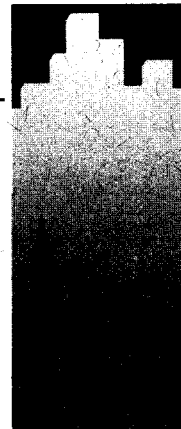


PWGSC

Quality in Environmental Services



**PHASE II ENVIRONMENTAL ASSESSMENT
OF THE
BIG THING
ABANDONED MINE SITE**



prepared for:

**Action on Waste Program
Indian and Northern Affairs Canada**

prepared by:

**Environmental Services
Public Works and Government Services Canada**

March 1997



**Public Works and
Government Services
Canada**

**Travaux publics et
Services gouvernementaux
Canada**

Canada

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EXECUTIVE SUMMARY

A phase II environmental assessment was conducted at the Big Thing abandoned mine site (60° 05'01"N, 134° 41'01"W) in July, 1996 by Environmental Services, Public Works and Government Services Canada for the Action on Waste Program, Indian and Northern Affairs Canada. Based on the findings of the Phase I investigation performed in 1993 by DIAND Technical Services, a phase II assessment was conducted to a) identify potential environmental and human health risks associated with the present condition of the mine site, and b) provide recommendations for remediation of those risks.

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

The results of the investigation concluded that the middle adit is not adequately secured from public access. An assessment of the acid rock drainage potential for the waste rock and adit shows that some of the rock is currently acid generating, however, there has been little impact on the adjacent stream's water quality. Three small surface soil stains with concentrations above remediation criteria and a large reinforced barrel with unknown contents were also noted at the site. Aesthetic concerns arise from rail track, a trestle, loadout facilities, pipe lengths, barrels, pails and assorted metal, machinery and wood debris throughout the site.

Using applicable federal and territorial criteria as well as northern mine reclamation guidelines, the recommendations are to secure the middle adit using surrounding rock and soil. The building should be demolished and burned and the ashes buried on site. Rail timbers and other wood waste should be collected, burned and also buried on site with the metal rails, pipe and remaining metal waste. An effort should be made to determine the contents of the reinforced barrel and it should be removed from the site.

The soil stains were small, with the exception of total extractable hydrocarbons no hazardous compounds were noted in any sample, and there were no sensitive environmental receptors in the immediate area of the stains. As such, the stained soils may be left as is and allowed to remediate by natural attenuation.

No further test work is recommended on the waste rock. Additional water quality sampling is required to monitor the impact of the acid generating waste on the receiving environment. It is recommended that every three years a monitoring program be undertaken to obtain water quality data for spring freshet, middle summer and late fall conditions.

Table 1: Summary of Potential Hazards at Big Thing Mine Site

ASSESSMENT COMPONENT	RISK	RECOMMENDATION
1. Building, Infrastructure, Equipment		
Building	Aesthetic concern	Burn and bury ashes on site
Middle/lower track & trestles	Health and safety concern	Burn and bury ashes on site
Loadout facilities	Health and safety concern	Burn and bury ashes on site
Hoist and heavy equipment	Aesthetic concern	Bury on site
Dam	Environmental concern	Excavate and restore
Retaining wall	Aesthetic concern	Leave as is
Mill foundation	Aesthetic concern	Leave as is
2. Non-Hazardous Waste Material		
Large volume metal debris	Aesthetic concern	Bury on site
Large volume wood debris	Aesthetic concern	Burn and bury on site
28 empty barrels, 27 empty pails	Aesthetic concern	Bury on site
3. Hazardous Materials		
1 sealed barrel	Health & safety concern and medium environmental risk	Transport off site
3 areas soils with contaminated soils	Low environmental risk	Leave as is
4. Water Quality		
Mine Seepage - lower adit	Unknown environmental risk	Hydrology & chemistry study
Site Drainage - none	Unknown environmental risk	Hydrology & chemistry study
Receiving Waters - Big Thing Creek	Unknown environmental risk	Hydrology & chemistry study
5. Waste Rock Disposal Areas		
Waste Rock - acidic	Medium to high environmental risk	Hydrology & chemistry study
6. Mine Openings		
1 open adit, 1 partly collapsed adit, 1 partly collapsed shaft	Health and safety concern	Seal with heavy equipment
7. Tailings		
None (at site)		

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1.0 INTRODUCTION AND BACKGROUND

In 1993, assessments of 49 abandoned Yukon mine exploration and development sites were completed under the Arctic Environmental Strategy - Action on Waste program by DIAND Technical Services. These assessments were intended to: provide a general overview of historical activities; describe site infrastructure, workings and wastes; describe existing environmental or safety concerns on each site; and provide general recommendations for remediation and/or mitigation work, as appropriate.

At the Big Thing abandoned mine site, the 1993 report recommended further investigation into possible environmental impacts resulting from the previous mining activities. According to this report, the potential areas of concern included: a safety concern at the unsecured mine adit, the trestle and loadout facilities; and aesthetic concerns with regard to the excavator and other metal wastes noted at the site. No rock, tailings, soil or water samples were collected in this assessment.

In light of these preliminary findings, Indian and Northern Affairs Canada has determined that further investigation is warranted. Environmental Services, Public Works and Government Services Canada was retained to conduct an environmental assessment of the Big Thing abandoned mine site to a) identify specific environmental and human safety risks; and b) provide clean-up recommendations.

1.1 LOCATION

The Big Thing abandoned minesite is located at 60° 05'01"N latitude and 134° 41'01"W longitude. It is situated 9 km south of the village of Carcross between Montana Mountain and Sugarloaf Hill. The site is between 1600 and 1700 m above sea level.

1.2 OVERVIEW OF SITE DEVELOPMENT

The Big Thing site includes the upper camp, at an elevation of 1725 m (5,660 ft), at the original Big Thing property. During the period 1905 to 1912 underground work completed included a 137 m (450 ft) inclined shaft driven into the southwest side of Sugarloaf Hill, and about 322 m (1,055 ft) of drifting on four levels. Some stoping was also done, two winzes having an aggregate depth of 12 m (40 ft) were sunk, and various workings were excavated. Assuming that the rock has a specific gravity of 2.65 and that the mine openings are 10 ft by 8 ft, it is estimated that more than 9,400 tonnes (10,300 tons) of waste rock were excavated.

During 1915 and 1916 the workings were rehabilitated and additional development along the vein occurred. The amount of development is reported to be small.

Underground development recommenced on the property in 1965. Underground work has been carried out from the main entry driven northwesterly from an elevation of about 1645 m (800 Level) for about 335 m into Sugarloaf Hill. Five main drifts (totalling about 700 m) have been turned off from the main crosscut. A second adit on the southwest side of Sugarloaf Hill, at the 1705 m elevation. No records have been located as to when development commenced on this second adit, however the infrastructure present indicates it was last used some time in the 1960's or 1970's.

Records do state that 1370 m of drifting was completed between 1965 and 1967. + lowest adit
This would generate approximately 27,260 tonnes (30,000 tons) of rock. 1968-1969

The last reported development work on the property took place during 1975 and 1976, when some underground rehabilitation work was completed and a small tonnage of ore was stockpiled.

In 1910, 1911 and 1925 hand-picked ore shipments totalling 2,727 tonnes (3,000 tons) were shipped from the Big Thing property. A 300 ton per day mill was constructed in 1967. The Arctic Gold and Silver Mill operated from May to December in 1968 and March to October in 1969 and treated 50,751 tonnes (55,826 tons).

1.3 SITE ACCESS

The site is accessible by road from the South Klondike Highway at the south end of the Nares River bridge. Access to the Big Thing mine is still possible with two wheel drive vehicles although the use of four wheel drive vehicles is recommended.

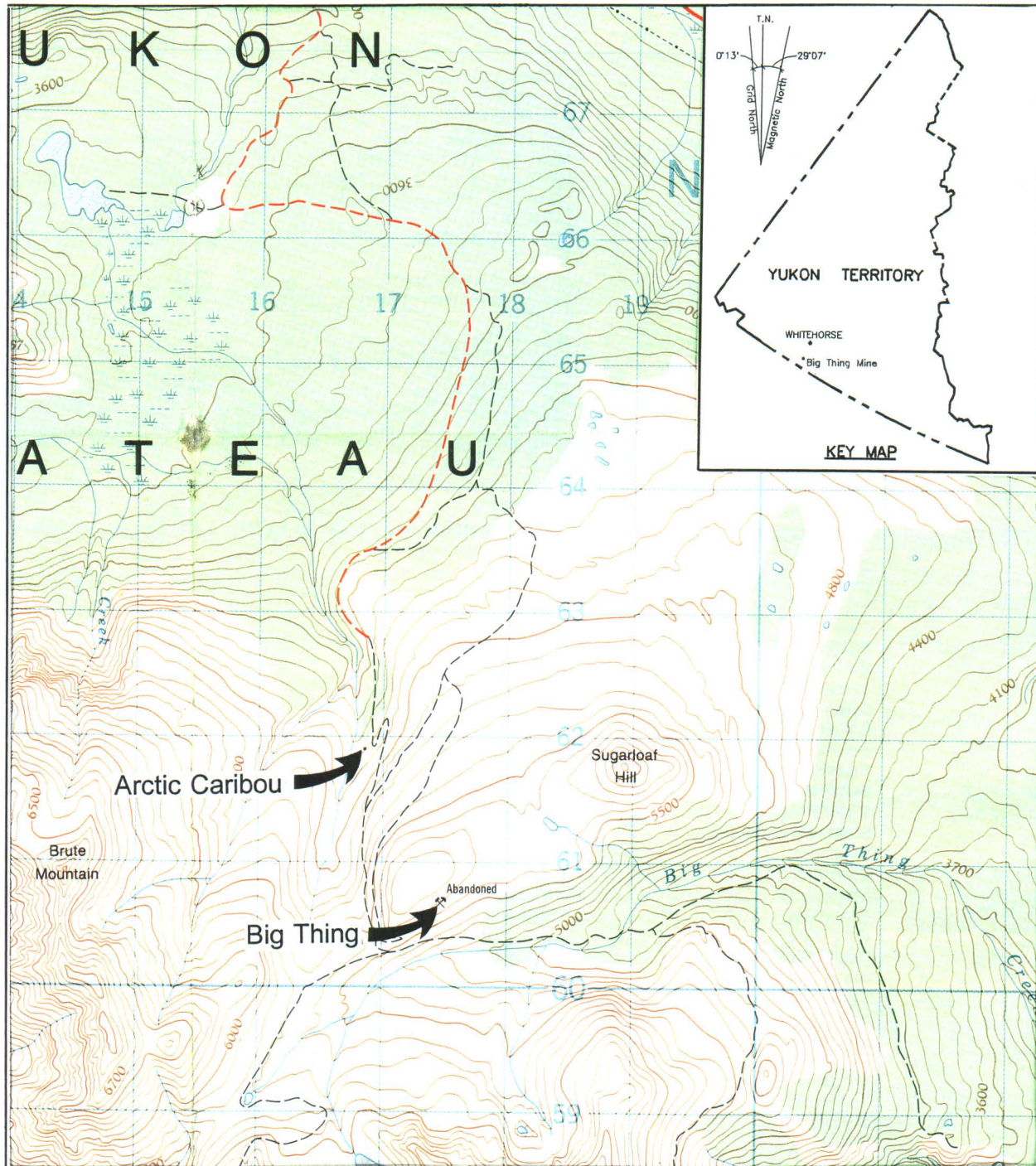


Figure 1. Location of Big Thing Mine - 1:50,000, NTS- 105 D/2 [Energy Mines and Resources Canada: 1986]

2.0 PURPOSE AND SCOPE OF WORK

The following assessment activities were completed:

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

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

- Physical stabilization of waste rock disposal areas;
- Chemical stabilization of the waste rock disposal areas as appropriate to local and background conditions, taking into account impact, on-site resources, and accessibility;
- Sealing of all mine openings;
- Consolidation and landfill of all non-hazardous, non-combustible solid wastes;
- Remediation or removal and disposal of contaminated soils as required to meet the more stringent of: Yukon Government's Contaminated Sites Regulations (1996) Schedule 1; and Canadian Council of Ministers of the Environment's Interim Canadian Environmental Quality Criteria for Contaminated Sites (1991) Commercial/Industrial criteria for soils;
- Removal and disposal of hazardous solid wastes;
- Draining, cleaning and disposal of drums or other containers containing petroleum products or other liquid hazardous wastes;
- Onsite flaring or removal and off-site disposal of petroleum products and other liquid hazardous wastes; and
- Demolition of buildings and infrastructure to foundation level and burning of combustible non-hazardous materials in approved location.

3.0 SITE ASSESSMENT METHODOLOGY

3.1 ASSUMPTIONS

The assessment was limited to the area specifically developed or occupied for exploration or mining purposes, and adjacent areas and resources believed to be affected by these activities. Water samples were taken off-site to determine potential impact to surface water bodies due to mining activities. Access roadways to mine sites were not included in the assessments.

3.2 ASSESSMENT CRITERIA

3.2.1 Criteria and Guidelines

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

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

- (i) the generic numerical soil standard of Schedule 1, or
- (ii) the matrix (pathway specific) numerical soil standards of Schedule 2

and, surface or groundwater used for aquatic life, irrigation, livestock, or drinking water which exceeds a concentration greater than or equal to:

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

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

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

The Canadian Council of Ministers of the Environment (CCME) Interim Canadian Environmental Quality Criteria for Contaminated Sites are numerical limits for contaminants in soil and water intended to protect, maintain or improve environmental quality and human health at contaminated sites in general.

CCME criteria include two types of benchmarks for soil and water quality - assessment criteria and remediation criteria. Assessment criteria are approximate background concentrations or approximate analytical detection limits for contaminants in soil and water, and remediation criteria are used as clean-up benchmarks based upon intended land use. Remediation criteria do not address site-specific conditions. They are considered generally protective of human and environmental health for specified uses of soil and water at contaminated sites. The remediation criteria for soil are classified by three land uses:

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

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

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

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

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

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

Barrel Clean Up Protocol, (INAC, 1992)

See Appendix F for protocol on testing and cleaning of barrels and contents

3.2.2 Application of Criteria and Guidelines

For the Big Thing abandoned mine site assessment the following criteria were used:

A. Soils:

CCME: Remediation Criteria for Soil -
Commercial/Industrial standard

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

B. Water:

ENVIRONMENT
CANADA: Metal Mining Liquid Effluent Regulations and
Guidelines - are compared to seepage from
mine openings and river/stream water quality

BACKGROUND: Downstream water quality results of rivers and
streams are compared to the results of
upstream (background) water quality (where
(available)

CCME: Remediation Criteria for Water - Freshwater
Aquatic Life standard

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

C. Mine Clean-Up and Reclamation:

INAC: Mine Reclamation in Northwest Territories and
Yukon Territory

D. Barrel Clean-Up:

INAC Barrel Clean Up Protocol

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 Big Thing abandoned mine site to that date. Other published information sources were examined for site or regional information as applicable. On the basis of available information, knowledge gaps regarding existing or potential safety and environmental risks at the site were identified and a site assessment plan was developed.

3.3.2 Site Assessment Components

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

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

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

Mine Openings were inspected and documented to identify closure requirements.

Non-Hazardous Site Debris was inventoried.

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

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

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, and any other pertinent information.

3.3.3 Sampling Methods and Quality Assurance

Test Pit Sampling

Test pits were excavated to a depth of about 0.3 to 1.0 m. Horizons in the test pit walls were logged, noting colour/weathering, rock composition, primary and secondary mineralization, particle size distribution, paste pH and paste conductivity, and moisture content. The test pit was photographed and its location was marked on the field map.

