# Appendix 17

•**Excerpts from Ulu Gold Project Prefeasibility Study, H.A. Simons Ltd., September 1995.**

# 2.0 GEOLOGY and RESOURCES

## 2.1 Geology

The Ulu claim block is situated on the western margin of the High Lake volcanic belt where rocks of the Yellowknife Supergroup are in contact with an Archean granitic batholith. The Ulu deposit lies within three mineral claims which cover a 2 to 3 km wide lobe of mafic metavolcanic and metasedimentary rocks.

The lobe is tightly folded into a north plunging asymmetrical anticline dissected by east-west trending faults. Mineralization is within the Flood Zone which consists of basalt with subordinate sediment and gabbro, cross cut by acidic and basic dykes. Four horizons of gabbro are noted in the succession forming the hanging wall. This succession lies on the west limb of the fold.

The west limb strikes north-south with a moderate westerly dip. A 15 m thick quartz feldspar porphyry dyke, striking north east, cross cuts the succession and coincides with a flexure in the flank of the west limb.

The Flood Zone can be traced on surface for 400 m in a north west direction near the core of the anticline. The 2 to 5 m thick mineralized zone dips steeply at 70° to 80° to the south west and has been intersected with diamond drilling to depths of 600 m. Areas of local thickening up to 10 m correspond to flexure points along the roughly tabular body.

Mineralization is comprised of an intensely silicified zone with arsenopyrite contained in fractures and dilatancies within tholeiitic basalts.

## 2.2 Resources

Resources for the total zone have been estimated by EBM from a geological block model prepared using Vulcan™ software. Estimated global resources above 3 g/t gold grade are summarized by grade interval in Table 2.1.

A mining plan based on vertical level intervals of 40 m has been prepared and resources for those intervals estimated. These are tabulated by interval and by vein in Appendix A. Initial production has been forecast based on access from a surface decline allowing mining to the 160 m elevation. Undiluted resources to that elevation and above 5 g/t have been estimated at 1,491,114 tonnes at an average grade of 12.781 g/t. This represents about 62% of the tonnage and 68% of the contained gold of the currently identified global resource to elevation -40 m.

Potential stoping blocks for the 40 m vertical level intervals have been identified and are shown schematically in Dwg: ULU-SEC 1. Mineralization above 5 g/t appears to occur in several veins within the Flood Zone to about 160 m elevation with some low grade areas. Below that elevation the extent of mineralization appears to be more limited but has been indicated to about elevation - 40 m from diamond drilling.

Diluted mining resources have been estimated assuming the addition of from 0.5 to 1.8 m of wallrock, depending on vein width, at zero grade and a S.G. of 2.8. Undiluted and diluted resources are shown by mining level in Tables 2.2 (a) and (b).

All resource data is summarized in Appendix A.

**Table 2.1: Total Resources**

| Resource by Grade Interval | | |
|---|---|---|
| **Grade (g/t)** | **Tonnes** | **Grade (g/t)** |
| 3-5 | 877,530 | 3.848 |
| 5-7 | 632,583 | 6.163 |
| 7-10 | 654,423 | 8.520 |
| > 10 | 1,107,388 | 16.684 |
| TOTAL | 3,271,924 | 9.574 |

Table 2.2 (a): Undiluted Mining Resources

| Level m asl | Tonnes | Grade gold g/t | Average width m |
|---|---|---|---|
| 440 - 400 | 177,444 | 14.096 | 5.0 |
| 400 - 360 | 92,942 | 13.424 | 3.0 |
| 360 - 320 | 136,979 | 15.658 | 5.0 |
| 320 -280 | 181,354 | 11.642 | 8.0 |
| 280 - 240 | 253,698 | 11.365 | 7.0 |
| 240 - 200 | 315,912 | 11.909 | 9.0 |
| 200 - 160 | 332,784 | 13.243 | 9.0 |
| Total | 1,491,114 | 12.781 | 6.6 |

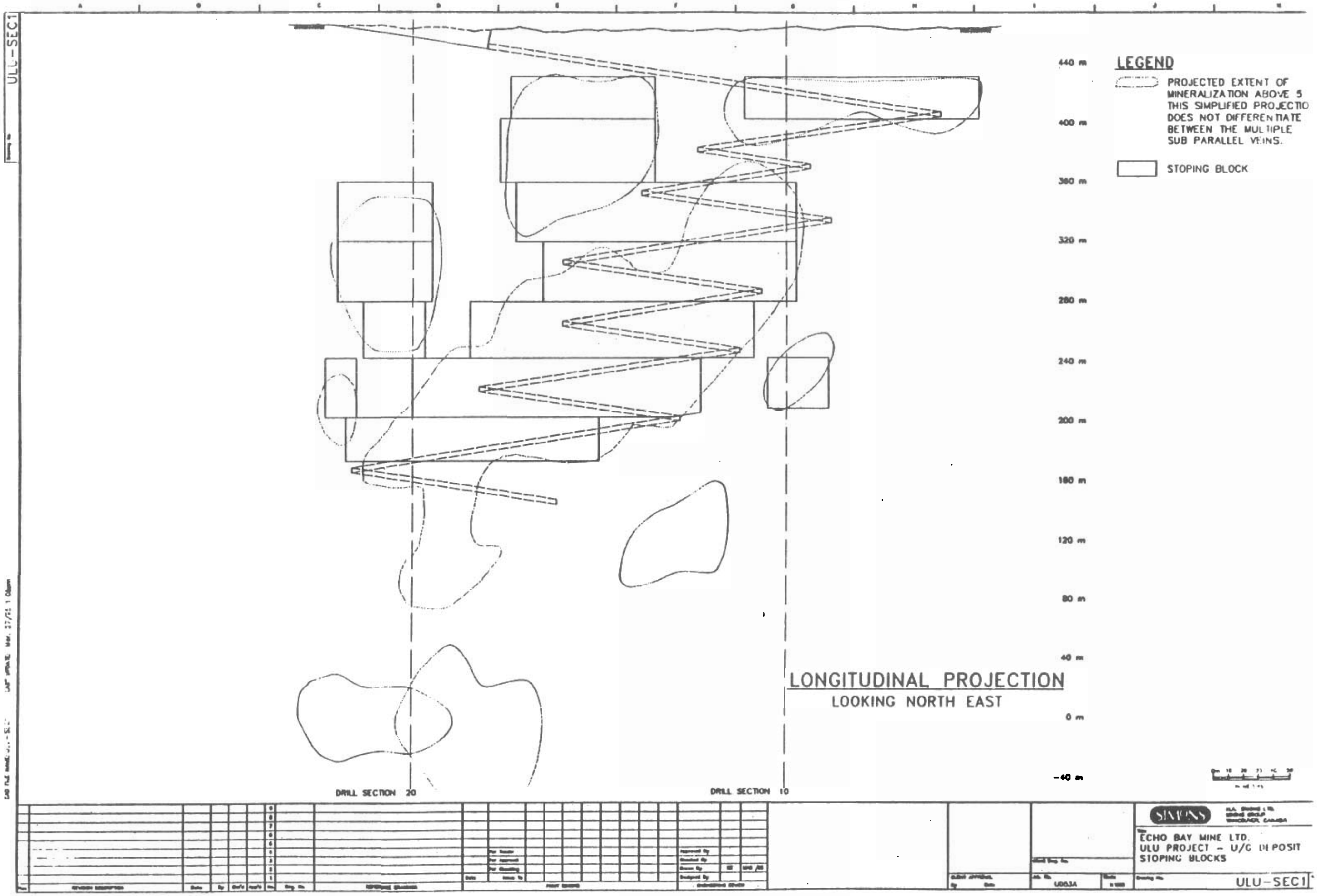
Table 2.2 (b): Diluted Mining Resources

| Level m asl | Tonnes | Grade gold g/t | Average width m |
|---|---|---|---|
| 440 - 400 | 211,602 | 11.820 | 6.1 |
| 400 - 360 | 106,496 | 11.716 | 3.5 |
| 360 - 320 | 163,348 | 13.130 | 6.1 |
| 320 -280 | 203,173 | 10.392 | 9.1 |
| 280 - 240 | 288,582 | 9.991 | 8.1 |
| 240 - 200 | 371,197 | 10.135 | 10.8 |
| 200 - 160 | 391,021 | 11.270 | 10.8 |
| Total | 1,735,419 | 10.981 | 7.9 |

## 2.3 Geotechnical

Indications from surface mapping and from exploration drill core are that the vein and foot and hangingwall rocks are competent. It has been assumed that ground support requirements will include only local support provided by rock bolts in development headings.

Vein widths up to 10 m are indicated with most areas being between 4 and 6 m in width. It has been assumed that stopes of those widths can be opened over the indicated mineralized strike length without requiring filling for regional support. To maintain local foot and hangingwall stability and to reduce sloughing of waste rock into broken ore piles it is proposed to install friction bolts in radial patterns from sub drifts driven in the vein. This is similar to the practice in the West Zone of the Lupin Mine.



440 m
400 m
360 m
320 m
280 m
240 m
200 m
180 m
120 m
80 m
40 m
0 m
-40 m
LEGEND
PROJECTED EXTENT OF MINERALIZATION ABOVE 5 THIS SIMPLIFIED PROJECTIO DOES NOT DIFFERENTIATE BETWEEN THE MULTIPLE SUB PARALLEL VEINS.
STOPING BLOCK
LONGITUDINAL PROJECTION
LOOKING NORTH EAST
DRILL SECTION 20
DRILL SECTION 10
SIMONS
ECHO BAY MINE LTD.
ULU PROJECT - U/G DEPOSIT
STOPING BLOCKS
U063A
ULU-SEC1

# 3.0 MINING

## 3.1 Introduction

A detailed mining evaluation has been performed for the Flood Zone above elevation 160 m. This initial limit to mining is based on access from the development of a surface ramp system. Mining below that elevation to the currently indicated resource limit of elevation -40 m could require the development of a shaft hoisting facility.

The mineralized zones dip steeply, are relatively narrow, and occur in competent rocks. The use of long hole open stoping has been assumed. Ore will be trucked to a surface stockpile for seasonal trucking to the Lupin Mill.

## 3.2 Primary Development

Access to the mine is by a ramp driven at -15% grade from surface at about 460 m elevation. The portal excavation will be in the footwall of the Flood Zone and in a south east direction. There is no surficial material and all excavation will be in rock and require drilling and blasting.

