MN-065

PWGSC

Quality in Environmental Services

**PHASE II ENVIRONMENTAL ASSESSMENT
OF THE
RUNER MINE SITE**

Prepared for:
Action on Waste Program
Indian and Northern Affairs Canada

March 1997

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

Canada

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Prepared by:

Environmental Services
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Executive Summary

The Runer exploration site is located at 63° 54' 51" N, 135° 14' 26" W, approximately 3 km east of the village of Keno Hill. Environmental Services, Public Works and Government Services Canada was retained to conduct an assessment of the Runer abandoned mine site to a) identify specific environmental and human safety risks and aesthetic concerns; b) provide clean-up recommendations; and c) provide a Class "D" cost estimate for recommended remediation or mitigation measures. The Runer mine site was inspected by PWGSC on 14 - 15 August, 1996.

Assessment components included mine openings and workings, buildings and infrastructure, waste disposal areas, waste rock disposal areas, surface water (including waste rock seepage and receiving waters), and hazardous and non-hazardous materials on the site.

Very serious safety risks are posed by slope instability and the potential for linked failures of adjoining waste rock piles. The imminent failure of the garage waste rock pad and roadway threatens those buildings and the safety of any persons present on the downhill road bed. The upper and lower trenches are deep, have steep walls, and are surmounted by loose waste rock or overburden piles at the edges of the trench walls. The margins of the trenches are not fenced, and no warning signs have been posted to alert site visitors of danger areas. The contents of two locked explosive magazines at Runer are not known.

While the site does have the potential to be acid generating and metal leaching the risk to the environment is low, and it is unlikely that acidic drainage or metal leachate from the waste rock is or will significantly impact the downstream environment. Hydrocarbon-stained soils within and adjacent to the garage are not believed to be an environmental concern.

It is strongly recommended that the site be fenced to prevent access to the upper and lower trenches and the waste rock pad supporting the two site buildings. To permanently address the safety risks, the upper and lower trenches should be backfilled with available waste rock.

The garage and storage shed should be burned in situ. Hydrocarbon products contained in 20-litre pails within the storage shed and garage should be burned with the buildings. After the buildings are burned, the west and south edges of the waste rock pad should be brought to a stable angle of repose by blasting.

Empty drums and the two ASTs should be cleaned, crushed or cut apart, and buried on site. All other non-hazardous wastes should be consolidated and buried on site.

Drummed salt and a Caterpillar battery located in the garage should be removed to Keno Hill for transport to an approved disposal facility.

The Yukon Workers Compensation Board Mine Safety Officer should be notified of the presence of the magazines, and solicited for appropriate action to decommission the magazines and dispose of any explosives.

Should further development occur on the site, regulatory agencies should ensure that a acid drainage prevention plan is developed which includes detailed measures for handling and disposal of mineralized waste rock.

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1. 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 initial assessments provided a general overview of historical activities, described site infrastructure, workings and wastes, summarized existing environmental or safety concerns on each site, and provided general recommendations for remediation or mitigation work.

At the Runer site, the overview assessment (DIAND, 1994) identified safety concerns associated with a) instability of waste rock, b) potential undermining of a waste rock pad supporting a garage and storage shed, and c) possible storage of explosives on site. A low-level environmental risk from hydrocarbon products remaining on site was identified, and a low-priority aesthetic concern was expressed with respect to deterioration of site buildings. No rock, soil or water samples were collected for the initial assessment.

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 abandoned Runer mine site to a) identify specific environmental and human safety risks and aesthetic concerns; b) provide clean-up recommendations; and c) provide a Class "D" cost estimate for recommended remediation or mitigation measures. The Runer mine site was inspected by PWGSC on 14 - 15 August, 1996.

1.1 Location

The Runer exploration site is located at 63° 54' 51" N, 135° 14' 26" W, approximately 3 km east of the village of Keno Hill. The toe of the waste rock disposal area is approximately 0.25 km north and 120 m in elevation above Lightning Creek.

1.2 Overview of Site Development

Production at the Runer site occurred over two periods: 1952 to 1959 and 1975 to 1985. An adit was apparently driven approximately 30 metres in the 1920's, following the discovery of the rich No. 9 Vein on Keno Hill. Activity at the site intensified when the Thunderbird claim was staked by E.W. Runer in 1946, and two short shafts (7.6 metres and 12.1 metres) were sunk. Between 1952 and 1953, the 3900-level adit was driven 305 metres and the 3800-level adit was driven 91 metres. A 45.7 metre adit was driven above the 3900-level or upper adit prior to 1959. 55.2 tonnes of ore were produced during this early period.

A bulldozer was used to expose a new vein 15 to 30 metres east of the 3800-level adit between 1975 and 1979. 41.2 tonnes of ore were shipped from this occurrence between 1979 and 1981. 19.1 tonnes of the ore was obtained from a 6.7 metre shaft. Between 1979 and 1982 the upper adit was rehabilitated and bulldozer trenching was completed.

The current claim holder, M. Swyzinski of Keno, YT, leased the property in 1982. In 1983 a new 35.4 metre adit was drive near the 3820 level. In 1986 a new exploration adit was collared, although its depth is unknown. 534 tonnes of ore were shipped from the site during this period. The last reported work on the property was a trenching program in 1987 (Yukon Minfile 105M 016). Approximately 500 metres of lateral underground development and 25 metres of shaft sinking is reported as occurring at the Runer mine site. Conditions observed at the site indicate that additional trenching may have occurred more recently (Photos 1 and 2).

1.3 Site Access

Runer is accessible by 4-wheel drive or all-terrain vehicles along a compacted gravel and blast rock road branching from the dirt road between Keno Hill and Keno Summit. The upper portion of the site is accessible by a 4-wheel drive gravel road to Minto Hill which branches from the Keno Hill-Keno Summit road. Runer is close to Keno Hill (an historical area which attracts tourists and occasional hikers), and all areas of the site can be easily accessed from the Keno Hill or Minto Hill roads.

2. PURPOSE AND SCOPE OF WORK

This assessment was carried out by PWGSC for Indian and Northern Affairs Canada to a) identify potential environmental and human safety risks associated with specific abandoned mine sites and b) to provide recommendations and preliminary cost estimates for remediation or mitigation of those risks. Accordingly, the following assessment activities were completed:

- Visual 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 waste rock seeps and receiving waters) and barrel contents
- Identification and inventory of hazardous and non-hazardous materials on the site
- Identification of environmental pathways and receptors for site contaminants
- Assessment of human safety hazards and potential for accidental or deliberate access to hazardous areas
- Assessment of acid rock drainage potential in waste rock and mine development areas

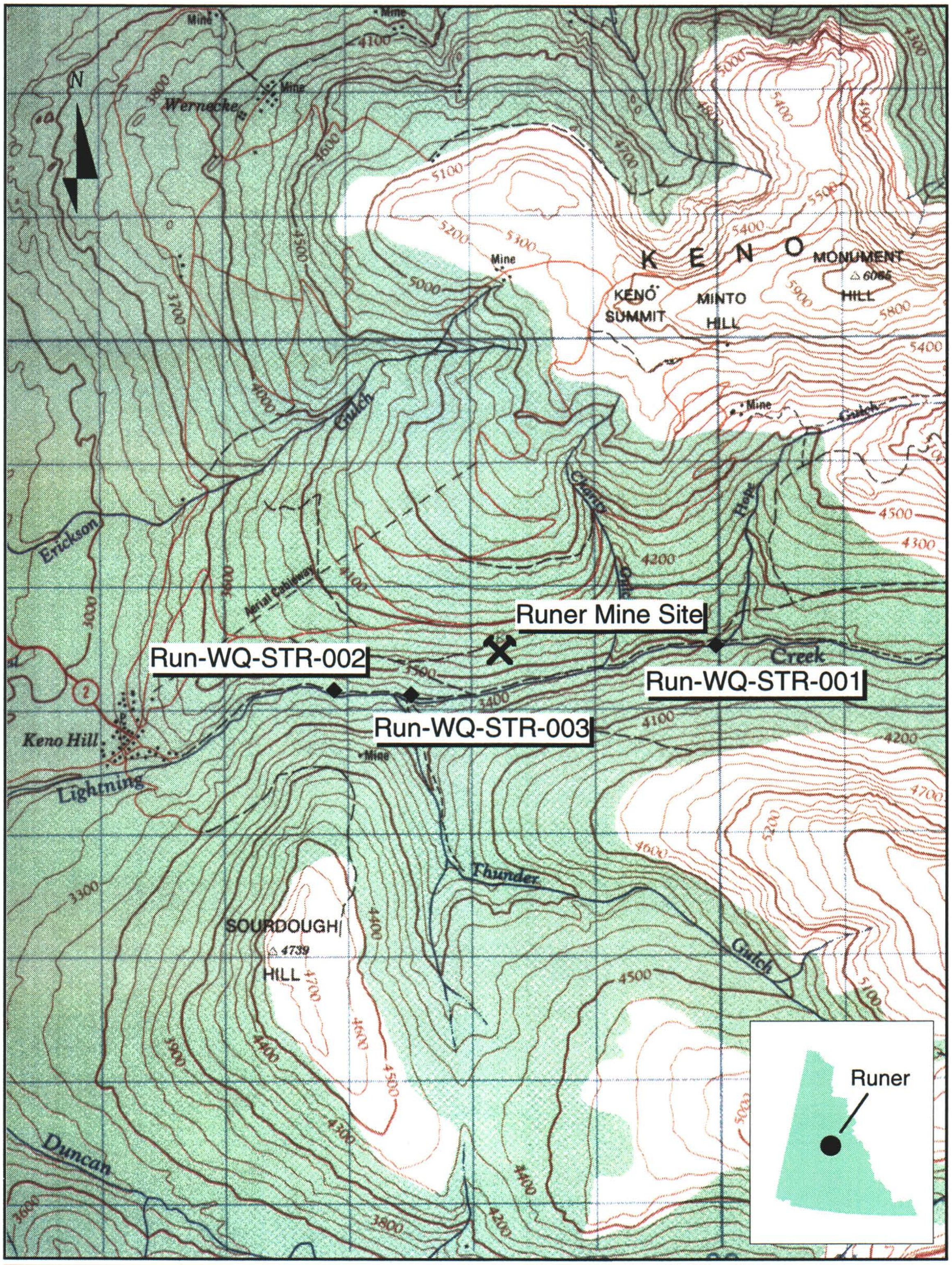
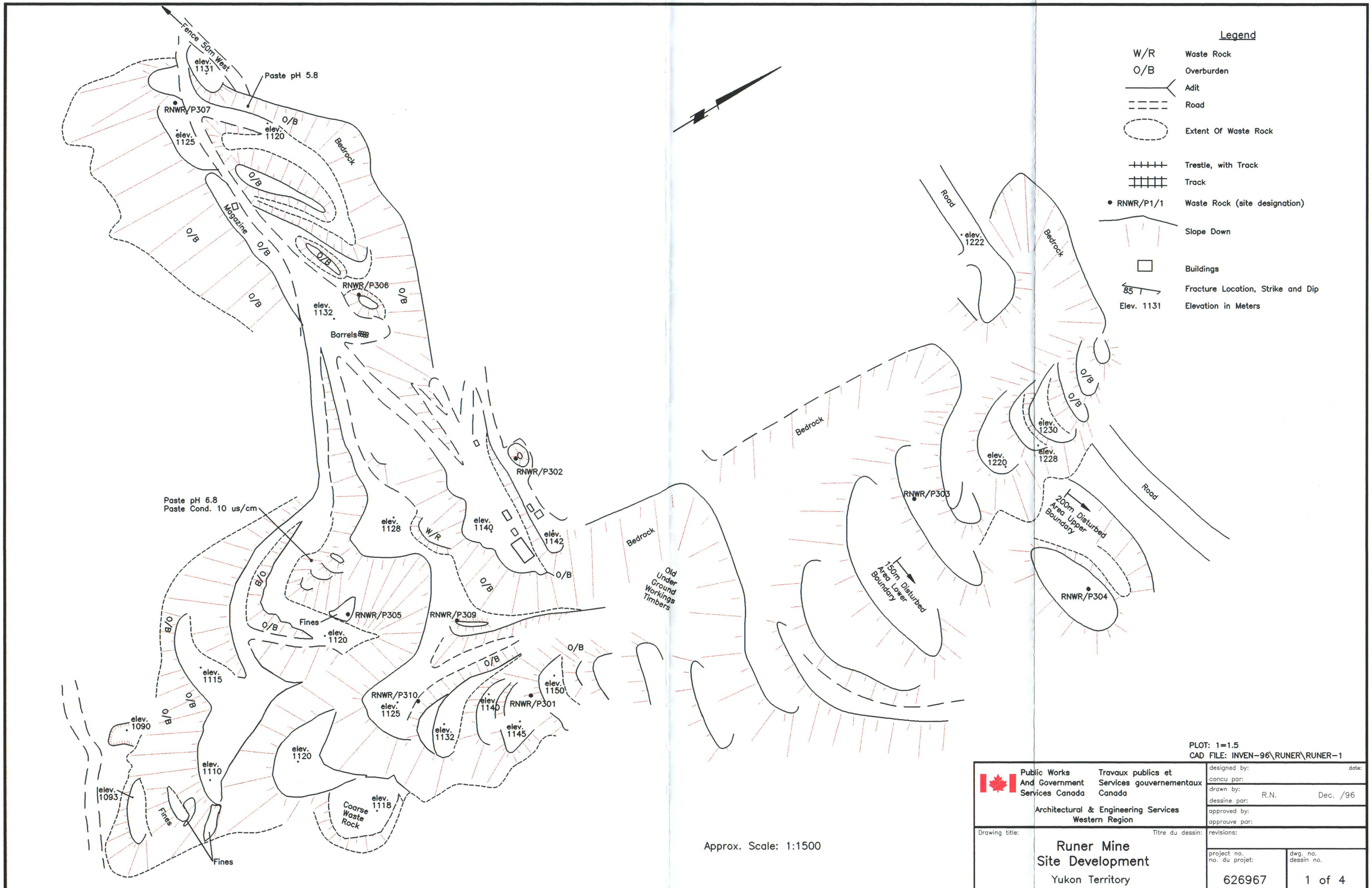