Approximately 2 kg of rock was collected at each sample site. For test pits showing a homogeneous wall face, a plastic sheet was placed at the bottom of the test pit and the pit wall was cut vertically down with a cleaned shovel. All rock larger than 75 mm in size was discarded. The sample was coned and quartered, discarding opposite quarters, until a 2 kg sample was obtained.

For test pit walls showing clearly-distinguishable horizons (distinguishable by the sulphide and carbonate contents), the horizons were sampled individually.

Water Sampling

Samples were collected from surface streams upstream and downstream of mine related flows, and from representative seeps emanating from waste rock, tailings, pit walls, and/or adits.

250 ml water samples were collected by hand, facing upstream, ensuring that the sample 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 HNO₃ were immediately added to water samples destined for metals analyses. For analyses of non-metallic parameters, water samples were brim-filled

to minimize 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 Sampling

Barrels 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.

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

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

4.0 ENVIRONMENTAL SETTING

4.1 MINERALIZATION

Approximately 20 polymetallic, gold-bearing quartz veins are hosted in rocks of the mid-Cretaceous Montana Mountain volcanic complex and Montana pluton along an eight kilometre, northwest-trending belt between Windy Arm and Brute Mountain.

The gold and silver ores occur in a series of northeast striking quartz veins that cut medium to coarse grained, locally porphyritic granodiorite. Sulphide mineralization consists chiefly of pyrite (FeS_2), arsenopyrite (FeAsS), sphalerite ($(\text{Zn,Fe})\text{S}$), galena (PbS) and minor chalcopyrite (CuFeS_2) occurring in irregular lenses and shoots within quartz vein material. The vein structures are commonly bordered by a selvage zone of altered granodiorite, consisting of bleaching and pyritization, extending up to 9.1 m (30 ft) either side of the vein. Weakly disseminated molybdenite (MoS_2) is sometimes present in the alteration envelope.

The major commodities identified at this site are gold and silver. Minor commodities include lead, zinc, copper, and molybdenum.

4.2 SURFACE HYDROLOGY

Both the site and regional drainage are to the east draining into Big Thing Creek, less than 300 m south of the lower adit, and subsequently into Windy Arm of Tagish Lake, approximately 6 km east of the site (see Figure 1).

Hydrological and water quality data are not available for Big Thing Creek.

Low seepage volumes were evident from the lower adit and drain towards the stream. Seepage was also detected from below the ore stockpile at the shaft and the site topography lends itself to seepage through the waste rock piles as a result of site drainage and surface infiltration from precipitation.

4.3 CLIMATE

The closest climatological information is from the town of Carcross, 60° 11' N, 134° 41' W; 663 m above sea level (Environment Canada, 1980). Total annual precipitation is 211.4 mm. This consists of 118.7 mm of rainfall and 101.3 mm of snowfall. Highest levels of rainfall occur in August and highest levels of snowfall occur in January. Temperatures range from -19.4° C in January to 12.7° C in July. The mean annual temperature is -1.4° C. Due to its higher elevation, Big Thing mine site is assumed to experience colder temperatures.

4.4 VEGETATION

Big Thing minesite occurs within the Stikine Highlands ecoregion. Alpine tundra dominates at higher elevations including the area of the mine site, with vegetation including scrub heather, dwarf birch, willow species, grass and lichen. At lower elevations, on the access road to the site, the subalpine ecosystem is dominated by white spruce, alpine fir and white birch. Much of the area surrounding the access road consists of second growth birch and alder that appears to have been cleared in the past.

4.5 FISH AND WILDLIFE RESOURCES

Typical carnivores in the area include grizzly and black bear and wolf. Arctic ground squirrel, pika and yellow-bellied marmots are common rodents in the area. A small colony of hoary marmots was noted at the site. Bird species representative of this alpine habitat include several ptarmigan species and rosy finch. A number of raptors hunt and nest in the area, and waterfowl such as mergansers and harlequin ducks are found in the rivers at lower elevations. It is not currently known whether Big Thing Creek supports a fish population.

4.6 SITE TOPOGRAPHY AND SOILS

The soils within the Yukon Stikine Highlands ecoregion are predominantly brunisolic and regosolic. Occasionally, cryosolic soils, dystric brunisols and eutric brunisols are also found.

The site is located on the south east side of the lower-middle slope of an unnamed peak, approximately 2 km south west of Sugarloaf Mountain. The mine site is situated within a wide valley running approximately east-west with Montana Mountain forming the south side of the valley. Big Thing Creek runs along the valley floor. The north side of the valley is vegetated and gradually sloped with few rock outcroppings.

4.7 PERMAFROST

Big Thing is in an area of discontinuous permafrost. No evidence of permafrost was discovered during the site visit and is not likely to affect project components.

5.0 SITE DESCRIPTION AND FINDINGS

5.1 BUILDING, INFRASTRUCTURE, EQUIPMENT

The building, infrastructure and equipment observed in and around the site are listed in Table 2.

Table 2: Buildings, Infrastructure and Equipment

Inventoried Material	Number/ Volume	Location	Comments
3.0 m x 3.0 m pumphouse	1	adjacent to Big Thing Creek below mine site	plywood construction
earthen dam and culvert	1	across Big Thing Creek	dam failed and culvert washed out
hoist equipment	1	upper drift site	unusable
rail track	120 m	from middle adit to loadout facilities	satisfactory condition

Inventoried Material	Number/ Volume	Location	Comments
loadout facilities	1	below middle adit	deteriorating wood
trestles	~75 m	adjacent to middle adit	portions in poor condition
abandoned heavy equip.	~2 m ³	slope below middle adit	unusable
retaining wall	60 m	below loadout facilities	remains in satisfactory condition
concrete mill foundation	9 x 24 & 6 x 9 (m)	adjacent to lower adit	not an aesthetic concern
trestle and track	2	from adit to lower loadout facilities	poor condition

Big Thing Creek has eroded a passage through the earthen dam and destroyed the metal culvert at the east end of the water reservoir. The dam has caused a narrowing of the creekbed and a steep drop of approximately 3 m. This constriction may restrict downstream movement of fish.

5.2 NON-HAZARDOUS WASTE MATERIALS

The non-hazardous waste material observed in and around the site are listed in Table 3.

Table 3: Non-Hazardous Waste Materials

Waste Material	Number/ Volume	Location
wood and metal debris	~15 m ³ wood & 5 m ³ metal	upper drift site
rails	~32	middle adit area
wood debris	45 timbers	toe of slope near middle adit

Waste Material	Number/ Volume	Location
timber crib	1.5 m x 1 m x 1 m	middle adit area
metal and wood debris	~ 10 m ³	scattered over mill foundation near middle adit
pile of cables, wood and metal debris including pipe, angle iron, poles and industrial garbage (dump)	~500 m ³	primarily at top of slope below middle adit
twisted rail, pipe and misc. metal debris	~ 50 m ³	adjacent to lower adit
wood debris	< 10 m ³	adjacent to road near lower adit
empty barrels and pails	28 barrels & 27 pails	areas downstream of dam and below middle adit slope

5.3 HAZARDOUS MATERIALS

The only potentially hazardous materials noted at the site were a sealed barrel with reinforced ribbing and a number of areas where stained soils were noted. The barrel was in satisfactory condition, however, its contents were unknown. The barrel was located near the bank of Big Thing Creek downstream of the dam in an area obscured by vegetation. An attempt to move the barrel by hand was not successful.

A total of seven surface soil samples were collected from potentially contaminated soils at separate locations of the site including stained areas and obvious drainage paths from the site. Sample locations are detailed in Table 5 below. Samples were analyzed for the presence of heavy metals and total extractable hydrocarbons (TEHs). Complete analytical results are provided in Appendix C.

Table 5: Soil Sample Locations

Sample #	Sample Location	Comments
BT-S201	generator site adj. to middle adit	dark stained area
BT-S202	soil on concrete pad adj. to middle adit	dark stained area
BT-S203	stain approx. 5 m from middle adit	dark stained area
BT-S204	adj. to middle adit	background
BT-S205	drainage below middle adit waste rock/ metal dump	no obvious staining; vegetation stress
BT-S206	drainage below middle adit waste rock/ metal dump	no obvious staining
BT-S207	bottom of drainage path from site approx. 100 m downstream of dam	no obvious staining

The concentration of arsenic was above CCME commercial/industrial remediation criteria in all samples including the background sample. Waste rock samples collected at the site for the acid mine drainage assessment were also elevated indicating that the background concentration of arsenic is high. The concentration of total extractable hydrocarbons (TEHs) was above Yukon remediation criteria in samples BT-S201, S202 and S203, indicating that petroleum hydrocarbon contaminated soils are present near the middle adit. Hydrocarbon distributions of these three samples indicate that contamination is the result of heavy oils, possibly attributable to waste oil spills or leaks. Laboratory results are detailed in Table 6 below. Complete analytical results are provided in Appendix C. Sample locations are included on Drawing 1.

Table 6: Soil Sample Laboratory Results (ppm)

Parameter	Yukon Cont. Sites Criteria	CCME Indust. Remed Criteria	Sample # (BT-S)						
			201	202	203	204	205	206	207
Antimony	40	40	< 20	33	28	< 20	37	< 20	< 20
Arsenic	-	50	2370	2540	2230	135	2340	1150	1370
Barium	2000	2000	69	76	62	96	90	51	45
Beryllium	8	8	0.7	< 0.5	0.5	1.5	0.9	< 0.5	0.6
Cadmium	-	20	4	7	8	5	12	3	5
Chromium	800	800	11	51	25	4	16	14	12
Cobalt	300	300	5	12	8	4	6	5	4
Copper	-	500	42	107	119	16	265	40	39
Lead	-	1000	254	410	302	194	281	145	169
Mercury	10	10	0.011	0.015	0.012	0.006	0.036	0.019	0.010
Molybdenum	40	40	7	19	7	4	12	6	6
Nickel	500	500	6	26	14	3	8	6	16
Selenium	10	10	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Silver	40	40	6	8	7	< 2	12	5	5
Tin	300	300	< 30	< 30	< 30	< 30	< 30	< 30	< 30
Vanadium	-	-	15	23	29	8	29	29	19
Zinc	-	1500	255	536	651	417	246	107	117
TEHs	1000	-	13700	28400	23200	< 40	85	84	< 40

5.4 SURFACE WATER QUALITY

Table 7 identifies the significant findings of the sampling program conducted to determine the potential impact of the site on surface water bodies. Samples were taken from a rock seep, lower adit water, and upstream and downstream of the mine on Big Thing Creek. Complete analytical results are provided in Appendix C.

Sample BT-WQ-A103 was collected from water discharging from the lower adit. A water sample, BT-WQ-S101, was collected from a seep below the ore stockpile at the shaft. No seeps of water were observed from the waste rock piles below the adits and no water was discharging from the middle adit. Surface run off from the seep and adit are absorbed by waste rock and do not directly enter Big Thing Creek. There is no evidence of ponding of potentially contaminated water that may be used by wildlife. Seep and adit sample locations are included on Drawing 1.

Elevated concentrations of arsenic, aluminum, copper, iron and zinc in the adit water and elevated concentrations of arsenic in the seep water were noted, however, the samples meet the criteria specified in Schedule 1 of the Metal Mining Liquid Effluent Regulations and Guidelines.

Comparison of the upstream, BT-WQ-Str104, and downstream, BT-WQ-Str102, water quality samples from Big Thing Creek suggests that the downstream environment is unaffected by the waste rock drainage. Field measurements of pH and conductivity were taken as for a secondary measurement.

Elevated concentrations of aluminum were noted in the background sample. The water quality of the downstream sample is below the criteria outlined in Schedule 1 of the Metal Mining Liquid Effluent Regulations and Guidelines for all parameters. None of the inorganic parameter analytes in the downstream water sample were elevated above background concentrations. For some metals, detection limits were above background values.

Table 7: Surface Water Samples - Significant Results

Sample ID	Sample Location	pH	^{Field} Conductivity (μ mhos/cm)	Metallic Parameters
BT-WQ-A103	Mine water from lower adit	5.13	10	As, Cu, Fe and Zn
BT-WQ-S101	Seep on roadside at bottom of waste rock below shaft	6.1	40	As
BT-WQ-Str102	~ 500 downstream of dam	5.54	20	low
BT-WQ-Str104	~ 500 m upstream of dam	5.62	20	low

5.5 WASTE ROCK DISPOSAL AREAS

Waste rock is located below the three underground mine openings. Stockpiled ore is located below the inclined shaft. Eight pits were dug in the waste rock, from which eleven samples were gathered for laboratory analysis. A sample of the gravel near the waste rock piles was also collected to establish the background chemistry of the site. Several paste pH and paste conductivity tests were completed. The sample locations and field paste test results are shown on the site map, Drawing 2.

Waste rock samples (BT/WR/*) P301/1, P301/2, P302, and P308 were collected from rock at the shaft. The rock deposited below the shaft is likely an ore stockpile. Samples (BT/WR/*) P303 and P309 were collected from rock located at the middle adit. Sample P309 was collected on the ore loadout ramp and sample P303 was collected on what appeared to be a waste rock loadout ramp. Sample BT/WR/P304 is not waste rock. It was collected from a pit dug in the gravel below the road leading to the ore loadout ramp. Waste rock samples (BT/WR/*) P305/1, P305/2, P306/1, P306/2 and P307 were collected from three pits below the loadout facilities at the lower adit. Sample BT/WR/P401 was collected from potential borrow source material 1 km west of the Big Thing site in the saddle between Montana Mountain and Sugarloaf Hill.

Waste rock samples collected from the middle adit, three of the four ore stockpile samples and two of the five waste rock samples from the lower adit had acidic paste pH values, ranging from 2.85 to 4.75. These samples also had high paste conductivity measurements. The results indicate that these samples are net acid generating. All waste/ore rock samples are potentially acid generating with NP:AP ratios less than one. Half of the samples analyzed are currently acid producing. All waste rock samples contained elevated levels of arsenic. Some samples also showed high zinc and cadmium concentrations. Accounting test results are shown in Table 8.

Table 8: Summary Acid/Base Accounting Test Results

Sample #	Paste pH	Total S (%) ^x	SO ₄ (%) ^x	AP	NP	Net NP	NP/AP
BT/WR/P301/1	2.3	331.00	40.00	90.94	7.19	-83.75	< 0.1
BT/WR/P301/2	2.53	53.00	no assay	16.56	556.25	-11.00	0.34
BT/WR/P302	2.63	297.00	31.00	83.13	481.25	-78.31	< 0.1
BT/WR/P303	2.66	66.00	no assay	20.31	0.00	-20.31	< 0.1
BT/WRO/P304	4.84	4.00	no assay	21.25	106.25	-0.19	0.85
BT/WR/P305/1	6.35	68.00	no assay	1.25	21.25	0.00	1.00
BT/WR/P305/2	2.33	1.25	17.00	33.75	-300.00	-36.75	< 0.1
BT/WR/P306/1	1.89	87.00	no assay	27.19	-200.00	-29.19	< 0.1
BT/WR/P306/2	4.34	111.00	15.00	3000.00	11.63	-1837.50	38.75
BT/WR/P307	6.02	52.00	no assay	16.25	17.13	0.88	1.05
BT/WR/P308	4.90	21.00	no assay	6.56	-0.81	0.00	< 0.1
BT/WR/P309	2.19	219.00	11.00	65.00	-387.50	-68.88	< 0.1
BT/WR/P401	4.29	2.00	no assay	0.63	0.63	0.00	1.00

5.6 MINE OPENINGS AND EXCAVATIONS

There are two adits and an inclined shaft at the site. The inclined shaft has caved in. Additional failure of the back may be occurring. The upper adit (1705 m Level) is open. The lower adit (1645 m Level) has caved. Table 9 shows the results of the mine openings investigation

Table 9: Mine Openings

Adit	Location	Drift Length	Condition
Inclined shaft	near the mountain peak, approx. 1740 m elev.	137 m	collapsed entrance, possibly unsafe conditions surrounding entrance
middle adit	SW of shaft, 1705 m elev.	unknown	open, wood entrance
lower adit	S of middle adit, 1645 m elev.	707 m	collapsed entrance

5.7 TAILINGS

Ore was not processed at the site and, therefore, no tailings are present at the Big Thing site. Hand-picked ore samples were shipped off the property for milling in 1910, 1911 and 1925. The milling likely occurred at the Conrad mill on the west shore of Windy Arm. The Arctic Gold and Silver Mill, which received ore from the site in the 1960's is located 4 km to the north.