An excavation 6 m wide on the driving surface with walls sloping at 1 in 3 has been assumed. When a 10 m high competent rock face is exposed the ramp will be collared. The overlying brow will be made secure with bolts and screen as required.

Current geological interpretation indicates the upper limit of mineralization above 5 g/t to be at about elevation 430 m. At this elevation access cross cuts will be driven to the veins. Sub drifts will be driven from these two cross cuts at about 430 m elevation to follow the veins to their strike limits. These will be driven on geology control and mapped and sampled.

The back of the drift will be maintained at about 25 m below surface. This ground will form the surface crown pillar for the mine and it will be necessary to maintain its integrity. Its depth below surface will be dictated by the competence of the overlying rock.

The layout of the ramp system is shown in Dwg ULU-SEC2. Alternate legs of the ramp will be driven about 20 m from the indicated footwall of the vein. At 40 m vertical intervals cross cuts will be driven from the ramp to intersect the vein. The ramp and cross cuts will be driven 4.8 m wide by 3.6 m high to accommodate haulage trucks. Remuck stations will be excavated every 100 m between crosscut locations.

The ramp will be driven using a 2 boom electro hydraulic jumbo drilling a 3.8 m round and breaking 3.6 m. Mucking will be with a 4.6 $m^3$ LHD to the nearest remuck station or crosscut. This muck will be later loaded into 34 tonne trucks for haulage to surface. A 1.5 x 1.5 m pattern of 3 m friction bolts has been assumed installed in the back of the ramp and the crosscuts. Services installed in the ramp will include a 900 mm diameter ventilation duct, 550 V power cable, 150 mm compressed air line, and 50 mm drill water and drainage lines.

The ramp will be driven to about 150 m elevation and a sump established.

## 3.3 Stope Development

As the ramp reaches the sub level elevations these will provide a second face for the development crews. Sub levels will be driven nominally 3.5 m wide and 3.5 m high. Actual widths will be dictated by the vein width. Each drift will be driven on geology control with mapping and sampling.

A single boom electro hydraulic jumbo will be used for driving the sub drifts. Mucking will be by 4.6 $m^3$ LHD to a truck located in the crosscut. Muck will be hauled to the surface waste dump or ore stockpile as appropriate.

A pattern of 3 to 4 m grouted extension rebar bolts will be installed in the foot and hangingwall of the vein from the sub drifts. A single boom roof bolter will be used.

## 3.4 Stoping

Blasthole open stoping will be used. Mineable vein widths appear to vary from 3 to 10 m. Accurate drilling, minimum hole deviation, and control of blasting to minimize overbreak and ore dilution are essential. Continuity and uniformity of the vein is also necessary. These appear to apply generally to the veins within the Flood Zone. There are areas of multiple sub parallel veins. Limits of stoping blocks and the need to include waste intervals within those stoping blocks can only be determined as detailed geological knowledge is acquired during level development.

The vertical and lateral extents of the multiple veins vary. It appears that areas of waste rock will be left unmined both between and within the veins. It has been assumed that these waste pillars will maintain local ground stability and permit stopes to be left open, except where it is expedient to dispose development waste rock into completed stopes.

Generally there will be from 36 to 37 m of vein material between levels. A vertical slot raise will be established at the stope block limit. A pattern of 15 blastholes will be drilled to create a 2 x 2 m raise. These will be blasted from the upper drift as a drop raise.

Production blastholes will generally be drilled from both the upper and lower drifts, with up to 2 m overlap between drill patterns. This will permit production to proceed as sub levels and stope blocks are established and while the main ramp is still advancing. Careful machine setup and controlled drilling will permit accurate drilling.

Holes will be drilled on a staggered pattern with the pattern and burden varying according to vein width. Side holes will be located about 0.3 m from the vein limit. Actual practice will depend on local conditions and will benefit from experience acquired at the Lupin Mine.

Design parameters for stoping widths of 3.0, 6.0, and 9.0 m are shown in Appendix B.

Blastholes will be drilled using a single boom electro hydraulic production drill. Depending on the final stope length, complete stope blocks could be drilled before starting production blasting. If the stope will be long, or if intervals of waste occur which are planned to be left as pillars, then drilling and blasting can proceed in cycles.

An explosives truck equipped with ANFO loader will be used for blasthole loading. It is anticipated that most holes will be loaded with ANFO, primed with NG explosive, and detonated using non-electric delays. Generally four rows will be blasted with a design break of between 1,200 and 4,000 tonnes, depending on vein width. Blasting will retreat back to the end of the stope, normally at the crosscut location.

## 3.5 Ore Handling

Broken ore will be mucked at the brow in the sub drift using a 4.6 m³ diesel powered LHD. Ore not removed can be recovered with ore from the sub level below. If there is no stope planned for immediately below that area then remote mucking beyond the brow will be required. At least one of the 4.6 m³ LHD's should be equipped with this capability.

The LHD's will tram muck back to the crosscut for loading into 34 tonne haul trucks. It is planned to have at least two stope blocks active and available for blasting and production mucking. Ore will be hauled to surface and dumped on the stockpile.

## 3.6 Exploration and Ore Definition

The primary exploration and ore definition for layout of stope blocks will be from development of the levels. Remuck stations and crosscuts will provide potential diamond drill sites along the ramp system.

## 3.7 Ventilation

A primary intake fan will be located at the collar of the ramp. During winter mine air will be heated using an indirect diesel powered system. Intake air will be ducted down the ramp.

Short ventilation cross cuts will be driven from alternate legs of the ramp and connected by ventilation raises. Raises will be driven as each crosscut becomes available to minimize forced ventilation distances on the ramp. The raises will be driven at 49° and 2.5 m wide by 2 m high. Raise lengths will be between 40 and 60 m. They will be driven using stopers and without timber, then equipped with a ladderway to serve as the second means of egress from the mine. The raise will break through to surface approximately above the mid point of the top level drift.

An exhaust fan will be installed on surface at the raise breakthrough. Regulators constructed in each raise access cross cut will control the air flow from the ramp. Connections will be made from production sub levels to the raises when required for stope exhaust.

## 3.8 Mine Services

The mine will be within permafrost and air temperatures will be low. All drilling will use brine solution to prevent freezing.

The maximum number of personnel underground at any time will vary from about 18 to 22. It is planned to provide refuge stations off the ramp at about the 360, 280, and 200 m elevations. These will also serve as lunchrooms. There will be no underground maintenance facilities. All mining equipment will be maintained and repaired in the surface shop. Explosives will be delivered daily from the surface magazines. Day boxes will be used for short term underground storage.

Mining equipment requirements are listed in Table 3.1 and manpower levels in Table 3.2.

The numbers shown are typical for the development and production periods, nominally from start to day 600 and from day 300 to mid-year 8. During concurrent activity the two numbers would not be added; the larger would apply.

Note that for twelve months development and production activities are concurrent and manpower is forecast to peak at 42.

Table 3.1: Mining Equipment

| | Development | Production |
|---|---|---|
| 2 boom jumbo | 1 | --- |
| 1 boom jumbo | 1 | --- |
| Longhole jumbo | --- | 2 |
| Rock bolter | 1 | --- |
| LHD 4.6m³ | 2 | 3 |
| Truck 34 tonne | 2 | 3 |
| Grader | 1 | 1 |
| Utility vehicle | 1 | 1 |
| Explosives truck | 1 | 1 |
| Mechanics truck | 1 | 1 |
| Service jeep | 2 | 2 |

Table 3.2: Mining Manpower

| On Site | Development | Production |
|---|---|---|
| Staff | | |
| Superintendent | 1 | 1 |
| Shift Boss | 2 | 2 |
| Geologist | 1 | 1 |
| Surveyor | 2 | 2 |
| Sampler | 2 | 2 |
| First aid | 1 | 1 |
| Hourly rated | | |
| Development miner | 6 | --- |
| Stope miner | --- | 8 |
| Equipment operator | 4 | 8 |
| Nipper | 2 | 2 |
| Diamond driller | 1 | 1 |
| Labourer | 1 | 1 |
| Lead mechanic | 1 | 1 |
| Journeyman mechanic | 2 | 2 |
| Tradesman | 3 | 3 |
| Journeyman electrician | 1 | 1 |
| Total | 30 | 36 |

## 3.9 Schedule

Development of the currently identified reserves to 160 m elevation is planned to be complete after 600 days. All ramp and sub level development will be performed by the same crews. Advance per day will average two rounds in the ramp and one in the second heading, either crosscuts or sub drifts. A schedule of development is shown in Figure 3.1.

The first stoping blocks are available 240 days after the start of development. Development and stoping are planned to proceed concurrently until about day 600. Stoping will continue until about the middle of the eighth year after the start of development.

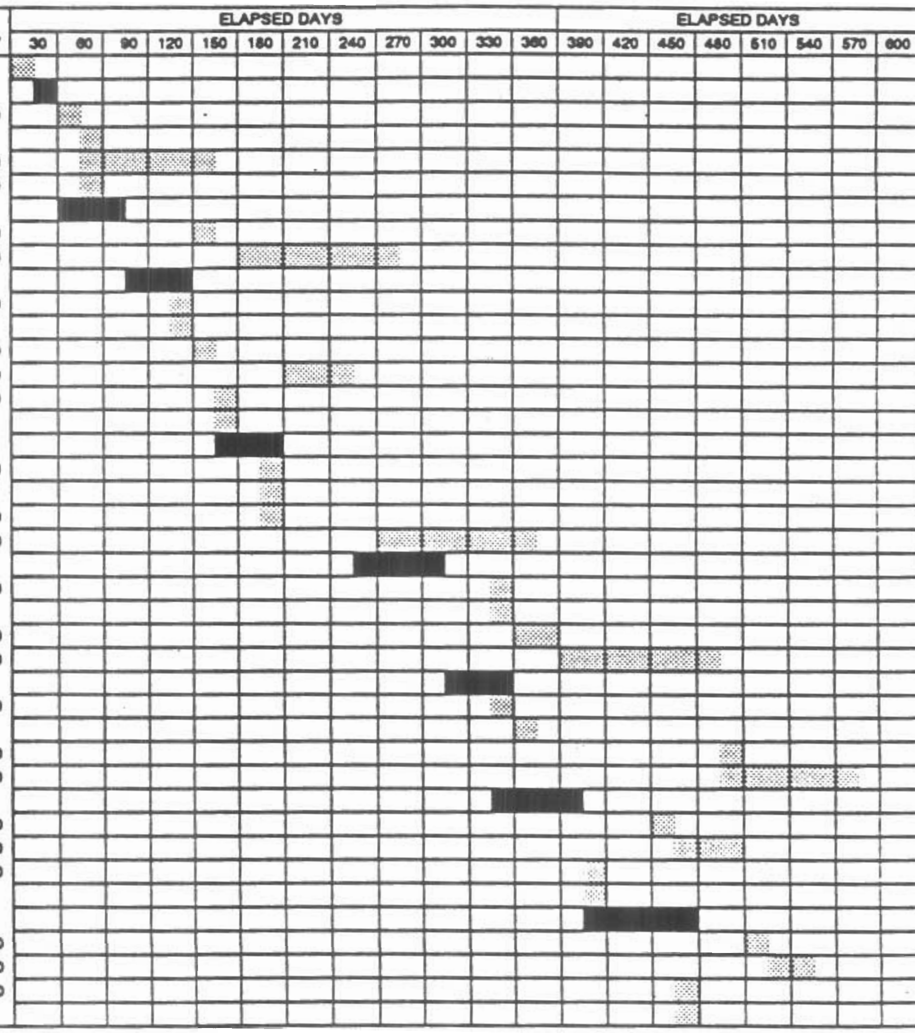
Combined production of ore from sub drift development and stoping averages 750 tonnes per day. On completion of development this production rate can be sustained from two stope blocks with another two being prepared with slot excavation and blasthole drilling. Currently identified stope blocks range in reserve size from 50 to 150 thousand tonnes.