Figure 1: RUNER SITE
N.T.S. 105 M/14 Map Name: Keno Hill Map Scale: 1:50,000
Latitude: 63° 54' 51" N Longitude: 135° 14' 26" W



Legend
W/R Waste Rock
O/B Overburden
Adit
Road
Extent Of Waste Rock
Trestle, with Track
Track
RNWR/P1/1 Waste Rock (site designation)
Slope Down
Buildings
85 Fracture Location, Strike and Dip
Elev. 1131 Elevation in Meters
Fence 50m West
elev. 1131
Paste pH 5.8
RNWR/P307
elev. 1125
elev. 1120
O/B
Bedrock
Magazine
RNWR/P306
elev. 1132
Barrels
RNWR/P302
Paste pH 6.8
Paste Cond. 10 us/cm
elev. 1128
W/R
elev. 1140
elev. 1142
RNWR/P305
Fines
RNWR/P309
elev. 1115
elev. 1090
elev. 1110
elev. 1093
Fines
RNWR/P310
elev. 1125
elev. 1132
elev. 1140
RNWR/P301
elev. 1150
elev. 1145
Coarse Waste Rock
elev. 1118
Old Under Ground Workings Timbers
Road
elev. 1222
elev. 1220
elev. 1230
elev. 1228
RNWR/P303
150m Disturbed Area Lower Boundary
200m Disturbed Area Upper Boundary
RNWR/P304
Approx. Scale: 1:1500
PLOT: 1=1.5
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Architectural & Engineering Services
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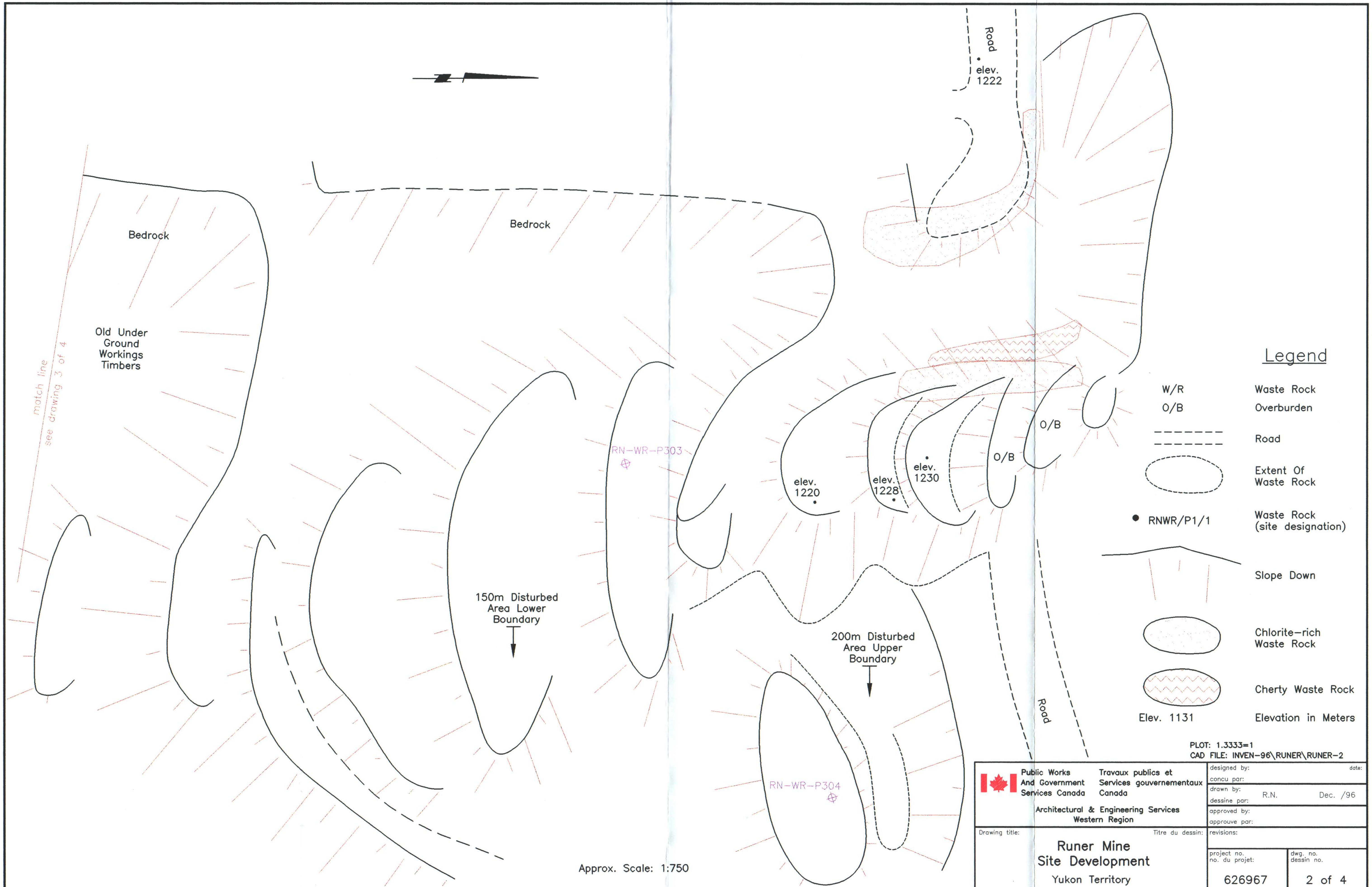
Runer Mine
Site Development
Yukon Territory
project no. no. du projet: 626967
dwg. no. dessin no. 1 of 4



Road
elev.
1222
Bedrock
Bedrock
Old Under
Ground
Workings
Timbers
match line
see drawing 3 of 4
RN-WR-P303
O/B
O/B
elev.
1220
elev.
1228
elev.
1230
150m Disturbed
Area Lower
Boundary
200m Disturbed
Area Upper
Boundary
RN-WR-P304
Road
Approx. Scale: 1:750
Legend
W/R Waste Rock
O/B Overburden
Road
Extent Of Waste Rock
RNWR/P1/1 Waste Rock (site designation)
Slope Down
Chlorite-rich Waste Rock
Cherty Waste Rock
Elev. 1131 Elevation in Meters
PLOT: 1.3333=1
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Site Development
Yukon Territory
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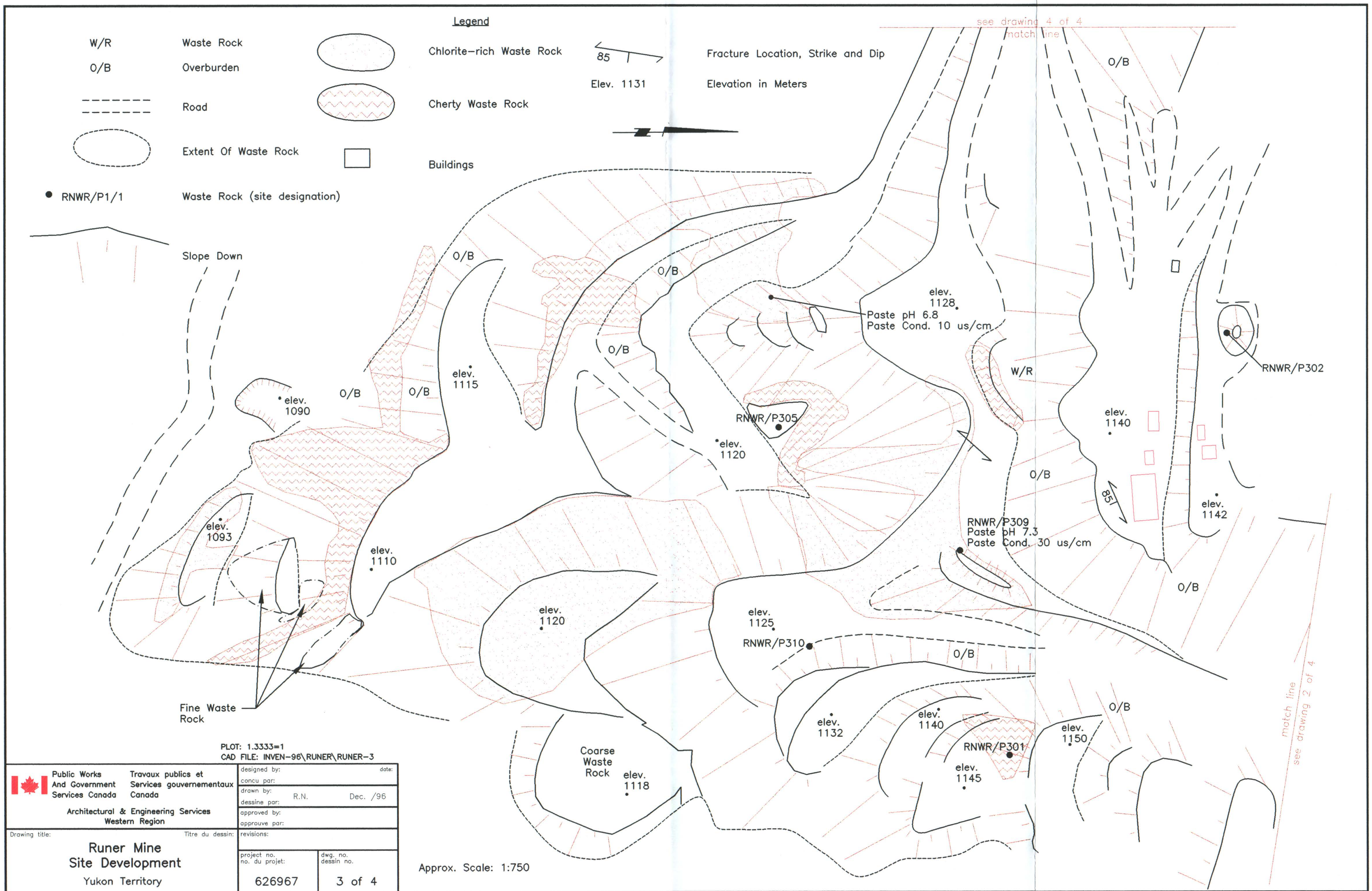
Legend
W/R
Waste Rock
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Fracture Location, Strike and Dip
Elev. 1131
Elevation in Meters
see drawing 4 of 4
match line
O/B
elev. 1090
elev. 1093
elev. 1110
elev. 1115
elev. 1120
elev. 1128
Paste pH 6.8
Paste Cond. 10 us/cm
RNWR/P305
W/R
RNWR/P302
elev. 1140
elev. 1142
RNWR/P309
Paste pH 7.3
Paste Cond. 30 us/cm
elev. 1125
RNWR/P310
elev. 1132
elev. 1145
RNWR/P301
elev. 1150
Coarse Waste Rock
elev. 1118
Fine Waste Rock
match line
see drawing 2 of 4
PLOT: 1.3333=1
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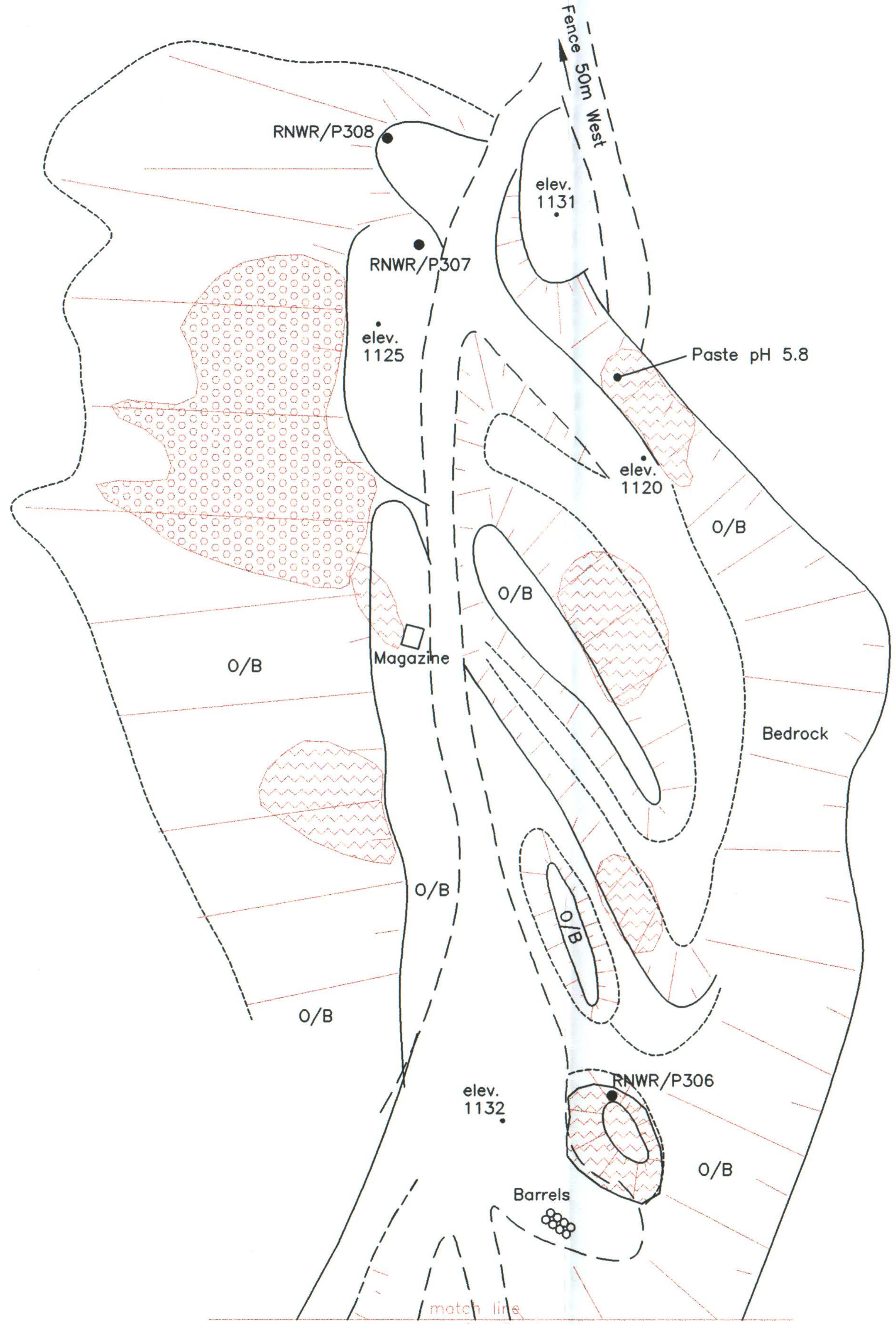
project no.
no. du projet:
626967
dwg. no.
dessin no.
3 of 4
Approx. Scale: 1:750



