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Quality in Environmental Services

PHASE II ENVIRONMENTAL ASSESSMENT OF THE LOGJAM ABANDONED MINE SITE

prepared for:

Action on Waste Program
Indian and Northern Affairs Canada

prepared by:

Environmental Services
Public Works and Government Services Canada

February 1997

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

Canada

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EXECUTIVE SUMMARY

A phase II environmental assessment was conducted at the Logjam abandoned mine site (0°01'55"N; 131°35'38"W) in July, 1996 by Environmental Services, Public Works and Government Services Canada for the Action on Waste Program, Indian and Northern Affairs Canada. Based on the findings of the Phase I investigation performed in 1993 by DIAND Technical Services, a phase II assessment was conducted to a) identify potential environmental and human health risks associated with the present condition of the mine site, and b) provide recommendations and preliminary cost estimates for remediation of those risks.

A field investigation of the abandoned mine site was conducted to evaluate environmental and human safety concerns with respect to: mine openings and workings; buildings and infrastructure; waste disposal areas; waste rock disposal areas; surface water (including adit and waste rock seepage, and receiving waters); and hazardous and non-hazardous materials on the site.

The results of the investigation concluded that the two mine openings are unstable and are not adequately secured from public and wildlife access. Rails and trestles below the upper 1700 m level adit are physically unstable and pose a health and safety hazard to humans visiting the site. An assessment of the acid rock drainage potential shows that the risk to the environment due to the presence of waste rock and adits are currently insignificant. Aesthetic concerns arise from two above ground fuel storage tanks (empty) numerous 205 litre barrels, timbers, and metal debris scattered primarily in the encampment area..

Using applicable federal and territorial criteria as well as northern mine reclamation guidelines, the recommendations are to remove the vertically inclined rails and trestle configuration from the upper 1700 m level, demolish and bury on-site rails and burn trestles, demolish and burn wood frame structures on site, remove and burn wood waste on site, and collect and bury metal waste using surrounding rock and soil. No further test work is recommended on the waste rock.

Additional water quality sampling is required to monitor the impact of the acid generating waste on the receiving environment. It is recommended that every five years a monitoring program be undertaken to obtain water quality data for the spring freshet, middle summer and late fall conditions. Should further development occur on the site, regulatory agencies should ensure that an acid drainage prevention plan is developed which includes detailed measures for handling and disposal of mineralized waste rock.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

ASSESSMENT COMPONENT	RISK	RECOMMENDATION
1. Building, Infrastructure, Equipment		
Five Prefab trailers	Aesthetic / Health & Safety	Demolish & Burn on site
Four wood frame sheds	Aesthetic / Health & Safety	Demolish & Burn on site
Wiring, piping & pails,	Aesthetic	Collect on site and bury in open area north of camp
2. Non-Hazardous Waste Material		
ASTs-1 @ 1.8 m X 5.5 m; 1 @ 3.6 m X 7.3 m	Aesthetic / Health & Safety	Clean, cut up on site and bury in open area north of camp
Barrels -23 X 205: no signs of staining	Aesthetic / Health & Safety	Clean, cut up on site and bury in open area north of camp
Timber & assorted wood waste	Aesthetic	Collect on site and burn in open area north of camp
3. Hazardous Materials		
None	None	None
4. Water Quality		
Mine Seepage - minor	Low Environmental Risk	None
Site Drainage	Low Environmental Risk	Monitoring for spring, summer & fall conditions every 5 years.
Receiving Waters - Creek	Low Environmental Risk	Monitoring for spring, summer & fall conditions every 5 years.
5. Waste Rock Disposal Areas		
None	None	None
6. Mine Openings		
1@1570 m; 1@1700 m	Health & Safety Concern	Demolish trestle & burn, bury track
7. Tailings		
None	None	None

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1.0 INTRODUCTION AND BACKGROUND

In 1993, assessments of 49 abandoned Yukon mine exploration and development sites were completed under the Arctic Environmental Strategy - Action on Waste program by DIAND Technical Services. These assessments were intended to provide a general overview of historical activities, describe site infrastructure, workings and wastes, describe existing environmental or safety concerns on each site, and provide general recommendations for remediation or mitigation work, as appropriate. For the Logjam abandoned mine site, the 1993 report recommended further investigation into possible environmental impacts resulting from the previous mining activities. The condition of drill sites and mining access roads was identified as questionable however no specific recommendations were provided. Both adit entrances were identified as requiring sealing however, at the time of the 1993 inspection, snow covered both entrances. A further inspection during the summer season following snow melt was recommended.

The remaining recommendations for this site concerned removal of existing buildings, infrastructure, and equipment, cataloguing remaining core rock, removing all tanks and barrels form the site and unhooking all service connections to buildings on site. An additional recommendation consisted of repairing the road connecting the site to the Alaska Highway. In light of these preliminary findings, Indian and Northern Affairs Canada has determined that further investigation is warranted. Environmental Services, Public Works and Government Services Canada was retained to conduct an environmental assessment of the Logjam abandoned mine site to a) identify specific environmental and human safety risks; b) provide clean-up recommendations; and c) provide a Class "D" cost estimate for remediation or mitigation of those risks.

1.1 LOCATION:

130 m

The Logjam mine site is located at 60^{0}01'55"N latitude, 131^{0}35'38"W longitude approximately 20 km north of the Alaska Highway by trail near the headwaters of the Smart River and 75 km east of Teslin, YT (**Figure 1**). The mine site consists of one adit located on a steep slope facing northeast 300 m above base camp and another adit located 50 m above this adit on the same mountain slope. The Logjam camp site is located at an elevation 1280 m on a small plain encompassing an unnamed creek which flows westward 7 km to the Smart River.

1.2 OVERVIEW OF SITE DEVELOPMENT:

Work on the Logjam Site began in 1944, based on Department of Indian Affairs and Northern Development (DIAND) and Yukon Territorial Government (YTG) assessment file and MinFile data. Work conducted on the site includes: approximately 4.5 km of road building, minor