## 3.10 Development and Production Forecasts

Activity levels are summarized by 30 day period for years 1 and 2 and by year thereafter in the tables in Appendix C. These include development by type of heading, stoping, and haulage.

# Figure 3.1: Development Schedule

| LEVEL | ITEM | ELEVATION FROM | ELEVATION TO | AT ELEV |
|---|---|---|---|---|
| SURF | PORTAL EXCAVATION | 460 | 450 | |
| | RAMP | 450 | 430 | |
| | VENT. CROSS CUT | | | 430 |
| | VENT. RAISE | 430 | 460 | |
| | SUB LEVELS (2) | | | 430 |
| 440 | ACCESS CROSS CUTS (2) | | | 430 |
| | RAMP | 430 | 400 | |
| 400 | ACCESS CROSS CUT | | | 400 |
| | SILL DRIFT | | | 400 |
| | RAMP | 400 | 360 | |
| | VENT. CROSS CUT | | | 390 |
| | VENT. RAISE | 390 | 430 | |
| 360 | ACCESS CROSS CUT | | | 360 |
| | SILL DRIFT | | | 360 |
| | VENT. CROSS CUT | | | 360 |
| | VENT. RAISE | 360 | 390 | |
| | RAMP | 360 | 320 | |
| | VENT. CROSS CUT | | | 320 |
| | VENT. RAISE | 320 | 360 | |
| 320 | ACCESS CROSS CUT | | | 320 |
| | SILL DRIFT | | | 320 |
| | RAMP | 320 | 280 | |
| | VENT. CROSS CUT | | | 280 |
| | VENT. RAISE | 280 | 320 | |
| 280 | ACCESS CROSS CUTS (2) | | | 280 |
| | SILL DRIFT | | | 280 |
| | RAMP | 280 | 240 | |
| | VENT. CROSS CUT | | | 240 |
| | VENT. RAISE | 240 | 280 | |
| 240 | ACCESS CROSS CUTS (2) | | | 240 |
| | SILL DRIFT | | | 240 |
| | RAMP | 240 | 200 | |
| 200 | ACCESS CROSS CUTS (2) | | | 200 |
| | SILL DRIFT | | | 200 |
| | VENT. CROSS CUT | | | 190 |
| | VENT. RAISE | 190 | 240 | |
| | RAMP inc. SUMP | 200 | 145 | |
| 170 | ACCESS CROSS CUT | | | 170 |
| | SILL DRIFT | | | 170 |
| 150 | VENT. CROSS CUT | | | 150 |
| | VENT. RAISE | 150 | 190 | |



# 4.0 SITE FACILITIES

## 4.1 Geographic Location

The Ulu deposit site is situated 45 km north of the Arctic Circle, at 110° 58' W longitude and 66° 54' N latitude, Nunavut Territory, and approximately 15 km north of the Hood River and 90 km south of the Coronation Gulf. The mine site will be located 155 km north of the existing Echo Bay Lupin gold mine/concentrator and approximately 530 km northeast of Yellowknife, North West Territories.

## 4.2 Access

The mine site is situated in treeless arctic tundra at a remote location that can only be accessed by aircraft or by winter road from Lupin.

A seasonal winter ice road, approximately 178 km in total length, will be developed to connect the Ulu mine site with the Lupin plant site at Contwoyto Lake to the south. The selected winter road is 65% over lake ice, and the remainder, i.e approximately 60 km, is a series of twenty short portages over land.

The winter road, which could operate from mid December to mid May, would be used to bring in construction equipment and supplies from Lupin. Transporting the bulk of crushed ore out from Ulu mine to Lupin will be accomplished using a dedicated truck fleet, operating for two shifts daily during the winter road season.

The winter road will cross the Hood River, approximately 15 km south of the mine site. It is proposed that crossing over the ice at a suitable location on the river can be made without the need to construct a permanent bridge.

During mine operations, access by air can be gained using an airstrip 2000 m long suitable for landing and take-off of large aircraft, e.g. Boeing 727 type or equal, throughout the year.

## 4.3 Climate

The weather in the Ulu area is typical of the continental barrenlands which experience extremely cold winters and cool summers. The climatic conditions for the Ulu area were monitored by BHP and data was collected between June and mid-September, 1990 - 1992. Comparison was made of this limited information to that published by Atmospheric Environment Service - Environment Canada - for a number of meteorological stations in the Northwest Territories, including Contwoyto Lake and Coppermine, for which over thirty (30) years of records are available. The preliminary data indicate close similarity in temperature ranges, but somewhat lesser magnitudes of rain precipitation.

Snow accumulation was observed to begin in September and remain into June. Spring breakup is complete by the third week of June and freeze-up starts by the end of September. Twenty-four hour daylight persists from May to early August due to the property's position above the Arctic Circle.

The climatic data to be used in the preliminary siting, structural design and indoor heating are extracted from the design values specified in the National Building Code of Canada, and summarized as follows:

| | | |
|---|---|---|
| - Temperature: | | |
| | January - 2.5% design | -44 ° C |
| | Extreme Low | -53.3 ° C |
| | July - 2.5% design | 22 ° C |
| | Extreme high | 32.2 ° C |
| - Degree-days below 18 deg C: | | 9114 |
| - Precipitation: | | |
| | Avg. annual total Precip. | 260 mm |
| - Snow Load: | | |
| | Ground Snow Load, Ss | 2.8 kPa |
| | Rain Load, Sr | 0.1 kPa |
| - Hourly Wind Pressures: | | |
| | 1/10 yr probability | 0.38 kPa |
| | 1/30 yr probability | 0.48 kPa |

Wind speed and direction were monitored at the site. It appears, however, that the early datalogger recordings did not correlate well with the manually observed values and that readjustment of the measuring equipment was made in 1992. Close study of the newly observed readings of wind speeds and directions should be made prior to finalizing the site and orientation of the airstrip.

## 4.4 Site Preparation

Geotechnical investigations at the site are not complete at this time, however, it is anticipated that subsurface conditions will consist of a relatively thin veneer of till over good quality metavolcanic bedrock. The thickness of the till would vary over the site and is expected to range from nil near exposed bedrock to in excess of 5.0m in some areas of the site. At similar sites, experience has shown that the till contains a significant amount of moisture in the form of thin ice lenses. The bedrock beneath the overburden could be slightly weathered, with infrequent joints and occasional ice lenses below and adjacent to the overburden.

Site grading should take into account the undulating terrain, rough microtopography and the need to preserve the permafrost. Benching and contouring of the site will require placement of a suitable well compacted borrow fill blanket, 1.0 m minimum thickness. Minor excavations and rock removal will be required at parts of the site. A crusher ramp will be required and will be constructed from material available from the mine preproduction activities.

A study to identify and investigate potential borrow pit sites was conducted by geotechnical consultants in 1991, involving a literature review, airphoto interpretation, field reconnaissance, subsurface exploration and laboratory testing. Sources of borrow material for construction of structural fill can be obtained from esker deposits, alternatively it could be obtained from quarried rock, either blast or crushed rock. There is abundance of non-acid generating deposits (e.g. Gabbro) within close proximity of the site.

## 4.5 General Site Arrangement (Dwg # U053-ULU-01A)

The mine surface facilities are located as close as possible to the portal to facilitate access to the underground mine, which is particularly desirable in view of the harsh winter environment.

The site facilities will include the following installations:

- Intake water pumphouse at Ulu Lake
- 60-man camp; sleepers and dining modules
- Vehicle repair shop, power house, warehouse and cold storage
- Office and change room modules.
- Fuel storage tanks
- Fresh water storage tank
- Sewage plant and incinerator
- Ore crusher & stockpiles
- Explosive storage Magazines

In addition, there is a need for a crushing plant suitably covered with a building structure to prevent ice forming in winter. A rockfill ramp will be constructed to allow for front end loaders to reach into the hopper. The crusher is located adjacent to the mine and a 180,000 tonne ore stockpile. The stockpile height will be kept to a 6.0m maximum, in order to avoid driving over the stockpile with equipment thus preventing the compaction and freeze up of the material. A suitable size pad is to be constructed under the stockpile area.

## 4.6 Water Supply and Distribution

Fresh water will be pumped from a Lake adjacent to the mine site. The pump station, situated to ensure an ice free intake to the pumps, will consist of two vertical turbine pumps, one operating and one standby, each with a capacity of 100 m3/hour (440 USgpm). The pumps will discharge through a 150 mm diameter insulated and heat traced HDPE pipe to a 500 m3 (130,000 USg) capacity insulated tank located close to the surface facilities. This tank provides both fire and fresh water storage, the fire water reserve occupying 225 m3 (60,000 USg). A pump station will be situated adjacent to the tank, which will house two fresh water supply pumps, one operating and one standby, each 27 m3/hour (120 USgpm) capacity, and one diesel engine driven fire pump, having discharge capacity of 115 m3/hour (500 USgpm). Potable water will be obtained from the fresh water supply and a suitable chlorination system, located in the pumphouse, will be provided.

Water distribution within the site will utilize a 50mm steel pipeline for potable water and a 150mm diameter steel pipeline for fire fighting water flow requirements. These pipes will be routed through the accommodation camp and the shop complex.

