.6	50	0.3	µg/g

% = percent

< = Less than detection limit

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

REPORTED TO: GeoViro Engineering Ltd.



REPORT DATE: October 17, 1996

GROUP NUMBER: 6091920

Metals Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:		GV206PAD1-15	GV206PAD1-16	GV206PAD1-17	GV206PEADI T201		
DATE SAMPLED:		Sep 12/96	Sep 12/96	Sep 12/96	Sep 12/96		
CAN TEST ID:		609190100	609190101	609190102	609190104	DETECTION LIMIT	UNITS
Moisture		34.8	16.1	12.9	8.0	0.01	%
Antimony	Sb	190	43	364	7420	10	µg/g
Arsenic	As	2370	235	641	54500	30	µg/g
Barium	Ba	70	97	105	21	0.1	µg/g
Beryllium	Be	<	<	<	<	1	µg/g
Cadmium	Cd	0.44	0.84	1.33	7.56	0.25	µg/g
Chromium	Cr	14	16	17	3	2	µg/g
Cobalt	Co	6	8	8	1	1	µg/g
Copper	Cu	89	61	81	175	1	µg/g
Lead	Pb	627	410	1410	4720	1	µg/g
Mercury	Hg	0.07	0.04	0.09	0.34	0.001	µg/g
Molybdenum	Mo	<	<	<	<	4	µg/g
Nickel	Ni	15	18	20	5	2	µg/g
Selenium	Se	<	<	<	21	3	µg/g
Silver	Ag	<	<	<	7	2	µg/g
Tin	Sn	7	<	8	56	5	µg/g
Vanadium	V	22	23	23	5	0.5	µg/g
Zinc	Zn	109	101	104	15	1	µg/g
Aluminum	Al	6250	8380	9430	988	10	µg/g
Boron	B	17	13	18	26	0.5	µg/g
Calcium	Ca	315	955	1260	102	1	µg/g
Iron	Fe	36200	27800	44800	45000	2	µg/g
Magnesium	Mg	1370	2480	2780	74	0.1	µg/g
Manganese	Mn	162	262	309	21	0.2	µg/g
Phosphorus	PO4	1290	1330	1520	1250	20	µg/g
Sodium	Na	26	28	50	8	5	µg/g
Strontium	Sr	21	16	34	7	0.1	µg/g
Titanium	Ti	38	79	81	6	0.3	µg/g

% = percent
 < = Less than detection limit

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

REPORTED TO: GeoViro Engineering Ltd.



REPORT DATE: October 17, 1996

GROUP NUMBER: 6091920

Metals Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:	GV206PEADI T203	GV206PEADI T203DUP	GV206PESOI L01		
DATE SAMPLED:	Sep 12/96	Sep 12/96	Sep 12/96	DETECTION LIMIT	UNITS
CAN TEST ID:	609190105	609190106	609190107		
Moisture	10.5	6.3	19.7	0.01	%
Antimony Sb	710	557	12600	10	µg/g
Arsenic As	1590	1570	27400	30	µg/g
Barium Ba	67	33	22	0.1	µg/g
Beryllium Be	<	<	<	1	µg/g
Cadmium Cd	0.79	0.79	5.84	0.25	µg/g
Chromium Cr	8	6	5	2	µg/g
Cobalt Co	1	1	1	1	µg/g
Copper Cu	23	41	214	1	µg/g
Lead Pb	1720	2140	19500	1	µg/g
Mercury Hg	0.23	0.16	2.25	0.001	µg/g
Molybdenum Mo	<	<	<	4	µg/g
Nickel Ni	4	3	9	2	µg/g
Selenium Se	<	<	196	3	µg/g
Silver Ag	7	3	10	2	µg/g
Tin Sn	33	26	353	5	µg/g
Vanadium V	8	7	6	0.5	µg/g
Zinc Zn	338	142	65	1	µg/g
Aluminum Al	2980	1650	2560	10	µg/g
Boron B	12	9	44	0.5	µg/g
Calcium Ca	716	368	252	1	µg/g
Iron Fe	23900	17200	85400	2	µg/g
Magnesium Mg	43	21	21	0.1	µg/g
Manganese Mn	102	78	31	0.2	µg/g
Phosphorus PO4	3600	1870	2140	20	µg/g
Sodium Na	12	8	28	5	µg/g
Strontium Sr	347	173	66	0.1	µg/g
Titanium Ti	2.9	2.5	2.2	0.3	µg/g

% = percent
 < = Less than detection limit

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

1.0 SAMPLES

In September, 1996, 20 samples were received at Cominco Engineering Services Ltd. (CESL) from CanTest Ltd.