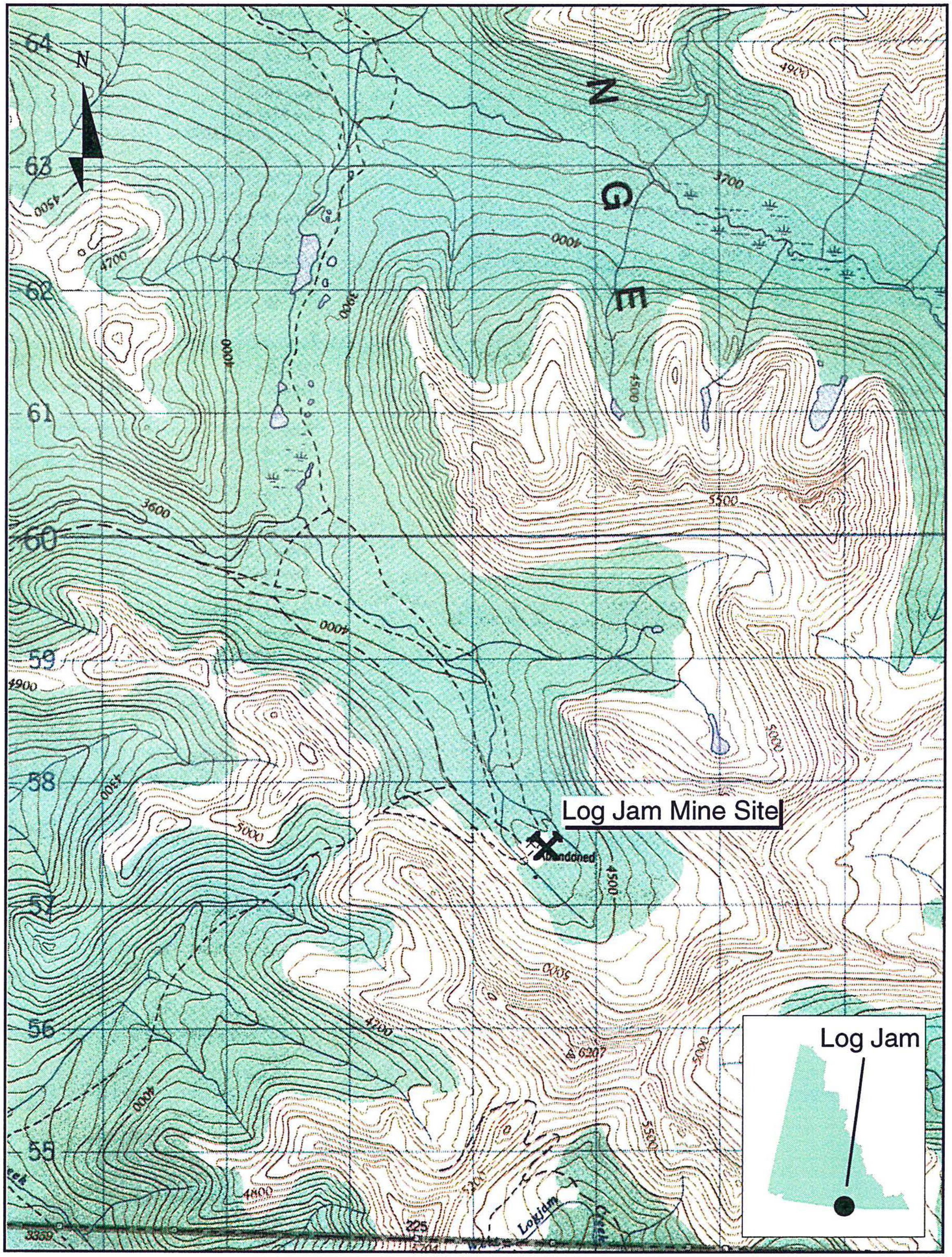
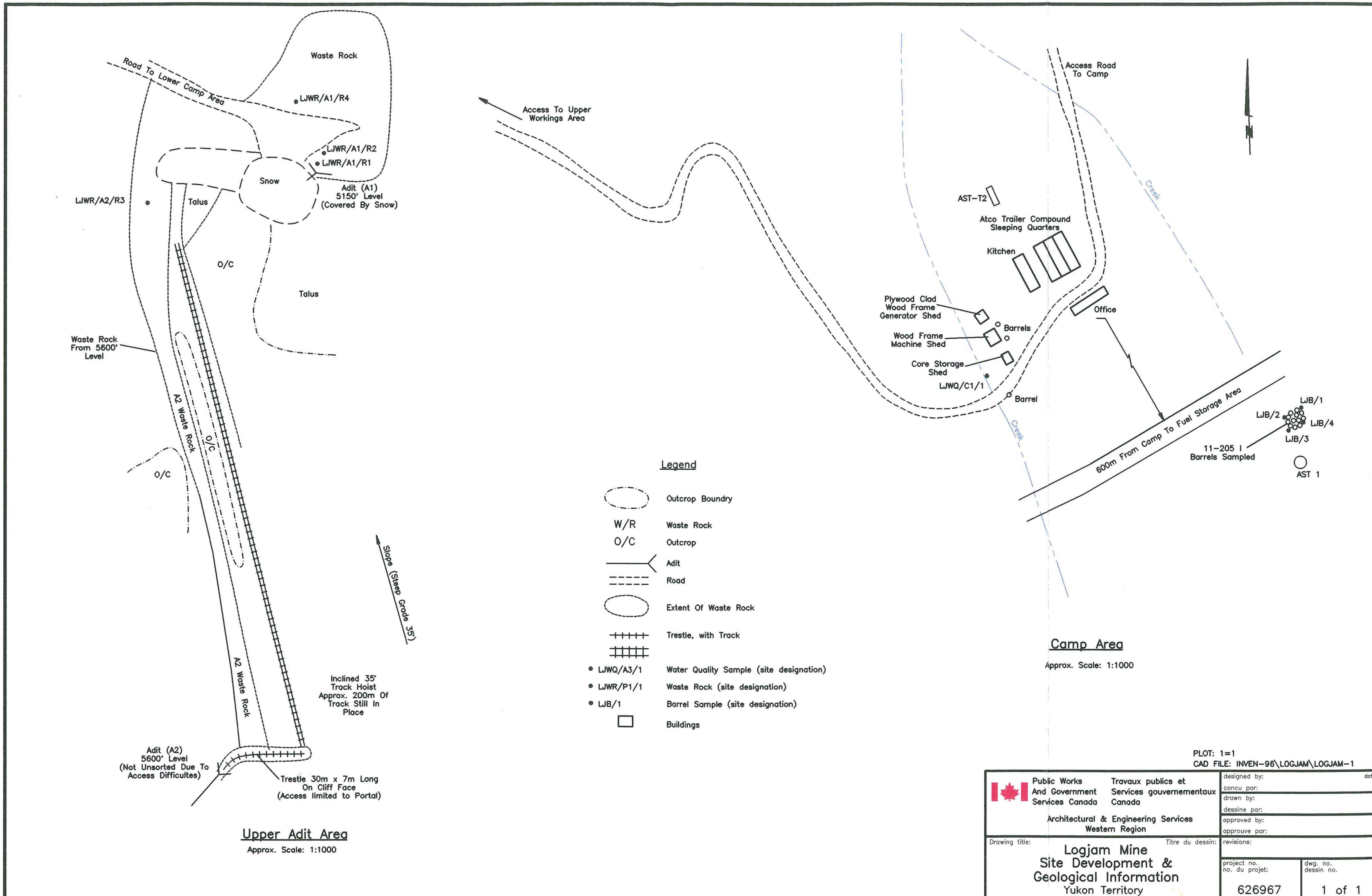


Figure 1: LOG JAM SITE
N.T.S. 105 B/4 Map Name: Dorsey Lake Map Scale: 1:50,000
Latitude: 60° 01' 55" N Longitude: 131° 35' 38" W


Waste Rock
Road To Lower Camp Area
LJWR/A1/R4
LJWR/A1/R2
LJWR/A1/R1
Snow
Adit (A1) 5150' Level (Covered By Snow)
LJWR/A2/R3
Talus
O/C
Talus
Waste Rock From 5600' Level
A2 Waste Rock
O/C
O/C
A2 Waste Rock
Inclined 35° Track Hoist Approx. 200m Of Track Still In Place
Adit (A2) 5600' Level (Not Unsorted Due To Access Difficultes)
Trestle 30m x 7m Long On Cliff Face (Access limited to Portal)
Upper Adit Area
Approx. Scale: 1:1000
Slope (Steep Grade 35°)
Access To Upper Workings Area
Legend
Outcrop Boundry
W/R Waste Rock
O/C Outcrop
Adit
Road
Extent Of Waste Rock
Trestle, with Track
LJWQ/A3/1 Water Quality Sample (site designation)
LJWR/P1/1 Waste Rock (site designation)
LJB/1 Barrel Sample (site designation)
Buildings
Access Road To Camp
Creek
AST-T2
Atco Trailer Compound Sleeping Quarters
Kitchen
Plywood Clad Wood Frame Generator Shed
Barrels
Wood Frame Machine Shed
Core Storage Shed
LJWQ/C1/1
Barrel
Office
Creek
600m From Camp To Fuel Storage Area
LJB/1
LJB/2
LJB/4
LJB/3
11-205 l Barrels Sampled
AST 1
N
Camp Area
Approx. Scale: 1:1000
PLOT: 1=1
CAD FILE: INVEN-96\LOGJAM\LOGJAM-1
Public Works And Government Services Canada
Travaux publics et Services gouvernementaux Canada
Architectural & Engineering Services Western Region
Drawing title: Titre du dessin:
Logjam Mine Site Development & Geological Information Yukon Territory
designed by: concu par:
date:
drawn by: dessine par:
approved by: approuve par:
revisions:
project no. no. du projet: 626967
dwg. no. dessin no. 1 of 1

hand trenching, 2,971.2 m of surface and underground drilling in over 28 holes and 729.3 m of underground development on two levels (MinFile 105B 007). The majority of the underground development was completed between 1965-67. Work also included a 25 km winter access road to the Alaska Highway, construction of the 200 metre inclined track for hauling materials to the uppermost 1700 metre level as well as a trailer camp. Mineral tenure on the Logjam mine site is currently held by 7188 Yukon Ltd. The property is comprised of 46 contiguous full sized and fractional claims. The underground workings are centred on the Barb 5 claim. The Barb 1-8 and Fractions 100-101 have been legally surveyed and are eligible for 21 year leases. The property owner was not contacted regarding this environmental site assessment.

1.3 SITE ACCESS:

Access to the site is available by means of a trail 20 km in length travelling north from the Alaska Highway (Mile 756) along the east side of the Smart River. The previous 1993 DIAND mine assessment report indicated that this road is in a severe state of disrepair and some work would need to be undertaken on approaches and bridge abutments. The project team chose to fly in by chartered helicopter from a base of operations at the east end of Edgar Lake located 90 km eastnortheast of the site.

2.0 PURPOSE AND SCOPE OF WORK

The following assessment activities were completed:

- Inspection of mine openings and workings, buildings and infrastructure, and waste disposal areas;
- Photo documentation and mapping of relevant site features;
- Sampling of waste rock disposal areas, stained soils, surface water (including adit and waste rock seepage, and receiving waters) and barrel contents;
- Identification and inventory of hazardous and non-hazardous materials on the site;
- Identification of potential or actual environmental pathways and receptors for site contaminants; and
- Assessment of human safety hazards and potential for accidental or deliberate access to hazardous areas.