Legend

W/R	Waste Rock
O/B	Overburden
	Road
	Extent Of Waste Rock
• RNWR/P1/1	Waste Rock (site designation)
	Slope Down
	Sericitic Waste Rock
	Cherty Waste Rock
85	Fracture Location, Strike and Dip
Elev. 1131	Elevation in Meters

Approx. Scale: 1:750

PLOT: 1.3333=1
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Drawing title: / Titre du dessin:

Runer Mine
Site Development
Yukon Territory

project no. / no. du projet:	dwg. no. / dessin no.
626967	4 of 4

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 waste rock disposal areas, taking into account onsite resources and accessibility
- Sealing of all mine openings
- Consolidation and landfill of all non-hazardous, non-combustible solid wastes
- Remediation and/or removal and disposal of contaminated soils as required to meet CCME Commercial/Industrial criteria for soils
- Removal and disposal of hazardous solid wastes
- Draining, cleaning, and disposal of drums, ASTs, 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
- Demolition of buildings and infrastructure to foundation level and burning of combustible non-hazardous materials in approved location

3. SITE ASSESSMENT METHODOLOGY

3.1 Assumptions

At the Runer mine site, the assessment was limited to the area specifically developed or occupied for mine exploration or mining purposes and off-site environmental resources potentially affected by mine exploration or development activities. The access road to Runer was not included in this assessment.

3.2 Assessment Criteria

<u>CCME Criteria</u>

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 for specified uses of soil and water. Remediation criteria are for generic use and 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.

For the Yukon mine assessments, Commercial/Industrial criteria were used to assess soil contaminants and the Freshwater Aquatic Life criteria were used to assess surface water quality.

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
- waste rock and tailings disposal
- acid generation and leaching, and
- estimating cleanup costs.

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 Runer 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 and metal leachate potential by:

- Identifying variations in rock type, mineralization and alteration
- Mapping and logging waste rock, pit walls and rock faces as appropriate
- Collecting and field testing (paste pH and conductivity) representative samples of mine wastes
- Laboratory testing of selected samples, including whole rock analysis (solids assay) and acid base accounting (ABA). Laboratory leach tests (static or kinetic) were not included in the Phase II assessment.

Mine Openings and Excavations were visually inspected and documented to identify safety concerns and closure requirements.

Non-Hazardous Site Debris was inventoried.

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

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

Barrels, Pails, and an Above-Ground Storage Tank containing petroleum products were sampled and analysed for metals and screened for total halides (indicative of chlorinated organic compound such as PCBs) to determine suitability for on-site incineration of barrel contents. Drums containing substances other than petroleum products were sampled as applicable to identify hazardous constituents.

Buildings and other Structures were inspected for hazardous materials and assessed for stability.

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

Scale site plans were prepared to identify the dimensions and locations of 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

Mine Waste Sampling

Test pits were excavated to depths between 0.3 m and 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. Test pits were photographed and the locations 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. Where test pit walls showed distinct horizons (distinguishable by the sulphide and carbonate contents), each horizon was sampled.

Water Sampling

Samples were collected from surface streams upstream and downstream of mine-related flows, and from representative seeps emanating from waste rock, pit walls, and/or adits. Observations of flow, flora, and fauna habitat, fisheries resources, and field pH and conductivity measurements were recorded. The field observations and a comparison of downstream water quality to the upstream were used to assess impact. Since water sampling was restricted to a single sampling event it does not necessarily reflect seasonal variations.
250 ml water samples were collected by hand, facing upstream, ensuring that the sample was 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.

2 ml of HNO_3 were immediately added to water samples intended 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, discoloration, 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 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.

One Above-Ground Storage Tank (AST) was sampled with a stainless steel Bacon bomb sampler. A plunger at the tip of the sampler depressed when contact with the tank bottom was made, allowing petroleum product to enter the body of the sampler. When the sampler was raised, the plunger closed to seal the sampler and allow removal of the sample from the AST. The sampled hydrocarbon was then drained into a 40-ml laboratory-cleaned vial which was then sealed and placed in a container for shipment to the laboratory. The bomb sampler was cleaned with laboratory-grade detergent between sampling events.

Since hydrocarbon samples were collected only for analyses of Total Halides and metals, no cooling or other preservative was required.

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. ENVIRONMENTAL SETTING

4.1 Mineralization

Regional geology consists primarily of underlying metamorphosed sedimentary and volcanic rocks with infrequent granitic intrusions. Other material consists of quartzite, chert, sandstone, shale, slate, phyllite, argillite and, occasionally, dolomite and limestone. The intrusive rocks are mostly granodiorite (Douglas and MacLean 1963).

The commodities of interest at the Runer site are silver, lead and zinc. The Keno Hill - Galena Hill silver-lead ores occur in erratic shoots and lenses lying in vein-faults that cut fine-bedded to massive quartzite, intercalated greenstone sills and lenses, and various schistose rocks. These rocks are intruded by gabbro and diabase sills. Mineralization at the Runer site consists of pyrite (FeS_2), galena (PbS), sphalerite ($(Zn,Fe)S$) and tetrahedrite ($(Cu,Fe)_{12}Sb_4S_{13}$) in quartzite and siderite ($FeCO_3$) gangue.

4.2 Hydrology

Regional drainage generally flows southwest along the Pelly, Ross, North and South Macmillan, Hess, Stewart and North and South McQuesten river systems, terminating at the Yukon River.

The toe of the bottom-most waste rock pile at Runer is situated approximately 600 m north of Lightning Creek, a third-order stream which drains east to west below Runer past the village of Keno Hill to Duncan Creek and eventually the Mayo River and Mayo Lake. Charity Gulch, a stream originating near Keno Summit and draining southward to Lightning Creek, is located approximately 1.1 km to the east of the mine site. Thunder Gulch enters Lightning Creek from the south about 800 m southwest of the Runer mine site.

No surface water bodies cross the Runer mine site, and despite heavy rains prior to and during the site visit, no active seep was found at any waste rock pile. Several small, ephemeral snowmelt channels were observed at the bases of the lowest waste rock piles.

Hydrological/water quality records were not available for Charity Gulch, and water quality records for Lightning Creek at the village of Keno Hill have only been collected over the past ten years. A water quality monitoring station has recently been established at the

Bellekeno Mine tailings discharge to Lightning Creek, located about 400 m downstream from the confluence of Thunder Gulch and Lightning Creek. Bellekeno Mine infrastructure and tailings disposal areas are located on the south side of Lightning Creek immediately west of Thunder Gulch.

4.3 Climate

Meteorological data are sparse and incomplete, but inferences from surrounding locations and data presented by Burns (1973, 1974) suggest the mean annual precipitation to be about 500 mm in the Keno Hill area. The mean annual temperature is estimated to be -6°C.

4.4 Vegetation

The terrain below treeline (1350 to 1500 m above sea level) lies within the B26c forest region (Rowe, 1972). Open black spruce and, occasionally, lodgepole pine form extensive forests. White spruce, occasionally with aspen or lodgepole pine, occurs on warmer and better drained sites. Paper birch is scattered throughout. Alpine fir occurs in the subalpine. An undescribed variety of pine, similar in appearance to Pinus albicaulis, occurs near treeline.

Moss, usually with ericaceous shrubs and willows, forms the most extensive understorey vegetation. Sedge tussocks, sphagnum and small shrubs prevail in poorly drained situations and on north-facing slopes. Shrub birch and willow are extensive in sub-alpine and lower alpine sites. Lichen development is common in dry situations, including tops of hummocks, tussocks and well-drained, rocky alpine sites.

4.5 Fish and Wildlife Resources

Fish inventory maps obtained from Yukon Renewable Resources indicate probable (though unconfirmed) presence of Arctic Grayling in Lightning Creek upstream from Thunder Gulch. Arctic Grayling are known to be present in Lightning Creek downstream of Thunder Gulch and in the vicinity of Keno Hill village.

4.6 Site Topography and Soils

The Runer area has been glaciated by ice from the Selwyn Lobe which moved in a westerly to north-westerly direction. The ice level reached about 1500 m above sea level; many higher areas were subjected to alpine glaciation. Lateral moraines, ice contact channels and kame terrace deposits occur on a number of hills in this area.

Generally, glacial scouring was not intense in this area. Mid and lower slopes are mantled with deep morainal and glaciofluvial material. Large lakes filled a number of valleys during deglaciation. Large deposits of silts occur in the Mayo Lake area, and small glaciolacustrine deposits are present throughout (Vernon and Hughes 1966; Hughes et ai. 1969; Bostock 1966; McTaggart 1960).

Runer is situated on a 35° south-facing slope. The garage and storage shed buildings are located at an approximate elevation of 1170 m above sea level, and waste rock disposal areas and mine trenches extend approximately from 1075 m to 1230 m.

Exposed side hill excavations indicate the underlying soil to be peaty silts and sands to a depth of 20-40 cm, underlain by well-mixed, compacted boulders, cobbles, sand and silt (perhaps indicative of morainal deposition) to depths varying between 3 and 8 m.

5. SITE DESCRIPTION AND FINDINGS

5.1 Buildings, Infrastructure, and Equipment

A garage and small storage shed are the only significant buildings at the Runer site. Both buildings have been moved onto a levelled waste rock pad. A "hanging fence" near the garage and slope failure cracks evident beside the garage (Photos 15 - 17) are indicative of ongoing wasting of the pad along the south and west edges. Details of construction features and interior contents are summarized in Table 5.1.

Two 22,750-litre welded steel above-ground storage tanks (ASTs) are located on an embankment behind the garage and storage shed buildings. A wooden support for a refuelling line joins the easternmost tank with a wood beam loading dock, which at one time supported a smaller-volume refuelling tank. A visual inspection of the tanks' interiors found the easternmost AST to be empty with a minimal sludge residue; the westernmost tank was tilted slightly downward at its western end, and approximately 1.5 cm of oily water was measured at the lowest point.

5.2 Non-Hazardous Waste Materials

Three non-hazardous material storage/disposal areas were discovered on the Runer property. Locations and inventoried materials are summarized in Table 5.2.

5.3 Hazardous Materials

5.3.1 Stained Soil and Other Solid Hazardous Materials

Stained soils at the storage shed doorway, on the waste rock/soil portion of the garage floor, and adjacent to the vehicle refuelling stand near the garage were assessed and sampled.