6.0 CONCLUSIONS

The primary concerns at Big Thing mine are the health and safety of humans and wildlife relating to the collapsing mine openings, trestle and loadout facilities and the environmental risk associated with ARD potential from the site. Secondary concerns are the environmental and human safety risk associated with potentially hazardous contents of a single barrel and petroleum hydrocarbon contaminated soils adjacent to the middle adit. Other concerns are the aesthetic appearance of various metal and wood wastes noted throughout the site, particularly the large volume of debris that has been spread down the slope below the middle adit.

6.1 HEALTH AND SAFETY

The Big Thing site is visited by tourists on a regular basis during the summer months. The public is exposed to a health and safety risk from unstable ground above the inclined shaft and the lower adit, as well as from the water quality of the small seep adjacent to the ore stockpile. The unstable trestle and loadout facilities also pose a human risk.

6.2 ENVIRONMENTAL RISKS

The waste rock and ore currently on site are generating acid. Analytical data received to date indicate that the rock piles are not impacting the local environment. However, future impacts cannot be anticipated without an understanding of the local hydrology. At this time, it is unknown whether the environmental quality of the site, as observed during the site visit in August 1996, will remain unchanged with time. No immediate action is required, with respect to ARD.

The earthen dam has caused significant changes to creek flow. In its current condition it probably affects local fish population movement, however, removal of the dam would require some disruption of the stream bed.

The contents of the reinforced barrel, currently in satisfactory condition, are unknown. If left alone, the barrel will degrade with time and may eventually result in a hazardous waste spill capable of impacting on the surrounding environment. There is also a moderate risk to workers moving the barrel since the contents are unknown.

6.3 AESTHETIC CONCERNS

Aesthetic concerns arise from the range of infrastructure, equipment and debris, both metal and wood, noted throughout the site, particularly the large refuse dump which has spread down the face of the waste rock slope below the middle adit.

7.0 RECOMMENDATIONS

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

Recommendation 1.

The open adit and the unstable area around the shaft openings should be secured from human and animal access for health and safety reasons. It is recommended that all the timber at the inclined shaft be removed, the area collapsed with a dozer and the depression filled by dozing with adjacent materials. All timbers and wood above the slope of the plane at the two adits should be cut and removed. The wood should be removed and burned, the middle adit collapsed with a dozer to the greatest extent possible and the depression filled by dozing.

Recommendation 2.

It is recommended that the reinforced barrel be removed from the site, transported to Whitehorse for identification and disposed of at a licensed facility.

Recommendation 3.

It is recommended that a more detailed assessment of site hydrology and chemistry be performed to assess the potential impacts of waste rock on the receiving environment. This study is required to develop an effective remediation plan for the

waste rock and ore stockpiles. There is currently insufficient information to determine whether leaving the piles as is will be environmentally acceptable.

No further test work is recommended on the waste rock. Additional water quality sampling is required to monitor the impact on the receiving environment. Samples should be collected at BT-WQ-STR-101, BT-WQ-STR-102, BT-WQ-STR-104 and BT-WQ-A-103. Any additional seeps observed at the base of the waste rock and ore stockpiles should also be sampled and analysed.

It is recommended that for 1997 a monitoring program be undertaken to obtain water quality data during spring freshet, middle summer and late fall conditions. The results can then be used to determine appropriate remediation measures and future monitoring requirements.

Recommendation 4.

Culverts at the earthen dam should be removed and buried and the creek bed should be restored to its original configuration. Fisheries and Oceans Canada should be consulted prior to initiating any in-stream work to ensure that fish habitats are not damaged.

Recommendation 5.

It is recommended that the building be demolished and burned on site. The rail track should be demolished, wood waste burned and metal buried in trenches on site. Hoist and heavy equipment should also be buried. The loadout facilities and trestles should be dozed, wood should be removed and burned and the areas restored to the original slopes by dozing. These activities can be accomplished using locally available resources and labour and the rails can be buried on-site together with other site debris. Burial can occur by covering waste material with surrounding rock and soil on a clearing adjacent to a rock slope.

Recommendation 6.

It is recommended that metal and wood site debris, including that noted in the middle adit slope debris pile, be collected and separated. The wood debris should be burned at a designated burn site and metal debris should be buried at a designated area on site using locally available labour and resources.

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APPENDIX A

DETERMINATION OF ACID ROCK DRAINAGE POTENTIAL

P118105

**BIG THING
ACID ROCK DRAINAGE
ASSESSMENT REPORT**

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SITE MAP

P118105

**BIG THING
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 Big Thing 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 Big Thing site.

This report assessed the existing, and potential acid rock drainage (ARD) conditions at the Big Thing 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 Big Thing site is located in the Wheaton River district, approximately nine kilometres west of the Village of Carcross, Yukon Territory. The site is accessible by vehicle.

The mine workings observed during the site assessment are located on three levels and consist of two adits, and a caved inclined shaft. Waste rock has been dumped in front of each of these workings, as shown on Drawing 2. Mill foundations and a tailings pond are located four kilometres to the north on a separate site, the Arctic Gold and Silver site. The waste rock present at the Big Thing site is the result of development work between 1905 and 1916 and between 1965 and 1967. The last reported underground activity was

1970

in 1975 and 1976, when the workings were rehabilitated and ore stockpiled (Yukon Minfile 105D-009).

The site is above the treeline and is covered with short grasses and alpine vegetation on top of glacial till. Surface runoff from the mine site flows into a second order stream 10 metres to the west of the lower waste rock pile.

2.0 GEOLOGY AND MINERALIZATION

The gold and silver ores occur in a series of northeast striking quartz veins that cut medium to coarse grained, locally porphyritic granodiorite. Sulphide mineralization consists chiefly of pyrite (FeS_2), arsenopyrite (FeAsS), sphalerite ($(\text{Zn,Fe})\text{S}$), galena (PbS) and minor chalcopyrite (CuFeS_2) occurring in irregular lenses and shoots within quartz vein material. The vein structures are commonly bordered by a selvage zone of altered granodiorite, consisting of bleaching and pyritization, extending up to 9 metres either side of the vein. Weakly disseminated molybdenite (MoS_2) is sometimes present in the alteration envelope (GSC Paper 68-68, p58-62).

The major commodities identified at this site are gold and silver. Minor commodities include lead, zinc, copper, and molybdenum.

3.0 WASTE ROCK DISPOSAL AREAS

3.1 Description

The volume of waste rock produced from all the historical underground development is in the order of 37,000 tonnes. The assumptions made to derive this estimate are:

- a specific gravity of 2.65;
- a total of 2,600 metres of underground development; and,
- 3.0 by 2.4 metre mine openings.

The waste rock covers a surface area of approximately 12,000 m². Approximately 64% of the surface is stained orange/brown from secondary iron mineralization, 26% of the surface is stained yellow as a result of arsenic secondary mineralization, and 10% has a

whitish staining. The distribution of mineralization in the waste rock piles is shown on a site map, Drawing 2.

Ore was not processed at the site, and therefore no tailings are present at the Big Thing site.

3.2 Samples

Eight pits were dug in the waste rock, from which eleven samples were gathered for laboratory analysis. A sample of the gravel near the waste rock piles was also collected to establish the background chemistry of the site and a till sample was also collected from possible borrow source material, these samples were submitted for geochemical testing. Several paste pH and paste conductivity tests were completed. The sample locations and field paste test results are shown on the site map.

Waste rock samples (BTWR/*) P301/1, P301/2, P302, and P308 were collected from rock at the shaft. The rock deposited below the shaft is likely an ore stockpile. Samples (BTWR/*) P303 and P309 were collected from rock located at the middle adit. Sample P309 was collected on the ore loadout ramp and sample P303 was collected below the waste rock loadout ramp. Sample BTWR/ P304 is overburden material, not waste rock. It was collected from a pit dug in the gravel below the road leading to the ore loadout ramp. Waste rock samples (BTWR/*) P305/1, P305/2, P306/1, P306/2 and P307 were collected from three pits below the loadout facilities at the lower adit. Sample BTS/P401 was collected from potential borrow source material one kilometre west of the Big Thing site in the saddle between Montana Mountain and Sugarloaf Hill. The test pit logs are summarized in Table 1.

A water sample, BTWQ/S101 was collected from a seep below the ore stockpile at the shaft. Sample BTWQ/A103 was collected from water discharging from the lower adit. Water sample BTWQ/STR208 was collected in Big Thing Creek 100 metres downstream of the dam, at which point all runoff from the mine site will have entered the creek. Sample BTWQ/STR102 was collected 500 metres below the dam in Big Thing Creek. Water sample BTWQ/STR104 was collected in Big Thing Creek 500 metres upstream of the dam at the mine site. No seeps of water from the waste rock piles below the adits were observed and no water was discharging from the middle adit. - flow rate?

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

Waste rock samples collected from the middle adit, three of the four ore stockpile samples and two of the five waste rock samples from the lower adit had acidic paste pH values, ranging from 2.85 to 4.75. These samples also had high paste conductivity measurements. The results indicate that these samples are net acid generating.

Acid Base Accounting

All waste/ore rock samples are potentially acid generating with Neutralization Potential to Acid Potential (NP:AP) ratios less than one. Half of the samples analyzed are currently acid producing.

The borrow source material and the overburden sample have NP:AP ratios of 1.00 and 0.85, respectively. These values suggest that these materials may produce acid at some future time. However, the total sulphur content, not accounting for sulphate, in both samples are low (0.02% and 0.04%, respectively) as are the paste conductivity values (30 $\mu\text{S}/\text{cm}$ and 20 $\mu\text{S}/\text{cm}$, respectively). Therefore, the borrow source material and the overburden are not potentially acid generating, and will be suitable for use in remediation work.

Metals Concentrations

All mine waste rock samples contained elevated levels of arsenic. Some samples also showed high zinc and cadmium concentrations.

Water Quality

All water samples meet the criteria specified in Schedule 1 of the Metal Mining Liquid Effluent Regulations and Guidelines. Concentrations of arsenic, copper, iron, manganese

and zinc in the discharge from the lower adit exceeded the CCME criteria for freshwater aquatic life.

The seep below the ore stockpile at the decline shaft had an elevated arsenic concentration. However, there does not appear to be any impact on the water quality in Big Thing Creek downstream of the site.

4.0 EXISTING AND POTENTIAL ACID ROCK DRAINAGE CONDITIONS

The ore stockpile and the wastes rock piles at the Big Thing abandoned mine site are net acid generating. However, the water quality in Big Thing Creek, downstream of the site, did not appear to be significantly impacted by the piles at the time of the site assessment. Low flow conditions may be limiting the release of contaminants from the waste rock piles. During high flow conditions increased flushing of the waste rock may result in increased metal release. It is possible that in the future the acid generating condition may get worse. However, the release of the oxidation products appears to be limited since the surface area for infiltration is small.

5.0 REMEDIATION OPTIONS

Typical reclamation options for acid rock drainage generating from abandoned mine waste rock piles include:

- source control which includes limiting further oxidation, for instance, by placing the waste under water or flooding the underground workings;
- migration control which limits the release of oxidation products to the environment, for example, by reducing infiltration to the waste by placing a low permeability soil cover; and,
- release control by collecting and treating contaminated flows prior to discharge.

Collection and treatment of the runoff from the Big Thing site was not considered a feasible control option, due to the lack of surface water discharging from the site.

Relocation of the waste rock to limit further oxidation to the underground workings through the middle adit may be possible, depending on the space available and the volume of waste rock to be relocated.

Consolidation and covering the waste rock with soil and/or geomembrane to reduce the risk of future acid generation was considered as a remediation option. This option is compared to relocation and "do nothing" in the table below.

Regardless of which option is chosen the sealing of the middle adit may be done by backfilling it with waste rock, which will limit oxygen entry to the adit and thus reduce the potential for acid generation from the underground workings.

Matrix for Evaluating Applicable/Potential Remediation

Option versus Evaluation Criteria	Big Thing			
	Collect and Treat	Relocate	Cover	Do Nothing
Public Health and Safety 5 = provides full protection of public 1 = provides no protection of public	not applicable	5	4	4
Worker Health and Safety 5 = relative low risk to workers 1 = high risk to workers	not applicable	1	4	5
Ecosystem Preservation and Protection 5 = relative low risk to environment 1 = relative high risk to environment	not applicable	3	4	2
Impact on Mineral Resource 5 = allows for continued exploration 1 = impedes continued exploration	not applicable	3	5	5
Direct Costs (mobilization & materials) 5 = relative low cost 1 = relative high cost	not applicable	1	2	5
Monitoring and Maintenance Costs 5 = relative low cost 1 = relative high cost	not applicable	4	3	3
Acceptability 5 = positive response anticipated 1 = negative response anticipated	not applicable	4	5	3
Total Score	0	21	27	27

The Big Thing site is visited by tourists on a regular basis during the summer months. The public is exposed to a health and safety risk from unstable ground above the shaft and the lower adit, as well as from the water quality of the small spring adjacent to the ore stockpile. Relocation of the waste rock underground would involve a significant safety risk to workers and would require the rehabilitation of the workings. Covering the waste rock piles represents a lower health and safety risk to workers since the topography of the site would allow for movement of heavy equipment without excessive risk.

Mine
Drainage

Peerless!

Covering or placing a cover on the waste rock would decrease the amount of infiltration into the pile; however, water quality data indicates that the waste rock currently has a significant impact on the downstream water quality. Relocating the waste underground may reduce the discharge from the lower adit, depending on the underground drainage patterns. Therefore, a moderate risk to the environment exists because the pattern of drainage is unknown. Covering the waste also entails a moderate risk to the ecosystem in two ways. First, disturbing the waste may cause a short term release of soluble metal constituents into the receiving environment. Second, an additional site would be disturbed to provide the cover material. The risk to the environment is slightly higher if no remediation action is undertaken since an increase in acid generation is anticipated. However, the site is located in a moderately dry area that has anomalous background mineralization and sulphides.

Future exploration on the site would be adversely effected if the underground workings were rendered inaccessible to heavy equipment. Covering the waste rock would not impede exploration at the site.

The cost to relocate and cover the waste rock would be relatively high compared to leaving the pile as is. Improvements to the access road would be required to mobilize equipment. Maintenance of the cover would also be required. Monitoring of the receiving water would be required regardless of the remediation option chosen.

Relocating and covering the waste rock pile would improve the aesthetic appearance of the site and are therefore ranked slightly higher for acceptability.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The evaluation of the potential remediation options does not clearly indicate which option is preferable for the long term. Further study will be required to allow a more definitive assessment.

The waste rock and ore currently on site are generating acid. Analytical data received to date indicate that the rock piles are not impacting the local environment. However, future impacts cannot be anticipated without an understanding of the local hydrology. At this time, it is unknown whether the environmental quality of the site, as observed during the site visit in August 1996, would remain unchanged with time.

Backfilling the middle adit, required from a public safety perspective, will reduce the risk for potential acidic discharge from the underground workings.