Upon completion of these activities, preliminary cost estimates were generated to meet the following remediation/mitigation requirements:

- Physical stabilization of waste rock disposal areas;
- Chemical stabilization of the waste rock disposal areas as appropriate to local and background conditions, taking into account impact, on-site resources, and accessibility;
- Sealing of all mine openings;

- Consolidation and landfill of all non-hazardous, non-combustible solid wastes;
- Remediation or removal and disposal of contaminated soils as required to meet the more stringent of: Yukon Government's Contaminated Sites Regulations (1996) Schedule 1; and Canadian Council of Ministers of the Environment's Interim Canadian Environmental Quality Criteria for Contaminated Sites (1991) Commercial/Industrial criteria for soils;
- Removal and disposal of hazardous solid wastes;
- Draining, cleaning and disposal of drums or other containers containing petroleum products or other liquid hazardous wastes;
- Onsite flaring or removal and off-site disposal of petroleum products and other liquid hazardous wastes; and
- Demolition of buildings and infrastructure to foundation level and burning of combustible non-hazardous materials in approved location

3.0 SITE ASSESSMENT METHODOLOGY

3.1 Assumptions:

At each mine site, the assessment was limited to the area specifically developed or occupied for mine exploration or mining purposes and immediately adjacent areas within applicable claim boundaries as well as off-site environmental resources believed to be affected by mine exploration or development activities. Water samples were taken off-site to determine potential impact to surface water bodies due to mining activities. Access roadways to mine sites were not included in the assessments.

3.2 ASSESSMENT CRITERIA

3.2.1 Criteria and Guidelines

<u>Metal Mining Liquid Effluent Regulations and Guidelines</u> (Environmental Protection Service, Environment Canada, 1977)

The intent of the requirements defined in this document is to limit the discharge of deleterious substances from base-metal, uranium and iron ore mines. These requirements are uniformly applied national standards and intended to provide protection for fish and other aquatic life.

<u>Interim Canadian Environmental Quality Criteria for Contaminated Sites</u> (Canadian Council of Ministers of the Environment, 1992)

The Canadian Council of Ministers of the Environment (CCME) Interim Canadian Environmental Quality Criteria for Contaminated Sites are numerical limits for contaminants in soil and water intended to protect, maintain or improve environmental quality and human health at contaminated sites in general. CCME criteria include two types of benchmarks for soil and water quality - assessment criteria and remediation criteria. Assessment criteria are approximate background concentrations or approximate analytical detection limits for contaminants in soil and water, and remediation criteria are used as clean-up benchmarks based upon intended land use.

Remediation criteria do not address site-specific conditions. They are considered generally protective of human and environmental health for specified uses of soil and water at contaminated sites. The remediation criteria for soil are classified by three land uses:

1) Agricultural,
2) Residential/Parkland, and
3) Commercial/Industrial.

Remediation criteria for water are classified by four uses of water likely of concern at contaminated sites:

1) Freshwater aquatic life,
2) Irrigation,
3) Livestock watering, and
4) Drinking water.

Contaminated Sites Regulations (draft) (Yukon Government, 1996)

According to these draft regulations a site is contaminated if it used for agricultural, commercial, industrial, parkland, or residential land use and contains a substance in concentration greater than or equal to:

(I) the generic numerical soil standard of Schedule 1, or
(ii) the matrix (pathway specific) numerical soil standards of Schedule 2
and, surface or groundwater used for aquatic life, irrigation, livestock, or drinking water which exceeds a concentration greater than or equal to:

(I) the generic numerical water standard of Schedule 3, or
(ii) the local background concentration of that substance in the soil, surface water, or groundwater.

Below 3 metres of the surface, commercial land use criteria is applicable.

Mine Reclamation in Northwest Territories and Yukon (INAC, 1992)

This report defines factors which are to be considered in reclamation of abandoned mine sites operating in northern climates. Factors include:

- open pit and underground mines;
- special mines such as uranium, sand and gravel, and coal;
- waste rock and tailings disposal;
- acid generation and leaching; and
- estimating cleanup costs.

3.2.2 Application of Criteria and Guidelines

The following assessment criteria were used for the Logjam abandoned mine site:

A. Soils:

CCME: Remediation Criteria for Soil - Commercial/Industrial standard

YUKON RENEWABLE RESOURCES: Draft Contaminated Sites Regulations - used for hydrocarbon screening parameters

B. Water:

Envir. Canada: Metal Mining Liquid Effluent Regulations and Guidelines - are compared to seepage from mine openings, and river/stream water quality

Background: Downstream water quality results of rivers and streams are compared to the results of upstream (background) water quality.

CCME: Remediation Criteria for Water - Freshwater Aquatic Life guideline for river and stream water quality

[Note: In this screening assessment of water quality, analytical results are primarily compared to background values which may more accurately characterize the local environment.]

C. **Mine Clean-Up and Reclamation:**

INAC: Mine Reclamation in Northwest Territories and Yukon

3.3 METHODS

3.3.1 Background Information

Available background information was consolidated from the Yukon Chamber of Mines mine records, Whitehorse Public Library, Yukon Archives holdings, and records and reports from the Yukon Renewable Resources Library, Yukon Water Board, DIAND Lands Branch, DIAND Water Resources, and DIAND Library. INAC (1994) provided an overview assessment of the Logjam mine site to that date. Other published information sources were examined for site or regional information as applicable. On the basis of available information, knowledge gaps regarding existing or potential safety and environmental risks at the site were identified and a site assessment plan was developed.

3.3.2 Site Assessment Components

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

Waste Rock disposal areas were inspected and sampled by a professional geologist to assess acid rock drainage potential by:

- Identifying waste rock mineralization with potential to release acidic and/or metal-contaminated drainage
- Mapping and logging waste rock, tailings, pit walls and rock faces
- Collecting and field testing representative samples of mine wastes

Mine Openings were inspected and documented to identify closure requirements.

Non-Hazardous Site Debris was inventoried.

Contaminated Soil Areas were measured and sampled to determine the degree and type of contamination and estimate soil volumes for remediation.

Hazardous Materials were inventoried and sampled for identification of contaminant constituents, as necessary.

Buildings & other Structures were inspected for hazardous material and assessed for stability.

Borrow Sources were identified and assessed for accessibility and approximate quantity and type of granular material.

Scale site plans were prepared to identify the dimensions and locations site structures, mine workings and adits, waste rock disposal areas, on-site sampling locations (as applicable), and any other pertinent information.

3.3.3 Sampling Methods and Quality Assurance

Test Pit Sampling

Test pits were excavated to a depth of about 0.3 m to 1.0 m. Horizons in the test pit walls were logged, noting colour/weathering, rock composition, primary and secondary mineralization, particle size distribution, paste pH and paste conductivity, and moisture content. The test pit and was photographed and its location was marked on the field map. Approximately 2 kg of rock was collected at each sample site. For test pits showing a homogeneous wall face, a plastic sheet was placed at the bottom of the test pit and the pit wall was cut vertically down with a cleaned shovel. All rock larger than 75 mm in size was discarded. The sample was coned and quartered, discarding opposite quarters, until a 2 kg sample was obtained. For test pit walls showing clearly-distinguishable horizons (distinguishable by the sulphide and carbonate contents), the horizons were sampled individually.

Water Sampling

Samples were collected from surface streams upstream and downstream of mine related flows, and from representative seeps emanating from waste rock, tailings, pit walls, and/or adits. 250 ml water samples were collected by hand, facing upstream, ensuring that the sample is not contaminated by disturbed sediment, debris and other floating materials. Sample bottles were rinsed three times with water from the sample stream prior to collecting the sample. Two (2) ml of HNO_3 were immediately added to water samples destined for metals analyses. For analyses of non-metallic parameters, water samples were brim-filled to minimise head space, placed in a cooler, and maintained at 4° C until delivery to the laboratory.

Soil Sampling

Soil lithology was recorded from observations of the side walls of the test pit, and soil samples for both field and laboratory testing were collected. Observations were recorded for each soil sample site, including soil particle size, consistency, colour, moisture, discolouration, stratification, odour, and any other observations of significance.

Samples were collected at depth intervals selected on the basis of stratigraphic observations and anticipated or apparent contamination. The lab samples were collected using disposable latex gloves and decontaminated stainless steel sampling utensils. All samples intended for organic analyses were stored in laboratory-cleaned 250 ml glass jars; samples intended for metals analyses were placed in new "Whirl-Pak" bags. All samples were placed in a cooler for shipment to the laboratory.

Barrel, Pail, and Above-Ground Storage Tank Sampling

Barrels and pails suspected as containing hydrocarbons were sampled with 1.2 m clean hollow glass rods ("drum thieves"), capable of extracting up to 25 ml of product. The rods were inserted into the drum or pail, and the uppermost open tip was sealed to maintain the sample within the rod as it was extracted from the drum or pail. The sampled hydrocarbon was then drained into a 40-ml laboratory-cleaned vial. The extractions were repeated until at least 20-30 ml of product was obtained. The vial was then sealed and placed in a container for shipment to the laboratory. Each used drum thief rod was subsequently destroyed to prevent accidental re-use.

Two above-ground storage tanks (ASTs) were identified: one large vertical AST located 600 m southeast of the camp area and one horizontal AST located 50 m northwest of the camp. Both tanks were inspected and found empty.