Water will be pumped to a Brine Plant, located near the mine portal, and then piped to the underground workings for use by drill equipment in the permafrost. It is estimated that on the average, approximately 75 m3/day (20,000 USgpd) will be used for this purpose. An insulated and heat traced pipeline will be connect the Brine Plant to the main water storage tank.

## 4.7 Sewage Disposal

Sewage will be collected from the accommodation camp and change room facilities then pumped to a sewage treatment plant. A Rotating Biological Contactors (RBC) treatment system will be designed and installed for this purpose. The effluent will meet NWT guidelines for wastewater discharge. The effluent will be pumped and discharged into the environment in an approved manner.

The sewage treatment plant will be sized for on-site work force of 60 people, and the plant design criteria will be as follows:

| | | | |
|---|---|---|---|
| Design Capacity | | 20.<br>0 | m3/day |
| Effluent Discharge quality | - BOD | 30 | ppm |
| | - SS | 35 | ppm |

The sewage treatment plant will be housed in a pre-engineered building adjacent to the power plant building.

## 4.8 Solid Waste Disposal

Solid waste from the accommodation camp, kitchen and repair shops will be burned in a packaged waste incinerator. The incinerator will be diesel fired and located on the down wind side of the facilities. Waste would be transported by pick-up truck and loaded into the incinerator.

## 4.9 Accommodation Camp

The 60 room accommodation complex will be set about 80m away from the power generator building. The accommodations will be connected to the office, service and warehouse buildings by enclosed walkways (utilidors).

The accommodation camp has been sized to house on-site mine and administration staff. Spare rooms for visitors and occasional staffing requirements are also being provided. Accommodation requirements will be as shown in Table 4.1.

**Table 4.1: Accomodation Requirements**

| | Accommodation Rooms | On Site Personnel |
|---|---|---|
| Mining Operation | 27 | 27 |
| Service Facilities | 8 | 8 |
| Admin/Superv | 9 | 9 |
| Caterers | 4 | 4 |
| Haul Truck Drivers | 6 * | 12 |
| Visitors | 6 ** | 6 ** |
| Total | 60 | 66 |

* Shared rooms

** Initially the rooms are used for peak labour force

The majority of the rooms will be single occupancy with gang washrooms/showers to serve the entire complex located centrally. Female occupancy for 15% of the work force, with separate washroom facilities, will be included in the design.

The rooms designated for visitors will be furnished with bunk beds for emergency use by additional haul truck drivers during emergencies and stormy weather periods. Beside sleeping quarters, the camp will include Dining & Kitchen areas, Lounge & TV room, Recreation room, Games room and Laundry and storage areas.

The accommodation complex is essentially composed of two structures, a dormitory building and a kitchen, dining and recreational building. Both buildings will be designed to meet the National building Code of Canada Group C fire safety and occupancy requirements.

The accommodation camp could be either new or used trailer units, Atco type modular construction units or equivalent. The modules should be supplied and delivered fully furnished complete with electrical, plumbing and electrical heating equipment. The size of the prefabricated modules shall be determined to suit transport requirements of the winter road from Yellowknife or Lupin.

The foundations to be used under the accommodation camp must be carefully designed to preserve the existing permafrost as well as facilitate construction and salvage of the modules.

## 4.10 Offices and Shops

The service buildings will house the mine maintenance shops, warehouse, change rooms and administrative offices. The details of the principal areas are presented in this section.

### *4.10.1 Offices*

The administration facility will occupy 100 square metres. Offices will be provided for the foreman/manager, shift supervisors, geologist/engineer and camp administrator. Work areas will be provided for drafting, surveyors, samplers and technicians. There will be areas for accounting records and one for drawings and engineering data. Space will also be provided for a photocopier, communications room, computer station and storage.

### *4.10.2 Mine Maintenance Shops*

The mine maintenance shops will be constructed using a fold-away type insulated steel building 12 m wide x 49 m long. Two overhead end doors as well as side mandoors will be provided. The building will include two service and repair bays separated by full height partition walls to prevent total heat loss when one door is opened. No permanent crane will be provided but access is available for a small mobile crane to be used.

The building will include a machine shop, an electrical area and a tool crib. Covered access to adjacent buildings will be available.

The building floor will be a concrete slab construction on grade to facilitate equipment maintenance and repair work as well as to contain and collect oil or other spills.

### *4.10.3 Warehouse*

The warehouse building will provide 300 square metres of covered and heated space. A fold-away type building, 12m x 24.5m will be constructed for this purpose.

### *4.10.4 Change Rooms*

The 130 square metre dry will be located adjacent to the offices and the shops and is sized for 40 men and 5 women. It will serve the mine, and maintenance personnel. The dry will be equipped with one clean locker and hanging baskets for each user. Showers and washrooms will be included within the dry.

### *4.10.5 Cold Storage*

The cold storage building will provide 288 square metres of covered space. A fold-away type building, 12 m wide x 24 m long will be provided for this use.

## 4.11 Fuel Storage

Diesel fuel will be delivered by tanker to the Ulu mine site during the winter ice road season.

The estimated fuel storage requirements at the Ulu mine site is 3,288,000 litres, based on eight (8) months consumption, as shown in Table 4.2.

**Table 4.2: Diesel Fuel Requirements**

| | Annual Consumption (litre) | Site Storage Capacity (litre) |
|---|---|---|
| Power Generation | 1,825,000 | 1,217,000 |
| Mine Equipment | 967,000 | 645,000 |
| Surface & Misc. Equipment | 350,000 | 233,000 |
| Mine Air Heating | 1,500,000 | 1,000,000 |
| Contingency | 290,000 | 193,000 |
| Total | 4,932,000 | 3,288,000 |

The storage facility will contain:

- Two steel tanks 12.0 m diameter and 16.0 m high, designed in accordance with API specifications.
- The tanks and pumps will be contained in a dyked area, approximately 36 m by 24m in plan area, lined with HDPE liner or equivalent.

The fuel will be pumped to the power plant day tank. A diesel fuel dispensing station for the mine mobile equipment and trucks will be provided at a suitable location.

## 4.12 Power Generation Building

The power plant building will house three diesel power generator units to supply electricity to the mine and surface facilities. A fold-away type uninsulated steel building approximately 12 m x 9 m will be required. The building will be constructed on a gravel pad overlaying an HDPE liner which will contain oil spillage and will be recovered and disposed of, in an environmentally acceptable manner at the end of the project.

## 4.13 Surface Mobile Equipment

Mobile equipment needed for surface transportation and yard maintenance are:

| | |
|---|---|
| Crew Bus | 1 |
| Pick-ups | 3 |
| Snow mobile | 1 |
| Grader | 1 |
| Boom Truck | 1 |
| Cat dozer | 1 |
| Forklift/FEL | 2 |

Mobile equipment for winter road construction/maintenance and mining are listed in Section 5 and Appendix C respectively.

## 4.14 Airstrip

The proposed new airstrip will be located south of the mine site, approximately 2 km along the winter ice road alignment. The runway construction will involve placement of processed crushed material and suitable granular fill over the natural terrain and will provide sufficient minimum thickness to preserve the existing ground frozen conditions.

The design of the airstrip will follow the requirements of recognized aviation standards taking into account actual topographical and geotechnical conditions at the site. The runway principal configuration and geometric characteristics are summarized as follows;

- Runway length = 2000 m
- Runway width = 45 m
- Aerodrome reference code = 4C (Transport Canada)
- the average longitudinal slope be limited to 1.0%
- the slope of the first and last quarter of the length not exceed 0.8%
- longitudinal changes along a runway that may have adverse effects on aircraft operations will be avoided as much as economically feasible.

The runway alignment will be along a north-south direction. The gravel airstrip will be 2000m long and 45m wide, suitable for use by Boeing 727 type aircraft. The surfacing layer specifications will meet the requirements of the aircraft operations. The existing Ham Lake drainage channel will be relocated to the west of the proposed airstrip alignment.

The primary reason for selecting this site for the airstrip location is its proximity to natural granular fill deposits required for construction of the runway. The site offers sufficient clearances from obstacles and high ground and will easily meet the requirements for safe take off/approach space needed for jet aircraft. Navigational aids, perimeter lighting and a waiting room/shelter building will be installed.

## 4.15 Power Supply and Demand

Power will be supplied by three Diesel Engine Generator sets rated 635 kW each for the mine site and facilities, and one Diesel Engine Generator set rated 150 kW for the air strip facilities. There is a provision to recover any waste heat from the engines at the mine site.

The forecast demand loads are 1,087 kW average and 1,351 kW peak. Total annual power consumption is 6,555,454 kWh. This total consumption includes load demand savings for camp heating from waste heat recovery. Annual fuel consumption for power generation is about 1,825,000 litres. A detailed load forecast is included in Table 4.3 and demand data is shown in Table 4.4.

The power plant operating cost is estimated at 13.33 cents per kWh with a fuel price of Cdn $0.49 per litre ($2.21 per gallon). The operating and maintenance labour costs are excluded from this calculation.

The labour costs are included in the site support costs (4.20).