The borrow source material and the gravel sampled are not potentially acid generating and would be suitable for use in remedial work.

6.2 Recommendations

A more detailed site assessment is required to assess the potential impacts of the waste rock and to develop an effective remediation plan. There is currently insufficient information to determine whether leaving the piles as is will be environmentally acceptable.

No further test work is recommended on the waste rock. Additional hydrology data and water quality sampling is required to evaluate the impact on the receiving environment. It is recommended that for 1997 a monitoring program be undertaken to obtain water quality data during spring freshet, middle summer and late fall conditions. Samples should be collected at BTWQ/STR-101, BTWQ/STR-102, BTWQ/STR-104 and BTWQ/A-103. Any additional seeps observed at the base of the waste rock and ore stockpiles should also be sampled and analyzed. The method detection limits used are to

the CCME for freshwater aquatic life. It is also recommended that a preliminary hydrology assessment be completed to estimate the surface run off from the mine site.

The results can then be used to determine appropriate remediation measures and future monitoring requirements.

7.0 REFERENCES

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TABLE 1 **Big Thing Waste Rock Sample Descriptions**

Sample ID	Sample Description
BTWR/P301/1	mineralized rock, high in arsenopyrite, possibly stockpiled ore. Surface was stained to a yellow/white colour. Sample collected over a thickness of 30 cm. Material sampled was cream/buff in colour and contained 60% fine grained sand, with the rest being pebbles and cobbles. 20% of the pebbles and cobbles were quartz/carbonate vein material containing 5% pyrite, arsenopyrite and chalcopyrite. The paste pH of the waste rock was 2.3 and the paste conductivity was >1990 $\mu\text{S}/\text{cm}$.
BTWR/P301/2	overburden located below the mineralized rock pile. Sample collected below BTWR/P301/1 for 20 cm. Consisted of brown fine grained sand that was moist to the touch. It contained rounded pebbles and minor quantities of organic. The paste pH of the material was 2.53 and the paste conductivity was 860 $\mu\text{S}/\text{cm}$.
BTWR/P302	mineralized rock, possibly stockpiled ore. Surface was stained a pale yellow/green. Sample collected over a thickness of 45 cm. Material was yellow/brown in colour, it contained quartz pebbles and cobbles. The quartz was stained yellow or red and contained pyrite and arsenopyrite. 60% sand, 30% pebbles, 10% cobbles with overall 3% sulphides as pyrite. The paste pH was 2.63 and the paste conductivity was 750 $\mu\text{S}/\text{cm}$.
BTWR/P303	waste rock, below waste loadout area at Middle Adit. Sample collected over a thickness of 40 cm. 70 % sand (5% maroon coloured sand, and 20% silica sand), 30% rounded cobbles with rusty surfaces. The paste pH was 2.66 and the paste conductivity was 900 $\mu\text{S}/\text{cm}$.
BTWR/P304	overburden above lower adit. Gravel collected from eroded slope. The paste pH was 4.84 and the paste conductivity was 20 $\mu\text{S}/\text{cm}$.
BTWR/P305/1	material below track at lower adit. Top 15 cm were buff/brown coloured sand and gravel with no mineralization observed. The paste pH was 6.35 and the paste conductivity was 140 $\mu\text{S}/\text{cm}$.
BTWR/P305/2	mineralized waste. Sample collected below BTWR/P305/1 over a thickness of 20 cm. Material had oxidized cobbles and the sand/silt was orange/brown in colour. The paste pH was 2.33 and the paste conductivity was 770 $\mu\text{S}/\text{cm}$.
BTWR/P306/1	mineralized waste at lower adit, sample collected over a thickness of 20 cm. Surface was stained a pale yellow/green colour. Sample consisted of a mixture of 20% pebbles, 40% cobbles (with 40% of their surfaces oxidized red), 40% orange sand. The paste pH was 1.89 and the paste conductivity was 980 $\mu\text{S}/\text{cm}$.

TABLE 2 Big Thing Waste Rock ABA and ICP Results

Parameter	Units	Sample Number BTWR											BTS	
		P301/1	P301/2	P302	P303	P304	P305/1	P305/2	P306/1	P306/2	P307	P308	P309	P401
Field Paste pH		2.30	2.53	2.63	2.66	4.84	6.35	2.33	1.89	4.34	6.02	4.90	2.19	4.29
Field Cond	µS/cm	>1990	860	750	900	20	140	770	980	740	100	60	1270	30
Lab Paste pH		3.07	2.85	3.01	4.75	6.77	8.01	4.04	4.37	6.87	7.71	6.20	3.60	6.90
Total Sulfur	%	3.31	0.53	2.97	0.66	0.04	0.68	1.25	0.87	1.11	0.52	0.21	2.19	0.02
Sulfate	%	0.40	na	0.31	na	na	na	0.17	na	0.15	na	na	0.11	na
AP		90.94	16.56	83.13	20.31	1.25	21.25	33.75	27.19	30.00	16.25	6.56	65.00	0.63
NP		7.19	5.56	4.81	0.00	1.06	21.25	-3.00	-2.00	11.63	17.13	-0.81	-3.88	0.63
NET NP		-83.75	-11.00	-78.31	-20.31	-0.19	0.00	-36.75	-29.19	-18.38	0.88	-7.38	-68.88	0.00
NP/AP		<0.1	0.34	<0.1	<0.1	0.85	1.00	<0.1	<0.1	0.39	1.05	<0.1	<0.1	1.00
Aluminum	%	0.13	0.35	0.18	0.39	0.55	0.71	0.33	0.40	0.42	0.51	0.34	0.21	0.85
Antimony	ppm	333	115	326	102	20	14	81	82	37	18	108	265	6
Arsenic	ppm	>10000	9086	>10000	6791	1281	1496	8125	5803	5149	2629	8713	>10000	125
Barium	ppm	43	66	25	42	60	34	25	34	33	29	77	20	55
Beryllium	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	ppm	45	8	31	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	ppm	>100	>100	>100	>100	<0.1	0.7	>100	96.1	>100	25.5	>100	>100	<0.1
Calcium	%	0.02	0.04	0.06	0.28	0.18	1.27	0.19	0.30	0.75	0.99	0.09	0.04	0.21
Chromium	ppm	154	108	146	125	102	76	116	112	122	109	95	127	106
Cobalt	ppm	6	5	17	5	5	5	5	5	6	6	4	6	4
Copper	ppm	119	63	113	76	31	26	75	70	74	31	84	114	8
Gallium	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	%	5.29	3.22	5.45	2.49	2.36	2.06	2.38	2.23	2.20	1.84	2.78	3.75	1.65
Lead	ppm	3108	759	1711	1217	289	145	358	372	219	142	569	1568	28
Lithium	ppm	<1	2	<1	2	3	6	2	3	3	4	<1	<1	9
Magnesium	%	<0.01	0.10	<0.01	0.10	0.12	0.30	0.07	0.11	0.19	0.21	0.03	<0.01	0.28
Manganese	ppm	29	110	35	151	442	698	83	244	765	658	227	13	365
Molybdenum	ppm	29	20	52	22	15	27	32	24	24	27	29	42	9
Nickel	ppm	13	11	12	10	12	12	8	9	13	10	9	11	11
Potassium	%	0.21	0.14	0.19	0.21	0.14	0.14	0.18	0.18	0.19	0.15	0.23	0.22	0.10
Phosphate	ppm	120	230	190	260	360	330	250	320	310	330	270	250	310
Silver	ppm	155.4	32.0	192.6	48.6	3.3	3.3	41.7	48.1	15.0	5.5	37.6	118.5	0.7
Sodium	%	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
Strontium	ppm	13	22	5	18	25	35	6	11	18	23	48	<1	26
Thorium	ppm	<1	<1	<1	5	4	9	3	6	7	10	5	<1	3
Tin	ppm	2	<1	3	<1	<1	<1	<1	<1	<1	<1	<1	2	<1
Titanium	%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tungsten	ppm	4	4	3	6	5	3	6	5	7	5	4	4	5
Uranium	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium	ppm	<0.1	9.0	<0.1	5.4	8.4	5.0	2.1	5.0	3.2	3.3	1.6	<0.1	15.5
Zinc	ppm	49	92	92	238	187	230	585	236	1060	120	184	174	61

AP = Acid Potential in tonnes CaCO₃ equivalent per 100 tonnes of material
 NP = Neutralization Potential in tonnes CaCO₃ equivalent per 1000 tonnes of material
 Net NP = Net Neutralization Potential = tonnes CaCO₃ equivalent per 1000 tonnes of material

na = no assay / analysis
 < = lower detection limit
 > = upper detection limit

*Steffen, Robertson and Kirsten
 February, 1997*

Sample ID	Sample Description
BTWR/P306/2	waste. Sample collected below BTWR/P306/1 over a thickness of 30 cm. Material was banded grey sand 70% and orange/brown sand 30%. The paste pH was 4.34 and the paste conductivity was 740 μ S/cm.
BTWR/P307	mineralized waste. Sample collected over a thickness of 40 cm at lower adit from an area where the surface had a whitish stain. The material in the pit had 50% grey buff coloured intrusive cobbles (granodiorite) the remainder of the material was sand and pebbles with 1% red iron stain blebs. The paste pH was 6.02 and the paste conductivity was 100 μ S/cm.
BTWR/P308	waste rock at the inclined shaft. Collected over a thickness of 30 cm. Surface material consisted of iron stained cobbles. The pit contained 70% brownish and yellowish coloured angular cobbles of mineralized intrusive rock having 1% pyrite along fractures and 30% sand. The angular cobbles formed stratified bands. The paste pH was 4.90 and the paste conductivity was 60 μ S/cm.
BTWR/P309	mineralized waste rock collected below the ore loadout railroad track at the middle adit. Sample collected over a thickness of 30 cm The material consisted of 70% angular fragments (cobble and gravel size) and 30% yellow/brown sand. The quartz carbonate vein fragments contained 3% pyrite and arsenopyrite, some fragments had been stained brown, but most were stained yellow. The paste pH was 2.19 and the paste conductivity was 1270 μ S/cm.
BTS/P401	Potential borrow source material collected approximately 1 kilometre west of Big Thing in the saddle between Montana Mountain and Sugarloaf Hill. The paste pH was 4.29 and the paste conductivity was 30 μ S/cm.

TABLE 3 Big Thing Water Quality Results

Parameter	Units	Sample Number BTWQ/				
		A 103	Str 102	S 101	Str 104	Str 208
Field Conductivity	umhos/cm	10	20	40	20	na
Field pH		5.13	5.54	6.1	5.62	na
Lab Conductivity	umhos/cm	56.1	22.6	44.2	15.1	21.7
Lab pH		5.46	6.68	6.62	6.8	7.08
Acidity (to pH 8.3) CaCO3	mg/L	5.2	1.9	4.1	1.6	1
Alkalinity-Total CaCO3	mg/L	<1.0	6.3	9.3	4.8	4.5
Sulphate SO4	mg/L	20.3	3.5	6.3	1.6	3.5
Aluminum T-Al	mg/L	3.5	0.3	<0.2	1.6	<0.2
Antimony T-Sb	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic T-As	mg/L	0.7	<0.2	0.4	<0.2	<0.2
Barium T-Ba	mg/L	0.04	<0.01	<0.01	<0.01	<0.01
Beryllium T-Be	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth T-Bi	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Boron T-B	mg/L	<0.1	<0.1	<0.1	0.2	<0.1
Cadmium T-Cd	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium T-Ca	mg/L	6.41	2.49	5.15	5.12	2.34
Chromium T-Cr	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt T-Co	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Copper T-Cu	mg/L	0.02	<0.01	<0.01	<0.01	<0.01
Iron T-Fe	mg/L	5.08	<0.03	0.08	0.08	<0.03
Lead T-Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium T-Li	mg/L	<0.01	<0.01	<0.01	0.19	<0.01
Magnesium T-Mg	mg/L	1.85	0.47	0.71	0.34	0.46
Manganese T-Mn	mg/L	0.506	<0.005	0.005	<0.005	<0.005
Molybdenum T-Mo	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel T-Ni	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus T-P	mg/L	<0.3	<0.3	<0.3	<0.3	<0.3
Potassium T-K	mg/L	<2	<2	<2	<2	<2
Selenium T-Se	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Silicon T-Si	mg/L	4.07	1.35	2.87	1.2	1.24
Silver T-Ag	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium T-Na	mg/L	<2	<2	<2	<2	<2
Strontium T-Sr	mg/L	0.034	0.019	0.017	0.033	0.019
Thallium T-Tl	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Tin T-Sn	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03
Titanium T-Ti	mg/L	0.03	<0.01	<0.01	<0.01	<0.01
Vanadium T-V	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03
Zinc T-Zn	mg/L	0.168	<0.005	0.009	0.012	<0.005

na = no assay / analysis

< = lower detection limit

Steffen Robertson and Kirsten
February, 1997

APPENDIX B
SITE PHOTOGRAPHS

Photos	Description
B.T. # 23	Loadout Facilities, Lower Loading Facility
B.T. # 24	Loadout Facilities
B.T. # 25	Loadout Facility - Deteriorating Condition
B.T. # 26	Loadout Facility - Deteriorating Condition
B.T. # 27	Debris East of Trestle, Dam in Background
B.T. # 28	Rails East of Adit
B.T. # 29	Twisted Rails and Debris by Road
B.T. # 30	Lower Adit, Collapsed
B.T. # 31	Debris by Adit: Relationship to Middle Adit
B.T. # 32	Lower Loadout Facility from Upper Drift
B.T. # 33	Debris near Upper Drift Site
B.T. # 34	Collapsed Upper Drift Site
B.T. # 35	Debris at Upper Drift Site
B.T. # 36	Debris at Upper Drift Site
B.T. # 37	Debris at Upper Drift Site
B.T. # 38	Pumphouse by Dam
B.T. # 39	Culverts and Collapsed Dam
B.T. # 40	Reinforced Barrel adjacent to Old Boiler
B.T. # 41	Collapsed Earthen Dam and Water Reservoir on Big Thing Creek
B.T. # 42	Approximately 100m Downstream of Earthen Dam
B.T. # 43	Approximately 100m Upstream of Water Reservoir
B.T. # 44	Soil Stains adjacent to Middle Adit
B.T. # 45	Soil Stains on Concrete Pad
B.T. # 46	Background Sample adjacent to Middle Adit Area
B.T. # 47	Sample Area below Waste Rock / Metal Debris Pile
B.T. # 48	Drainage Path below Lower Adit