Table 5.1 Runer Building Construction Features and Interior Contents

Structure	Construction Features	Interior Contents	Photo No.
Garage	-11 x 4.3 m in plan and 4 m in height - 25 x 25 cm beam foundation to a height of 1 m - "2 x 4" wood frame - wood planking over a waste rock base, covering two-thirds (7 x 4.5 m) of the garage floor; remaining floor area is compacted waste rock and soil - plywood interior cladding - anodized sheet metal exterior cladding and roof covering - swinging overhead door installed for vehicle access at the east end of the garage	- 2 Caterpillar tractor batteries (one with cracked casing) - 2 pneumatic rock drills and associated drill steel - 15 empty 20 litre motor oil pails - various hand tools - 3 x 205-litre drums (one drum is one-third filled) containing solidified white-brown salt-like substance - galvanized sheeting, rubber hosing of various lengths	3, 4, 5 6
Storage shed	- 2.4 x 4.9 m in plan and 3 m in height - 25 x 25 cm beam foundation to a height of 1 m - "2 x 4" wood frame - raised wood plank floor - plywood interior cladding - anodized sheet metal exterior cladding and roof covering	- 6 x 20 litre motor oil pails, 3 empty and 3 partially full - miscellaneous steel couplings and pipe fittings - coil of aluminum spiral electrical cable - miscellaneous steel rods - plastic tarps and fibreglass insulation	7
Log and beam structure (perhaps a water tower) situated about 200 m east of the garage	- structure is supported by log and beam cross bracing to a height of 5 m - 5 x 5 m wood plank deck is attached to top of the base support - deck is surmounted by a 3 x 3 x 3 m wood beam box with attached steel wire cabling	None	8

Table 5.2 Runer Non-Hazardous Waste Materials

Area	Location	Inventoried Materials	Photo No.
Garage/storage shed area		- 2 x 22,750 litre (5000 gal) welded steel ASTs, one empty and one with very minor amount of hydrocarbon-contaminated water, each mounted on 25 x 25 cm timbers - wood frame and plywood work bench, 2 wood ladders to ASTs - 8 x 205 litre drums, 1 empty, 3 filled with wood stakes - 4 x 20 litre plastic pails, empty - wood timber frame formerly supporting vehicle fuel dispensing tank, wood support for fuel line - miscellaneous drill steel and steel piping	3 4
Material laydown area	Immediately west of the storage shed	- various steel heavy equipment parts and Caterpillar tread placed on two wooden pallets - approximately 80 timber poles, 75 - 200 mm diameter at the butt ends and ranging in length from 2 - 6 m - approximately 35 pieces of steel pipe, 75 - 100 mm diameter and averaging 8 m in length - 2 pieces of 400 mm diameter galvanized metal ducting, each 4 m in length - Approximately 40 pieces of "2x4" and "4x4" lumber - 1 empty 205 litre drum and 2 x 20 litre empty pails - 1 wooden outhouse (serviceability unknown) - 16 x 6 m steel ore car rails, situated on the top of an embankment approximately 10 m north of the material laydown area	9
Material storage area	Approximately 125 m west of garage	- 20 x 205 litre empty drums - one steel ore car, 8 x 6 m steel ore car rails - 10 pieces of steel casing 150 - 200 mm in diameter and varying in length between 2 and 6 m - approximately 2m^3 of stacked shoring timber - miscellaneous steel heavy equipment parts	
Drum disposal area	On top of slope above material storage area	- approximately 315 x 205 litre empty drums stacked in four contiguous rows - 6 x 205 litre empty drums at various locations in immediate vicinity	10

Sample RU-SL-201 was collected in the garage interior from the surface of discolored gravel and sandy silt next to two Caterpillar batteries (one of which had a broken casing and no remaining electrolyte). The area of discoloration was about 0.5 m^2 (Photo 5). Analytical results showed antimony, arsenic, cadmium, lead and zinc above CCME Commercial/Industrial criteria, while PAH compounds were within C/I limits.

Almost all of the untimbered portion and about one-quarter of the timbered section of the garage floor exhibited moderate to heavy hydrocarbon staining (Photo 11). The waste rock/soil portion was most heavily stained, and appeared to have been used as a disposal area for waste motor and transmission oil.

Sample RU-SL-202 was collected from the surface of a heavily-stained area of near the northwest corner of the garage(Photo 12). Approximately 1 m^2 was heavily stained, and the surrounding 3.5 - 4 m^2 was moderately stained. A pick and shovel were used to excavate the area of heaviest staining to a depth of 40 cm. The soil profile consisted of mixed, compacted waste rock (50% >50 mm) and sandy silt to 40 cm; similar materials appeared to extend past that depth. A layer of oily soil was evident to 30 cm depth, and significant staining continued from 30 cm to the excavation bottom at 40 cm. The coarse granular nature of the garage floor base suggests hydrocarbons have penetrated well beyond 40 cm depth. A very strong oily smell was noted in soil from all levels of the excavation. Analytical results showed antimony, lead and zinc above CCME Commercial/Industrial criteria, while PAH compounds were within C/I limits.

A second excavation to 40 cm depth was completed 1.5 m from RU-SL-202 in another area of heavy staining (Photo 13). Soil composition in the area of this excavation was similar to sample location RU-SL-202. Stained soil with a strong oily smell was evident from the surface to 40 cm, and the coarse waste rock and sandy silt present in the excavation profile suggests contamination below 40 cm depth. Sample RU-SL-203 was collected from the side wall of this excavation at 30 cm depth. Analytical results showed antimony, arsenic, and lead above CCME Commercial/Industrial criteria , while PAH compounds were within C/I limits.

RU-SL-204 was a sample of the white and brown consolidated salt-like substance from one of the three drums housed in the garage (Photo 6). Analytical results showed the substance to be nearly 50% chloride measured as chlorine ions, and the substance is therefore presumed to be common salt, perhaps used to depress the freezing point of water used during drilling.

Stained soil was also noted adjacent at the southwest corner of the timber frame refuelling structure west of the garage and south of the two ASTs. The stained area was excavated to a depth of 30 cm using a pick and shovel. Soil profile consisted of waste rock and sandy silt to 30 cm; rocks >20 cm diameter were encountered at 30 cm depth. Minor staining was evident throughout the profile. Sample RU-SL-205 was collected from the excavation side wall at 30 cm depth. Metals and PAH compounds were within CCME Commercial/Industrial limits.

Soil staining was evident outside the doorway to the small storage shed located west of the garage. The stained area was excavated to 30 cm depth; stained wood fibre was found to 5 cm depth beneath which was waste rock and sandy silt to 30 cm. No obvious signs of soil discoloration were noted below the layer of wood fibre. RU-SL-206 was collected from the soil surface beneath the wood fibre layer. Metals and PAH compounds were within CCME Commercial/Industrial limits.

A small area of staining was noted immediately south of the drum stack. Soil composition was sandy and exhibited a slight hydrocarbon odor. RU-SL-207 was collected from the soil surface beneath the wood fibre layer. Metals and PAH compounds were within CCME Commercial/Industrial limits.

Organic analyses of all stained soil samples found PAH compounds to be below CCME limits; these results suggest hydrocarbons in the soil are highly weathered or comprised of heavier lubricating oils which are beyond the PAH analytical range (and for which no CCME criteria exist).

5.3.2 Petroleum Hydrocarbons and Other Liquid Hazardous Materials

Samples RU-BL-2, -5, -6, and -7 were obtained from 20 litre pails of motor oil located within the storage shed and were analyzed for cadmium, chromium, lead and total halides (total halides were used as a screening measure for PCBs). Metals in all samples were non-detectable except in Sample RU-BL-6, where lead at 12.6 ppm was measured.Total halide concentrations were below 300 ppm in the four oil samples.

5.3.3 Explosives

Two locked 1.5 x 1 m red-painted steel magazines were found approximately 30 m west of the material storage area, and another steel locked magazine (2 x 3 x 3 m) was located approximately 80 m southwest of the materials storage area. Contents of the three magazines are unknown. All magazines were at the side of a roadway leading to the garage and storage shed.

5.4 Surface Water Quality

No seepage from waste rock was observed at the toe of the piles, and no seepage was observed in the trenches.

Surface water samples were obtained from Lightning Creek at points upstream and downstream from the Runer site. Complete analytical results are provided in Appendix B; significant results are summarized in Table 5.3.

Silver and lead levels were above CCME Freshwater Aquatic Life criteria at RU-WQ-STR-002 below the Bellekeno mine tailings discharge; however, water quality upstream and downstream from the Runer mine site (but upstream of the Bellekeno mine) is acceptable for protection of instream fish resources. The upstream reaches of Thunder Gulch and Lightning Creek are actively placer-mined. Placer mining can cause significant fluctuations in both downstream hydrology and water quality, and the water quality and hydrology of Lightning Creek may therefore show marked changes over the course of a year.

Table 5.3 Significant Results - Runer Surface Water Samples

Sample ID	Sample Location	pH	Conductivity (μmhos/cm)	Metallic Parameters
RU-WQ-STR-001	Immediately downstream from confluence of Lightning Creek & Charity Gulch	7.7 (7.5)	155 (120)	-
RU-WQ-STR-002	Approx. 100 m downstream from Bellekeno mine tailings discharge	7.8 (7.8)	169 (140)	Ag, Pb >CCME Freshwater Aquatic Life
RU-WQ-STR-003	Lightning Creek approx. 50 m upstream from confluence with Thunder Gulch	7.7 (7.6)	159 (120)	-

Note: pH and conductivity readings in brackets are field measurements; unbracketed values are lab measurements.

5.5 Waste Rock Disposal Areas

The disturbed rock on site is predominately a result of the surface trenching programs. Records indicate a limited extent of waste rock would have been generated from underground development, in the order of 10,000 tonnes. The assumptions made to derive this estimate are:

- a specific gravity of 2.65;
- a total of 550 metres of development; and,
- mine openings 2.5 metres by 2.7 metres.

There are four areas disturbed by trenching and underground development at the Runer mine site, as shown in Drawing 2. Waste rock from the underground workings has been mixed with overlaying weathered bedrock and overburden at each of the disturbed areas.

The slopes of the trench walls are steep and unstable. The slopes of the bulldozer-worked piles of overburden and rock appeared to be at the angle of repose and are considered relatively stable, with one critical exception. A near-vertical fracture in the weathered bedrock below the machine shop has caused the ground to cave within 10 metres of the building. Extension cracks are present within 2 metres of the building (Photos 15 and 16).

Samples of the overburden/weathered bedrock material were collected at each of the disturbed areas (RUWR/P303, P304, P307, P308, P310). Samples were also collected from chert-rich material in a waste rock pile beside the western adit (RUWR/P306) and beside the lower trench (RUWR/P301). Samples RUWR/P305 and RUWR/P309 were collected from chlorite-altered waste rock beside the lower trench. Sample RUWR/P302 was collected from a pile of sphalerite-rich, carbonitized waste rock near the garage.

The samples were analyzed for Acid Base Accounting (ABA) and metals concentrations by Inductively Coupled Plasma - Atomic Emission Spectrophotometry (ICP-AES). Several field paste pH and paste conductivity tests were completed on the site. Sample locations and the field test results are shown on the site map. Sample descriptions and a detailed discussion of the results are included in Appendix A.

The samples had neutral paste pH values ranging from 7.2 to 8.2. The total sulphur of all the samples was low, ranging from 0.02% to 0.17%. The NP:AP ratios of the samples were all below 3, suggesting that the material has a potential for acid generation. Select samples contained significant concentrations of arsenic, lead, manganese, silver, antimony and zinc. ABA test results are summarized in Table 5.4.

5.6 Mine Openings and Excavations

The remains of an adit (possibly the 3800-level adit) were observed high in the wall of the lower trench (Photo 14); a timber retaining wall above the adit and the adit entrance have been crushed by slumping overburden and bedrock.

The adit is inaccessible because of the instability of the surrounding rock. Tracks and an ore car indicate the presence of a buried adit approximately 150 metres west of the lower trench. No accessible underground workings were encountered during the site assessment.

It appears that the extensive trenching program conducted in the vicinity of the 3800-level and 3900-level adits have buried, caved, or removed the historical workings. An area approximately 70,000 m^2 has been disturbed by the trenching in the vicinity of the these adits. The trenches themselves are approximately 10 m wide, cover a strike length of 300 m, and are over 30 m deep in places. The remaining area of disturbance is created by the deposition of waste rock and overburden in piles that average 5 m in height.

Table 5.4 Acid-Base Accounting Test Results - Runer Waste Rock Samples

Sample #	Paste pH	Total Sulphur (%)	Sulphur as SO_4 (%)	AP	NP	Net NP	NP/AP
RU-WR-P301	7.50	0.13	No assay	4.1	2.6	-1.4	0.6
RU-WR-P302	7.25	0.17	No assay	5.3	3.4	-1.9	0.6
RU-WR-P303	7.61	0.06	No assay	1.9	2.6	0.8	1.4
RU-WR-P304	7.50	0.09	No assay	2.8	2.9	0.1	1.0
RU-WR-P305	7.43	0.05	No assay	1.6	2.1	0.6	1.4
RU-WR-P306	7.71	0.03	No assay	0.9	-0.1	-1.0	<0.1
RU-WR-P307	7.49	0.02	No assay	0.6	0.7	0.19	1.1
RU-WR-P308	7.98	0.03	No assay	0.9	-0.5	-1.4	<0.1
RU-WR-P309	7.54	0.06	No assay	1.9.9	-1.3	-3.2.8	<0.1
RU-WR-P310	8.23	0.10	No assay	3.1	-22.2	-25.3	<0.1

AP - Acid Potential in tonnes $CaCO_3$ equivalent per 1000 tonnes of material
NP - Neutralization Potential in tonnes $CaCO_3$ equivalent per 1000 tonnes of material
Net NP - Net Neutralization Potential equals tonnes $CaCO_3$ equivalent per 1000 tonnes of material

Additional trenching has occurred in the vicinity of the buried adit 150 m west of the lower trench. The disturbed area is approximately 11,000 m^2. Two trenches, 10 m wide by 50 m long and approximately 5 m deep, exist at this location. Trenching has also taken place on the east side of the upper/lower trench area. The area disturbed is approximately 100 m by 150 m. The trenches in this area were generally less than 5 m deep. Undercuts and rotational slumps evident and at the top edge of the upper workings (Photo 18) are indicative of ongoing slope wasting.

Because both trenches have been cut into rock, the trench wall slopes range from 40° to near-vertical (Photo 19). Loose waste rock or overburden piles are "perched" atop the trench walls at the trench edges. The margins of both trenches are not fenced, and no warning signs have been posted to alert site visitors of danger areas.