## Table 4.3: Power Forecast

ULU_Load.WK1.U053A.WWHC

| Qty | DESCRIPTION | Connected Load HP | Connected Load kW | Peak kW | Load Factor | Average kW | Operating Duty %/Day | Operating Duty Hrs/Yr | Annual kWH |
|---|---|---|---|---|---|---|---|---|---|
| | Mine Primary Fans | 150 | 111 | 105.45 | 0.85 | 94.35 | 85% | 7446 | 702,530 |
| | Mine Auxiliary Fans | 100 | 74 | 70.30 | 0.85 | 62.90 | 75% | 6570 | 413,253 |
| | Mine Air Heater | 50 | 37 | 35.15 | 0.85 | 31.45 | 85% | 7446 | 234,177 |
| | Mine Pumps | 25 | 18.5 | 17.58 | 0.60 | 11.10 | 85% | 7446 | 82,651 |
| | Mine Air Compressor | 175 | 129.5 | 123.03 | 0.70 | 90.65 | 75% | 6570 | 595,571 |
| | Misc U/G Heaters | 15 | 11.1 | 10.55 | 0.60 | 6.66 | 85% | 7446 | 49,590 |
| | Jumbo's | 210 | 155.4 | 147.63 | 0.85 | 132.09 | 40% | 3504 | 462,843 |
| | **Total Mining Load** | 725 | 536.5 | 509.68 | | 429.20 | | | 2,540,615 |
| | Fresh Water Pump | 15 | 11.1 | 10.55 | 0.85 | 9.44 | 50% | 4380 | 41,325 |
| | Yard Lighting | | 15 | 14.25 | 0.85 | 12.75 | 60% | 5256 | 67,014 |
| | Mobile Equipment Plug-in's | 25 | 18.5 | 17.58 | 0.50 | 9.25 | 50% | 4380 | 40,515 |
| | Crusher | 150 | 111 | 105.45 | 0.85 | 94.35 | 75% | 6570 | 619,880 |
| | Crusher Feeder | 35 | 25.9 | 24.61 | 0.85 | 22.02 | 75% | 6570 | 144,639 |
| | Other Crusher | 35 | 25.9 | 24.61 | 0.85 | 22.02 | 75% | 6570 | 144,639 |
| | Camp - 60 Rooms | | 210 | 199.50 | 0.85 | 178.50 | 85% | 7446 | 1,329,111 |
| | Camp - Kitchen | 150 | 111 | 105.45 | 0.60 | 66.60 | 50% | 4380 | 291,708 |
| | Warehouse Lighting & Services | | 15 | 14.25 | 0.80 | 12.00 | 60% | 5256 | 63,072 |
| | Dry & Offices - Lighting & Services | | 15 | 14.25 | 0.80 | 12.00 | 60% | 5256 | 63,072 |
| | Shops - Lighting & Services | | 30 | 28.50 | 0.80 | 24.00 | 60% | 5256 | 126,144 |
| | Shop Air Compressor | 25 | 18.5 | 17.58 | 0.85 | 15.73 | 50% | 4380 | 68,876 |
| | Cold Storage Lighting & Services | | 10 | 9.50 | 0.80 | 8.00 | 60% | 5256 | 42,048 |
| | Power Plant - Misc | 50 | 37 | 35.15 | 0.85 | 31.45 | 75% | 6570 | 206,627 |
| | Misc Heat Tracing allowance | | 100 | 95.00 | 0.85 | 85.00 | 50% | 4380 | 372,300 |
| | Communications Equipment | | 15 | 14.25 | 0.25 | 3.75 | 90% | 7884 | 29,565 |
| | Air Strip - Misc | | 80 | 76.00 | 0.25 | 20.00 | 90% | 7884 | 157,680 |
| | Contingency | 50 | 37 | 35.15 | 0.85 | 31.45 | 75% | 6570 | 206,627 |
| | **Total Surface Facilities Load** | 535 | 885.9 | 841.605 | | 658.29 | | | 4,014,839 |

## ECHOBAY - ULU PROJECT POWER FORECAST

| | Connected Load kW | Peak kW | Average kW | Annual kWH |
|---|---|---|---|---|
| **Total Mining Load** | 537 | 509.68 | 429.20 | 2,540,615 |
| **Total Surface Facilities Load** | 885.9 | 841.61 | 658.29 | 4,014,839 |
| **Total Power Required** | **1,422** | **1,351** | **1,087** | **6,555,454** |

### Design Basis :

Duty is based on 365 operating days per year
Peak Load (KW) = Total kW(Op) x Design Factor(1.0) x Availability(0.95)
Average Operating Load = Operating Load x Load Factor
Annual Consumption (kWH) = Av Op Load (kW) x Duty (Hr)

**Table 4.4: Power Demand**

| | Av Load kW | Peak Load kW | Consumption kWh/yr |
|---|---|---|---|
| U/G Mining Loads | 429 | 510 | 2,540,615 |
| Surface Facilities Loads | 658 | 841 | 4,014,839 |
| Total Power Required | 1,087 | 1,351 | 6,555,454 |
| | | | |
| Total Fuel Required | 1,825,000 litres per year | | |
| Operating Cost | 13.33 Cdn cents per kWh | | |

## 4.16 Power Generation

### *4.16.1 Mine Site*

The mine site power plant will have three diesel generator sets, each rated at 635 kW, 1,800 rpm, 0.8 p.f., 4,160V. All generators will be capable of operating in parallel. Two generator sets will normally be operating to handle both the average and peak demand loads. The third unit will be on standby and/or for maintenance.

The mine site generators will be housed in a fold-away building (about 14 m long and 9 m wide) with space for another Diesel Engine Generator set for future hoisting load. An external 4,000 litre day tank adjacent to the building will supplement the on-site fuel storage tanks.

### *4.16.2 Air Strip*

The air strip will have one diesel generator set rated at 150 kW, 1,800 rpm, 0.8 p.f., 600V c/w external day tank. This generator will be operating continuously to handle the air strip loads. The generator will be housed in a fold-away building with a passenger waiting room. A UPS system is also provided to power communications equipment and lighting in case of emergency.

## 4.17 Power Distribution (Drawing #U053A-EE-001)

4,160V Power is distributed to the mine via single 3c #2 AWG Teck underground feeder and to the Fresh Water pumphouse via single 3c #4 Teck underground feeder. Two 500 kVA Load Centres will be tapped off from the mine feeder termination boxes. A 500 kVA Crusher Load Centre will be tapped off from the fresh water pumphouse feeder which will have a 45 kVA Load Centre.

600V Power is distributed to various mine site facilities via a 1,000 kVA step down dry type transformer to a 600V Secondary Distribution Centre (SDC). A 600V Motor Control Centre (MCC) will also be located in the Power Plant.

From the SDC, 600V power will be distributed to Shops and Fuel Storage, Cold Storage, Warehouse, Dry and Offices, Sleeper, Dining/Recreation and Sewage Plant. The distribution feeders will be of direct buried 3c #500 MCM Teck cables.

Some allowance has been made for yard lighting and heat tracing.

### *4.17.1 Emergency Generation*

The Ulu site location is distant from the Lupin operations. Maintenance support and spare equipment would take some time to get to site, therefore emergency power will be supplied by a 100 kW Diesel Engine Generator to a Sleeper module. This generator will provide power for communications equipment and heating loads.

### *4.17.2 Heat Recovery*

Waste heat recovery units for the diesel generator sets at the mine site are included. With waste heat recovery units installed, the result will be a saving of approximately $131,000 per year in operating cost (983,178 kWh).

## 4.18 Power Costs

Power costs have been estimated at 13.33 cents per kWh based on operating for 365 days each year.

## 4.19 Communications

### *4.19.1 Voice Radio Communication*

The Surface Facilities and the mining areas will have voice radio communication to allow operating and maintenance personnel to talk to each other using portable (hand held) and mobile (vehicle mounted) radios. The radio system will provide a communication link between the Surface Area and the Mine. The system, operating on a single frequency, would consist of two radio repeater stations one at the Mine and one in the Offices of the Surface Area. 10 portable and/or mobile radios will be assigned to operating supervisors and maintenance personnel. In addition to this, 2 less expensive desk sets will be utilized in warehousing and the Truck/Maintenance Shop where personnel need to communicate but are not moving around.

### *4.19.2 Telephone System*

The on-site telephone system is divided into Private telephones and Business telephones all sharing common switching and off-site connections. The private telephones (2 provided), located in the recreation area of the Camp, will be provided outside access through a "calling card" billing method. The business telephones, which do not require calling cards for off-site access, will be located in the warehouse, shop and offices. Both systems will be interconnected.

### *4.19.3 Data Communications*

Ten personal computers for word processing, warehousing, drafting and mine planning functions will be connected together through a Local Area Network (LAN) and will share a common file server. These computers will be located in the camp, warehouse, shop and offices. Satellite data communication equipment will allow on-site computers to communicate with off-site computers.

### *4.19.4 Satellite Voice and Data Communications*

Off-site communications for data and telephone systems will be provided via satellite channels. No long distance charges will be incurred if the call terminates at Lupin or in Yellowknife (optionally Vancouver, BC). Normal long distance rates apply for other off-site calls. Data communications will be via a dial-up circuit.

### *4.19.5 Satellite TV*

Each room in the Camp will be wired with a TV outlet. Six satellite TV channels and a radio channel will be provided from the Anik E1 Satellite.

### *4.19.6 Haulage Truck Voice Radio Communication*

There will be radio communication between haulage trucks and the camp.

### *4.19.7 Air Strip Communication*

The estimate for the Mill Air Strip is based on using Class B navigation aids capable of a company non-precision approach. Air to ground radios, Weather station and Threshold, Edge Lighting, Strobe and Odals will be provided.

## 4.20 Site Support Costs

The costs in this section are estimates for costs which have not already been accounted for elsewhere. Underground mining costs are shown in Section 3 and the appendices; access road, crushing, and haulage in Section 5.0; and capital costs in Section 8.0.

The site support costs are shown on an annualized basis for the project, based on mining 270,000 tonnes per year for a mine life of eight years.

**Power Costs:**

Total annual power required (kWH) x cost per kWH ($/kWH)

| | |
|---|---|
| 6,555,454 kWh x 0.1333 $/kWh | $873,843 |

**Surface Equipment Costs:**

| | |
|---|---|
| Snow clearing and misc allowance | $125,000 |

**Assaying:**

| | |
|---|---|
| Allowance of about $0.19 per tonne mined | $51,840 |

**Freight:**

Transport cost = Yellowknife/Lupin/Ulu
= (662 x 178)km x $0.18/t/km
= $151.20/t

Total Tonnes = Mine + Other Fuel + Consumables

| | |
|---|---|
| Average annual freight | 5,400 tonnes |
| Average annual cost | $815,837 |

**Personnel Costs** (not including staff, mining, trucking or catering):

| | |
|---|---|
| Service personnel, 8 x 3 x $3,700/mth | $88,800 |
| Travel, 8 site x 3 rotations x $350/trip | $8,400 |
| Accommodation, 8 x 3 x 10 mandays x $30/day | $ 7,200 |
| **Total** | $104,400 |
| Annualized personnel cost, 104,400 x 12 | $1,252,800 |