Photo # 1 - Entrance to Middle Adit



Photo # 2 - Track to Middle Adit, Upper Shoot Above



Photo # 3 - Rails by Middle Adit



Photo # 4 - Wood Debris by Middle Adit



Photo # 5 - Retaining Wall



Photo # 6 - Timber Crib



Photo # 7 - Foundations and Debris North of Adit



Photo # 8 - Track to Loading Facilities



Photo # 9 - Structures Supporting Loadout Facilities, Middle Adit



Photo # 10 - Loading Facility - Detail



Photo # 11 - Deteriorating Structure - Detail



Photo # 12 - Dangerous Conditions - Loadout Facility



Photo # 13 - Top of Loadout Facility looking South



Photo # 14 - Dangerous Conditions - North Rails



Photo # 15 - Cable and Debris on Slope



Photo # 16 - Debris by Loadout Facility



Photo # 17 - Abandoned Heavy Equipment



Photo # 18 - Debris on Slope



Photo # 19 - Debris on Slope



Photo # 20 - General View looking up to Middle Adit



Photo # 21 - General Arrangement Lower Loading Facilities



Photo # 22 - Deteriorated Track, Lower Loading Facility



Photo # 23 - Loadout Facilities, Lower Loading Facility



Photo # 24 - Loadout Facilities



Photo # 25 - Loadout Facility - Deteriorating Condition



Photo # 26 - Loadout Facility - Deteriorating Condition



Photo # 27 - Debris East of Trestle, Dam in Background



Photo # 28 - Rails East of Adit



Photo # 29 - Twisted Rails and Debris by Road



Photo # 30 - Lower Adit, Collapsed



**Photo # 31 - Debris by Adit:
Relationship to Middle Adit**



Photo # 32 - Lower Loadout Facility from Upper Drift



Photo # 33 - Debris near Upper Drift Site



Photo # 34 - Collapsed Upper Drift Site



Photo # 35 - Debris at Upper Drift Site



Photo # 36 - Debris at Upper Drift Site



Photo # 37 - Debris at Upper Drift Site

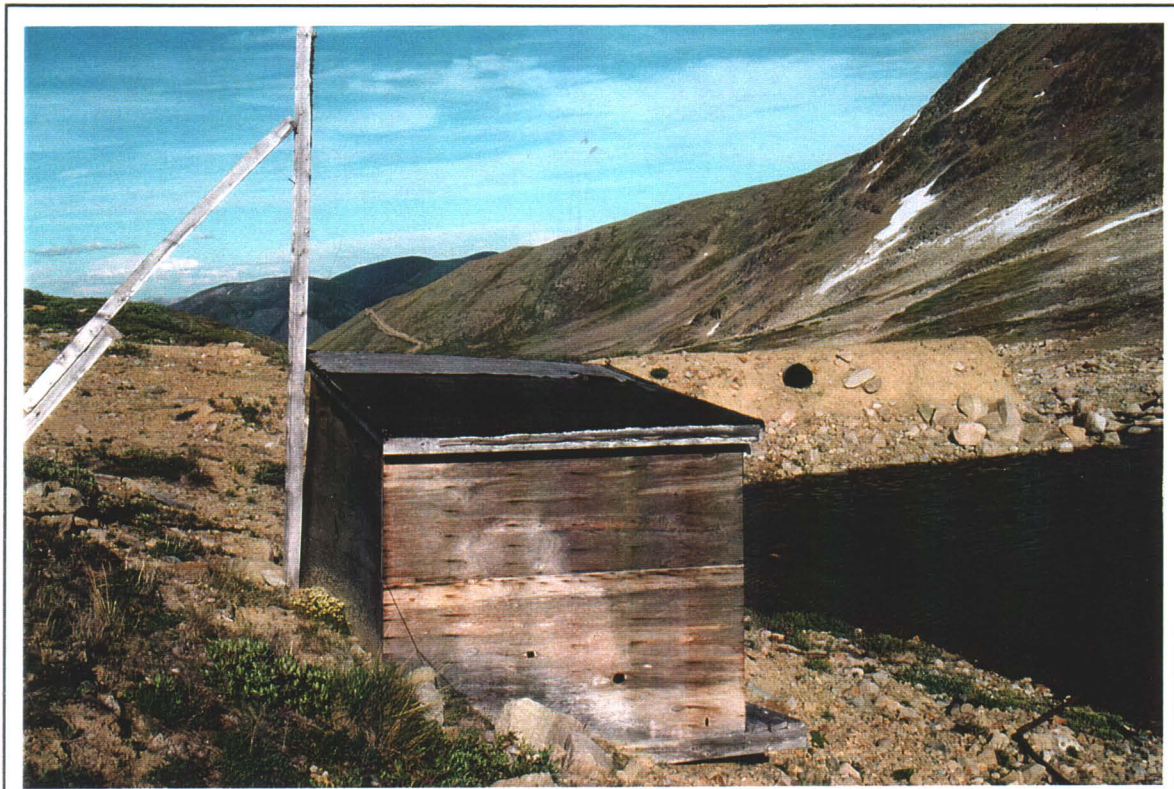


Photo # 38 - Pumphouse by Dam



Photo # 39 - Culverts and Collapsed Dam



Photo # 40 - Reinforced Barrel adjacent to Old Boiler

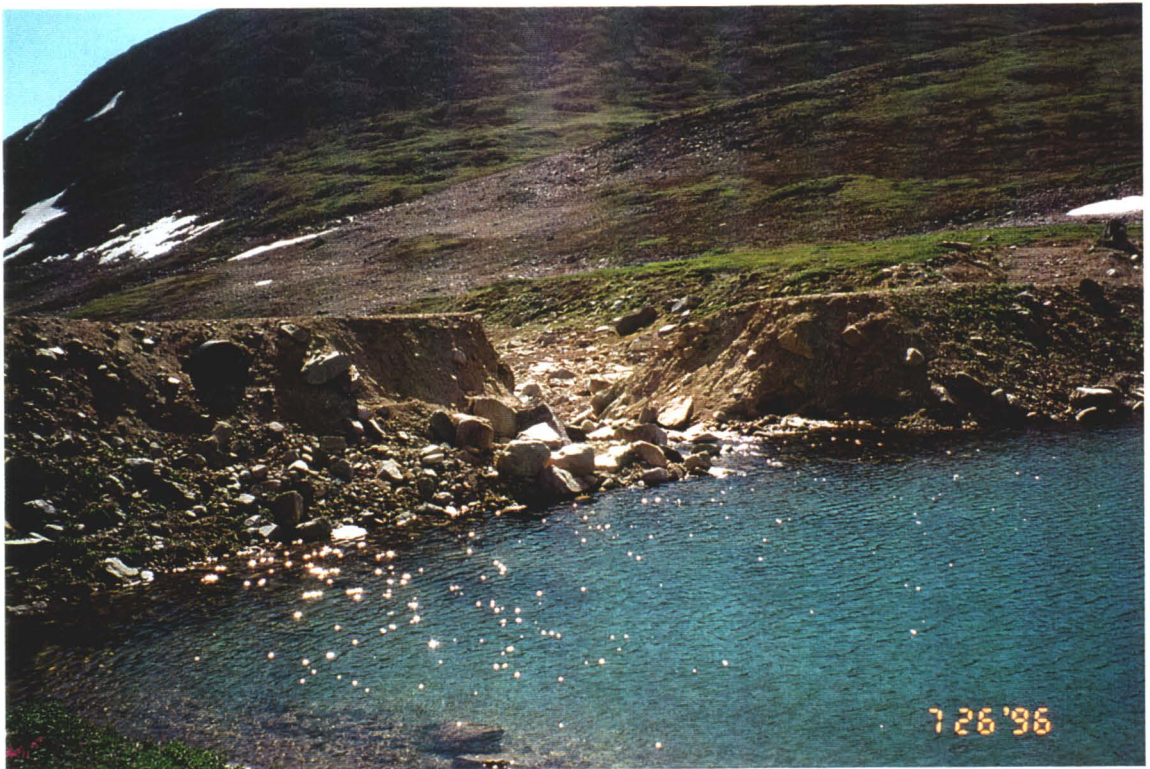


Photo # 41 - Collapsed Earthen Dam and Water Reservoir on Big Thing Creek



Photo # 42 - Approximately 100m Downstream of Earthen Dam



Photo # 43 - Approximately 100m Upstream of Water Reservoir



Photo # 44 - Soil Stains adjacent to Middle Adit



Photo # 45 - Soil Stains on Concrete Pad



Photo # 46 - Background Sample adjacent to Middle Adit Area



Photo # 47 - Sample Area below Waste Rock / Metal Debris Pile

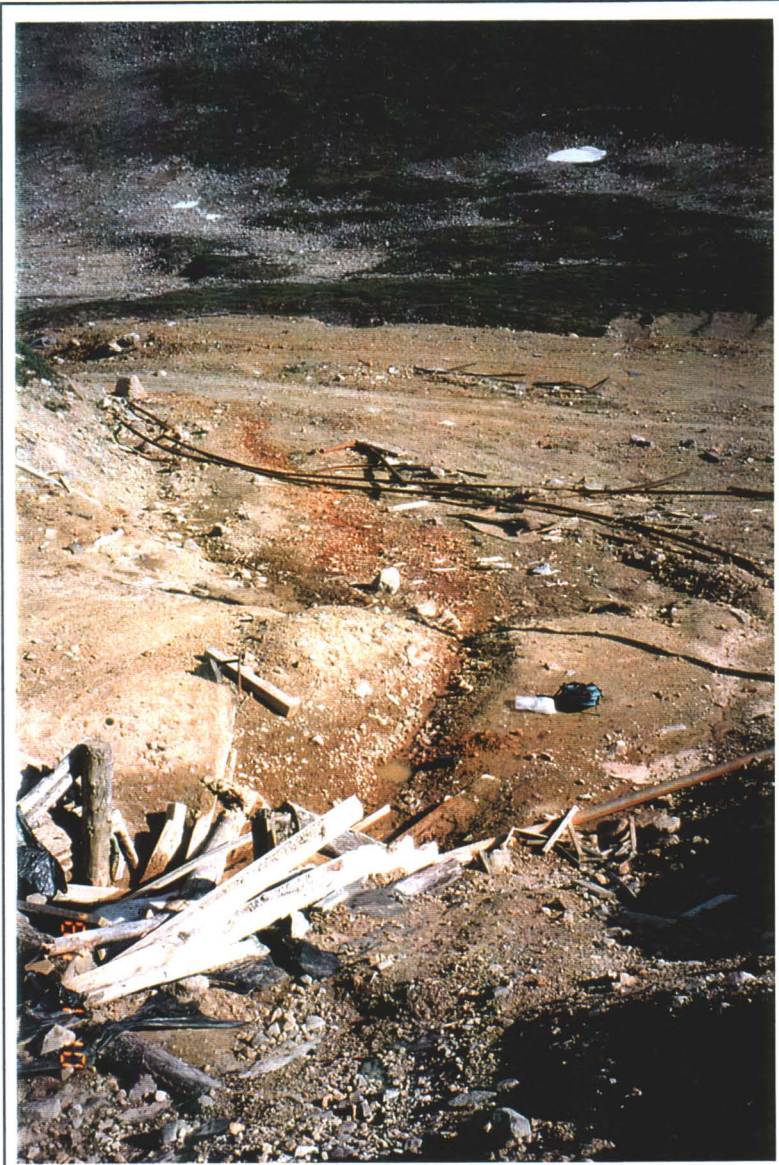


Photo # 48 - Drainage Path below Lower Adit

APPENDIX C
ANALYTICAL RESULTS



RESULTS OF ANALYSIS - Sediment/Soil¹

File No. G3879

	SM-S202	BT-S201	BT-S202	BT-S203
<u>Polycyclic Aromatic Hydrocarbons</u>				
Acenaphthene	2.8	-	-	-
Acenaphthylene	2.3	-	-	-
Anthracene	0.6	-	-	-
Benzo(a)anthracene	<0.1	-	-	-
Benzo(a)pyrene	<0.1	-	-	-
Benzo(b)fluoranthene	<0.1	-	-	-
Benzo(g,h,i)perylene	<0.1	-	-	-
Benzo(k)fluoranthene	<0.1	-	-	-
Chrysene	0.1	-	-	-
Dibenz(a,h)anthracene	<0.1	-	-	-
Fluoranthene	0.2	-	-	-
Fluorene	12.2	-	-	-
Indeno(1,2,3-c,d)pyrene	<0.1	-	-	-
Naphthalene	1.3	-	-	-
Phenanthrene	12.6	-	-	-
Pyrene	0.9	-	-	-
<u>Extractables</u>				
Total Extr Hydrocarbons (C10-30)	51500	13700	28400	23200
<u>Organic Parameters</u>				
Extractable Organic Halide	<1.5	-	-	-

Remarks regarding the analyses appear at the beginning of this report.

< = Less than the detection limit indicated.

¹Results are expressed as milligrams per dry kilogram except where noted.



RESULTS OF ANALYSIS - Sediment/Soil'

File No. G3879

SM-S202 BT-S201 BT-S202 BT-S203

Physical Tests

Moisture % 14.7 2.8 4.5 2.8

Total Metals

Antimony T-Sb <20 <20 33 28
Arsenic T-As 48.3 2370 2540 2230
Barium T-Ba 86 69 76 62
Beryllium T-Be 0.7 0.7 <0.5 0.5
Cadmium T-Cd <2 4 7 8
Chromium T-Cr 68 11 51 25
Cobalt T-Co 2 5 12 8
Copper T-Cu 95 42 107 119
Lead T-Pb 82 254 410 302
Mercury T-Hg 0.011 0.011 0.015 0.012
Molybdenum T-Mo 17 7 19 7
Nickel T-Ni 19 6 26 14
Selenium T-Se <50 <50 <50 <50
Silver T-Ag <2 6 8 7
Tin T-Sn <30 <30 <30 <30
Vanadium T-V 89 15 23 29
Zinc T-Zn 71 255 536 651

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

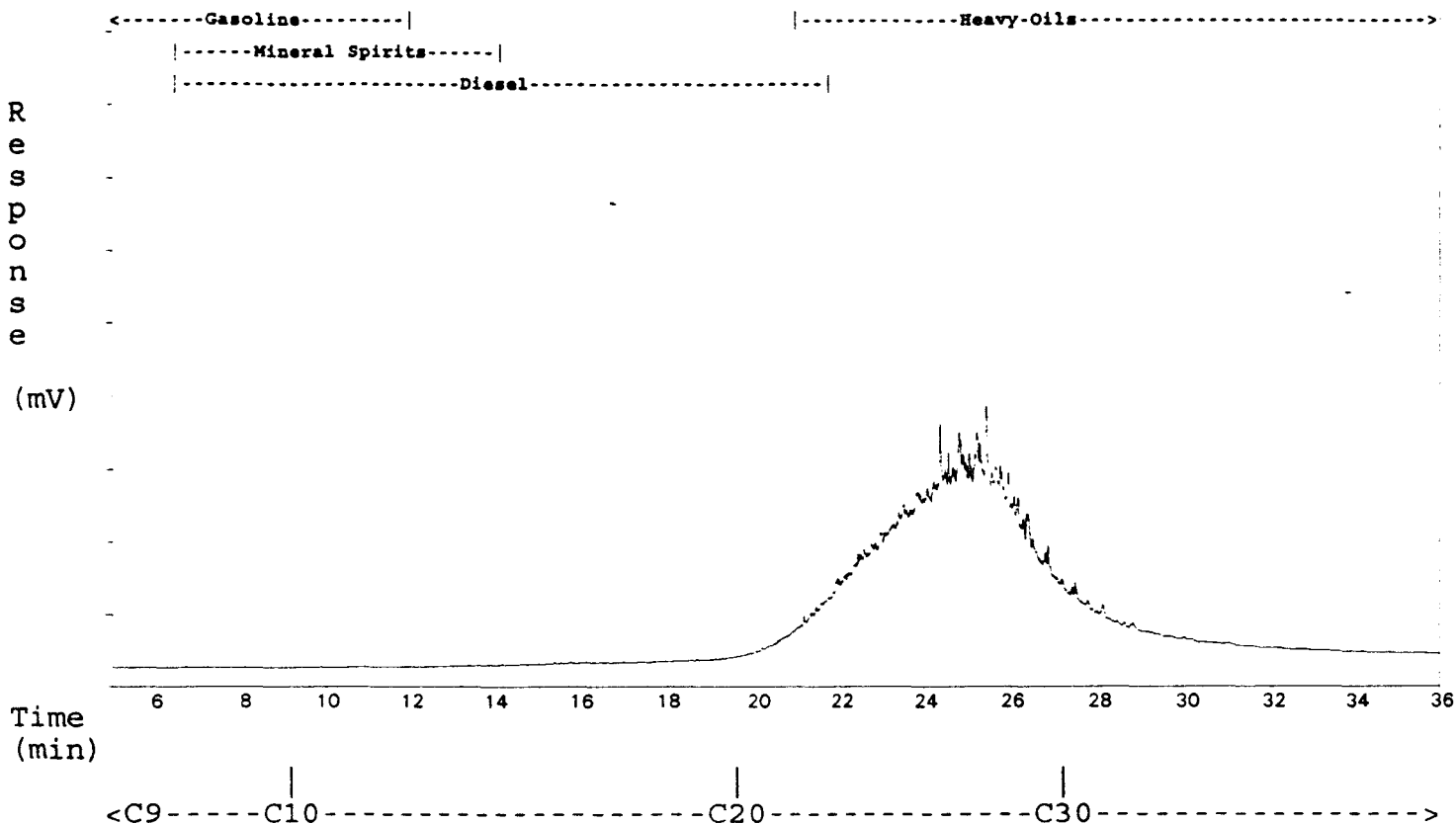
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G3879 39 BT-S201