6. CONCLUSIONS

Existing or potential health and safety hazards or environmental/aesthetic concerns associated with the Runer mine site are summarized in Table 6.1, and are examined more fully in the following sections.

Table 6.1 Summary of Hazards or Concerns at Runer Mine Site

Site Assessment Component	Hazard or Concern
Buildings, Infrastructure, and Equipment	Garage and storage shed are located on a waste rock pad which is being undermined by slumping.
Non-Hazardous Waste Materials	Empty drums, 2 empty ASTs, and other non-hazardous wastes near storage shed and explosive magazines are an aesthetic concern
Waste Rock Disposal Areas	Waste rock is potentially acid-generating. Several waste rock piles are unstable and show signs of imminent slumping.
Mine Openings and Excavations	No openings to underground workings. Upper and lower trenches have steep to near-vertical sides, and are surmounted with loose, perched overburden and waste rock. No fences or warning signs in vicinity of danger areas.
Hazardous Materials	Hydrocarbon-stained soil within and near garage and storage shed is a minor environmental concern. Explosive magazines were locked and presence of explosives is unknown.

6.1 Health and Safety

Safety risks from unidentified mine openings is present throughout the Keno Hill - Galena Hill mining camp. Only one of the five reported adits at Runer were observed and none of the four shafts encountered during the site assessment. While it is believed that most of the underground workings are now inaccessible because of the extensive surface trenching the existence of accessible workings is still possible.

Very serious safety risks are posed by slope instability and the potential for linked failures of adjoining waste rock piles. The imminent failure of the garage waste rock pad and roadway threatens those buildings and the safety of any persons present on the downhill road bed.

The upper and lower trenches are deep, have steep walls, and are surmounted by loose waste rock or overburden piles at the edges of the trench walls. The margins of the trenches are not fenced, and no warning signs have been posted to alert site visitors of danger areas. These features pose a safety risk to persons walking toward the edges of the trenches and persons within the trenches.

The contents of two explosive magazines are not known. Both magazines were locked, although access could be gained by persons using a bolt-cutter.

6.2 Environmental Risks

While the site does have the potential to be acid generating and metal leaching the risk to the environment is low. Considering the near neutral paste pH of the material; the volume of weather bedrock and overburden mixed in with the waste rock; and the lack of surface runoff at the site it is unlikely that acidic drainage or metal leachate from the waste rock is or will significantly impact the downstream environment.

Although the depth of hydrocarbon-contaminated soil is not certain, there are no obvious signs of off-site transport and no significant environmental features in the vicinity of the stained soil. Therefore, the hydrocarbon-stained soils within and adjacent to the garage are not believed to be an environmental concern.

6.3 Aesthetic Concerns

The principal aesthetic concerns are associated with waste materials inventoried in Table 5.2 and with site buildings.

Because of the instability of many of the waste rock piles, no recontouring or reseeding of the development area solely for aesthetic reasons is recommended. Recontouring and revegetation should be carried out after the upper and lower trenches have been filled with available waste rock and the remaining waste rock piles are stabilized.

7. RECOMMENDATIONS

Recommended remediation and management actions are compliant with applicable federal or territorial regulations and criteria, rely upon available technology, and intended to be appropriate for local conditions and sensitivities.

Recommendation 1. Assuming no further mine development work at Runer, it is strongly recommended that the site be fenced to prevent casual access to the upper and lower trenches and the waste rock pad supporting the two site buildings. Approximately 1400m of wire fencing is required to surround the danger areas; high-visibility warning signs should be attached to the fencing at intervals of 50m.

To permanently address the safety risks, the upper and lower trenches should be backfilled with available waste rock. Backfilling should begin at the upper trench and proceed toward the lower trench, using adjacent waste rock resources in a similar top-to-bottom sequence. Trenches should be backfilled to a level approximating the existing, adjacent grade. The estimated volume of material required to backfill the trenches is 260,000m^3. The top edges of the upper workings should be re-contoured to achieve a stable angle of repose.

Recommendation 2. The garage and storage shed are at risk from incremental slumping or an acute slope failure at the edge of the buildings' waste rock pad. Heavy equipment movement on the pad may trigger a major slump; therefore, mechanical removal of either building is not recommended. Both buildings should be demolished by burning in situ. Metal cladding and other metal parts and components should be removed by hand before burning. After the buildings are burned, the west and south edges of the waste rock pad should be brought to a stable angle of repose by blasting.

Recommendation 3. Telephone poles and wood wastes located west of the storage shed should be consolidated and burned on site.

Recommendation 4. Should further development occur on the site, regulatory agencies should ensure that a acid drainage prevention plan is developed which includes detailed measures for handling and disposal of mineralized waste rock.

Recommendation 5. Stained soil areas within and adjacent to the garage and storage shed should not be actively remediated. As described above, the integrity of the waste rock pad supporting these buildings is at risk from an undermining slope failure, and for that reason no mechanical scarification with heavy equipment is advised. Overall, the environmental risk of the stained soils in their present condition is minor, while a safety risk could be incurred by personnel and equipment while actively remediating those areas.

Recommendation 6. Hydrocarbon products contained in 20-litre pails within the storage shed and garage should be burned with the buildings.

Recommendation 7. Empty drums should be consolidated, rinsed, crushed and buried on site. Similarly, the two ASTs should be cleaned, cut apart, and buried on site. Oily residues should be separated from wash water should be recovered with sorbent material. Tank sludge and the contaminated sorbents can be burned on site.

Recommendation 8. All other non-hazardous wastes should be consolidated and buried on site. The preferred burial location for all non-hazardous wastes is the present material storage area about 125m west of the garage. Waste rock cover material is available at that site. Drummed salt located in the garage should remain in their present containers and be removed to Keno Hill for transport to an approved disposal facility.

Recommendation 9. The battery located in the garage should be removed to Keno Hill for transport to an approved disposal facility.

Recommendation 10. The Yukon Workers Compensation Board Mine Safety Officer should be notified of the presence of the magazines, and solicited for appropriate action to decommission the magazines and dispose of any explosives.

8. 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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RUNER
ACID ROCK DRAINAGE
ASSESSMENT REPORT

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RUNER
ACID ROCK DRAINAGE
ASSESSMENT REPORT

1.0 INTRODUCTION

This site specific report has been prepared in conjunction with a *Phase II Environmental Assessment of the Runer 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 associated with the site, which is the subject of this report. The reader is directed to the PWGSC report for a comprehensive environmental assessment of the Runer site.

This report assesses existing, and potential acid rock drainage (ARD) conditions at the Runer 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 SRK, which includes similar assessments for a number of 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 Runer exploration site is located on the southern slope of Keno Hill, three kilometres east of the village of Keno Hill, Yukon Territory. The site is accessible by vehicle. An operating mine, the Bellekeno Mine, is located one kilometre to the southwest, on Sourdough Hill. Lightning Creek flows between the two sites.

Mining related disturbances observed during the site assessment consist of four areas of trenching with remnants of older underground workings. The waste rock consists of mine rock, weathered bedrock and overburden and is the result of two periods of development: 1952 to 1959; and 1975 to 1985 (Yukon Minfile 105M 016). All ore was shipped off site for processing.

The site is located in a transition zone between western boreal forest and subalpine forest. Sparse vegetation, in the form of fireweed, grasses (foxtail barley) and sedges, is growing along the crests of rock piles. The slopes and tops of the piles are generally barren of vegetation, except for the eastern workings were shrubs and small trees are growing. The toe of the waste rock is approximately 250 metres north of Lightning Creek, a third-order stream.

2.0 GEOLOGY AND MINERALIZATION

The Keno Hill silver-lead ores occur in erratic shoots and lenses lying in vein-faults that cut fine-bedded to massive quartzite, intercalated greenstone sills and lenses, and various schistose rocks (GSC Paper 68-68, p.21). These rocks are intruded by gabbro and diabase sills. The vein-faults at the Runer site consist of brecciated quartzite, graphite schist, phyllite and some greenstone. The mineralization consists of oxidized forms of pyrite (FeS_2), galena (PbS), sphalerite ((Zn,Fe)S) and tetrahedrite ($(Cu,Fe)_{12}Sb_4S_{13}$) in quartzite and siderite ($FeCO_3$) gangue (GSC Bulletin 111, p. 46-47).

3.0 WASTE ROCK DISPOSAL AREAS

3.1 Description

There are four areas of workings, each disturbed by trenching and underground development, at the Runer site. The trenches, which were excavated by a bulldozer mounted ripper (pers. comm. J.B. O'Neill), appear to have buried or caved the underground workings. The cut slopes of the trenches and roads are relatively steep. The faces of the push dumped rock piles are gentler, at 30° to 35°, and the underlying hillside generally slopes at 25°.

Portions of the rock piles, as shown on the site maps, are rich in quartzite and chert, phyllite altered to sericite, and chlorite schist. The piles at the lower workings are predominately overburden and consist of rounded cobbles and boulders. No ponding water or surface runoff was observed, nor were any seeps encountered below the rock piles.

Records indicate that only a limited amount of the waste rock in the piles was generated from underground development, in the order of 10,000 tonnes (Yukon Minfile 105M 016). The assumptions made to derive this estimate are:

- a specific gravity of 2.65;
- a total of 550 metres of development; and,
- mine openings 2.5 metres by 2.7 metres.

An area approximately 70,000 m^2 was disturbed by trenching in the central area of the workings (upper and lower trench area). The trenches are approximately 10 metres wide, and cover a strike length of 330 metres and are over 30 metres deep in places. The remaining area of disturbance at the upper and lower trench area was created by the pushing and end dumping waste rock and overburden in piles that average 5 metres in height. The upper trench area extends from the road at the north end of the site southward to a level area just above the timbers from the old underground workings. The west and north wall of the trench is cut into weathered bedrock. The excavated material has been piled on the east side of the trench. The lower trench area consists of one deep trench, that extends 130 metre south from the old underground workings. The west, north and east walls of the trench have been cut into overburden and weathered bedrock. The excavated material has been piled on the east side of the trench and push dumped to the south. Between this trench and the southern road piles of excavated material indicate the location of buried trenches.

Additional trenching occurred in the vicinity of a buried adit, 150 metres west of the lower trench. The disturbed area is approximately 11,000 m^2. Two trenches, 10 metres wide by 50 metres long and approximately 5 metres deep are located in the western half of the workings, below the bedrock face. Rail lines mark the location of the adit.

Trenching has also taken place on the east side of the upper trench area. The area disturbed is approximately 100 metres by 150 metres. The trenches in this area were generally less than 5 metres deep.

Steep and unstable slopes were encountered along the walls of the trenches in the central area. A near vertical fracture in the weathered bedrock below a garage, as shown on the site map of the central workings, has caused the ground to cave within 10 metres of the building. Extension cracks were observed within 2 metres of the garage.The slopes of the remaining cut faces and rock piles appeared to be at the angle of repose and relatively stable.

3.2 Sampling

Samples RUWR/P303, RUWR/P304, RUWR/P307, RUWR/P308 and RUWR/P310 were collected of the overburden/weathered bedrock material. Samples RUWR/P306 and RUWR/P301 were also collected from chert-rich quartzite material in a waste rock pile beside the western adit and beside the lower trench. Samples RUWR/P305 and RUWR/P309 were collected from chlorite altered waste rock beside the lower trench. Sample RUWR/P302 was collected from a stockpile which contained approximately 100 m^3 of ore grade material. Descriptions of the samples are summarized in Table 1.

Three water samples were collected from Lightning Creek. Sample RUWQ/Str-001 was collected approximately 500 metres upstream of the site, below the confluence of Charity Gulch with Lightning Creek. Sample RUWQ/Str-002 was collected approximately 500 metres downstream of the site and 100 metres downstream of the Bellekeno discharge point. Sample RUWQ/Str-003 was collected approximately 350 metres below the Runer workings, 50 metres above the confluence of Thunder Gulch with Lightning Creek, and above the Bellekeno Mine site.

3.3 Analytical Results

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

Paste Parameters

The laboratory paste pH values for the ten rock samples ranged from 7.2 to 8.2, indicating that the material is not currently generating acid. Conductivity values of the waste rock were measured at four locations in the field and ranged between 10 μS/cm to 30 μS/cm.

Acid Base Accounting

The rock samples had Neutralization Potential to Acid Potential (NP:AP) ratios of less than 1.5, suggesting that the material is potentially acid generating. Total sulphur concentrations ranged from 0.02% to 0.13%. Four of the samples had negative NP values and neutral to alkaline paste pH values, which indicating that this material has undergone acid generation in the past but that its acid generation potential has been nearly exhausted.

Metals Concentrations

The sample from the ore grade stockpile contains elevated concentrations of antimony, copper, lead, manganese and silver. Two samples of waste rock/overburden also contain elevated concentrations of lead and manganese. The metal concentrations of the remaining samples are comparatively low.

Water Quality

All the water samples had field pH values between 7.5 and 7.8 and laboratory conductivity readings between 155 μS/cm and 170 μS/cm. The upstream and downstream samples obtained from Lightning Creek above the Bellekeno workings contained <0.0001 ppm silver, <0.03 ppm iron and 0.006 ppm zinc.

Zinc concentrations were elevated to 0.02 ppm and iron concentrations to 0.13 ppm below the Bellekeno workings. Concentrations of silver (0.0002 ppm) in the sample collected below the Bellekeno workings exceed CCME freshwater aquatic life criteria.