Quality Assurance

Quality Assurance (QA) is a set of procedures for ensuring that the results of chemical analyses are, and can be shown to be, accurately representative of field conditions. A complete QA program includes both a field component and a laboratory component. In addition to the standard sample collection methods outlined above, the field QA measures that were implemented for this assessment study include:

- chain of custody procedures and forms;
- a sample labelling and sample location identification scheme;
- laboratory preparation of all sampling containers;
- laboratory defined sample preservation and shipping procedures; and
- regular maintenance (including re-calibration) and cleaning of field equipment.

Laboratory QA measures included replicate analyses of selected soil and water samples. Replicate analytical results were submitted with each analytical report

4.0 ENVIRONMENTAL SETTING

4.1 MINERALIZATION

The Logjam vein hosted silver-gold deposit is situated within the Yukon Tanana terrane. The regional geology includes rocks of the Yukon Cataclastic Complex, an allocthonous assemblage of tectonically interleaved Triassic diorite to ultramafic dykes and Carboniferous and younger sediments and volcanics. Later mafic and pyritic felsic dykes also intrude the package. The Cretaceous Logtung biotite granite intrusive stock occurs 2 km to the south. A system of ten northeasterly striking, near vertical, quartz veins occur at the contact between the metasediments and a steep dipping, north-south striking, 300 m thick diorite dyke. The veins vary from a few cm to a metre in width, with the thickest and best developed sections of mineralization occurring in the diorites.

The precious metals veins and the felsic dykes both follow the same prominent jointing, suggesting they may be related to the Logtung Stock (Miller, 1986). Most of the work on the Logjam property to date has focused on the No. 4 and No. 5 veins. Mineralization includes sections of pyrrhotite, pyrite, arsenopyrite, galena and sphalerite, and trace scheelite, bismuthinite and stibnite within a predominantly quartz gangue.

4.2 SURFACE HYDROLOGY

The southern portion of the Pelly Mountain Ecoregion drains southward by the Swift , Smart and Morley Rivers which in turn flow into Teslin Lake. The creek draining the property area was sampled **(LJWQ-C1-1)** where it is forded by the Logtung mine road at an elevation of 1280 m, just west of camp and a km north and down current of the mine adits. The creek is a tributary of the Smart River, located approximately 9 km down stream **(Figure 1)**. At the time of sampling, the creek was approximately 2.5 m wide and 0.2 m deep, and exhibited an iron manganese staining.

4.3 CLIMATE

The Logjam mine site lies in the Pelly Mountain Ecoregion which comprises an area of 31,712 km^2 and is situated within the southeastern portion of the Yukon. The site is subject to a predominating cold continental climate which provides colder winter and warmer summer temperatures than other areas of the Yukon which are under a more significant marine influence.

Generally speaking, the climate of this portion of the Yukon consists of long cold winters and short warm summers. Mean annual temperatures are below freezing and vary from a low of -25 °C to a high of 15 C with annual precipitation varying from 375 mm to 500 mm, increasing with elevation and during the summer months of July, August and September.

This ecoregion receives mean annual precipitation from 375 mm to 625 mm with higher levels at higher elevations in the north and south. Temperature isotherms of -4°C to -6°C are common for this area. (Ecoregions of Yukon Territory, Oswald, E.T. & Senyk, J.P., p. 14 & p. 32)

4.4 VEGETATION

The Pelly Mountain Ecoregion is included in the Eastern Yukon (B26c) forest subregion. While treeless tundra is common at higher elevations, white and black spruce predominate at lower elevations, white spruce and lodgepole pine on warmer sites, with alpine fir and shrub birch-willow in subalpine areas. Tree level hovers about 1350 m - 1500 m with moderately high precipitation and moderate temperatures. While much of the region at higher elevations is treeless and lies in tundra, lower elevation plateaus are in the B26c forest region with open growing black & white spruce occurring at the lower slope areas as well as in valleys. Lodgepole pine is common in burned over areas and alpine fir in the subalpine. Feathermoss laces with sphagnum is common in plateaux understory. Ericaceous shrubs & willows occur over much of the area however forbs are scarce. Shrub birch and willow are common in the subalpine and form extensive patches in protected areas above treeline. Alpine tundra areas are dominated by lichens, ericaceous shrubs and willows whereas sedge tussocks dominate alpine wetlands. (Soil, Site & Land Classification, Rowe, J.S. 1972).

4.5 FISH AND WILDLIFE RESOURCES

No data concerning fish species for the Teslin Lake system was available. The Logjam site is considered within established mountain goat range. Golden eagles are known to nest in surrounding mountains and likely hunt around the site. (Val Loewen, YTG Habitat Inventory Specialist).

4.6 SITE TOPOGRAPHY AND SOILS

The Logjam mine site is situated high on the east facing wall of a north facing cirque. A tributary of the Smart River drains north from the site out the one km wide valley. The cirque walls are 40% outcrop and 60% colluvium and talus. The valley floor is mapped as covered with mixture of alluvial, colluvial and glacial deposits. Ice contact deposits and meltwater channels often extend up slopes to mid elevations. Deep morainal and colluvial material cover much of the middle and lower slopes. (Ecoregions of Yukon Territory, Oswald, E.T. & Senyk, J.P., p.32).

4.7 PERMAFROST

The Logjam site is situated within the scattered subzone of discontinuous permafrost zone that stretches in a band across the southwestern portion of the land mass of the Yukon. In this area, permafrost tends to be localized with the active layer varying in thickness and depth. Quite often, the relative distribution of permafrost varies according to terrain and elevation with variations in local terrain conditions responsible for the occurrence in discontinuous zones as well as the thickness in these zones. (Ecoregions of Yukon Territory, Oswald, E.T. & Senyk, J.P., 19).

5.0 SITE DESCRIPTION AND FINDINGS:

5.1 BUILDINGS, INFRASTRUCTURE, EQUIPMENT

The Logjam mine site consists of a lower camp area and upper level exploration area **(See Photo 1)**. A total of five (5) prefabricated "ATCO" type trailers form the nucleus of the lower level encampment with 3 trailers joined together for sleeping and washing quarters, 1 trailer functioning as an office and 1 trailer functioning as eating quarters **(See Photos 2, 3, & 4)**.

Table 1: Buildings, Infrastructure, Equipment

Structure	Construction Features	Interior Contents
Prefabricated "ATCO" trailers	3.6 m wide X 10.7 m long wood frame & metal clad	Sleeping quarters, kitchen, washing quarters & office
Wood frame wood clad structure	3 m X 4 m plywood clad wood frame structure (uninsulated) in fair condition	Generator, assorted electrical equipment incl. wiring (no PCBs identified)
Wood frame wood clad structure	4 m X 5 m plywood clad wood frame structure (uninsulated) in fair condition	Toolshed; no sign of tools left, assorted wood waste
Wood frame wood clad structure	4 m X 5 m plywood clad wood frame structure (uninsulated) in poor condition	Core sorting area; core in wood sortation boxes left
Wood frame wood clad structure	3 m X 5 m plywood clad wood frame structure (uninsulated) in poor condition	Maintenance; miscellaneous waste & refuse remaining
Metal Track & Wood Trestle	75 m at lower adit & 50 m at upper adit of wood/rail trestle assembly in poor condition; impending risk of collapse	n/a

Four additional wood structures were identified on site including a generator shed, tool shed, core sorting shed and maintenance shed, (all in varying stages of repair/disrepair) **(See Photos 5, 6 & 7)**. The only other infrastructure and equipment identified on this site was located at the upper workings area 200 m above the camp area and 50 m above at the 2nd adit. Here, the remains of track and trestles hang precariously from a severe slope from a lower adit and an upper inaccessible adit **(See Photo 14)**.

5.2 NON-HAZARDOUS WASTE MATERIALS

Non-hazardous waste materials observed in and around the site are listed in **Table 2**.

Table 2 <u>Non-Hazardous Waste Materials</u>

Waste Material	Number/ Volume	Location	Comments
22700 litre fuel tank (vertical)	1	- approximately 800 m southeast of camp area	empty, valve secured, no staining
13620 litre fuel tank (horizontal)	1	- approximately 500 m south of camp area	empty, valve secured, no staining
205 litre barrel	23	- scattered southeast of camp	empty, no staining
timbers, core boxes, wood waste	<10 m^3	- core shed area & scattered around site	non-preserved, burnable
aluminum piping; 100 mm diameter	<100 m	- 100 m south of camp	non-burnable and rusted
metal 20 litre pails	$<$ 10	- scattered southeast of camp	non-burnable and rusted
- electrical wiring; assorted metal	<10 m^3	- near generator shed & 1570 m adit level	non-burnable and rusted

5.3 HAZARDOUS MATERIALS

No signs of stained soils were observed during the course of the site inspection and consequently no soil samples were taken at this location. However, a total of 23 x 205 litre steel barrels were scattered about the main site **(See Photos 10 & 11)**. Although a number of the barrels contained some liquid, a random sampling with drum thieves revealed a minor amount of diesel fuel or lubricant and water mixture. Consequently, no samples were submitted for analysis.