Sample acquired: AUG 24, 1996 23:56:36

File Name: c:\TEH\TEHAUG23.75R , Sample Name: G3879 39

Sequence file: TEHAUG23



ASL Sample ID: G3879 39* 10 X Dilution

HYDROCARBON RANGE (C#)	RELATIVE AMOUNT (%)
Less than Carbon 10 (<C10)	0.0
Carbon 10 to Carbon 20 (C10-C20)	1.9
Carbon 20 to Carbon 30 (C20-C30)	77.0
Greater than Carbon 30 (>C30)	21.0

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

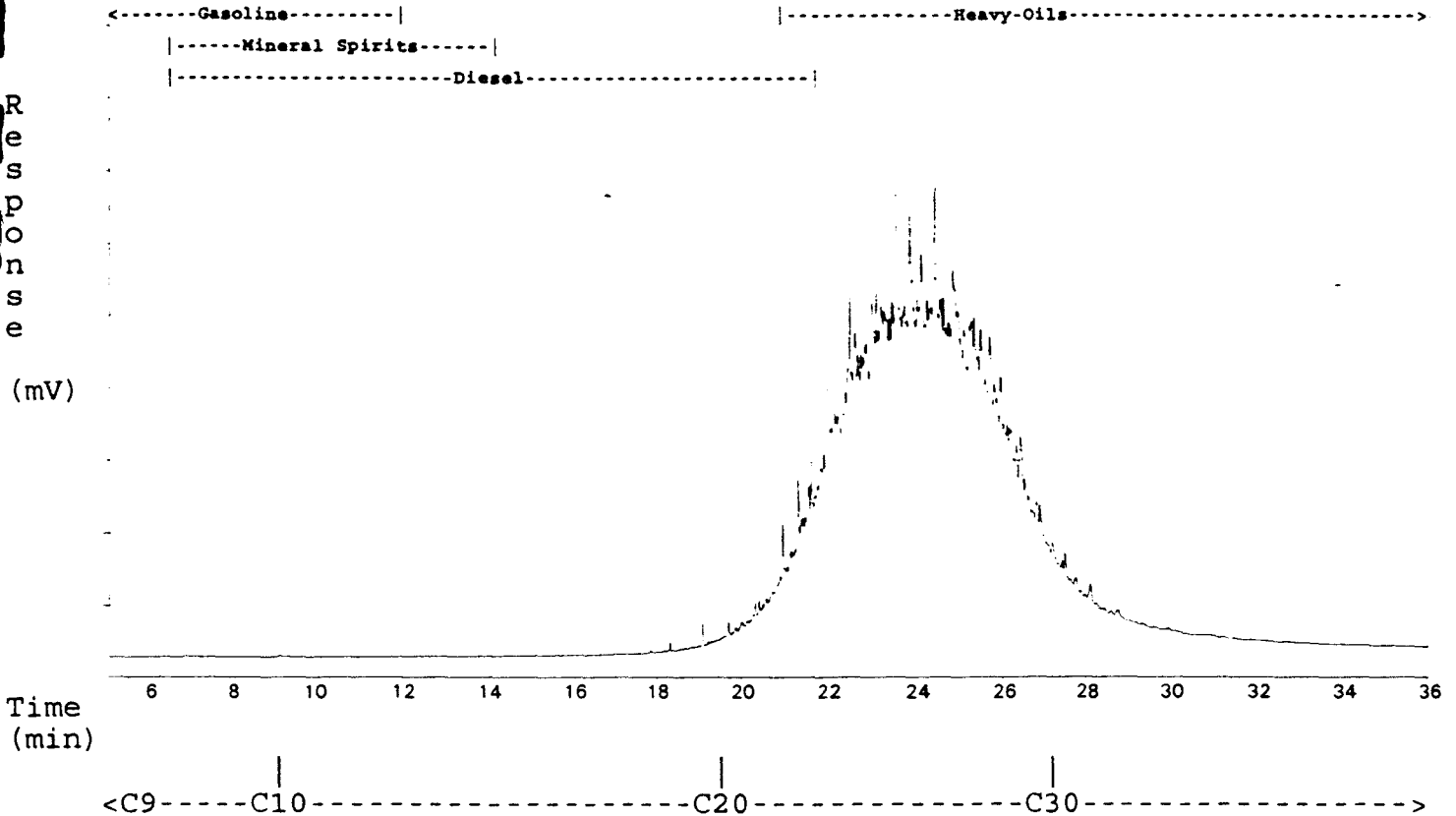
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G3879 40 BT-S202

Sample acquired: AUG 24, 1996 23:56:36

File Name: c:\TEH\TEHAUG23.76R , Sample Name: G3879 40

Sequence file: TEHAUG23



ASL Sample ID: G3879 40* 10 X Dilution

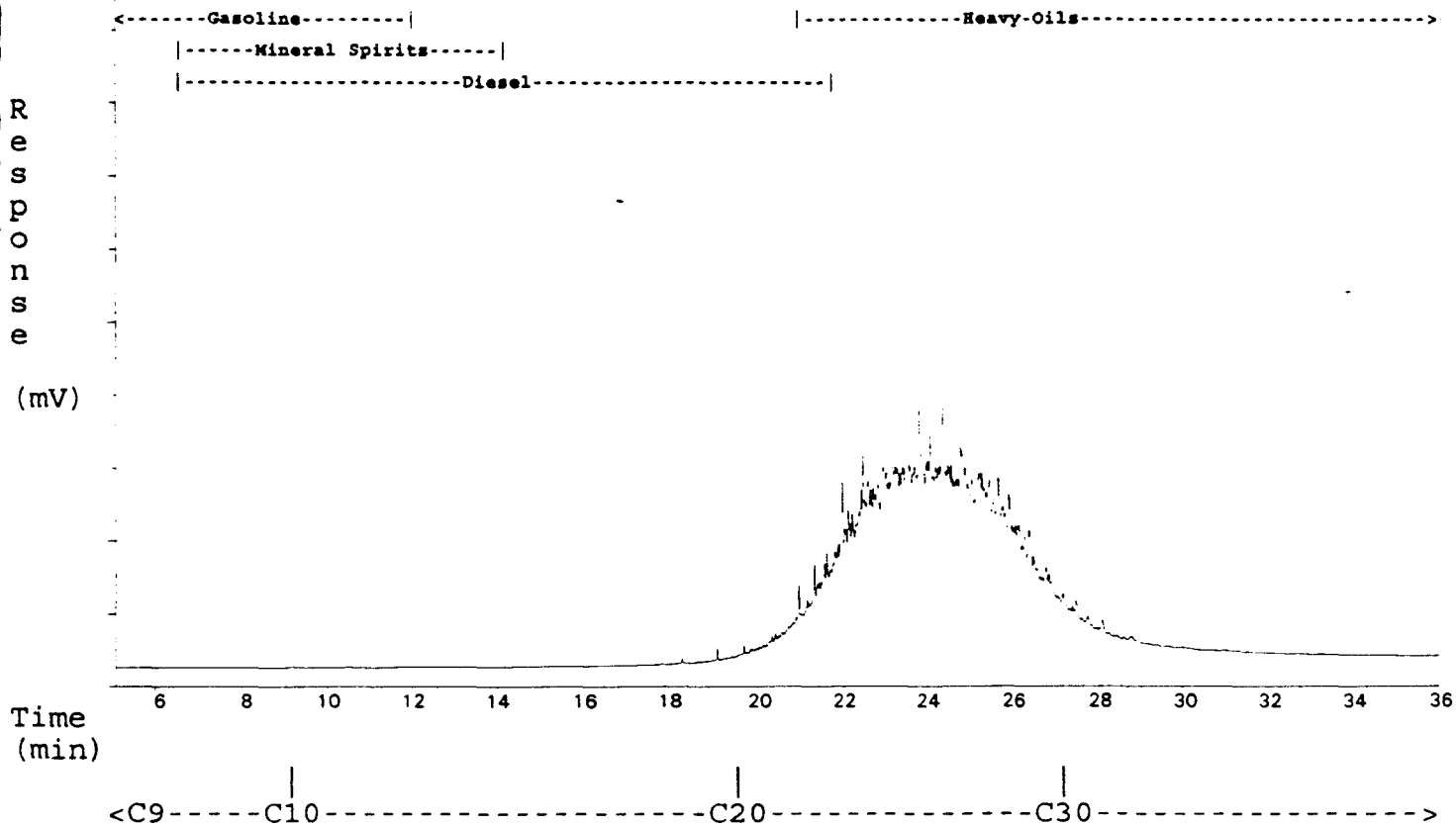
HYDROCARBON RANGE (C#)	RELATIVE AMOUNT (%)
Less than Carbon 10 (<C10)	0.0
Carbon 10 to Carbon 20 (C10-C20)	2.1
Carbon 20 to Carbon 30 (C20-C30)	83.9
Greater than Carbon 30 (>C30)	13.9

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G3879 41 BT-S203

Sample acquired: AUG 25, 1996 00:45:56
 File Name: c:\TEH\TEHAUG23.77R , Sample Name: G3879 41
 Sequence file: TEHAUG23



ASL Sample ID: G3879 41* 10 X Dilution

HYDROCARBON RANGE (C#)	RELATIVE AMOUNT (%)
Less than Carbon 10 (<C10)	0.0
Carbon 10 to Carbon 20 (C10-C20)	2.0
Carbon 20 to Carbon 30 (C20-C30)	83.7
Greater than Carbon 30 (>C30)	14.2

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G3879 24

BT-S205

Sample acquired: AUG 16, 1996 18:35:33

File Name: c:\TEH\TEH16AUG.05R , Sample Name: G3879 24

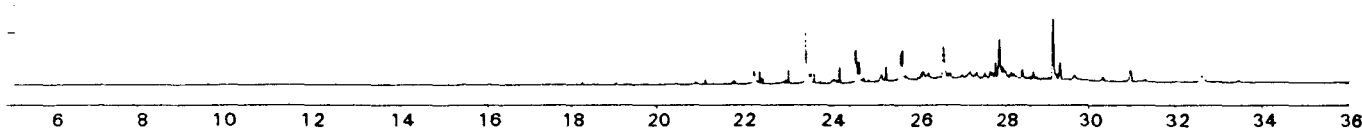
Sequence file: TEHAUG16

R
e
s
p
o
n
s
e

(mV)

Time
(min)

<-----Gasoline-----|-----Heavy-Oils----->
 |-----Mineral Spirits-----|
 |-----Diesel-----|



<C9-----C10-----C20-----C30----->

ASL Sample ID: G3879 24* 1.0Dilution

HYDROCARBON RANGE (C#)	RELATIVE AMOUNT (%)
Less than Carbon 10 (<C10)	0.5
Carbon 10 to Carbon 20 (C10-C20)	1.6
Carbon 20 to Carbon 30 (C20-C30)	35.6
Greater than Carbon 30 (>C30)	63.0

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G3879 25

BT-S206

Sample acquired: AUG 16, 1996 19:24:06

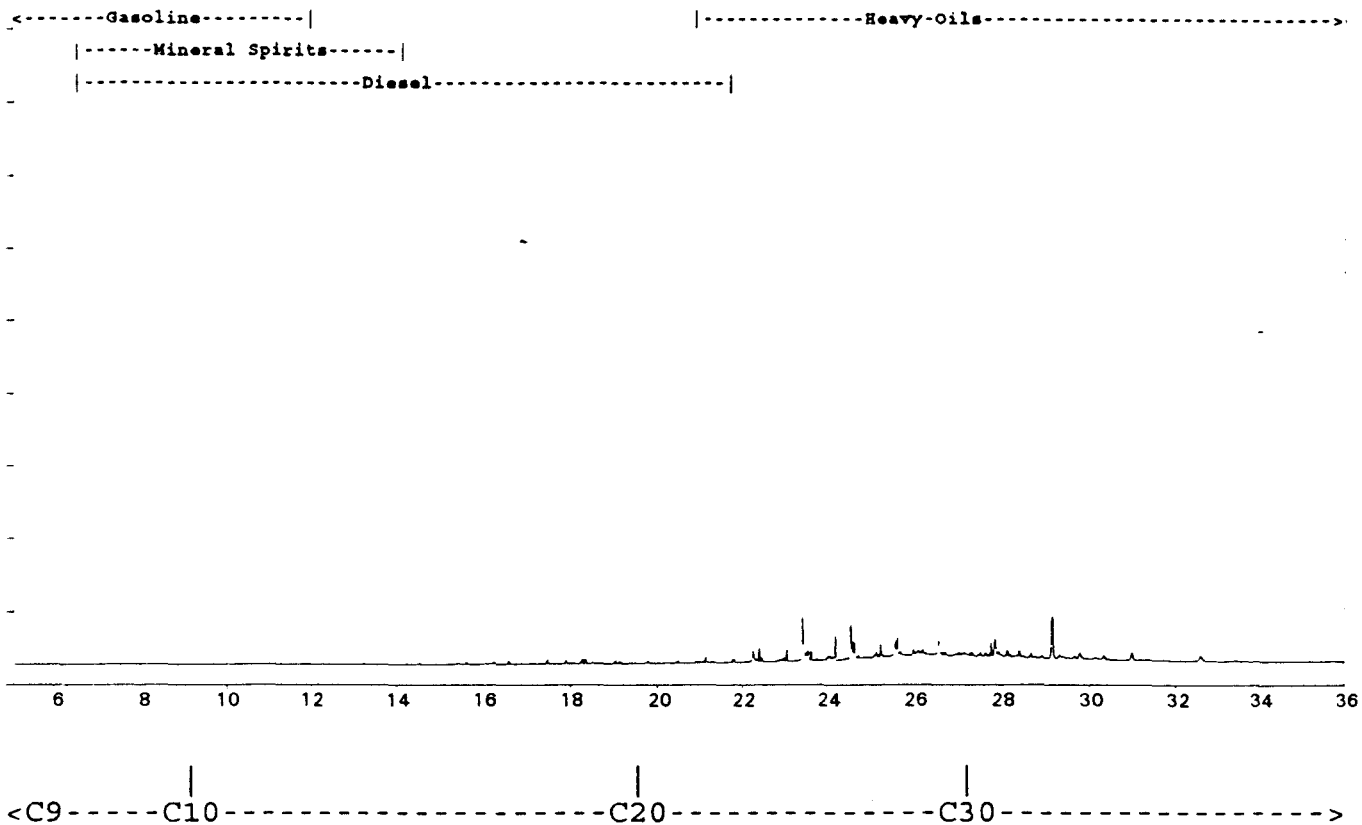
File Name: c:\TEH\TEH16AUG.06R , Sample Name: G3879 25

Sequence file: TEHAUG16

Response

(mV)

Time (min)



ASL Sample ID: G3879 25* 1.0Dilution

HYDROCARBON RANGE (C#)	RELATIVE AMOUNT (%)
Less than Carbon 10 (<C10)	0.2
Carbon 10 to Carbon 20 (C10-C20)	3.7
Carbon 20 to Carbon 30 (C20-C30)	42.6
Greater than Carbon 30 (>C30)	53.9

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amount of hydrocarbon product present in the ranges specified.