1.1 Sample Preparation

Most samples were wet and therefore air-dried at ambient temperature (16-20°C). The coarse samples were jaw crushed to minus 1/4 inch. Each sample was riffled down to approximately 300 g and these fractions were pulverized for head analysis and static testing.

2.0 STATIC TESTING

Head sample assays and acid-base accounting tests were carried out on 16 of the 20 samples.

2.1 Solids Analysis

A fraction of pulverized material was submitted to CanTest Ltd. for total sulphur analysis by the LECO method. For samples with greater than 1% total sulphur, sulphate sulphur was also determined using acid digestion, precipitation as barium sulphate and gravimetric analysis.

2.2 Determination of Neutralization Potential (Acid-Base Account)

The determination of paste pH was done prior to acid-base accounting (ABA). For this test a small amount of pulverized sample was wetted with distilled water and upon saturation the pH of the paste was measured. A fizz test (adding 25% HCl to sample) was also employed to provide an additional guide to the strength and amount of acid to be initially added to each sample.

Acid-base accounting tests were carried out using the Modified Sobek method. Two grams of pulverized sample was weighed into an Erlenmeyer flask to which standardized hydrochloric acid was added to obtain a target pH of 1.5 to 2.0. The flask was then placed on an oscillating table and agitated for 24 hours at 150 RPM during which time the pH was periodically checked and adjusted as required to maintain sufficient acidity for reaction. At the end of the shaking period the contents of the flask were titrated to pH 8.3 with standardized sodium hydroxide. The neutralization potential (NP) of the sample was then calculated from the titration data. The acid producing potential (AP) was derived from the calculated sulphide sulphur analysis, assuming the total conversion of sulphide to sulphate and

the production of 4 moles H⁺ per mole of pyrite oxidized. In some instances, other sulphur species might be determined. The AP can be balanced against the NP to yield the net neutralization potential (Net NP).

3.0 INTERPRETATION OF RESULTS

Interpretation of the Net NP value requires judgement, since although a negative value indicates the theoretical potential of a sample to produce acid rock drainage, some samples with this classification may not be confirmed as acid producers in the field. However, this does not imply that ARD will not result given sufficient time. Likewise, a sample with a positive Net NP might, under the right conditions, produce ARD.

Although the Net NP value provides a good initial indication of ARD potential, an interpretation based on the arithmetic difference between the NP and AP values should be used with caution. A sample with a Net NP value of +10 calculated from a high sulphide content and a high acid consuming ability might have a greater likelihood of generating acid than another sample with the same Net NP but with a very low sulphide content. A ratio between NP and AP values might provide a more reliable classification guideline, especially if sulphide content is also taken into account.

Samples which have a significantly negative Net NP should be considered for kinetic ARD prediction tests. The most commonly used and accepted tests are humidity cells, columns and lysimeters. Humidity cells are weathering chambers designed to provide simple control over air, temperature and moisture conditions while allowing for leachate removal which is analyzed to determine the onset of ARD. Columns and lysimeters are larger than humidity cells and therefore allow larger samples to be used.

These tests simulate the geochemical processes of weathering and can confirm or reduce the uncertainty of the results of static ARD prediction tests. They can also determine the rate of acid generation and how it effects water quality over time.