4.0 EXISTING OR POTENTIAL ACID ROCK DRAINAGE CONDITIONS

The rock piles at the Runer site are composed of predominately oxidized rock and overburden. The material has either undergone acid generation in the past or is potentially acid generating. Testing indicates that the material is not currently generating acid.

Comparison of the upstream and downstream water quality from Lightning Creek suggests that the downstream environment is unaffected by waste rock drainage. There is no evidence of surface run off and no seeps or relic staining was observed below the dumps at the time of the assessment.

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 the Runer site was not considered a feasible control option due to the lack of contaminated surface water discharging from the site. Remediation requirements are generally limited to providing public safety and improving the aesthetic appearance of the site, since the receiving environment does not appear to be significantly impacted.

Relocation of part of the excavated rock to infill the deepest trenches and buttress the cut slopes will address physical stability concerns. It is unlikely that all of the waste rock at the site will fit back in the trenches because of bulking. Relocating the dump material to the trenches will also help control migration of oxidation products by reducing the catchment area for surface run-on and by compacting the pile to minimize the surface area available for infiltration.

Covering the rehandled dump material with a simple soil cover (such as silt-glacial till) and encouraging vegetation to grow will improve the physical stability and the aesthetic appearance of the site. Migration of oxidation products from the rock would also be reduced.

6.0 CONCLUSIONS AND RECOMMENDATIONS

While the site does have the potential to be acid generating and metal leaching the risk to the environment is low. Considering the near neutral paste pH of the material; the volume of weather bedrock and overburden mixed in with the mine rock; and the lack of surface runoff at the site it is unlikely that acidic drainage or metal leachate from the waste rock is or will significantly impact the downstream environment.

Based on the limited samples collected to date, no remediation action is required with respect to acid rock drainage at the Runer site. Remediation requirements are therefore limited to providing public safety and improving the aesthetic appearance of the site. The excavated material is suitable for backfilling the trenches.

7.0 REFERENCES

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TABLE 1 Runer Waste Rock Sample Descriptions

Sample ID	Sample Location and Description
RUWR/P301	Sample of chert/quartzite rich material collected on the east side of the lower trenches. The sample was collected over a thickness of 40 cm and consisted of carbonitized schist and 20% quartzite fragments up to 8 cm in diameter. Surface was a buff/orange colour.
RUWR/P302	Sample collected over a thickness of 20 cm from 100 m^3 stockpile of mineralized rock behind the garage. The surface of the pile was weathered black by manganese oxides. Field paste pH was 7.4 and conductivity 20 μS/cm.
RUWR/P303	Grab sample of typical weathered bedrock and overburden collected on the east side of the upper trenches. Fragments included quartzite, schist and greenstone.
RUWR/P304	Grab sample of a pile of typical weathered bedrock collected beside the eastern trenches. This material did not appear to be significantly reworked by a bulldozer and contained less overburden as compared to the piles beside the central trenches.
RUWR/P305	Sample collected from a pile of schist and quartzite vein material on the west side of the lower trenches. The sample was collected over a thickness of 30 cm. The upper 5 cm consisted of sand and silt sized chlorite schist and quartzite and organic material. Cobbles up to 25 cm in diameter of chlorite altered greenstone were dominate below the sand and silt layer.
RUWR/P306	Sample of chert/quartzite rich dump material collected beside the buried adit at the western trenches. Surfaces of the quartzite have oxidized to a red/brown colour. Sample collected over a thickness of 26 cm and contained >50% sand sized material with minor clay. The field paste pH was 7.5 and the paste conductivity was 10 μS/cm.
RUWR/P307	Sample of overburden and weathered bedrock collected at the crest of the rock pile below the western trenches. Sample collected over a thickness of 22 cm from subrounded fragments of chloritized greenstone and quartzite. The field paste pH was 5.6.

Sample ID	Sample Location and Description
RUWR/P308	Sample of overburden and weathered bedrock, similar to P307, collected below the western trenches at the crest of the rock pile. The sample was collected over a thickness of 20 cm and contained more silt sized material than P307. The field paste pH was 7.4.
RUWR/P309	Sample of chlorite waste rock piled on the western side of the lower trenching, collected over a thickness of 25 cm in quartzite and chlorite schist, with fragments up to 15 cm in diameter. The sand and silt fraction was moist to the touch. The field paste pH was 7.3 and the field conductivity was 30 μS/cm.
RUWR/P310	Sample of typical waste rock material collected on the east side of the lower trenches, collected over a thickness of 30 cm in chlorite schist and minor quartzite fragments.

TABLE 2 Runer Waste Rock ABA and ICP Results

Parameter	Unit	Sample Number RUWR									
		P301	P302	P303	P304	P305	P306	P307	P308	P309	P310
Lab Paste pH		7.50	7.25	7.61	7.50	7.43	7.71	7.49	7.98	7.54	8.23
Total Sulfur	%	0.13	0.17	0.06	0.09	0.05	0.03	0.02	0.03	0.06	0.10
Sulfate	%	na	na	na	na	na	na	na	na	na	na
AP		4.06	5.31	1.88	2.81	1.56	0.94	0.63	0.94	1.88	3.13
NP		2.63	3.44	2.63	2.88	2.13	-0.06	0.69	-0.50	-1.31	-22.19
NET NP		-1.44	-1.88	0.75	0.06	0.56	-1.00	0.06	-1.44	-3.19	-25.31
NP/AP		0.65	0.65	1.40	1.02	1.36	<0.1	1.10	<0.1	<0.1	<0.1
Aluminum	%	0.26	0.48	1.12	2.16	1.11	0.40	0.45	0.65	1.28	1.15
Antimony	ppm	94	999	32	21	10	4	3	3	18	35
Arsenic	ppm	1060	<1	<1	<1	28	37	40	24	<1	87
Barium	ppm	36	90	139	70	77	111	64	72	66	46
Beryllium	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium	%	0.12	0.13	0.17	0.31	0.14	0.11	0.09	0.18	0.20	0.92
Chromium	ppm	154	93	94	65	104	117	136	144	115	97
Cobalt	ppm	9	22	11	35	9	5	6	7	11	16
Copper	ppm	169	1262	81	146	47	29	17	22	60	108
Gallium	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	%	3.65	12.52	4.01	7.57	3.10	1.63	1.67	1.75	3.98	4.00
Lead	ppm	3192	>10000	969	1173	206	100	10	2	382	1756
Lithium	ppm	2	4	12	27	16	4	6	8	17	15
Magnesium	%	0.07	0.23	0.53	1.31	0.51	0.15	0.12	0.28	0.56	0.67
Manganese	ppm	7419	>10000	965	9789	570	285	262	219	1059	2684
Molybdenum	ppm	13	35	13	23	11	6	7	7	13	13
Nickel	ppm	40	183	34	91	32	18	21	19	32	41
Potassium	%	0.04	0.05	0.06	0.10	0.06	0.06	0.04	0.04	0.04	0.05
Phosphate	ppm	460	530	700	860	540	350	400	350	610	520
Silver	ppm	114.0	>200	34.0	13.8	7.0	3.2	0.3	0.3	14.3	58.1
Sodium	%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	ppm	24	30	23	41	20	13	23	14	19	14
Thorium	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tin	ppm	3	11	2	6	2	<1	<1	<1	2	3
Titanium	%	<0.01	<0.01	0.04	0.03	<0.01	<0.01	<0.01	0.03	<0.01	0.02
Tungsten	ppm	21	4	3	<1	4	6	7	7	3	4
Uranium	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium	ppm	4.4	20.9	27.5	72.4	28.4	9.8	7.8	33.1	29.0	36.0
Zinc	ppm	441	1645	185	1006	170	99	83	54	217	865

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

Steffen, Robertson and Kirsten
February, 1997

TABLE 3 Runer Water Quality Results

Parameter	Units	Sample Number RUWQ/		
		STR-001	STR-002	STR-003
Field Conductivity		120	140	120
Field pH		7.5	7.8	7.6
Conductivity	umhos/cm	155	169	159
Hardness CaCO3	mg/L	72.4	78.3	75.2
Moisture %	%	-	-	-
pH		7.66	7.81	7.7
Acidity (to pH 8.3) CaCO3	mg/L	2.7	3.3	2.5
Alkalinity-Total CaCO3	mg/L	30.3	37.1	31.8
Chloride Cl	mg/L	-	-	-
Sulphate SO4	mg/L	45.3	42.7	45.5
Aluminum T-Al	mg/L	0.013	0.074	0.011
Antimony T-Sb	mg/L	-	-	-
Arsenic T-As	mg/L	0.0023	0.0031	0.0022
Barium T-Ba	mg/L	0.06	0.06	0.06
Beryllium T-Be	mg/L	<0.005	<0.005	<0.005
Boron T-B	mg/L	<0.1	<0.1	<0.1
Cadmium T-Cd	mg/L	<0.0002	0.0004	<0.0002
Calcium T-Ca	mg/L	22.2	24.3	23.1
Chromium T-Cr	mg/L	<0.001	<0.001	<0.001
Cobalt T-Co	mg/L	<0.02	<0.02	<0.02
Copper T-Cu	mg/L	<0.001	0.001	<0.001
Iron T-Fe	mg/L	<0.03	0.13	<0.03
Lead T-Pb	mg/L	<0.001	0.012	<0.001
Lithium T-Li	mg/L	<0.02	<0.02	<0.02
Magnesium T-Mg	mg/L	4.14	4.27	4.26
Manganese T-Mn	mg/L	0.006	0.017	0.005
Mercury T-Hg	mg/L	<0.00005	<0.00005	<0.00005
Molybdenum T-Mo	mg/L	<0.03	<0.03	<0.03
Nickel T-Ni	mg/L	<0.02	<0.02	<0.02
Selenium T-Se	mg/L	0.0009	0.0009	0.0006
Silver T-Ag	mg/L	<0.0001	0.0002	0.0001
Sodium T-Na	mg/L	<2	<2	<2
Tin T-Sn	mg/L	-	-	-
Vanadium T-V	mg/L	<0.03	<0.03	<0.03
Zinc T-Zn	mg/L	0.006	0.02	0.006

< = lower detection limit

Appendix B

Site Photographs

Photo 1. Runer mine site viewed from the west.

Photo 2. Runer mine site viewed from the east.

Photo 3. Storage shed (middle of photo) and garage (right) looking to northeast. Two 22,750 litre (5000 gal) ASTs visible on bench above buildings.

Photo 4. Garage viewed from AST location.

Photo 5. Interior of garage (looking toward doorway) with 2 Caterpillar tractor batteries and areas of soil staining visible.

Photo 6. Salt-like substance in one of 3 drums inside garage.

Photo 7. Storage shed viewed toward northwest.

Photo 8. Water tower (?) located ~200m east of garage.

Photo 9. Material laydown area west of storage shed, viewed toward northwest.

Photo 10. Drum disposal area on slope above material storage area, viewed toward northwest. About 320 empty 205 litre drums stacked or in vicinity.

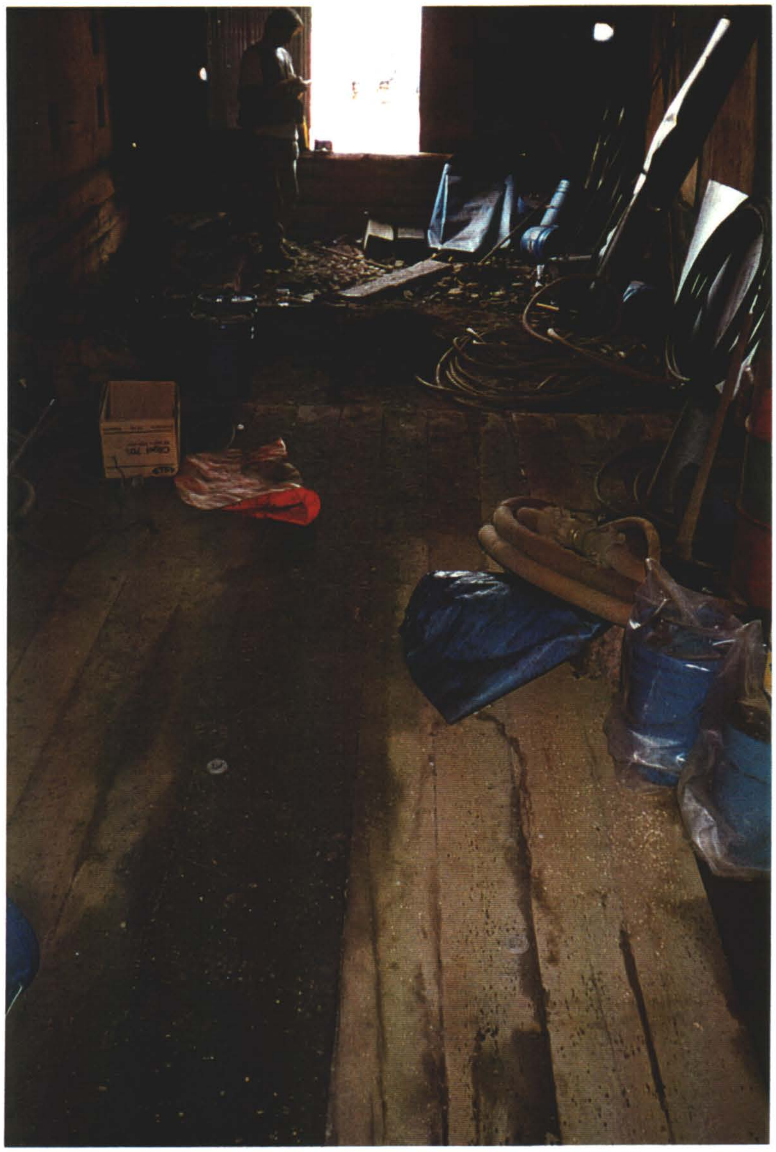

Photo 11. Interior of garage; note extensive hydrocarbon staining of timbered floorboards.