RESULTS OF ANALYSIS - Sediment/Soil¹

File No. G3879

BT-S204 BT-S205 BT-S206 BT-S207 VE-S201

Extractables

Total Extr Hydrocarbons (C10-30)	<40	85	84	<40	2600
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Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
¹Results are expressed as milligrams per dry kilogram except where noted.



RESULTS OF ANALYSIS - Sediment/Soil¹

File No. G3879

BT-S204 BT-S205 BT-S206 BT-S207 VE-S201

Physical Tests

Moisture % 3.3 28.0 10.0 7.6 1.4

Total Metals

Antimony	T-Sb	<20	37	<20	<20	<20
Arsenic	T-As	135	2340	1150	1370	597
Barium	T-Ba	96	90	51	45	161
Beryllium	T-Be	1.4	0.9	<0.5	0.6	0.9
Cadmium	T-Cd	5	12	3	5	3
Chromium	T-Cr	4	16	14	12	38
Cobalt	T-Co	4	6	5	4	12
Copper	T-Cu	16	265	40	39	30
Lead	T-Pb	194	281	145	169	106
Mercury	T-Hg	0.006	0.036	0.019	0.010	0.016
Molybdenum	T-Mo	4	12	6	6	<4
Nickel	T-Ni	3	8	6	16	23
Selenium	T-Se	<50	<50	<50	<50	<50
Silver	T-Ag	<2	12	5	5	<2
Tin	T-Sn	<30	<30	<30	<30	<30
Vanadium	T-V	8	29	29	19	49
Zinc	T-Zn	417	246	107	117	180

Remarks regarding the analyses appear at the beginning of this report.

< = Less than the detection limit indicated.

¹Results are expressed as milligrams per dry kilogram except where noted.



RESULTS OF ANALYSIS - Water

File No. G3765

	AC-WQ-Str 102	AC-WQ-A 101	BT-WQ-A 103	BT-WQ-Str 102	BT-WQ-S 101
	96 07 26	96 07 26	96 07 25	96 07 25	96 07 25
Physical Tests					
Conductivity (umhos/cm)	43.4	746	56.1	22.6	44.2
pH	6.90	7.68	5.46	6.68	6.62
Dissolved Anions					
Acidity	CaCO3 2.9	4.7	5.2	1.9	4.1
Alkalinity - Total	CaCO3 12.0	98.1	<1.0	6.3	9.3
Sulphate SO4	6.3	337	20.3	3.5	6.3
Total Metals					
Aluminum T-Al	<0.2	0.2	3.5	0.3	<0.2
Antimony T-Sb	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic T-As	<0.2	<0.2	0.7	<0.2	0.4
Barium T-Ba	<0.01	<0.01	0.04	<0.01	<0.01
Beryllium T-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth T-Bi	<0.1	<0.1	<0.1	<0.1	<0.1
Boron T-B	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium T-Cd	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium T-Ca	5.54	130	6.41	2.49	5.15
Chromium T-Cr	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt T-Co	<0.01	<0.01	<0.01	<0.01	<0.01
Copper T-Cu	<0.01	<0.01	0.02	<0.01	<0.01
Iron T-Fe	<0.03	0.10	5.08	<0.03	0.08
Lead T-Pb	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium T-Li	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium T-Mg	0.77	21.6	1.85	0.47	0.71
Manganese T-Mn	<0.005	0.937	0.506	<0.005	0.005
Molybdenum T-Mo	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel T-Ni	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus T-P	<0.3	<0.3	<0.3	<0.3	<0.3
Potassium T-K	<2	<2	<2	<2	<2
Selenium T-Se	<0.2	<0.2	<0.2	<0.2	<0.2
Silicon T-Si	1.38	3.72	4.07	1.35	2.87
Silver T-Ag	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium T-Na	<2	3	<2	<2	<2
Strontium T-Sr	0.030	0.569	0.034	0.019	0.017
Thallium T-Tl	<0.1	<0.1	<0.1	<0.1	<0.1
Tin T-Sn	<0.03	<0.03	<0.03	<0.03	<0.03
Titanium T-Ti	<0.01	<0.01	0.03	<0.01	<0.01
Vanadium T-V	<0.03	<0.03	<0.03	<0.03	<0.03

< = Less than the detection limit indicated.
 Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).



RESULTS OF ANALYSIS - Water

File No. G3765

	AC-WQ-Str 102	AC-WQ-A 101	BT-WQ-A 103	BT-WQ-Str 102	BT-WQ-S 101	
	96 07 26	96 07 26	96 07 25	96 07 25	96 07 25	
<hr/>						
<u>Total Metals</u>						
Zinc	T-Zn	<0.005	0.056	0.168	<0.005	0.009

< = Less than the detection limit indicated.
Results are expressed as milligrams per litre except for pH and
Conductivity (umhos/cm).



RESULTS OF ANALYSIS - Water

File No. G3765

	BT-WQ- Str 104	AS-WQ- Str 102	VE-WQ-S 201	UN-WQ- Str 203	VE-WQ-S 301
	96 07 25	96 07 30	96 07 30	96 07 24	96 07 30
Physical Tests					
Conductivity (umhos/cm)	15.1	63.2	435	219	569
pH	6.80	6.99	8.04	7.74	7.84
Dissolved Anions					
Acidity	CaCO3 1.6	4.5	1.4	2.3	5.4
Alkalinity - Total	CaCO3 4.8	28.3	170	64.2	189
Sulphate SO4	1.6	2.7	72.0	43.0	121
Total Metals					
Aluminum T-Al	1.6	<0.2	<0.2	<0.2	<0.2
Antimony T-Sb	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic T-As	<0.2	<0.2	0.3	<0.2	<0.2
Barium T-Ba	<0.01	<0.01	0.04	0.01	0.02
Beryllium T-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth T-Bi	<0.1	<0.1	<0.1	<0.1	<0.1
Boron T-B	0.2	<0.1	<0.1	<0.1	<0.1
Cadmium T-Cd	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium T-Ca	5.12	9.64	44.6	38.6	84.1
Chromium T-Cr	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt T-Co	<0.01	<0.01	<0.01	<0.01	<0.01
Copper T-Cu	<0.01	<0.01	<0.01	<0.01	<0.01
Iron T-Fe	0.08	0.11	0.28	<0.03	<0.03
Lead T-Pb	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium T-Li	0.19	<0.01	0.02	<0.01	<0.01
Magnesium T-Mg	0.34	1.99	24.8	1.96	21.6
Manganese T-Mn	<0.005	<0.005	0.031	<0.005	<0.005
Molybdenum T-Mo	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel T-Ni	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus T-P	<0.3	<0.3	<0.3	<0.3	<0.3
Potassium T-K	<2	<2	<2	<2	<2
Selenium T-Se	<0.2	<0.2	<0.2	<0.2	<0.2
Silicon T-Si	1.20	3.51	3.56	2.43	3.84
Silver T-Ag	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium T-Na	<2	<2	5	<2	5
Strontium T-Sr	0.033	0.048	1.10	0.355	1.06
Thallium T-Tl	<0.1	<0.1	<0.1	<0.1	<0.1
Tin T-Sn	<0.03	<0.03	<0.03	<0.03	<0.03
Titanium T-Ti	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium T-V	<0.03	<0.03	<0.03	<0.03	<0.03

< = Less than the detection limit indicated.
 Results are expressed as milligrams per litre except for pH and
 Conductivity (umhos/cm).



RESULTS OF ANALYSIS - Water

File No. G3765

	BT-WQ- Str 104	AS-WQ- Str 102	VE-WQ-S 201	UN-WQ- Str 203	VE-WQ-S 301
	96 07 25	96 07 30	96 07 30	96 07 24	96 07 30
<hr/>					
<u>Total Metals</u>					
Zinc T-Zn	0.012	<0.005	0.038	<0.005	<0.005

< = Less than the detection limit indicated.
Results are expressed as milligrams per litre except for pH and
Conductivity (umhos/cm).



RESULTS OF ANALYSIS - Water

File No. G3765

	BT-WQ- Str 208	UN-WQ- Str 201	UN-WQ- Str 101	AS-WQ- Str 101	UN-WQ- Str 202
	96 07 26	96 07 24	96 07 24	96 07 30	96 07 24
Physical Tests					
Conductivity (umhos/cm)	21.7	175	169	70.9	219
pH	7.08	7.60	7.43	7.39	7.58
Dissolved Anions					
Acidity	CaCO3 1.0	2.3	3.5	3.3	2.7
Alkalinity - Total	CaCO3 4.5	52.2	53.5	31.7	63.8
Sulphate SO4	3.5	33.4	29.8	3.6	43.4
Total Metals					
Aluminum T-Al	<0.2	<0.2	<0.2	<0.2	<0.2
Antimony T-Sb	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic T-As	<0.2	<0.2	<0.2	<0.2	<0.2
Barium T-Ba	<0.01	0.01	0.01	<0.01	0.02
Beryllium T-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth T-Bi	<0.1	<0.1	<0.1	<0.1	<0.1
Boron T-B	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium T-Cd	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium T-Ca	2.34	31.1	27.6	7.79	36.1
Chromium T-Cr	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt T-Co	<0.01	<0.01	<0.01	<0.01	<0.01
Copper T-Cu	<0.01	<0.01	<0.01	<0.01	<0.01
Iron T-Fe	<0.03	<0.03	<0.03	0.66	<0.03
Lead T-Pb	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium T-Li	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium T-Mg	0.46	1.37	1.39	1.84	1.93
Manganese T-Mn	<0.005	<0.005	<0.005	0.017	<0.005
Molybdenum T-Mo	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel T-Ni	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus T-P	<0.3	<0.3	<0.3	<0.3	<0.3
Potassium T-K	<2	<2	<2	<2	<2
Selenium T-Se	<0.2	<0.2	<0.2	<0.2	<0.2
Silicon T-Si	1.24	2.24	2.01	3.09	2.32
Silver T-Ag	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium T-Na	<2	<2	<2	<2	<2
Strontium T-Sr	0.019	0.256	0.230	0.039	0.346
Thallium T-Tl	<0.1	<0.1	<0.1	<0.1	<0.1
Tin T-Sn	<0.03	<0.03	<0.03	<0.03	<0.03
Titanium T-Ti	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium T-V	<0.03	<0.03	<0.03	<0.03	<0.03

< = Less than the detection limit indicated.
 Results are expressed as milligrams per litre except for pH and
 Conductivity (umhos/cm).



RESULTS OF ANALYSIS - Water

File No. G3765

	BT-WQ- Str 208	UN-WQ- Str 201	UN-WQ- Str 101	AS-WQ- Str 101	UN-WQ- Str 202
	96 07 26	96 07 24	96 07 24	96 07 30	96 07 24
<hr/>					
<u>Total Metals</u>					
Zinc T-Zn	<0.005	0.008	<0.005	0.006	<0.005

< = Less than the detection limit indicated.
Results are expressed as milligrams per litre except for pH and
Conductivity (umhos/cm).



Appendix 1 - QUALITY CONTROL - Replicates

File No. G3765

Water	BT-WQ-A 103	BT-WQ-A 103
	96 07 25	QC # 69472

Physical Tests

Conductivity (umhos/cm)	56.1	55.8
pH	5.46	5.39

Dissolved Anions

Acidity	CaCO3	5.2	4.9
Alkalinity - Total	CaCO3	<1.0	<1.0
Sulphate SO4		20.3	19.7

< = Less than the detection limit indicated.
Results are expressed as milligrams per litre except for pH and
Conductivity (umhos/cm).



Appendix 1 - QUALITY CONTROL - Replicates

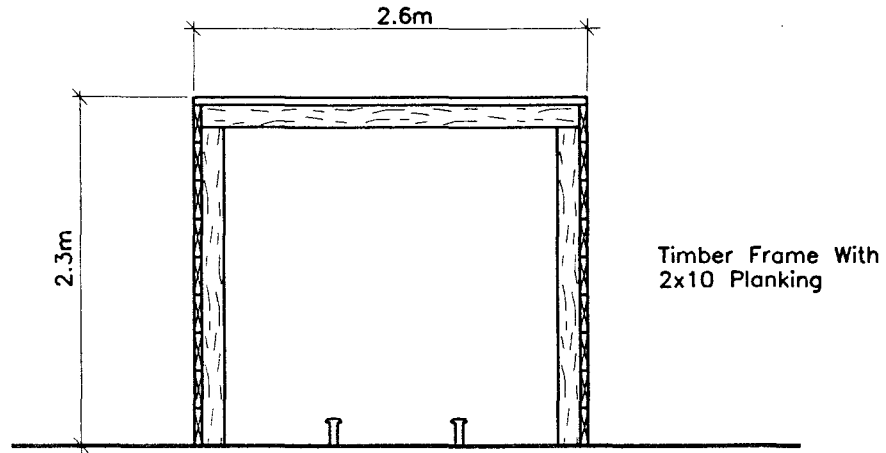
File No. G3765

Water		BT-WG-A 103	BT-WG-A 103
		96 07 25	QC # 69472
<hr/>			
Total Metals			
Aluminum	T-Al	3.5	3.6
Antimony	T-Sb	<0.2	<0.2
Arsenic	T-As	0.7	0.7
Barium	T-Ba	0.04	0.04
Beryllium	T-Be	<0.005	<0.005
Bismuth	T-Bi	<0.1	<0.1
Boron	T-B	<0.1	<0.1
Cadmium	T-Cd	<0.01	<0.01
Calcium	T-Ca	6.41	6.53
Chromium	T-Cr	<0.01	<0.01
Cobalt	T-Co	<0.01	<0.01
Copper	T-Cu	0.02	0.02
Iron	T-Fe	5.08	5.19
Lead	T-Pb	<0.05	<0.05
Lithium	T-Li	<0.01	<0.01
Magnesium	T-Mg	1.85	1.89
Manganese	T-Mn	0.506	0.514
Molybdenum	T-Mo	<0.03	<0.03
Nickel	T-Ni	<0.02	<0.02
Phosphorus	T-P	<0.3	<0.3
Potassium	T-K	<2	<2
Selenium	T-Se	<0.2	<0.2
Silicon	T-Si	4.07	4.14
Silver	T-Ag	<0.01	<0.01
Sodium	T-Na	<2	<2
Strontium	T-Sr	0.034	0.034
Thallium	T-Tl	<0.1	<0.1
Tin	T-Sn	<0.03	<0.03
Titanium	T-Ti	0.03	0.04
Vanadium	T-V	<0.03	<0.03
Zinc	T-Zn	0.168	0.170

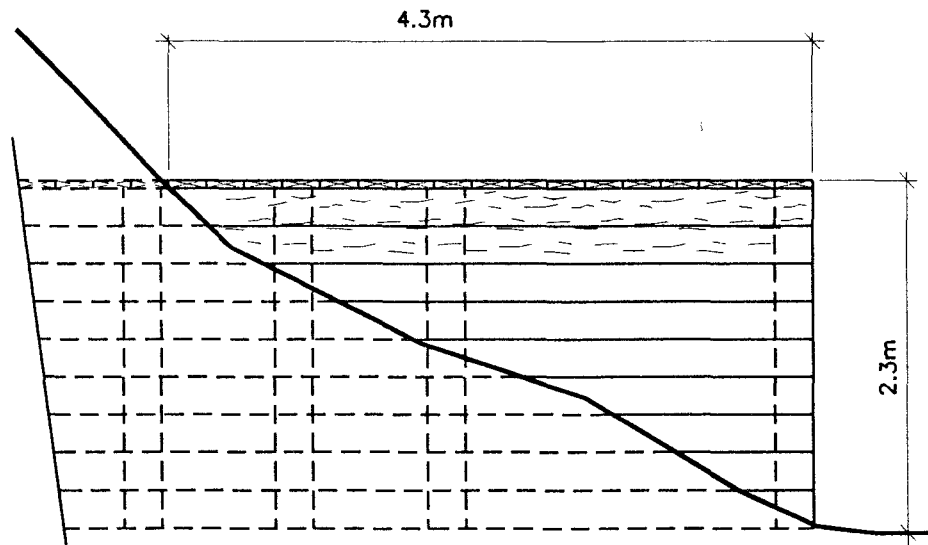
< = Less than the detection limit indicated.
Results are expressed as milligrams per litre except for pH and
Conductivity (umhos/cm).