CLIENT : GeoViro Engineering Ltd.
PROJECT : Soil Samples
PROJECT # : GV206.01
TEST : MODIFIED SOBEK METHOD ACID-BASE ACCOUNTING

SAMPLE #	PASTE pH	S(T) %	S(SO4) %	AP	NP	NET NP	NP/AP
PESO BACKGROUND	4.81	0.03	#N/A	0.9	-1.4	-2.3	<0.1
GV206 PAD1-1	4.04	1.79	0.41	43.0	-1.1	-44.1	<0.1
GV206 PAD1-2	3.34	0.81	#N/A	25.3	-6.3	-31.6	<0.1
GV206 PAD1-3	2.97	1.38	0.46	28.8	-9.1	-38.0	<0.1
GV206 PAD1-5	3.09	1.2	0.68	16.1	-6.6	-22.7	<0.1
GV206 PAD1-7 3FT.	1.90	13	1.21	368	-26	-394	<0.1
GV206 PAD1-14	3.02	0.33	#N/A	10.3	-6.4	-16.7	<0.1
GV206 PAD1-15	3.33	0.15	#N/A	4.7	-5.8	-10.4	<0.1
GV206 PAD1-16	4.01	0.17	#N/A	5.3	-1.0	-6.3	<0.1
GV206 PAD1-17	5.02	0.07	#N/A	2.2	0.1	-2.1	<0.1
GV206PE ADIT201	3.97	0.15	#N/A	4.7	-1.0	-5.7	<0.1
GV206PE ADIT203	4.84	0.10	#N/A	3.1	-0.4	-3.6	<0.1
GV206PE ADIT203 DUP	4.74	0.06	#N/A	1.9	-0.1	-1.9	<0.1
GV206PESOIL01	3.69	0.84	#N/A	26.3	-3.1	-29.3	<0.1
GV206PESOIL02	3.79	0.48	#N/A	15.0	-1.9	-16.9	<0.1
GV206HAYSOIL01	6.46	0.10	0.07	0.8	1.5	-2.3	<0.1

#NA - SAMPLE WITH S(T)<1% NOT ASSAYED FOR S(SO4). AP CALCULATION ASSUMES S(SO4)=0.

AP = ACID POTENTIAL IN TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.

NP = NEUTRALIZATION POTENTIAL IN TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.

NET NP = NET NEUTRALIZATION POTENTIAL = TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.

APPENDIX F

INTERPRETATION OF ACID BASE ACCOUNTING

APPENDIX F INTERPRETATION OF ACID BASE ACCOUNTING

Acid base accounting (ABA) may be summarised as follows:

Net acid producing potential (NAPP) equals the amount of acid produced (AP) minus the neutralisation potential (NP).

$$\text{NAPP} = \text{AP} - \text{NP}$$

Therefore, when acid production exceeds neutralisation capacity or rate of neutralisation, acid rock drainage results.

Acid base accounting is a static test that can only be used to indicate whether or not there is the potential to generate net acidity at some unknown time in the future. The ABA test should only be used as an initial screening technique to assess the potential for acid rock drainage and not as a means to predict actual field geochemistry or waste rock drainage/groundwater quality.

Acid base accounting cannot be relied upon to predict post mining soil and water quality because many factors that are important in the field, such as the kinetic aspects of the acid - base reaction, are ignored in the accounting procedure. As a result, the acid base account results only indicate the total acidity and alkalinity that could be produced if the pyrite and carbonates react.

The rate of sulphide oxidation and subsequent acid generation is influenced by pH, temperature, humidity, oxygen content, particle size, sulphide species and microbial activity (specifically Thiobacillus Ferrooxidans). Neutralisation capacity (or potential) is typically associated with the presence of carbonates, silicates and exchangeable cations in clays; with calcite (CaCO_3) and Dolomite ($\text{CaMg}(\text{CO}_3)_2$) being the predominant forms. The release of alkalinity is a solubility based process whereas the release of acid is kinetically based. Therefore, in some instances, production of acid may outstrip the neutralisation potential even when a theoretical excess of acid neutralising capacity is present.

The predictive ability of acid base accounting is generally considered to be reliable when the net acid production potential is greater than 20 kg H_2SO_4 per tonne (acid producing) or less than -20 kg H_2SO_4 per tonne (non acid producing).

Based on the BCELPA interim policy for acid rock drainage at mine sites, the NP to AP ratio is to be considered as a means of assessing acid generating potential. Under this guideline, samples with ratios of more than 4:1 would be considered acid consuming, while samples with ratios of less than 1:1 would be considered acid producing. Between these ratios, samples would be neither clearly acid producing or consuming. Under this type of assessment criteria all the waste rock pile samples collected from the Peso abandoned mine site would be considered to be acid generating. The acid generating potential of the Peso background and native soil sample is uncertain.