Photo 12. Sample location RU-SL-202 near NW corner of garage.

Photo 13. Sample location RU-SL-203 in garage near timbered floorboards.

Photo 14. Collapsed adit entrance in lower trench (centre of photo). Note steep, unstable overburden above at top of trench.

Photo 15. Slope failure crack within 3 metres of SE corner of garage.

Photo 16. Slope failure cracks and “hanging fence” near garage, looking northeast.

Photo 17. View of garage and sheer wall of waste rock pad, looking northwest.

Photo 18. View of upper workings looking northeast. Note evidence of undercut (left side of photo) and rotational slumping (right side) along vegetated edge of workings.

Photo 19. Lower trench looking south from upper trench area. Note waste rock piled to trench edge at left centre of photo.

Appendix C

Analytical Results

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

analytical service laboratories ltd.

FAX 604 253-6700 TEL 604 253-4188

CHEMICAL ANALYSIS REPORT

Date: September 24, 1996

ASL File No. G4270

Report On: Soil, Water And Product 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: August 20, 1996

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Heather A. Ross, B.Sc.
Project Chemist

Frederick Chen, B.Sc.
Supervisor, Trace Metals Lab

Canada's 50 Best Managed Private Companies

REMARKS File No. G4270

The Total Organic Halide and Metals analysis for the product samples was subcontracted to Powertech Labs, Surrey. Please note that the sample identified as "RU-BL-1" could not be analysed for the above listed tests due to the fact that there was not a fuel or product layer present in the vials. Only the organic layer (oil or fuel) was analysed and any water present was excluded from the analysis. Please refer to the attached subconsultants report for details.

Please note that the detection limits for some of the polycyclic aromatic hydrocarbons have been increased for several of the samples reported in the following data tables. These samples contain hydrocarbon material that interferes with the quantification of these compounds.

The detection limits for some of the trace metals have been increased for the samples identified as "SG-SL-201" and "SG-SL-202". These samples contain high levels of iron and required dilution prior to analysis.

RESULTS OF ANALYSIS - Product[1,2]

File No. G4270

		RU-BL-2	RU-BL-5	RU-BL-6	RU-BL-7
		96 08 14 11:00	96 08 14 11:00	96 08 14 11:00	96 08 14 11:00
Total Metals					
Cadmium	T-Cd	<1.0	<1.0	<1.0	<1.0
Chromium	T-Cr	<1.0	<1.0	<1.0	<1.0
Lead	T-Pb	<1.0	<1.0	12.6	<1.0

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1] Results are expressed as milligrams per litre.
[2] Adsorbable Organic Halide may be considered to be Total Organic Halide in product samples.

RESULTS OF ANALYSIS - Product[1,2] File No. G4270

	RU-BL-2	RU-BL-5	RU-BL-6	RU-BL-7
	96 08 14 11:00	96 08 14 11:00	96 08 14 11:00	96 08 14 11:00
Organic Parameters				
Adsorbable Organic Halide	<300	<300	<300	<300

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre.
[2]Adsorbable Organic Halide may be considered to be Total Organic Halide in product samples.

ASL

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4270

		RU-SL-201 96 08 15 13:00	RU-SL-202 96 08 15 13:00	RU-SL-203 96 08 15 13:00	RU-SL-[2] 204 96 08 15 13:00	RU-SL-205 96 08 15 13:00
Physical Tests						
Moisture	%	5.9	1.2	9.4	37.5	11.2
Dissolved Anions						
Chloride	Cl	-	-	-	499000	-
Total Metals						
Antimony	T-Sb	139	82	88	-	<20
Arsenic	T-As	163	29.8	159	-	38.1
Barium	T-Ba	146	84	149	-	184
Beryllium	T-Be	<0.5	<0.5	<0.5	-	<0.5
Cadmium	T-Cd	33	18	8	-	<2
Chromium	T-Cr	12	9	16	-	22
Cobalt	T-Co	24	17	11	-	8
Copper	T-Cu	492	280	130	-	47
Lead	T-Pb	9490	4320	1910	-	85
Mercury	T-Hg	0.178	0.111	0.019	-	0.012
Molybdenum	T-Mo	<4	<4	<4	-	5
Nickel	T-Ni	39	32	24	-	19
Selenium	T-Se	0.6	0.7	0.3	-	0.2
Silver	T-Ag	14	6	9	-	3
Tin	T-Sn	<30	<30	<30	-	<30
Vanadium	T-V	31	14	39	-	44
Zinc	T-Zn	2670	1700	653	-	98

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.
[2]Chloride results are based on a one part soil to ten parts water leach.

ASL

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4270

		RU-SL-206	RU-SL-207
		96 08 15 13:00	96 08 15 13:00
Physical Tests			
Moisture	%	9.8	11.8
Total Metals			
Antimony	T-Sb	<20	<20
Arsenic	T-As	33.4	62.7
Barium	T-Ba	229	168
Beryllium	T-Be	<0.5	<0.5
Cadmium	T-Cd	<2	<2
Chromium	T-Cr	25	27
Cobalt	T-Co	9	8
Copper	T-Cu	28	44
Lead	T-Pb	70	231
Mercury	T-Hg	0.020	0.040
Molybdenum	T-Mo	<4	<4
Nickel	T-Ni	22	18
Selenium	T-Se	0.2	0.2
Silver	T-Ag	3	3
Tin	T-Sn	<30	<30
Vanadium	T-V	49	49
Zinc	T-Zn	84	92

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

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4270

	RU-SL-201	RU-SL-202	RU-SL-203	RU-SL-205	RU-SL-206
	96 08 15 13:00	96 08 15 13:00	96 08 15 13:00	96 08 15 13:00	96 08 15 13:00
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	<0.01	<0.05	0.15	0.53	<0.01
Acenaphthylene	<0.01	<0.05	0.08	0.13	<0.01
Anthracene	<0.01	<0.05	0.03	0.25	<0.01
Benzo(a)anthracene	<0.01	<0.05	<0.01	0.03	<0.01
Benzo(a)pyrene	<0.01	<0.05	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	<0.01	<0.05	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	<0.01	<0.05	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.05	<0.01	<0.01	<0.01
Chrysene	0.02	0.10	0.03	0.19	<0.01
Dibenz(a,h)anthracene	<0.01	<0.05	<0.01	<0.01	<0.01
Fluoranthene	<0.01	0.08	0.04	0.07	<0.01
Fluorene	<0.01	<0.05	0.09	0.69	<0.01
Indeno(1,2,3-c,d)pyrene	<0.01	<0.05	<0.01	<0.01	<0.01
Naphthalene	0.01	<0.05	<0.05	<0.1	<0.01
Phenanthrene	0.03	0.64	1.14	1.57	<0.01
Pyrene	0.02	0.15	0.15	0.64	<0.01

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

RESULTS OF ANALYSIS - Sediment/Soil[1] File No. G4270

	RU-SL-207 96 08 15 13:00
Polycyclic Aromatic Hydrocarbons	
Acenaphthene	<0.01
Acenaphthylene	<0.01
Anthracene	0.02
Benzo(a)anthracene	0.02
Benzo(a)pyrene	<0.01
Benzo(b)fluoranthene	0.01
Benzo(g,h,i)perylene	<0.01
Benzo(k)fluoranthene	<0.01
Chrysene	0.04
Dibenz(a,h)anthracene	<0.01
Fluoranthene	0.11
Fluorene	0.01
Indeno(1,2,3-c,d)pyrene	<0.01
Naphthalene	<0.01
Phenanthrene	0.14
Pyrene	0.10

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

RESULTS OF ANALYSIS - Water[1]

File No. G4270

		RU-WQ-STR-001 96 08 14 12:30	RU-WQ-STR-002 96 08 14 12:30	RU-WQ-STR-003 96 08 14 12:30
Physical Tests				
Conductivity (umhos/cm)		155	169	159
Hardness	CaCO3	72.4	78.3	75.2
pH		7.66	7.81	7.70
Dissolved Anions				
Acidity	CaCO3	2.7	3.3	2.5
Alkalinity - Total	CaCO3	30.3	37.1	31.8
Sulphate SO4		45.3	42.7	45.5
Total Metals				
Aluminum T-Al		0.013	0.074	0.011
Arsenic T-As		0.0023	0.0031	0.0022
Barium T-Ba		0.06	0.06	0.06
Beryllium T-Be		<0.005	<0.005	<0.005
Boron T-B		<0.1	<0.1	<0.1
Cadmium T-Cd		<0.0002	0.0004	<0.0002
Calcium T-Ca		22.2	24.3	23.1
Chromium T-Cr		<0.001	<0.001	<0.001
Cobalt T-Co		<0.02	<0.02	<0.02
Copper T-Cu		<0.001	0.001	<0.001
Iron T-Fe		<0.03	0.13	<0.03
Lead T-Pb		<0.001	0.012	<0.001
Lithium T-Li		<0.02	<0.02	<0.02
Magnesium T-Mg		4.14	4.27	4.26
Manganese T-Mn		0.006	0.017	0.005
Mercury T-Hg		<0.00005	<0.00005	<0.00005
Molybdenum T-Mo		<0.03	<0.03	<0.03
Nickel T-Ni		<0.02	<0.02	<0.02
Selenium T-Se		0.0009	0.0009	0.0006
Silver T-Ag		<0.0001	0.0002	0.0001
Sodium T-Na		<2	<2	<2
Vanadium T-V		<0.03	<0.03	<0.03
Zinc T-Zn		0.006	0.020	0.006

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

ASL

Appendix 1 - QUALITY CONTROL - Replicates

File No. G4270

Sediment/Soil[1]		RU-SL-201 96 08 15 13:00	RU-SL-201 QC # 70790
Physical Tests			
Moisture	%	5.9	5.8
Total Metals			
Antimony	T-Sb	139	198
Arsenic	T-As	163	139
Barium	T-Ba	146	136
Beryllium	T-Be	<0.5	<0.5
Cadmium	T-Cd	33	31
Chromium	T-Cr	12	12
Cobalt	T-Co	24	19
Copper	T-Cu	492	461
Lead	T-Pb	9490	11300
Mercury	T-Hg	0.178	0.211
Molybdenum	T-Mo	<4	<4
Nickel	T-Ni	39	43
Selenium	T-Se	0.6	0.7
Silver	T-Ag	14	12
Tin	T-Sn	<30	<30
Vanadium	T-V	31	32
Zinc	T-Zn	2670	2200

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

ASL

Appendix 1 - QUALITY CONTROL - Replicates

File No. G4270

Sediment/Soil[1]	RU-SL-201 96 08 15 13:00	RU-SL-201 QC # 70790
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	<0.01	<0.01
Acenaphthylene	<0.01	<0.01
Anthracene	<0.01	<0.01
Benzo(a)anthracene	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01
Benzo(b)fluoranthene	<0.01	<0.01
Benzo(g,h,i)perylene	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.01
Chrysene	0.02	0.02
Dibenz(a,h)anthracene	<0.01	<0.01
Fluoranthene	<0.01	<0.01
Fluorene	<0.01	<0.01
Indeno(1,2,3-c,d)pyrene	<0.01	<0.01
Naphthalene	0.01	0.01
Phenanthrene	0.03	0.04
Pyrene	0.02	0.02

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

Appendix 1 - QUALITY CONTROL - Replicates

File No. G4270

Water[1]			RU-WQ-STR-002 96 08 14 12:30	RU-WQ-STR-002 QC # 70791
Physical Tests				
Conductivity (umhos/cm)			169	162
Hardness		CaCO3	78.3	78.3
pH			7.81	7.84
Dissolved Anions				
Acidity		CaCO3	3.3	2.1
Alkalinity - Total		CaCO3	37.1	36.0
Sulphate	SO4		42.7	44.0
Total Metals				
Aluminum	T-Al		0.074	0.072
Arsenic	T-As		0.0031	0.0031
Barium	T-Ba		0.06	0.06
Beryllium	T-Be		<0.005	<0.005
Boron	T-B		<0.1	<0.1
Cadmium	T-Cd		0.0004	0.0003
Calcium	T-Ca		24.3	24.3
Chromium	T-Cr		<0.001	<0.001
Cobalt	T-Co		<0.02	<0.02
Copper	T-Cu		0.001	0.001
Iron	T-Fe		0.13	0.13
Lead	T-Pb		0.012	0.012
Lithium	T-Li		<0.02	<0.02
Magnesium	T-Mg		4.27	4.29
Manganese	T-Mn		0.017	0.017
Mercury	T-Hg		<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02
Selenium	T-Se		0.0009	0.0010
Silver	T-Ag		0.0002	0.0002
Sodium	T-Na		<2	<2
Vanadium	T-V		<0.03	<0.03
Zinc	T-Zn		0.020	0.020

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

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

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 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

Powertech Labs - Interim Results - Tel: 590-7448

Analytical Service Laboratories
1988 Triumph St.
Vancouver, B.C.
V5L 1K5

Date: 28 August 1996

Project#: 1511-44
Powertech Ref#: 96197 & 96199
P.O.#: ASL Ref G4270 & G4271

Attention: Fred Chen

Re: Waste Oil Analysis

Number of samples received:	6
Number of samples analyzed:	5
Sample Type:	Waste Organic Liquids
Date Received:	Aug 21 & Aug 23, 1996
Date Reported:	Aug 28, 1996 (by fax)

METHODOLOGY

Organic Halogen was determined by a laboratory test method mod. EPA 9020 and was analyzed with a Mitsubishi TOX 10 analyzer. Elements were determined in accordance with laboratory test method ASTM D5185.