APPENDIX D

DRAWINGS



FRONT VIEW
N.T.S.



Notes:

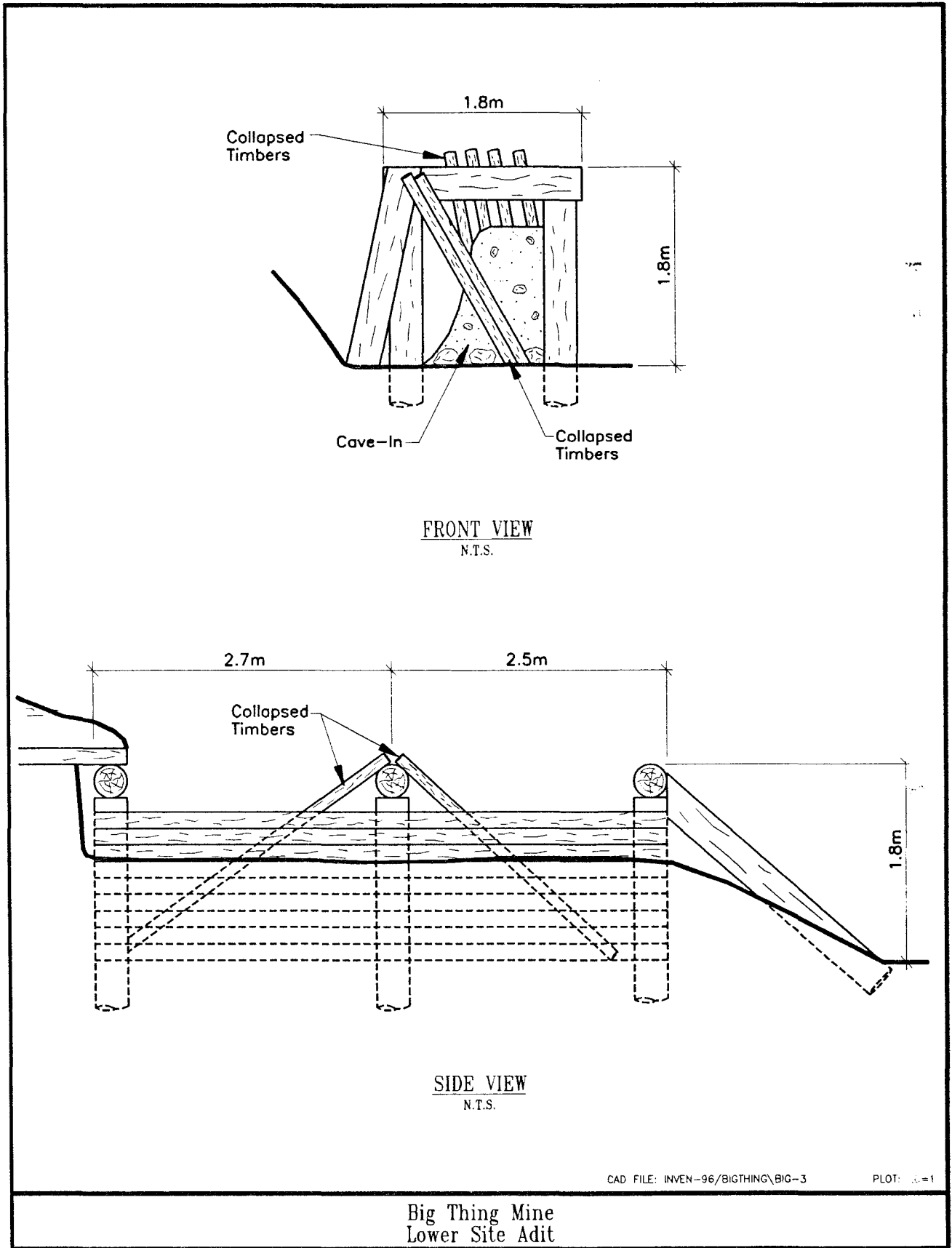
- Timber Frame With 2x10 Planking.
- Timbers First At 2.3m Then Approx. 1.0m Intervals.

SIDE VIEW
N.T.S.

CAD FILE: INVEN-96/BIGTHING\BIG-4

PLOT: 20=1

Big Thing Mine
Adit

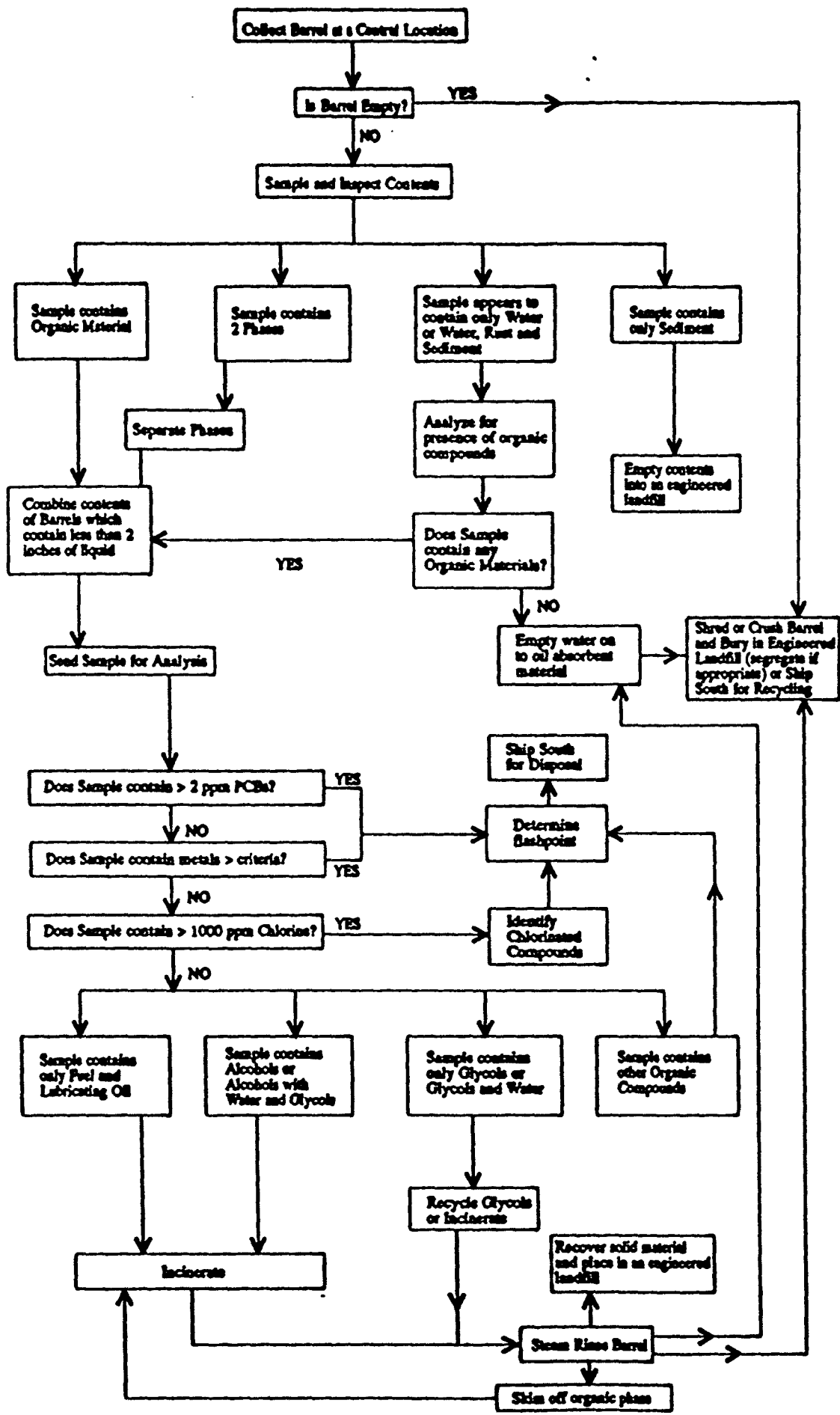


CAD FILE: INVEN-96/BIGTHING\BIG-3

PLOT: 1/1

Big Thing Mine
Lower Site Adit

APPENDIX E
BARREL PROTOCOL



BARREL CLEAN UP PROTOCOL

A flow diagram of the methodology for the processing, cleanup and disposal of barrels is attached.

A. Inspection

1. *The area around the barrels should be tested with a VOC metre to ensure safe working conditions. If the VOC levels exceed 20% of the Lower Explosive Limit (LEL), then all work shall be conducted in accordance with appropriate sections of the NIOSH Guidelines, the National Fire Code of Canada and the TDGA for flammable and combustible materials.*
2. *All barrels are to be inspected to address the following items which shall be recorded and used as a guide when opening barrels (section B.3):*
 1. *Symbols, words, or other marks on the barrel that identify its contents, and/or that its contents are hazardous: e.g. radioactive, explosive, corrosive, toxic, flammable.*
 2. *Symbols, words, or other marks on the barrel that indicate that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume containers.*
 3. *Signs of deterioration or damage such as corrosion, rust, or leaks at seams, rims, and V grooves.*
 4. *Spillage or discolouration on the top and sides of the barrel.*
 5. *Signs that the barrel is under pressure such as bulging and swelling.*

B. Opening and Sampling

1. *Pressurized barrels are extremely hazardous and shall be opened with extreme caution. Only non-sparking equipment shall be used to open barrels. All personnel responsible for opening barrels shall be provided with appropriate safety equipment and clothing. Procedures outlined in NIOSH USEPA 1988 Safety and Health Compliance for Managers (165.8) USEPA-29-CFR, 1910-1920, shall be followed.*
2. *If the bungs can readily be moved; then the barrels shall be opened slowly allowing time for any pressure in the barrel to be released before the bung is fully removed.*
3. *If the bungs are not readily moved, or inspection suggests that opening of the barrel presents a special hazard, then the barrels shall be vented remotely to relieve any internal pressure that may be present prior to opening. Remote venting shall be conducted using a suitable device such as a sharp spear weighted and dropped from an appropriate height or released from a tube housing a spring to penetrate the barrel. The remote venting operation shall be conducted from a safe distance from other site operations and from behind suitable walls or barricades. After sampling, the spear opening shall be plugged.*

4. *Samples of the contents of all barrels shall be extracted using a drum thief. All barrels shall be clearly numbered using spray paint or other suitable marker.*
5. *Barrels shall not be transported until it has been determined that they are not under pressure, do not leak and are sufficiently sound for transport.*
6. *Barrels containing less than 50 mm of liquid may be combined with compatible material prior to sampling; samples inferred to contain only water on a visual examination shall be tested prior to this consolidation. Barrel contents which consist of black oil shall not be consolidated.*
7. *Consolidation of barrel contents shall take place in a secure barrel processing area. At many DEW Line sites several caches of barrels are present and, therefore, it may be desirable to establish several secure sorting areas; barrels scattered on the tundra may be vented, then closed, and then transported to a barrel sorting area for sampling and possible consolidation.*

C. Testing

1. *Liquid samples shall be inspected and classified as either containing water or organic materials. Samples thought to contain water shall be analysed on-site to confirm that they are indeed water and contain less than 2% glycols or alcohols by Fourier transform infrared spectroscopy (FTIR).*
2. *The contents of barrels containing organic materials, including aqueous samples which contain more than 2% glycols or alcohols, shall be tested for PCBs, Total chlorine, cadmium, chromium and lead, in addition to identification of the major components e.g. fuel oil, lubricating oil. Samples containing greater than 1000 ppm chlorine shall be further tested to identify the chlorinated compounds present.*
3. *Contents of barrels which contain two or more phases shall have all phases analysed; the organic phases as described above and the aqueous phases to ascertain whether it contains less than 2% organics. In addition, the aqueous phases shall be tested for any components found in the organic phases above the criteria described below.*

D. Disposal of Barrel Contents

1. *Barrels containing only rust and sediment shall be treated as empty barrels.*
2. *Barrel contents comprising water only (less than 2% glycols or alcohols) shall be transferred to an open vessel such as a utility tub or half-barrel and any organic material removed by agitation with a pillow or segment of oil absorbent material. The water may then be discarded on to the ground that is a minimum of 30 metres distance from natural drainage courses. Used oil absorbent material shall be treated as described in Section D.5.*
3. *Barrel contents which are composed of water with glycols and/or alcohols or*

organics phases, and which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium and 100 ppm lead, may be disposed of by incineration. Alternatively these contents may be disposed of off-site at a licensed disposal facility. The solid residual material resulting from incineration shall be subjected to a leachate extraction test. Material found to be not leachate toxic material shall be treated as hazardous waste, packaged in accordance with TDGA and/or IATA regulations as required, and disposed of off-site at a licensed disposal facility.

4. Barrel contents which contain greater than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium or 1000 ppm lead shall be disposed of off-site at a licensed disposal facility. Contents may be combined with compatible materials for shipping purposes (note section E.1). Flash point may be required to be determined if they cannot be inferred from the product identification.
5. Used oil absorbent material should be treated as hazardous waste and disposed of off-site at a licensed disposal facility unless, it is shown to be uncontaminated with PCBs (<2 ppm), chlorine (<1000 ppm) cadmium (<2 ppm), chromium (<10 ppm) and lead (<100 ppm) in which case it may be incinerated on site.

E. Cleaning and Disposing of Barrels

1. Empty barrels resulting from consolidation of contaminated material (Section D.4) shall be triple rinsed with solvent (varsol, diesel, etc.) Prior to steam cleaning; solvent washings shall be added to the bulked contaminated products unless analysed separately and shown to be suitable for incineration. Alternatively, the empty barrels may be shipped off-site and labelled appropriately (TDGA).
2. Only empty barrels resulting from consolidation of small volumes (section B.6), from incineration (section D.3) and from solvent washing (section E.1) require steam cleaning; after cleaning they shall be treated as described in E.3. Recycling of rinsate is permitted. The resulting wash water shall have any organic material removed by agitation with a pillow or segment of oil absorbent material. The water shall then be analysed for cadmium, chromium and lead. If these metals are present at less than 0.01, 0.10 and 0.10 ppm respectively, then the water may be discarded on land that is a minimum of 30 metres from natural drainage courses, but if not then it shall be disposed of off-site at a licensed disposal facility. Alternatively, the wash water may be shipped off site without testing for disposal at a licensed disposal facility. Used absorbent material shall be disposed of as described in section D.5.
3. Empty barrels may be crushed or shredded and be landfilled on-site as non-hazardous wastes. The barrels shall be crushed in such a manner so as to reduce their volume by a minimum of 75%. Shredded barrels may be disposed of off-site as recycled metals.