5.4 SURFACE WATER QUALITY

Table 3 (below) identifies the significant findings of the sampling program conducted to determine the potential impact of the site on surface water bodies. Samples were collected only from site drainage courses. Surface water run-off near the portals is unlikely due to the limited annual precipitation in the area and the highly porous conditions of the underlying colluvium and the waste rock material itself. Upstream site drainage samples were collected to represent the site background conditions for which downstream sample results will be compared. Field measurements of pH and conductivity were taken. Complete analytical results are provided in **Appendix C**.

Table 3 Surface Water Samples - Significant Laboratory Results

Sample ID	Sample Location	pH	Conductivity (μmhos/cm)	Metallic Parameters
LJWQ-C1-2	Unnamed creek adj. to camp	7.4 [7.0]	80 [106]	n/a

Notes: 1) pH and conductivity readings in square brackets are field measurements; non-bracketed readings are lab measurements
2) Low field conductivity readings for all samples may have been due to a calibration error on the conductivity meter.
3) n/a indicates that none of the readings from analytical samples submitted to the lab exhibited levels beyond parameters identified

All water sample concentrations (except for Ag for **LT-WQ-A1-1**) were found to be below method detection limits for all elements identified as parameters for "Freshwater Aquatic Life Remediation Criteria for Water" by Canadian Council of Ministers of the Environment (CCME). 1995. Canadian Water Quality Guidelines.

5.5 WASTE ROCK DISPOSAL AREAS:

Waste rock dumps extend down the slope of the cirque wall from both the 1570 m and 1700 m mine levels where they were end dumped from track mounted ore cars. The waste rock from the 1570 m level dump is spread over a total area of approximately 900 m^2. Mine rock from the most recent underground development work (1986) appears to have been dumped in a pile extending south of the portal over waste rock from earlier mining. The older material appears to have been reworked by a bull dozer to form the landing area, which would have increased its homogeneity.

Some amount of talus deposited from the slope above also appears to have been worked in with the waste rock. The more recent waste rock at the 1570 m level from the 1981-82 work has a total volume of approximately 300 m^3 and is represented by sample **LJWR-A1-R1** and **LJWR-A1-R2 (See Photo 12 & 13).** The material is still relatively fresh with only 20% rusty weathering. A pit profile of the material indicated that two rock types are represented.

The upper 0.55 m layer is comprised of green-yellow altered sediments and with 20% quartz. The rock is oxidized at surface where 20% rusty weathering is apparent, but appears fresh to depth. From 0.6 m to 0.9 m, dark gray hornfels with 0.5% to 2.0% pyrite and 20% quartz has been dumped.

The older waste rock at the 1570 m level dating from the 1965-67 phase of work has a volume of approximately 2,550 m^3. This waste rock is represented by sample **LJWR-A1-R4** and extends 85 m across the slope of the hill. A test pit located on the face of the waste dump to a depth of 0.5 m identified the material as primarily coarse (60%), mostly rusty weathered, bright orange brown, diorite and hornfels. It likely includes a significant proportion of naturally deposited talus material. A paste pH of 5.9 from field tests is possibly indicative of this material having been in place for almost 30 years and having the potential for acid generation.

The waste dump rock from the 1700 m level extends from the portal site downslope just north of the 1570 m level to an elevation of approximately 1550 m. A single sample **(LJWR-A2-R3)** was collected from a 0.5 metre test pit approximately 60 m upslope from the toe of the waste dump. The top 0.01 m layer forms a hard cap and is assumed to originate from the 1982 underground development work. The bottom 0.49 m is primarily medium sized (60%), green yellow (90%) diorite and hornfels.

Results of the static analysis and acid-base accounting (ABA) for the Logjam property indicate that the waste rock material at the adit dump site has Neutralizing Potential/Acid Potential ratios (NP/AP) below 3. The results are listed below in Table 4: Summary of Acid Base Accounting.

NP/AP ratios are all near or equal to 1.0 and the Net NP is generally low to negative suggesting that the waste rock at the Logjam site could generate acidity. The total sulphur content is high in two of the samples and vein mineralization is massive, reducing the potential for intimate contact of neutralizing and acid generating minerals and increasing the potential for some acid generation depending on climatic conditions.

Table 4 Summary of Acid Base Accounting

Logjam Property Acid-Base Accounting Results - 1570 Level Adit Waste Rock								
Sample No.	Field Paste pH	Lab Paste pH	Sulphur (Total) %	Sulphur (SO_4) %	Acid Potential (AP*)	Neutral. Potential (NP*)	Net NP*	NP/AP
LJWR-A1-R1	8.2	6.55	0.04	0.00	1.3	2.1	0.9	1.7
LJWR-A1-R2	7.9	7.97	2.75	0.18	80.3	103.8	23.4	1.3
LJWR-A1-R4	7.4	7.12	0.19	0.00	5.9	6.0	0.1	1.0
Acid-Base Accounting Results - 1700 Level Adit Waste Rock								
LJWR-A2-R3	5.9	7.80	2.88	0.15	85.3	73.8	-11.6	0.9
* AP and NP reported in tonnes $CaCO_3$ equivalent per 1000 tonnes of material.								

Table 5 Sulphuric Acid Generation Potential

Sample No.	Volume Material Represented (m^3)	Tonnes Material Represented	Sulphur (Total) %	Tonnes Sulphur	Potential Tonnes H_2SO_4 Acid
LJWR-A1-R1	240	504	0.04	0.2	0.6
LJWR-A1-R2	1,160	2,436	2.75	67.0	205.2
LJWR-A1-R4	1,750	3,675	0.19	7.0	21.4
LJWR-A1-R3	2,015	4,232	2.88	121.9	373.3
Totals	**5,165**	**10,847**	-	**196.1**	**600.5**

Based on the risk of acid generation from the waste and ore stockpiles, the total potential tonnes of sulphuric acid (H_2SO_4) that could be generated is calculated above in **Table 5** Sulphuric Acid Generation Potential. The potential total amount of H_2SO_4 that could be produced at the Logjam site is approximately 600 tonnes, assuming 100% of the sulphur is available and is converted, a pour space of 30% in the stockpiles, a specific gravity of 3.0 for the waste rock and using a H_2SO_4 to sulphur ratio of 3.06:1.

5.6 MINE OPENINGS AND EXCAVATIONS

The two adits at the Logjam mine site are located at elevations 1570 m and 1700 m approximately UTM 6656790 North/355060 East and UTM 6656680 North/354960 East respectively. The 1700 m level portal was not visited due to access difficulties and limited time. The 1700 m portal is situated at the base of the rock cliff face.

A now dilapidated, 35° inclined rail bed extends down the rock and talus slopes from the south end of a 20 m trestle built into the cliff face at the 1700 m portal to the 1570 m level. The trestle is intact but does not appear sound or operational. The portal is not obstructed and has been left open. No obvious trench sites were observed. A summary of adit features is listed below in **Table 6**.

Table 6: Mine Openings

Adit	Location	Drift Length	Condition
A1	lower site, 1570 m elev.	unknown due to snow	- entirely obscured by snow and talus material; could not be examined; rails removed from portal area, but unknown if they are still intact underground; newer road pushed up to the 1570 m portal from camp area; landing area has been built out with mine waste rock and talus; small shack situated adjacent to the portal; slope below is littered with metal scraps and old rails.
A2	upper site, 1700 m elev.	inaccessible	- not visited due to access difficulties and limited time; situated at base of rock cliff face; dilapidated, 35° inclined rail bed extends down rock & talus slopes from south end of 20 m trestle built into cliff face at the 1700 m portal to the 1570 m level; trestle is intact, but not sound or operational; portal is not obstructed and left open. No obvious trench sites were observed.

5.7 Tailings

There has been no milling or ore processing on the Logjam site, and there are no mill tailings present on the site as a result.

6.0 CONCLUSIONS

The primary concern is the health and safety of humans and wildlife relating to the collapsing mine openings and the unstable rails and trestles. A secondary concern is the aesthetic appearance of scattered timbers, metal debris site, and loose tanks and barrels located throughout the site.

6.1 HEALTH & SAFETY:

Risks relating to health and safety at the Logjam mine site can be considered medium-low. The 1570 m level portal is caved in by talus material and was completely covered by snow at the time of the site visit (August) suggesting a year round condition **(See Photos 12 & 13)**. The portal at the 1700 m level is relatively inaccessible. Both the inclined track and the horizontally inclined trestle **(See Photo 14)** are severely deteriorated and could in future be subjected to collapse and further deterioration as a result of weathering and the law of gravity. The 1700 m level could present long term safety problems to humans visiting the site as the trestle and inclined rails become more unstable and begin to fall down the steep face of the cirque. No obvious risks to human health and safety were identified at the exploration camp area

6.2 ENVIRONMENTAL RISKS:

Based on the sampling program conducted at the Logjam abandoned mine site as well as the Acid Rock Drainage Assessment Report submitted by SRK (Jan, 1997), the overall environmental risks of the Logjam site relating to the mining and exploration activity are considered medium-low. However, some potential for acid generation exists. Situated on the heavily weathered, talus covered slopes of a steep cirque basin, the physical nature of the Logjam vein occurrence and mineralized host rock can be considered to contribute some amount of natural acid rock drainage and metals contamination.