Some of the samples contained a layer of water. The water layer was excluded from the analyses. Only the organic liquid layer (oil or fuel) was analyzed. Some of the samples received did not contain an oil or fuel layer and were likely composed of mainly water. The water samples were not analyzed as per discussion with ASL. The ASL lab numbers of the samples not analyzed are as follows: G4270-1.

Results:

Results of analysis are attached

Prepared By: ______________
Ed Hall
Sr. Chemical Technologist

Approved By: ________________
H. Schellhase
Research Chemist
Applied Chemistry

POWERTECH LABS INC.

Results of Analysis
Powertech Labs Ref: 96197
ASL Ref: G4270

ASL Ref	Powertech Ref	Organic Halogen mg/L	Arsenic mg/L	Cadmium mg/L	Chromium mg/L	Lead mg/L
RU-BL-2	96197-2	<300	<4	<1	<1	<1
RU-BL-5	96197-3	<300	<4	<1	<1	<1
RU-BL-6	96197-4	<300	<4	<1	<1	12.6
RU-BL-7	96197-5	<300	<4	<1	<1	<1
RUBL-14	96199-1	<300	<4	<1	<1	<1

APPENDIX

CHAIN OF CUSTODY FORMS

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

ASL Specialists in Environmental Chemistry
analytical service laboratories ltd.
1988 Triumph Street
Vancouver, BC
Canada V5L 1K5
FAX: (604) 253-6700
TEL: (604) 253-4188
TOLL FREE: (800) 665-0243

CLIENT: PWGSC ENVIRONMENTAL SERVICES
204 - 1166 ALBERNI ST.
VANCOUVER B.C.
V6E 3W5

PH/FAX#: (W) 623 6388 / (W) 623-6239

CONTACT: TIM SACKMANN.

SAMPLED BY: T. SACKMANN, A. LAUDRUM, D. CHARBONEAU

PAGE 1 OF 5

YUKON A.M.W., PHASE II AUG/96

ASL CONTACT: HEATHER THOMAS

CLIENT PROJECT #:

PO #:

DATE SUBMITTED:

RESULTS REQUIRED BY:

G4270

ANALYSIS REQUESTED

LAB USE	SAMPLE IDENTIFICATION	SAMPLE TYPE	DATE/TIME Y	M	D	SAMPLED	FIELD PRESERVATION	TOTAL METALS	IMMEDIATES	TOTAL HALIDES TOX	P.A.H.	CHLORIDES							COMMENTS
1	RU-BL-1	BARREL	96	14	08	11:00 AM	Ø	✓	✓										
2	RU-BL-2	"	96	14	08	11:00 AM	Ø	✓	✓										
3	RU-BL-5	"	96	14	08	11:00 AM	Ø	✓	✓										
4	RU-BL-6	"	96	14	08	11:00 AM	Ø	✓	✓										
5	RU-BL-7	"	96	14	08	11:00 AM	Ø	✓	✓										
(6)	RU-SL-201	SOIL	96	15	08	1:00 PM	Ø	✓		✓									
7	RU-SL-202	"	96	15	08	1:00 PM	Ø	✓		✓									
8	RU-SL-203	"	96	15	08	1:00 PM	Ø	✓		✓									
9	RU-SL-204	"	96	15	08	1:00 PM	Ø				✓								
10	RU-SL-205	"	96	15	08	1:00 PM	Ø	✓		✓									
11	RU-SL-206	"	96	15	08	1:00 PM	Ø	✓		✓									
12	RU-SL-207	"	96	15	08	1:00	Ø	✓		✓									
13	FO-SL-201	"	96	20	08	11:00 AM	Ø	✓		✓									
14	FO-SL-301	"	96	13	08	11:00 AM	Ø	✓		✓									
15	SG-SL-203	"	96	17	08	11:30 AM	Ø	✓											

NOTES/COMMENTS

Immediates = SO_4^{2-}, Acidity, Alk, pH, Conductivity,

CONDITION RECEIVED
FROZEN ____
COLD ____
AMBIENT ____
TOTAL PACKAGES

RELINQUISHED BY		
AFFILIATION		
RECEIVED BY	DB 96/08/20	Y/M/D
AFFILIATION	ASL : AM/PM	: AM/PM

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1988 Triumph Street
Vancouver, BC
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TEL: (604) 253-4188
TOLL FREE: (800) 665-0243

CLIENT: DOUGL ENVIRONMENTAL SERVICES
204 / 1166 ALBERNI ST
VANCOUVER, B.C
V6E 3Z5

PH/FAX#: 623 6348 / 623 6279

CONTACT: TIM SACKMANN

SAMPLED BY: T. SACKMANN, A LONDIUM
D. CHARBONEAU

YUKON A.M.D, PHASE II, AUG 96

ASL CONTACT: HEATHER THOMAS

CLIENT PROJECT #

PO #

DATE SUBMITTED

RESULTS REQUIRED BY

ANALYSIS REQUESTED

LAB USE	SAMPLE IDENTIFICATION	SAMPLE TYPE	DATE/TIME Y	M	D	SAMPLED	FIELD PRESERVATION	TOTAL METALS	IMMEDIATES	GENERAL CHEMISTRY										COMMENTS
	SH-WQ-A1-1	WATER	96	07	29	10:00 AM	NITRIC	✓												
16	SH-WQ-A1-1	"	96	07	29	:	Ø		✓											
	DU-WQ-STR-302	"	96	08	17	9:30 AM	NITRIC	✓												
17	DU-WQ-STR-302	"	96	08	17	9:30 AM	Ø		✓											
	FO-WQ-STR-001	"	96	08	13	11:00 AM	NITRIC	✓												
18	FO-WQ-STR-001	"	96	08	13	11:00 AM	Ø		✓											
	FO-WQ-STR-301	"	96	08	13	11:30 AM	NITRIC	✓												
19	FO-WQ-STR-301	"	96	08	13	11:30 AM	Ø		✓											
	FO-WQ-STR-302	"	96	08	13	11:30 AM	NITRIC	✓												
20	FO-WQ-STR-302	"	96	08	13	11:30 AM	Ø		✓											
	RU-WQ-STR-001	"	96	08	14	12:30 PM	NITRIC	✓												
21	RU-WQ-STR-001	"	96	08	14	12:30 PM	Ø		✓											
	RU-WQ-STR-002	"	96	08	14	12:30 PM	NITRIC	✓												
22	RU-WQ-STR-002	"	96	08	14	12:30 PM	Ø		✓											
						: AM PM														

NOTES/COMMENTS

CONDITION RECEIVED
FROZEN ____
COLD ____
AMBIENT ____
TOTAL PACKAGES

RELINQUISHED BY		
AFFILIATION		
RECEIVED BY	Y / M / D	Y / M / D
AFFILIATION	: AM PM	: AM PM

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TEL: (604) 253-4188
TOLL FREE: (800) 665-0243

CLIENT: PWGSC Environmental Services, 800 / 1166 Alberni St, Vancouver B.C, V6E 3W5

PAGE 3 OF ~~4~~ 5

Yukon A.M.D. Phase II Aug. 96

ASL CONTACT: Heather Adams

CLIENT PROJECT #

PO #

DATE SUBMITTED

RESULTS REQUIRED BY

PH/FAX#: 623 6388 / 623 6234

CONTACT: Tim Sackmann

SAMPLED BY: T. Sackmann, A. Laudrum, D. Charbonneau

ANALYSIS REQUESTED: Total Metals | Immediates | General Chemistry

LAB USE	SAMPLE IDENTIFICATION	SAMPLE TYPE	Y	M	D	SAMPLED	AM/PM	FIELD PRESERVATION	Total Metals	Immediates	General Chemistry											COMMENTS
23	RU-WQ-STR-003	Water	96	08	14	12:30	PM	Nitric	✓													
	RU-WQ-STR-003	"	96	08	14	12:30	PM	φ		✓												
24	SG-WQ-STR-202	"	96	08	17	10:00	AM	Nitric	✓													
	SG-WQ-STR-202	"	96	08	17	10:00	AM	φ		✓												
25	MACT-WQ-STR-001	"	96	08	15	11:00	AM	Nitric	✓													
	MACT-WQ-STR-001	"	96	08	15	11:00	AM	φ		✓												
26	MACT-WQ-STR-002	"	96	08	15	11:15	AM	Nitric	✓													
	MACT-WQ-STR-002	"	96	08	15	11:45	AM	φ		✓												
27	MACT-WQ-003	"	96	08	15	11:30	AM	Nitric	✓													
	MACT-WQ-003	"	96	08	15	11:30	AM	φ		✓												
28	MACT-WQ-004	"	96	08	15	1:00	PM	Nitric	✓													
	MACT-WQ-004	"	96	08	15	1:00	PM	φ		✓												
29	MACT-WQ-005	"	96	08	15	1:15	PM	Nitric	✓													
	MACT-WQ-005	"	96	08	15	1:15	PM	φ		✓												
						:	AM/PM															

NOTES/COMMENTS

CONDITION RECEIVED
FROZEN ____
COLD ____
AMBIENT ____
TOTAL PACKAGES ____

RELINQUISHED BY		
AFFILIATION		
RECEIVED BY	Y / M / D	Y / M / D
AFFILIATION	: AM/PM	: AM/PM

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

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TEL: (604) 253-4188
TOLL FREE: (800) 665-0243

CLIENT: [illegible] ENVIRONMENTAL SERVICES, 204/1166 ALBERNI ST., VANCOUVER, BC, V6E 3W5

PH/FAX#: 623-6398 / 623-6234

CONTACT: T. SACKMANN

SAMPLED BY: T. SACKMANN, A. LAURIN, D. CHARBONNEAU

ASL CONTACT: [illegible]

CLIENT PROJECT #:

PO #:

DATE SUBMITTED:

RESULTS REQUIRED BY:

ANALYSIS REQUESTED

LAB USE	SAMPLE IDENTIFICATION	SAMPLE TYPE	Y	M	D	SAMPLED	FIELD PRESERVATION	TOTAL METALS	IMMEDIATES	GENERAL CHEMISTRY	PAH										COMMENTS
30	SAMOV WQ-001	WATER	96	08	15	2:00 PM	NITRIC	✓													
	SAMOV-WQ-001	WATER	96	08	15	2:00 PM	Ø		✓												
31	SAMOV-WQ-002	"	96	08	15	2:15 PM	NITRIC	✓													
	SAMOV-WQ-002	"	96	08	15	2:15 PM	Ø		✓												
32	SAMOV WQ-003	"	96	08	15	2:30 PM	NITRIC	✓													
	SAMOV-WQ-003	"	96	08	15	2:30 PM	Ø		✓												
	~~SAMOV WQ~~ -					: AM/PM	~~NITRIC~~														
	~~SAMOV WQ~~					: AM/PM	~~Ø~~														
33	SG-SL-201	SOIL	96	08	17	11:00 AM	Ø	✓		✓											
34	SG-SL-202	SOIL	96	08	17	11:00 AM	Ø	✓		✓											
35	GAMBLER-SL-001	SOIL	96	08	17	10:45 AM	Ø	✓		✓											
	" SL-001					: AM/PM	NITRIC	✓													
						: AM/PM	Ø		✓												
						: AM/PM	NITRIC	✓													
						: AM/PM	Ø		✓												

NOTES/COMMENTS

CONDITION RECEIVED
FROZEN ____
COLD ____
AMBIENT ____
TOTAL PACKAGES

RELINQUISHED BY		
AFFILIATION		
RECEIVED BY	Y / M / D	Y / M / D
AFFILIATION	: AM/PM	: AM/PM

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CLIENT ____________________

PAGE 5 OF 5

ASL CONTACT ____________________

CLIENT PROJECT # ____________________

PH/FAX# ____________________ PO # ____________________

CONTACT ____________________ DATE SUBMITTED ____________________

SAMPLED BY ____________________ RESULTS REQUIRED BY ____________________

ANALYSIS REQUESTED

LAB USE	SAMPLE IDENTIFICATION	SAMPLE TYPE	DATE/TIME Y	M	D	SAMPLED	FIELD PRESERVATION	Gen. Chemistry	Total Metals	[illegible]										COMMENTS
36	DU WQ STR 301				17	: AM PM	φ	✓												
	301					: AM PM	NITRIC		✓											
37	[illegible] WQ 201					: AM PM	NITRIC													
	201					: AM PM	φ													
38	GMMB WQ ST -001				17	: AM PM	NITRIC													
	-001				17	: AM PM	φ													
39	FORM-WQ-STR -002				17	: AM PM	NITRIC													
	-002				17	: AM PM	φ													
						: AM PM														
						: AM PM														
						: AM PM														
						: AM PM														
						: AM PM														
						: AM PM														
						: AM PM														

NOTES/COMMENTS

CONDITION RECEIVED
FROZEN ______
COLD ______
AMBIENT ______
TOTAL PACKAGES ______

RELINQUISHED BY		
AFFILIATION		
RECEIVED BY	Y / M / D	Y / M / D
AFFILIATION	: AM PM	: AM PM