**Site General Supplies:**

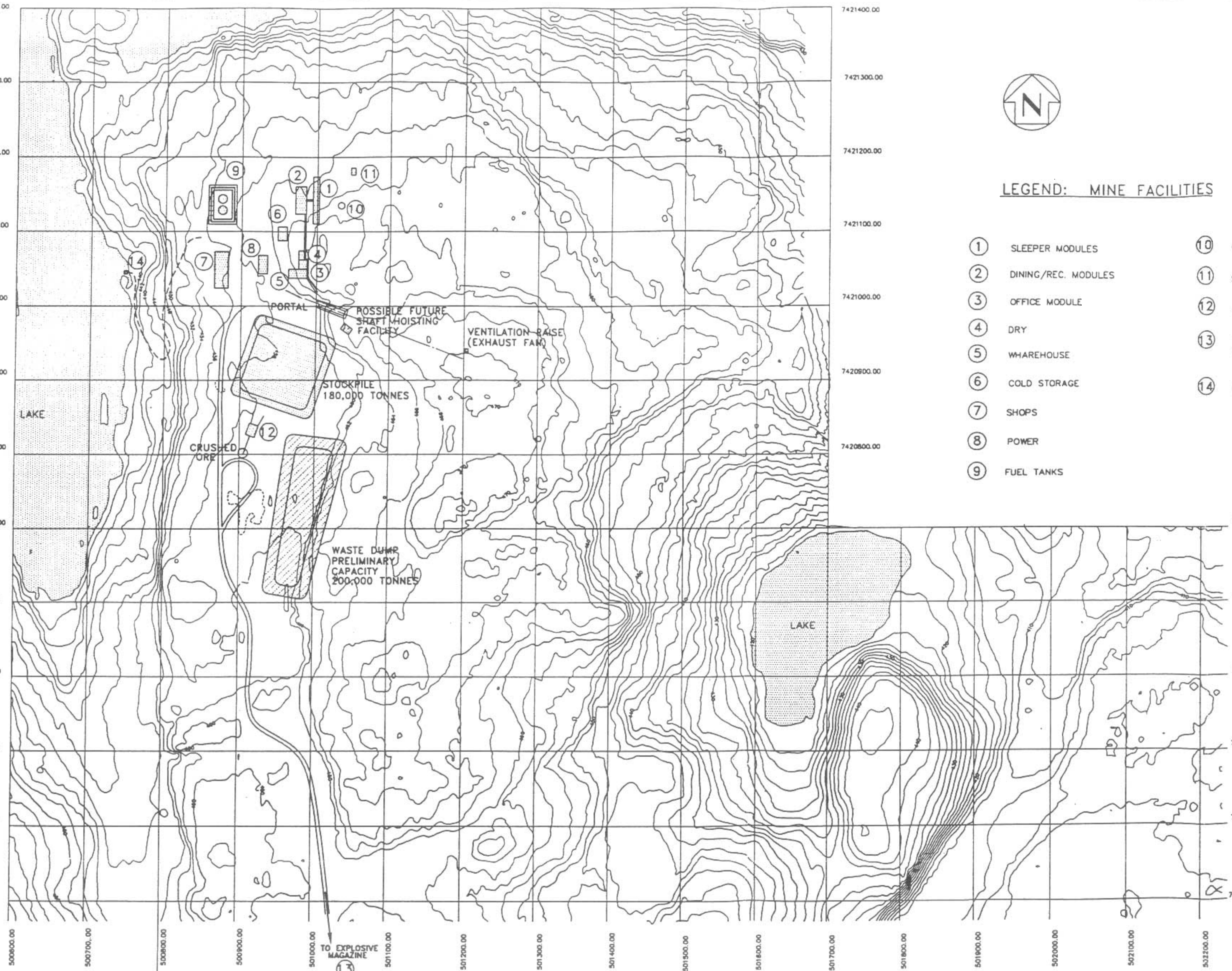
| | |
|---|---|
| Allowance | $75,000 |

**General Site Maintenance:**

| | |
|---|---|
| Allowance for power plant/site | $125,000 |

**Site Summary - Annual Costs**

| | |
|---|---|
| Power | $873,843 |
| Surface Equipment | $125,000 |
| Assaying | $51,840 |
| Freight | $815,837 |
| Personnel | $1,252,800 |
| General Supplies | $75,000 |
| General Maintenance | $125,000 |
| Total | $3,319,320 |




LEGEND: MINE FACILITIES

1. SLEEPER MODULES
2. DINING/REC. MODULES
3. OFFICE MODULE
4. DRY
5. WHAREHOUSE
6. COLD STORAGE
7. SHOPS
8. POWER
9. FUEL TANKS
10. WATER TANK
11. SEWER
12. CRUSHER
13. EXPLOSIVE MAGAZINE
14. FRESH WATER PUMPHOUSE

SCALE 1:2500

CONTOUR INTERVAL 2m

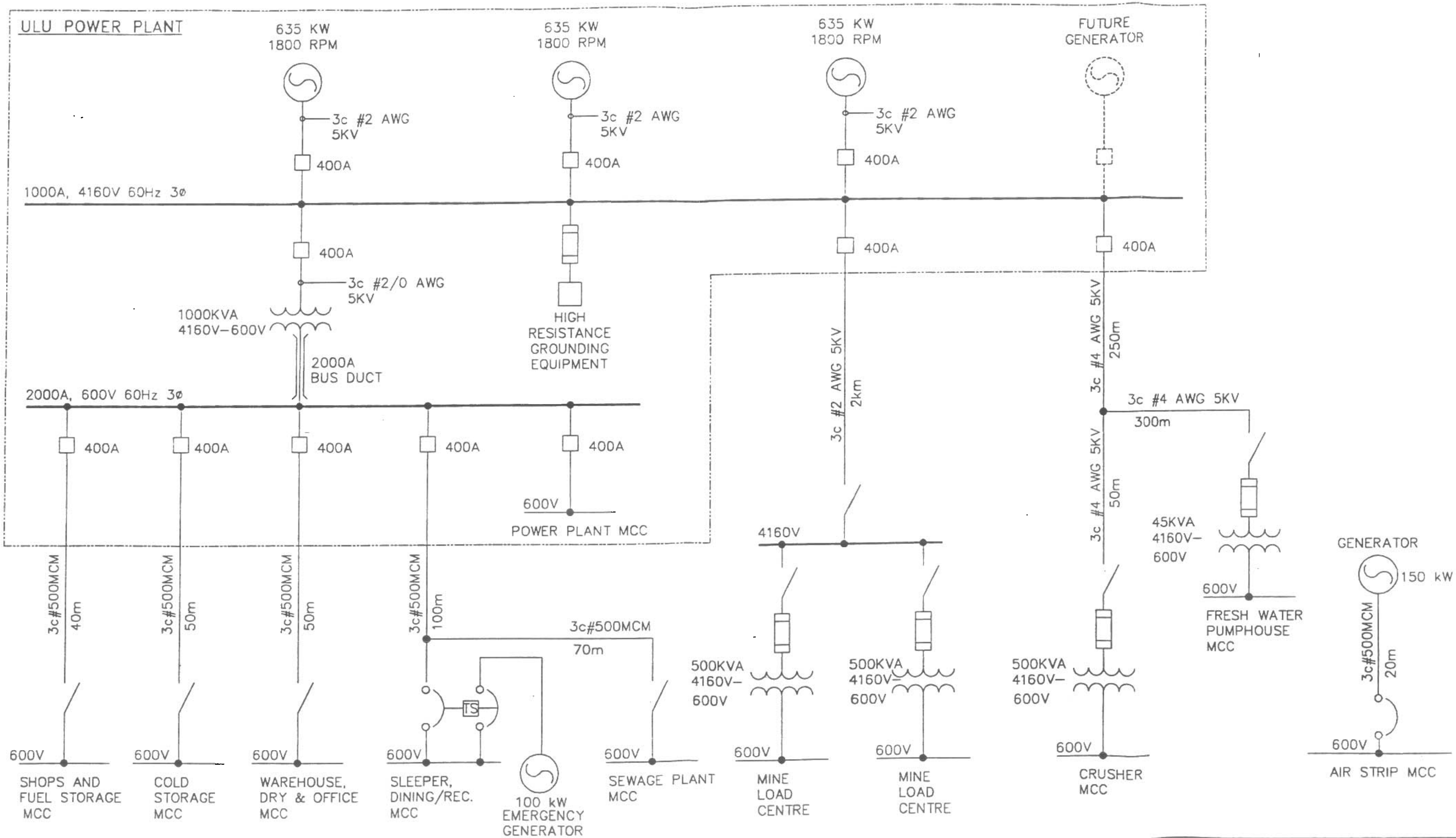
SIMONS

ECHO BAY MINES LTD.
ULU FEASIBILITY STUDY
ULU MINE SITE

U053A

U053-ULU-01 A

CAD FILE NAME: U053-001 LAST UPDATE: Mar. 28, 1995




| Rev. | Revision Description | Date | By | Chk'd | App'd | No. | Dwg. No. | Reference Drawings |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 4 | | |
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| A | FOR FEASIBILITY STUDY | | HFF | | | 1 | | |

PRINT RECORD

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| Approved By | | |
| Checked By | | |
| Drawn By | HFF | 95/03/28 |
| Designed By | HFF | 95/03/28 |

SIMONS
H.A. SIMONS LTD.
MINING GROUP
VANCOUVER, CANADA

Job No. U053A

Title
ECHO BAY MINES LTD.
ULU FEASIBILITY STUDY
MAIN SINGLE LINE DIAGRAM

Drawing No. U053A-EE-001 Rev. A

# 6.0 PROCESSING at LUPIN

## 6.1 Lupin Ore Processing - Current Practice

The Lupin mineral processing plant is a conventional gold ore processing facility using crushing and grinding, pre-aeration, cyanide leaching and Merrill-Crowe zinc precipitation for gold recovery.

The crushing plant receives primary crushed ore from underground and crushes through a secondary standard cone and a tertiary shorthead cone to produce a 14 mm screened product which is stored in a fine ore bin.

Ore is reclaimed from the fine ore bin and fed to a rod mill at the nominal rate of 82 s.tons/hour. Rod mill product joins the product of the two ball mills to feed cyclones. The cyclone underflow (sands) is ball mill feed and is split between the two ball mills (half the cyclones feed one mill, the other half the other mill). The cyclone overflow is fed to a thickener ahead of the pre-aeration circuit. The Lupin ore over the past year has had an operating work index between 12 and 14, compared to 1980 testwork carried out on Lupin ore which had an average of 12.4 (range 10.7-13.5). The cyclone overflow target product from the Lupin grinding circuit is $k_{80}$ 74$\mu$m and $k_{57}$ 37$\mu$m.

Pre-aeration residence time is two hours at 50% solids.

Cyanide leaching is at 50% solids with a residence time of 32 hours at the 82 s.tons/hr nominal throughput rate. Cyanide strength is maintained at 350-400 ppm during the leach. Cyanide consumption is around 1.2 lbs/s.ton and lime around 1.6 lbs/ton.