However, the volume of mine waste rock (although more metals concentrated) can be expected to be small in proportion to the total volume of natural sulphide mineralized material in the mine area. In considering the potential effects from the mining activity at Logjam, both the present state of the environment and the water quality of the adjacent drainage show no obvious effects from this larger natural sulphide source.

The present mine waste dumps are likely to generate some acid based on the limited data available. The overall risk from acid rock drainage caused by the mine waste rock is considered moderately low for the following reasons:

- the limited volume to material in the mine dumps;

- the maximum total potential sulphuric acid is low, estimated to be 600 tonnes;

- the waste rock has near to neutral, if not slightly elevated, paste pH;

- climatic conditions are dry with moderately low annual precipitation, approximately half of which is stored in the winter snow pack, and;

- surface water run-off is unlikely due to the highly porous conditions of the underlying colluvium and the waste rock material itself.

The potential for release of a range of metals into the environment is considered a moderately low. Lead, zinc, copper, arsenic antimony and cadmium are all present in elevated concentrations in the waste rock piles at Logjam. The results of this environmental assessment of the potential for acid generation and metals contamination resulting from mining and exploration work done on the site are limited by a number of parameters. These are listed as follows:

1. The limited number of samples and profile depths taken to represent the various rock dumps, specifically the single sample of waste rock material from the two larger volumes of 1960's development rock;

2. The static analytical procedures used for the ABA can only be considered indicative of the potential for acid generation and requires kinetic testing to establish a more accurate prediction model;

3. Assumptions built into the calculation of the total potential H_2SO_4, including the percentage of pour space and specific gravity of the rock, and;

4. The total metals analysis of the water samples were not sensitive enough to meet CCME guideline levels.

The results of this environmental assessment of the geologically related aspects of the Logjam site can be considered indicative of the present state of the site and its potential to adversely affect the immediate surrounding environment. No further testing is recommended at this time based the generally low to moderately low environmental risks identified and the present body of data available. More intense sampling and definitive analytical procedures would be required to accurately test those parameters identified in this study as a potential risk.

6.3 AESTHETIC CONCERNS:

Aesthetic concerns at the Logjam mine site include two large above ground fuel storage tanks, empty 205 litre metal barrels scattered about the site, aluminum piping, metal waste, wood waste and debris scattered throughout the lower exploration camp area.

7.0 RECOMMENDATIONS

Recommended remediation and management actions are compliant with applicable federal or territorial regulations and criteria, are reliant upon available technology, and are intended to be appropriate for local conditions and sensitivities. An estimated breakdown of expected remediation/mitigation costs to an accuracy of 25% is provided under separate cover to this report. The cost estimate includes contractor and project management costs and contingencies.

Recommendation 1.

An attempt should be made to remove the rail and trestle configuration at the upper 1700 m adit level by using a winch off of a tracked vehicle and pulling the structure down slope, burning the wood waste on the slope and burying the metal waste.

Recommendation 2.

Implement a more intensive water sampling program to monitor the impact of any acid generating waste from this site on the receiving environment by monitoring for spring, summer & fall conditions every 5 years.

Recommendation 3.

Existing wood frame buildings on site should be demolished and burned on site. Remove core boxes and store on site.

Recommendation 4.

Cut up ASTs and empty 205 litre metal barrels on site, and bury in pit area at north end of camp. Burn waste wood materials at north end of camp in pit area. Bury waste metal materials in pit area.

Recommendation 5.

Haul out prefabricated trailers off site for salvage. Retain wood core boxes from core sorting structure and burn structure on site. Bury miscellaneous plastic and metal waste in north pit area.

8.0 COST ESTIMATES TO IMPLEMENT RECOMMENDATIONS

An estimated breakdown of expected remediation/mitigation costs to an accuracy of 25% is provided under separate cover to this report. The cost estimate includes contractor and project management costs and contingency.

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APPENDIX A

DETERMINATION OF ACID ROCK DRAINAGE POTENTIAL

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LOGJAM
ACID ROCK DRAINAGE
ASSESSMENT REPORT

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LOGJAM
ACID ROCK DRAINAGE
ASSESSMENT REPORT

1.0 INTRODUCTION

This report has been prepared in conjunction with a *Phase II Environmental Assessment of the Logjam Abandoned Mine Site*, prepared by Environmental Services, Public Works and Government Services Canada (PWGSC). As part of the phase II assessment prepared by PWGSC, Steffen, Robertson and Kirsten (SRK) was requested to assess the potential for acid rock drainage at the site, which is the subject of this report. The reader is directed to the PWGSC report for a comprehensive environmental assessment of the Logjam site.

This report reviews the existing, and the potential, for acid rock drainage (ARD) conditions at the Logjam site and provides recommendations for remediation. This site-specific report is part of the *Acid Rock Drainage Review Report, Yukon Abandoned Mine Site Assessments*, prepared by Steffen, Robertson and Kirsten (SRK), which includes similar assessments for a number of other sites. The reader is directed to that report for detail regarding the scope of work, site assessment methodology, ARD remediation options and the evaluation of potential remediation options.

The Logjam site is located in the southern Yukon, approximately 20 kilometers north of the Alaska Highway, near Rancheria, YT. It is situated at the headwaters of the Smart River. The site is accessible by helicopter and by a 25 kilometre winter road from the Alaska Highway.

Mining related disturbances observed during the site assessment consist of two adits with waste rock deposited in front of each. The majority of the 730 metres of underground development was completed between 1965 and 1967. The last reported underground development was in 1986 (PWGSC, 1997).

The mine site is situated high on the west wall of a north facing cirque above a creek which flows north from the site and empties into the Smart River, 9 kilometres downstream.

2.0 GEOLOGY AND MINERALIZATION

The Logjam vein hosted silver-gold mineral occurrence is situated within the Yukon Tanana terrane. A system of ten northeasterly striking, near vertical, quartz veins occur at the contact of metasediments (hornfels) with a steeply dipping, north-south striking, 300 metres thick diorite dyke. The veins vary from a few centimetres to a metre in width, with the thickest and best developed sections of mineralization occurring in the diorites.

Most of the work on the Logjam property to date has focused on the No. 4 and No. 5 veins. Mineralization includes sections of pyrrhotite ($Fe_{1-x}S$), pyrite (FeS_2), arsenopyrite ($FeAsS$), galena (PbS), and sphalerite ($(Zn, Fe)S$), with trace scheelite ($CaWO_4$), bismuthinite (Bi_2S_3), and stibnite (Sb_2S_3) within a predominantly quartz gangue.

3.0 WASTE ROCK DISPOSAL AREAS

3.1 Description

The waste rock dumps extend down the slope of the cirque wall from the 1570 and 1770 level adits. Approximately 11,000 tonnes of rock was end dumped from track mounted ore cars.

The waste rock from the 1570 level dump is spread over a total area of approximately 900 m^2. Mine rock from the most recent underground development work (1986) appears to have been dumped in a pile extending south of the adit over waste rock from earlier mining. There is approximately 300 m^3 of this relatively fresh waste rock, of which 20% of the surface material exhibits rusty secondary mineralization. The rock is oxidized at surface where the rusty weathering is apparent, but appears fresh at depth.

The older material at the 1570 level (circa 1965-1967) appears to have been reworked by a bull dozer. It has a volume of approximately 2550 m^3 and extends 85 metres across the slope of the hill. Most of the older material exhibits rusty weathering on the surface, and contains a significant amount of talus material.

The waste rock dump from the 1700 level extends from the adit down the slope, just north of the 1570 level adit to an elevation of approximately 1550 metres.

3.2 Samples

Four samples of waste rock were collected for laboratory analysis. Two samples, LJWR/A1/R1 and LJWR/A1/R2, were collected from the relatively fresh waste rock at the lower adit. This material consisted of green-yellow altered sediments and quartz, overlaying hornfels. Sample LJWR/A1/R4 was collected from the older, weathered material at the lower adit which contains a significant amount of talus. Sample LJWR/A2/R3 was collected 60 metres up slope of the toe of the upper waste rock dump. The test pit logs are summarized in Table 1 and the sample locations are shown on the site map, Drawing 2.

No adit discharges, seepage through the waste rock or surface runoff were observed at the mine site. The tributary of Smart River, drains the area. A sample was collected (LJWQ/C1/1) where it is forded by the access road, approximately one kilometre downstream of the mine workings. At the time of sampling, the creek was approximately 2.5 metres wide and 0.2 metres deep, and exhibited iron manganese staining.