Leach discharge goes through two stages of filtering for pregnant solution recovery using barren solution as a counter-current wash. Tailings contain 250 ppm residual cyanide.

Pregnant solution is clarified in a pre-coat pressure filter, de-aerated under vacuum, and fed to a plate and frame press after zinc dust addition in the standard Merrill-Crowe recovery method.

The plate and frame press is periodically emptied and the gold slime dried and smelted to Dore bullion.

## 6.2 Ulu Ore Processing Characteristics

The Minerals Lab of BHP carried out testwork on ULU ore. Much of this testwork addressed pre-concentration by flotation.

The early work reported in May 1990 was carried out at very fine grinds and determined that, as grind increased from 85% minus 400 mesh ($k_{85}$ 37$\mu$m) to 98% passing 400 mesh ($k_{98}$ 37$\mu$m) cyanide leach recovery improved. This grind is significantly finer than could be realistically achieved at Lupin at anything approaching a reasonable treatment rate, and would preclude co-processing the ore with Lupin material.

In September 1990 the Minerals Lab reported on some follow-up testwork carried out under less extreme conditions. Direct cyanide leaching of ore at a number of grinds demonstrated an improvement in recovery as fineness increased but that satisfactory recoveries could be achieved at a Lupin grind ($k_{80}$ 74$\mu$m):

| Grind $k_{80}$ size | main zone % Au extraction | NW extension % Au extraction |
|---|---|---|
| 208 | 82.9 | 83.7 |
| 150 | 86.2 | 87.2 |
| 74 | 88.6 | 87.0 |
| 37 | 91.0 | 89.2 |

The testwork indicates that these results are reported after pre-aeration but does not indicate times for pre-aeration or cyanide leach. Cyanide consumptions are around 1 kg/t, lower than reported from the earlier work at finer grinds. The earlier work suggests Ulu may benefit from slightly longer lead times than are currently used at Lupin, possibly an additional leach tank. Flotation of sulphide from the leach residue produces a low grade concentrate (11-12 g/t Au) and increases recovery by 10%.

Mineralogical and gold distribution by size fraction suggest that potential exists for making a gravity concentrate, although no direct testwork has been carried out. The Lupin plant does not currently have a gravity circuit. However, indications are that Ulu ore would benefit from gravity concentration and it is possible that such a circuit may be installed at Lupin in the future.

No information is available on ore hardness from work index determinations, and any future work should include work index determination. Mineralogical examination suggests ore hardness will be similar to Lupin (Wi 12-15). This only affects tonnage treatment rates, as the required grind is similar to Lupin ore. On the information available from the September 1990 Minerals Lab report there is no reason to believe that any serious problems would be presented in treating Ulu ore through the Lupin plant in conjunction with Lupin ore.

## 6.3 Lupin Process Plant Modifications

Modifications are not essential. However, the following modifications would offer some benefit.

There are indications Ulu ore contains coarse free gold, recoverable by gravity. The installation of a jig in the grinding circuit and a cleaner jig and table to clean up primary jig concentrate may offer some benefit. Course gold is generally retained in mill grinding circuits because this gold reports to the cyclone underflow, and in most cases is ground fine enough to leach.

Ulu ore appears to benefit from a slightly longer leach time than is currently available. The addition of another leach tank may offer some benefit, but should only be considered after more definitive data are available.

## 6.4 Continuous vs Batch Processing

The ores are sufficiently similar to make continuous processing of the mixed ores viable. Some concern over leach residence time suggests that additional leach capacity would be desirable and may offer some benefit on Ulu ore. When the work index for Ulu ore is known, the grinding circuit should be reviewed.

## 6.5 Assaying and Gold Recovery

Additional assaying will be required to operate the peripheral orebodies, related to grade control at the mines. This additional load could probably be accommodated in the existing Lupin laboratory, although additional labour may be required.

Accounting at the plant will require additional samples of crushed ore to be taken so that credit can be given to the appropriate deposit.

No additional assaying will be required directly related to mill operations.

Very significant thought should be given to properly account fairly for gold from the different properties, and the establishment of procedures for crushed ore sampling, standardized leach procedures and umpires would be required before treatment of outside ore. More metallurgical work is required on Ulu ores (and possibly Lupin) to enable appropriate procedures to be established.

Samples from the Ulu site will be transported by plane or truck and the results radioed to site.

## 6.6 Costs

No process plant capital costs have been considered related to the installation of a gravity circuit. The scheme recommended for adoption for Ulu material is below and would apply if the addition of gravity equipment was demonstrated in future testwork:

- Purchase and install two jigs on each ball mill discharge or cyclone underflow. The ball mill discharge is preferred by some operators but is a slightly more difficult installation. Installation on the cyclone underflow makes density control within the grinding circuit difficult.

- Relocate the cyclone feed pumps and pumpbox to accept jig discharge (it may be possible to leave this where it is and launder from the mill to the jig and back to the pumpbox)

- Purchase and install a vertical pump with each jig to pump jig concentrate to the cleaner jig.

- Purchase and install a single cleaner jig directly over a cleaner jig concentrate storage tank.

- Purchase and install a shaking table adjacent to the jig concentrate storage tank.

- Install a pump to pump away table tailings: buckets and trays are used for concentrate.

- Install security enclosure around table and purchase and install cameras to view gravity area.

- Purchase and install electrical and piping to go with the above.

Purchasing the three jigs, table, pumps and fabricated items (tank, support steel etc.) will cost $250,000. Installation is in addition to the cost shown.

As this work will likely be done by Lupin maintenance crews the overall cost of the capital installation has been allocated as follows (excluding project management and indirects):

| | |
|---|---|
| Capital purchase | $250,000 |
| Transportation | $25,000 |
| Installation Labour* | $36,900 |
| Installation Supplies | $12,000 |
| Steel and Concrete | $15,000 |
| Design and Supervision | $20,000 |
| Total | $358,000 |

* 900 hours @ $41.00 /hr

**NOTE: The above capital costs have not been included for capital cost determination or financial evaluation. These costs may be incurred after additional testwork is complete.**

Factors that impact the operating costs for Ulu ore are as follows:

- Cyanide consumption on Ulu ore is double that of Lupin, when comparing lab tests to actual operating data. The earlier May 1990 report indicates much higher consumption rates than the later September 1990 report. The additional 0.7 kg/t projected would add about $1/tonne to the operating costs of Ulu ore. Lime consumptions are also indicated as somewhat higher.

For Ulu ore processing, allocated costs will be as follows:

| | |
|---|---|
| Current Lupin Direct Costs | $13.81 /tonne |
| Cyanide | $1.00 /tonne |
| Portion of direct transport of supplies | $1.30 /tonne |
| Total | $16.11 /tonne |

NOTE:
1. Transport cost is prorated based on the tonnage contributed by Ulu.
2. G&A costs are accounted for in the financial model
3. No cost is included for additional steel ball consumption or use of additional power. The need for these would be established only after additional testwork.

# 7.0 ENVIRONMENT AND PERMITTING

Protection of the environment is the key function of environmental permitting requirements. Project design and development to date has duly considered all potential environmental effects. The following sections describe the work performed to date in preparation for an environmental assessment of the mine and its associated infrastructure, and outline the tasks remaining.

## 7.1 Baseline Studies

Several baseline type studies have been completed for the Ulu Project in the NWT. A list of the documents reviewed and summarized for this preliminary study is presented in Table 7.1. Some baseline studies commenced as early as 1990 in the Ulu Project area. BHP Minerals initiated an assessment of background water quality and surface hydrology conditions in the summer of 1990. In 1991, Rescan Environmental Services Ltd. was commissioned to initiate studies required for an assessment of potential project related impacts. The environmental baseline studies started by Rescan included climate, hydrology, water quality, fisheries and aquatic resources, wildlife and vegetation. The following outlines the work performed:

**Climate:** Site specific data collection of daily temperature, humidity, rainfall, wind speed and direction began in the summer of 1990. A remote datalogger was installed on-site in June of 1991 and recorded and averaged data over one hour intervals.

**Hydrology:** In June 1991, a staff and crest gauge and an automated water stage recorder was installed.

**Water Quality:** Twelve sites were identified for water quality measurements in 1991. Parameters measured included both field and laboratory pH, temperature, total dissolved solids, conductivity, turbidity, acidity, alkalinity, the major cations and anions, and total heavy metals.

**Table 7.1: Summary of Reference Reports**

| Title | Author | Date Published |
|---|---|---|
| Mineralogy of Ulu Samples | E.U. Peterson University of Utah | March, 1991 |
| Summary of Preliminary Examination of Lithologies, Vein Textures and Alteration Associated with Flood Zone Auriferous Mineralization, Ulu Claims, NWT | Peter Kleespies University of Alberta | 1991 |
| Ulu Project, NWT Environmental Review | Rescan Environmental Services Ltd. | December, 1991 |
| Wildlife Survey for the Ulu Project 1992 Update | S. Howson/ C. Dierker | November, 1992 |
| 1992 Compilation Geological, Geochemical and Drilling Report | E. Flood et al. | January, 1993 |

**Fisheries and Aquatic Resources:** Baseline data were collected in the summer of 1991 on fish species presence/absence, population estimates, fish tissue metal bioaccumulation and benthic invertebrate species composition. The characterization of fish habitat and habitat use was included in these studies as well as bathymetric surveys of Penthouse and Ulu Lakes.

**Wildlife and Vegetation:** A preliminary wildlife study was completed in 1990 by compiling a literature review with the field observations of BHP personnel, and was updated in 1992. The study reports the presence of barrenground caribou, musk oxen, barrenland grizzly, wolves, arctic fox, arctic ground squirrel, peregrine falcons and ptarmigan. Vegetation is reported to consist of several varieties of lichens, mosses, sedges, willows, and flowering plants.

## 7.2 ARD Characterization of Ore and Waste Rock

The Ulu property is located in the High Lake Supracrustal Belt which is part of a northerly trending complex of volcanic rocks, bounded to the west by extensive granitic plutons and to the east by volcaniclastics, carbonate and turbidite sediments. The High Lake metavolcanic belt is known for its abundant pyritic siliceous gossans, major shear zones and occasional banded iron formations.

The geology hosting the mineralized zone, or "Flood Zone", consists of Archaean, lower amphibolite-grade basalt with subordinate sediment and gabbro. The mineralized zone is an intensely silicified, 2 m - 5 m thick steeply dipping body. The distribution and relative abundance of the gold are variable. It also possesses arsenopyrite in fractures and dilatancies within the basalt. The arsenopyrites comprises 5% to 10% of the zone while accessory sulphide minerals such as pyrrhotite and pyrite comprise of 2% and <1% respectively. Arsenopyrite thus represents 45-60% of the total sulphide content, and pyrrhotite commonly constitutes 20-30%.

Acid/base accounting (ABA) is one of the first steps in determining the potential for acid generation from ore and waste rock. ABA attempts to determine the net neutralization potential (NNP) of a material by examining the balance between potentially acid producing sulphide minerals (typically pyrite, $FeS_2$) and acid consuming minerals (typically carbonate bearing).

ABA testwork was first completed on 15 samples obtained from drill core collected in 1990, representing each lithology encountered on-site. Results of this program indicated that these rocks are neither significant potential acid producers, nor are they highly acid consuming. In the summer of 1992, another 15 samples were collected from a surface trench excavated across the mineralized zone and its hangingwall. These samples were tested for both acid producing potential (APP) and acid consuming potential (ACP).

Of the samples collected from the hangingwall (probable waste rock material), three of the five displayed a ratio of ACP:APP greater than 3:1 indicating acid rock drainage is not likely to occur. The remaining hangingwall samples, while exhibiting greater ACP than APP, lie in a range in which static tests such as ABA are unable to predict whether acid generation might occur or not.

The mineralized zone samples exhibited the greatest APP, with most samples displaying negative NNP and ACP:APP ratios less than one. In a temperate climate, this rock would probably generate acidic drainage. To determine the length of time which would elapse before acid generation would become observable will require kinetic testwork such as humidity cells. Given the site specific arctic climate conditions it is likely that any acid drainage would occur while the ore is stockpiled for shipment to Lupin, however, this will need to be confirmed with laboratory testwork prior to project permitting.

## 7.3 Waste Rock Surface Dumps

The waste rock at Ulu which gets brought to surface will be stockpiled in a waste rock dump. Almost all of the waste rock will not be potentially acid generating material as it will be excavated in the Pre-production phase of the mine development, which will be in waste rock well removed from the ore body, and as was shown in the 1990 study, free of sulphides. Only a small amount of waste rock will be generated in the ore development work which might be potentially acid generating material. Most of the waste rock from adjacent to the mineralized zone can be disposed of underground, where it will remain as permafrost material. If the waste rock adjacent to the ore body is proven to be potentially acid generating material through a program of kinetic testing, it will be sampled for ABA analysis as the rock is excavated and brought to surface. If the sampling confirms an excess of sulphides in the waste rock, the rock will be stored in a segregated waste rock dump. Design will include plans to minimize drainage through the dump and incorporate the rock into the permafrost. It may be possible to return some of this material into the underground workings on mine closure.

## 7.4 Solid/Liquid Waste Disposal

Garbage disposal will require the strategic placement of bear proof metal containers with lids. All burnable refuse would be incinerated. Non-combustible waste and scrap metal should be collected and stockpiled until it can be relocated to adequate disposal facilities.

A majority of the flow of waste water from the mine infrastructure will originate from the kitchen and dry facilities. The water will be comprised of washroom discharge, and grey water from shower, laundry and kitchen discharge. All sanitary sewerage and waste water will be collected and channelled to a small treatment plant for treatment prior to final discharge.

Fuel and oil storage sites will require a bermed and lined storage area. The refuelling area could be constructed with a lined pad covered by esker material.

## 7.5 Tailings

As the current plan calls for the ore to be milled at Lupin, the tailings produced will be handled in accordance with Lupin's tailings management plan. Since Lupin already has a secure tailings disposal system in place, with reclamation planning oriented towards avoiding acid generation, the acid generating characteristics of the mineralized rock from Ulu is not critical.

## 7.6 Access Considerations

Access to the Ulu site for most of the year is by air. An esker located approximately 10 km south of Crown Camp has been used as a makeshift airstrip by exploration crews. Equipment and supplies are dropped off at the airstrip and then shuttled by helicopter to the camp. The property can be accessed by winter road from Lupin.

Access during construction and operations will make use of combination of winter and all-weather roads and an expanded airstrip. All-season roads will be required in the immediate vicinity of the mine site. The crossing of the Hood River does not appear to require an engineered bridge as an ice bridge appears to provide a sufficient window for economical ore haulage to Lupin. Portions of the winter road are overland and will probably require some construction work to make them passable. There are 3 or 4 possible eskers available for potential use as an airstrip. All areas to be altered or affected will require some environmental and archaeological studies to document resource loss. These evaluations need to be performed at least one summer before construction is to start to allow time for data analysis and permitting approvals.

Construction may require borrow of esker material. Eskers are valued ecosystem components in the arctic both from a wildlife use perspective and as a potential heritage resource. Consequently, extensive use of esker materials will necessitate some environmental studies.

## 7.7 Site Disturbance Considerations

The mine should present only a small area of site disturbance. The camp and infrastructure will provide the main disturbances while waste rock disposal may not contribute to the visual impact. The areal extent of the camp, waste rock dumps and ore stockpiles should be minimized. A no hunting policy should be introduced to further minimize the impact on local wildlife.

## 7.8 Closure Plans and Costs

Closure plans will restore the area to an acceptable environmental level consistent with pre-development and long term land use considerations. The main objectives for closure are to protect hydrological resources, control erosion and revegetate mine, camp and road locations where practical. It may be necessary to borrow surficial materials from the airstrip or existing roads to provide an adequate growth medium for revegetation.

All machinery, equipment and buildings will be removed, as well as all tanks removed and foundations buried and revegetated. Contaminated soils which cannot be recycled or reused will be disposed of in the underground workings and allowed to "freeze".

Portal areas will be revegetated and recontoured. The portal will be permanently sealed.

Watercourses will be restored to their original drainage or to a new drainage that will require no maintenance. Culverts and obstruction will be removed and water courses designed to provide maximum use for wildlife. Slopes requiring protection from erosion will be rip-rapped or vegetated.

Road and access ways not required will be reclaimed. Reclamation will consist of scarification to reduce compaction and reseeding vegetation of a suitable species to the prescribed land use. Permanent access such as the airstrip, will require slopes to be stabilised through revegetation.

If acid generation tests indicate the potential for acid rock drainage, special waste rock disposal and reclamation planning will be completed. It may be possible to return any potentially acid generating waste rock underground as backfill to plug the portal.

Under the NWT Waters Act, the company will be required to furnish security to enable reclamation to occur should the project shut down at any time. This bond will be required at the exploration stage and can be on the order of $100,000 for an advanced exploration program. Financing for the reclamation bond for full-scale operations is a function of the predicted effects, can be as much as 10% of the project development capital cost, but is not usually required to be posted in cash, up front.

## 7.9 Permitting Issues and Data Collection Costs

Updates on all baseline studies initiated in 1991 and 1992 including vegetation, wildlife, fisheries, archaeology and heritage resources should be completed. Further characterisation of the waste rock and its geochemistry will require a program of acid/base accounting tests and a number of kinetic tests to determine the critical NP/AP ratios and rates and time to the onset of acid generation.

The main issues will revolve around water extraction and discharge at the mine site as well as the incorporation of mine access into the environment. Baseline studies for mine access will include archaeological studies, wildlife habitat and utilization assessments, and fisheries assessments of all areas to be disturbed, particularly eskers, lake shores and stream/river crossings. Baseline studies for water use will need to focus on water chemistry and water management planning (eg., sedimentation control).

The collection and compilation of this data is can probably be complete over one spring to autumn caribou migration period (ie., April to October). The archaeology work and wildlife habitat assessments will only take a few weeks in mid-summer, while the fisheries work will need to start at thaw and continue intermittently until freeze-up. Water quality sample collection could coincide with period over which the caribou surveys occur. The expected cost to cover the length of the overland sections of the road, the proposed airstrip and the mine site is on the order of approximately $100,000, including completion of the waste rock characterization studies. It may be appropriate to combine geotechnical studies, particularly in regards to effects on permafrost along the road route, with the summer wildlife studies.

Prior to initiation of the field program, consultation with potentially affected members of the Nunavut Tungavit Federation (NTF) will be required, as part of the scientific research permit application process and as an integral part of the studies to obtain the traditional knowledge of the area. This is inherently part of the on-going liaison with the First Nations people.

The baseline assessment program will also have to take into consideration possible cumulative environmental effects with projects such as BHP's NWT Diamond Project and the Boston gold property as well as Metall's Izok Lake and Echo Bay's own Ski property and Lupin operations. Furthermore, the regional study of the Slave Geological Province recently initiated may have an affect on future land use considerations which could affect both operational and reclamation planning.

## 7.10 Permitting Procedure Description

Apart from the acquisition of a mining permit, under the *Canada Mining Regulations* in the *Territorial Lands Act*, issued by DIAND, there are a number of associated permits regulating collection of scientific data and use of territorial lands and water.

Scientific permits will be required from the Science Institute of the NWT (SINT) to carry out further studies for fisheries, water quality, and wildlife habitat assessment. The federal Department of Fisheries and Oceans (DFO) will also provide permits for the fisheries studies. The Prince of Wales Northern Heritage Centre administers the permits issued for archaeological studies through the *Archaeological Sites Regulations* under the *Northwest Territories Act* as well as through the *Historical Resources Act*.

Submission of a comprehensive Project Description Report (PDR) to the Regional Environmental Review Committee (RERC) will determine the final level of environmental review required. If the PDR adequately describes the potential effects and indicates a low level of concern and uncertainty, the project could proceed directly to permitting. If there is a sufficient degree of uncertainty caused by substantial data gaps and lack of understanding, an Initial Environmental Evaluation (IEE) may be required and if there is sufficient public concern a full Environmental Impact Statement (EIS) may be required. The decision on the level of review will be made in conjunction with the NTF.

A Land Use Permit will be required to initiate advanced exploration and to encompass the camp and surface facilities, airstrip, site roads and winter road. The Land Use Permit will allow the company to carry out work under certain conditions designed to protect the environment.

A Water Licence must also be acquired both for exploration and prior to the project development. A public hearing will be required in conjunction with a technical review of the water licence application by the Technical Advisory Committee of the Northwest Territories Water Board. Water licences do take a much longer period of time (up to 6 to 8 months) than a Land Use Permit and therefore should be scheduled into the project development accordingly.

Quarry Permits will be needed for the excavation of concrete aggregate and common backfill and ballast material for roads and mine infrastructure. Mineral Land Claims can be converted into Mineral Leases and Land Tenure Agreements once the mine enters production.

Approval from the Nunavut Tungavit Federation will be required.