3.3 Analytical Results

Results of geochemical analyses of waste rock samples are provided in Table 2 and the analytical results for the water sample is provided in Table 3.

Paste Parameters

The paste pH values for all samples were neutral (7.1 to 8.0), indicating that the material is not currently generating acid.

Acid Base Accounting

The Neutralizing Potential to Acid Potential (NP:AP) ratios of the rock samples ranged from 0.85 to 1.29, suggesting a potential for acid generation. Total sulphur concentrations from the samples collected at the lower adit (LJWR/A1/R1, R2, R4) ranged between 2.4% and 2.9%, with sulphate concentrations between 0.15% and 0.2%. The sample from the upper waste rock pile contained 0.2% total sulphur.

Metals Concentrations

The rock samples from the lower waste rock pile contained elevated concentrations of arsenic (ranging from 1417 to 8044 ppm), cadmium (ranging from 43.3 to >100 ppm), copper (ranging from 164 to 242 ppm), manganese (ranging from 630 to 1454 ppm), lead (ranging from 1617 to 4441 ppm) and zinc (ranging from 1953 to 4921 ppm). The sample from the upper dump had lower concentrations of metals, except manganese (925 ppm).

Water Quality

The water sample collected approximately 1 km downstream from the mine had a neutral pH of 7.0 (field measurement) and a conductivity of 80 μS/cm (field measurement). Concentrations of metals of concern were below the method detection limit.

4.0 EXISTING AND POTENTIAL ACID ROCK DRAINAGE CONDITIONS

Waste rock at the Logjam site is not currently generating acid, has the potential to become net acid generating. However, most of the rock has been exposed on surface for 29 years, without producing acid which indicates that the sulphides in the waste react slowly.

Stream water quality from the creek suggests that the downstream environment is not significantly effected by the mining related disturbances.

5.0 REMEDIATION OPTIONS

Typical reclamation and control options for acid generating mine waste and mine openings include:

- source control which includes limiting further oxidation, for instance, by placing the waste under water thus preventing oxygen entry;

- migration control which limits the mobility of oxidation products, for example, by reducing infiltration to the waste by placing a low permeability cover; and,

- release control by collecting and treating contaminated flows prior to discharge.

Collection and treatment of the runoff from Logjam site is not considered a viable option due to the lack of surface water at the site. Relocation of the waste rock was not considered since there does not appear to be a secure placement location readily available, such as the underground workings or an open pit. Placement of a soil cover is impractical due to the location of the waste rock along the steep wall of the cirque. Therefore, unless acidic conditions develop, no remediation actions are viable.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The mine rock, totalling an estimated 11,000 tonnes, has the potential to generate acid. Considering the neutral to alkaline paste pH of the material after 29 years of exposure, the rate of release of acid has been limited and is expected to be long term. Based on the climatic conditions of the site, which are dry with a moderately low annual precipitation, the amount of water available would be limited. Also, surface runoff is likely uncommon due to the highly porous conditions of the underlying colluvium and the waste rock material itself. Therefore, if acidic conditions were to develop the impact on the receiving environment would likely be limited because of the lack of water available for transport of soluble constituents.

Water quality monitoring of the creek below the workings is recommended every 3 to 5 years, during spring freshet, middle summer and fall conditions. The method detection limits used should correspond to those criteria approved by CCME and BC for freshwater aquatic life. A paste pH and conductivity survey of the mine rock should be conducted in conjunction with the water sampling in order to detect changes in the oxidation rate of the material.

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TABLE 1 Logjam Waste Rock Sample Descriptions

Sample ID	Sample Description
LJWR/A1/R1	collected at the lower adit, from pits composed of 0.55 metres of green-yellow altered sediments and 20% quartz overlaying 0.6 to 0.9 metres of dark gray hornfels with 0.5% to 2% pyrite and 20% quartz. Field paste pH 8.2, lab paste pH 6.55.
LJWR/A1/R2	collected at the lower adit, from pits composed of 0.55 metres of green-yellow altered sediments and 20% quartz overlaying 0.6 to 0.9 metres of dark gray hornfels with 0.5% to 2% pyrite and 20% quartz. Field paste pH 7.9, lab paste pH 7.97.
LJWR/A2/R3	collected 60 metres upslope from the toe of the upper waste rock pile, in a 0.5 metre pit. upper 1 cm forms a hard cap overlaying 60% medium sized material, green yellow in colour (90%) diorite and hornfels. Field paste pH 5.9, lab paste pH 7.80.
LJWR/A1/R4	collected from the older, weathered material in a 0.5 metre test pit located on the face of the lower waste dump. 60% of the material in the pit was coarse. Field paste pH 7.4, lab paste pH 7.12.

TABLE 2 Logjam Waste Rock ABA and ICP Results

Parameter	Units	Sample Number LJWR			
		A1/R1	A1/R2	A2/R3	A1/R4
Field Paste pH		8.2	7.9	7.4	5.9
Lab Paste pH		7.97	7.80	7.68	7.12
Total Sulfur	%	2.75	2.88	2.44	0.19
Sulfate	%	0.18	0.15	0.19	na
AP		80.31	85.31	70.31	5.94
NP		103.75	73.75	59.75	6.00
NET NP		23.44	-11.56	-10.56	0.06
NP/AP		1.29	0.86	0.85	1.01
Aluminum	%	1.83	1.08	1.60	1.87
Antimony	ppm	3	96	197	56
Arsenic	ppm	1417	8044	6740	687
Barium	ppm	17	26	24	89
Beryllium	ppm	<0.1	<0.1	<0.1	<0.1
Bismuth	ppm	<1	25	<1	<1
Cadmium	ppm	43.3	>100	>100	0.1
Calcium	%	4.31	3.34	3.16	0.66
Chromium	ppm	135	100	110	86
Cobalt	ppm	22	14	24	20
Copper	ppm	210	242	164	104
Gallium	ppm	<1	<1	<1	<1
Iron	%	5.37	4.24	4.82	4.30
Lead	ppm	1617	4441	2287	408
Lithium	ppm	126	54	39	31
Magnesium	%	2.45	1.58	1.66	1.50
Manganese	ppm	1454	895	630	925
Molybdenum	ppm	17	28	17	18
Nickel	ppm	52	53	42	43
Potassium	%	0.34	0.16	0.09	0.21
Phosphate	ppm	1160	880	1220	830
Silver	ppm	13.5	44.7	37.9	11.0
Sodium	%	0.01	0.01	0.03	0.03
Strontium	ppm	123	112	74	120
Thorium	ppm	<1	<1	<1	<1
Tin	ppm	4	3	4	3
Titanium	%	<0.01	<0.01	0.06	0.05
Tungsten	ppm	4	10	5	<1
Uranium	ppm	<1	<1	<1	<1
Vanadium	ppm	103.9	72.5	89.9	68.8
Zinc	ppm	2960	4921	1953	452

AP = Acid Potential in tonnes $CaCO_3$ equivalent per 100 tonnes of material
NP = Neutralization Potential in tonnes $CaCO_3$ equivalent per 1000 tonnes of material
Net NP = Net Neutralization Potential = tonnes $CaCO_3$ equivalent per 1000 tonnes of material
na = no assay / analysis
< = lower detection limit
> = upper detection limit

TABLE 3 Logjam Water Quality Results

Parameter	Units	Sample Number LJWQ/ C1-1
Field Conductivity	umhos/cm	80
Field pH		7.0
Lab Conductivity	umhos/cm	106
Lab pH		7.75
Acidity (to pH 8.3) CaCO3	mg/L	2.5
Alkalinity-Total CaCO3	mg/L	20.7
Sulphate SO4	mg/L	28.4
Aluminum T-Al	mg/L	<0.2
Antimony T-Sb	mg/L	<0.2
Arsenic T-As	mg/L	<0.2
Barium T-Ba	mg/L	<0.01
Beryllium T-Be	mg/L	<0.005
Bismuth T-Bi	mg/L	<0.1
Boron T-B	mg/L	<0.1
Cadmium T-Cd	mg/L	<0.01
Calcium T-Ca	mg/L	16.7
Chromium T-Cr	mg/L	<0.01
Cobalt T-Co	mg/L	<0.01
Copper T-Cu	mg/L	<0.01
Iron T-Fe	mg/L	<0.03
Lead T-Pb	mg/L	<0.05
Lithium T-Li	mg/L	<0.01
Magnesium T-Mg	mg/L	0.93
Manganese T-Mn	mg/L	<0.005
Molybdenum T-Mo	mg/L	<0.03
Nickel T-Ni	mg/L	<0.02
Phosphorus T-P	mg/L	<0.3
Potassium T-K	mg/L	<2
Selenium T-Se	mg/L	<0.2
Silicon T-Si	mg/L	2.22
Silver T-Ag	mg/L	<0.01
Sodium T-Na	mg/L	<2
Strontium T-Sr	mg/L	0.051
Thallium T-Tl	mg/L	<0.1
Tin T-Sn	mg/L	<0.03
Titanium T-Ti	mg/L	<0.01
Vanadium T-V	mg/L	<0.03
Zinc T-Zn	mg/L	<0.005

< = lower detection limit

APPENDIX B

SITE PHOTOGRAPHS

Photo 1. Aerial view of site with camp area (centre), large AST (center rear), secondary tributary of Smart River (right) and access road to adit area (upper right).

Photo. 2. Atco trailer compound with core storage area, core analysis structure, office trailer, kitchen and sleeping quarters.

Photo 3. Office trailer with core analysis shed at rear.

Photo 4. Kitchen trailer with power lines to generator shed.

Photo 5. Small loading facility adjacent to office trailer with empty 205 litre drum.

Photo 6. Maintenance shed southwest of trailer compound.

Photo 7. Electrical generator shed with power line to trailer compound visible.

Photo 8. Empty AST with assortment of 205 litre metal barrels previously reported as all empty.

Photo 9. Large vertical AST located approximately 600 m south of trailer camp area.

Photo 10. Damaged, rusted and empty metal 205 litre barrels located in vicinity of large vertical AST.

Photo 11. Purge and trap vials (40 ml) used during sampling of product of barrels.

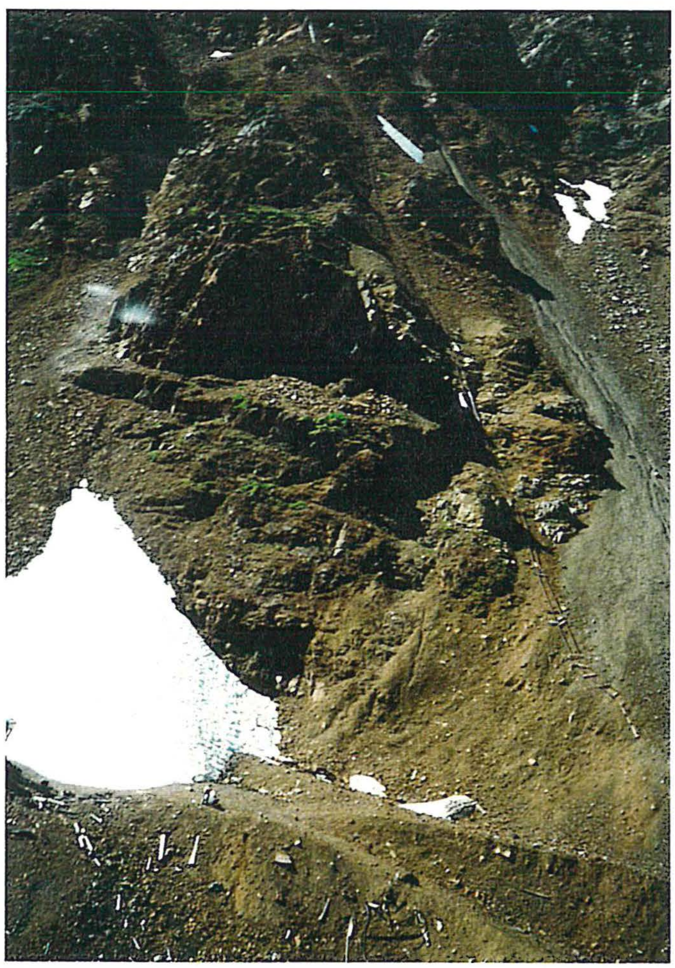

Photo 12. View of typical terrain at Adit A1 (1570 m level). Note geologist below snow accumulation, talus, and beginning of hoist track to upper adit level.

Photo 13. Profile of upper exploration area with Adit A1 (1570 m level) and access road to camp. Note severity of 35^0 slope.

Photo 14. Track and trestle at Adit A2 (1707 m level). Note severity of slope, unstable surface and deteriorated condition of trestle and supports.

APPENDIX C

ANALYTICAL RESULTS

CHEMICAL ANALYSIS REPORT

Date: INTERIM

ASL File No. G3599

Report On: 762-186 Water Analysis

Report To: **Public Works & Gov't Services**
Environmental Services
204-1166 Alberni Street
Vancouver, BC
V6E 3W5

Attention: **Mr. Tim Sackmann**, Manager, Contaminated Sites

Received: July 31, 1996

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Heather A. Ross, B.Sc.
Project Chemist

RESULTS OF ANALYSIS - Water

File No. G3599

		S7WG-C2	LJWG-C1-1	LTWG-A1-1	LTWG-C1-2
		96 07 26 17:30	96 07 28	96 07 28	96 07 28
Physical Tests					
Conductivity (umhos/cm)		146	106	260	79.7
pH		7.75	7.37	7.52	7.33
Dissolved Anions					
Acidity	CaCO3	2.3	2.5	2.9	1.9
Alkalinity - Total	CaCO3	68.9	20.7	24.3	14.6
Sulphate	SO4	6.5	28.4	89.0	22.1
Total Metals					
Aluminum	T-Al	[redacted]	[redacted]	[redacted]	[redacted]
Antimony	T-Sb	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As	[redacted]	[redacted]	[redacted]	[redacted]
Barium	T-Ba	<0.01	<0.01	<0.01	<0.01
Beryllium	T-Be	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.1	<0.1	<0.1	<0.1
Boron	T-B	<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd	[redacted]	[redacted]	[redacted]	[redacted]
Calcium	T-Ca	28.1	16.7	42.2	11.2
Chromium	T-Cr	[redacted]	[redacted]	[redacted]	[redacted]
Cobalt	T-Co	<0.01	<0.01	<0.01	<0.01
Copper	T-Cu	[redacted]	[redacted]	[redacted]	[redacted]
Iron	T-Fe	<0.03	<0.03	<0.03	<0.03
Lead	T-Pb	[redacted]	[redacted]	[redacted]	[redacted]
Lithium	T-Li	<0.01	<0.01	<0.01	<0.01
Magnesium	T-Mg	0.84	0.93	2.56	1.22
Manganese	T-Mn	<0.005	<0.005	<0.005	<0.005
Molybdenum	T-Mo	<0.03	<0.03	0.29	<0.03
Nickel	T-Ni	<0.02	<0.02	<0.02	<0.02
Phosphorus	T-P	<0.3	<0.3	<0.3	<0.3
Potassium	T-K	<2	<2	<2	<2
Selenium	T-Se	[redacted]	[redacted]	[redacted]	[redacted]
Silicon	T-Si	3.20	2.22	6.98	4.93
Silver	T-Ag	[redacted]	[redacted]	[redacted]	[redacted]
Sodium	T-Na	<2	<2	<2	<2
Strontium	T-Sr	0.182	0.051	0.112	0.043
Thallium	T-Tl	<0.1	<0.1	<0.1	<0.1
Tin	T-Sn	<0.03	<0.03	<0.03	<0.03
Titanium	T-Ti	<0.01	<0.01	<0.01	<0.01
Vanadium	T-V	<0.03	<0.03	<0.03	<0.03

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

RESULTS OF ANALYSIS - Water File No. G3599

		S7WQ-C2	LJWQ-C1-1	LTWQ-A1-1	LTWQ-C1-2
		96 07 26 17:30	96 07 28	96 07 28	96 07 28
Total Metals					
Zinc	T-Zn	<0.005	<0.005	0.005	<0.005

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

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

:rror opening method file.

Extractable Organic Halide (EOX) in Oil

This analysis is carried out using a procedure that is consistent with the requirements of the appropriate regulatory agencies and adapted from U.S. EPA Method 9020 (Publ. # SW-846, 3rd ed., Washington, DC 20460). The procedure involves extracting a subsample with ethyl acetate and analysing the extract with a TOX analyser.

Moisture

This analysis is carried out gravimetrically by drying the sample to constant weight at 103 C.

Conventional Parameters in Sediment/Soil

These analyses are carried out on a leachable basis. The procedure involves mixing with reagent grade water and leaching for several hours. The leachate is centrifuged and analysed in accordance with "Standard Methods for the Examination of Water and Wastewater" 17th ed. published by the American Public Health Association, 1989.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050 or Method 3051, published by the United States Environmental Protection Agency (EPA). The procedures involve a digestion using a 1:1 ratio of nitric acid and hydrochloric acid, along with hotplate or microwave heating. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010).

Method Limitation: The stated acid digestion will provide excellent results for total recoverable metals; however, it is only partially effective on mineralized or non-environmentally available metals.

Polycyclic Aromatic Hydrocarbons in Sediment/Soil

This analysis is carried out using a procedure adapted by ASL from U.S. EPA Methods 3500, 3630, and 8270 (Publ. #SW-846 3rd ed., Washington, DC 20460). The procedure involves a microwave assisted extraction with

Appendix 2 - METHODOLOGY (cont'd) File No. G4270

dichloromethane followed by a clean-up using silica gel column chromatography. This clean-up procedure has been found to effectively remove aliphatic and heterocyclic hydrocarbons which could potentially interfere with the analysis. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection.

Conventional Parameters in Water

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

Metals in Water

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

Mercury in Water

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

End of Report