MINERAL INDUSTRIES IN WESTERN CANADA

THE TENTH COMMONWEALTH MINING AND METALLURGICAL CONGRESS – SEPTEMBER 2-28, 1974

SPONSORED BY: THE CANADIAN INSTITUTE OF MINING AND METALLURGY

NORANDA MINES LIMITED

Bell Copper Division

(Latitude 55°- 00'N, Longitude 126°- 14'W, Elevation 2450 Feet)

LOCATION, ACCESS AND CLIMATE

The Bell Copper Mine is located on Newman Peninsula on the east side of Babine Lake approximately 170 miles north west of Prince George, British Columbia.

Access to the property is by means of a 30 mile paved road from Topley on Highway 16 to the Village of Granisle. An unpaved road 8 miles in length connects the village and Bell Copper's west barge landing. The lake is crossed by means of an 120 ton barge pushed by a 9 ton tug. Barge service to the minesite during the winter months is maintained by a compressed air bubble channel approximately 12,000 feet in length.

The ambient air temperature ranges from a mid-winter minimum of 44 degrees Celsius to a summer maximum of 34 degrees Celsius. Freezing conditions start in the latter part of October and last for six months. The lake normally freezes over in mid-December and the break-up occurs in the early part of May. Snow fall accounts for approximately two-thirds of the twenty-one inches of annual precipitation.

HISTORY AND OWNERSHIP

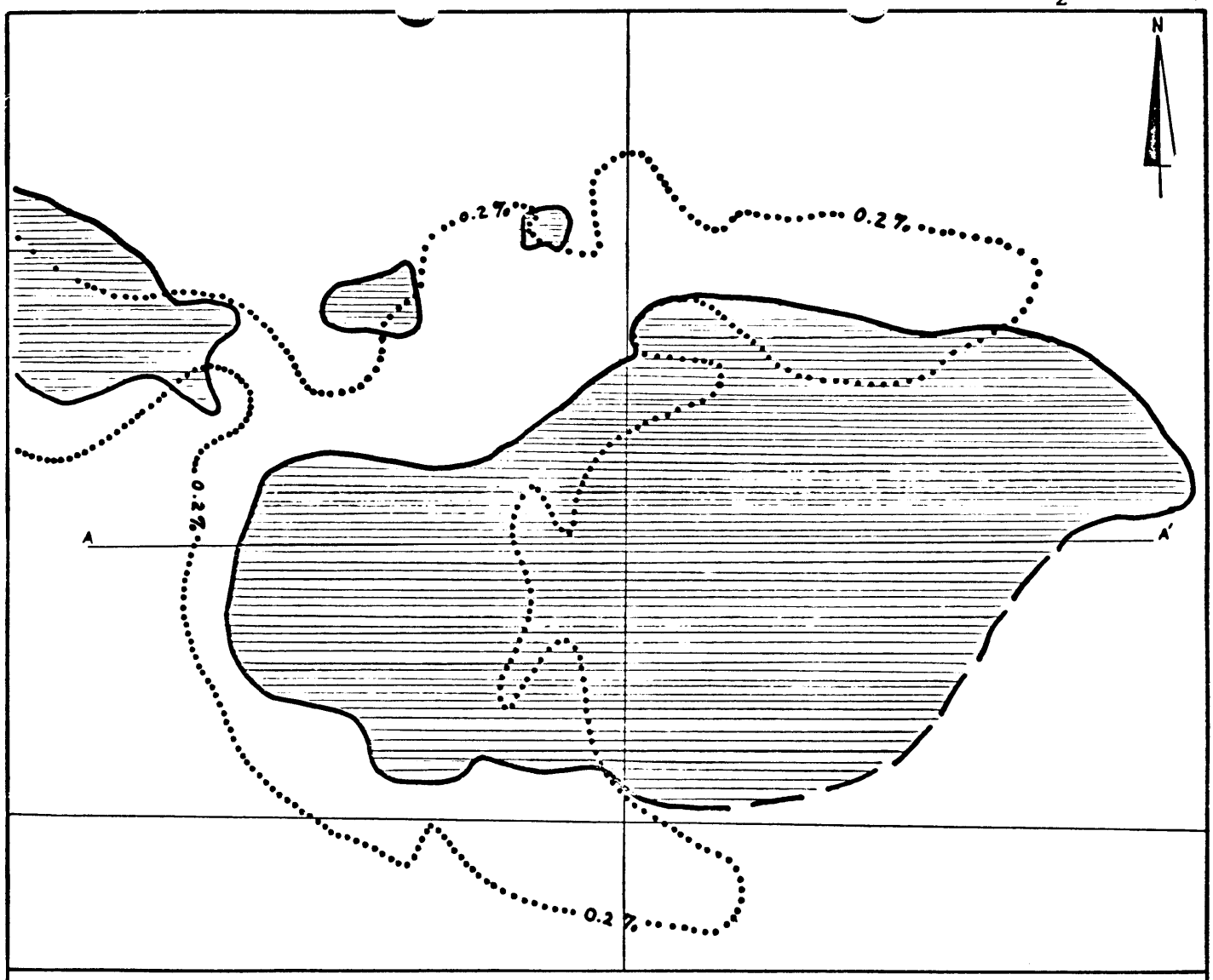
The region of the deposit was first examined in the mid 1920's by Charles Newman, whose name has been given to the peninsula on which the mine is located. Newman put in the two adits at the base of a cliff on the lakeshore following some small veins of chalcocite with galena and sphalerite. Most of his workings are still visible.

Some trenching was done around the minesite during the second world war, but nothing of any significance was uncovered, and the property lay open.

In 1962, Noranda Exploration examined the showings on the lakeshore, and staked the site. Geochemical sampling revealed a stream sediment anomaly related to the orebody. A JEM survey provided three drill targets, the third of which was in the orebody.

Nearly 100,000 feet of diamond drilling was completed before pre-production work began. Mineable reserves at a 0.3% Cu design cut-off are 46,000,00- tons at 0.5% Cu.

Pre-production stripping began in 1970. Production commenced in 1972 at a nominal rate of 10,000 TPD. The mine is operated by Noranda Mines Limited, Bell Copper Division.



LEGEND

Scale 1" = 400'

Tertiary - Biotite Feldspar Porphyry

Jurassic-Cretaceous - Hazelton Group
Siltstone, Tuff, Porphyrytic volcanic

Geologic Contact

0.2% Cu isopleth

inches
0 1 2
0 1 2 3 4 5
centimetres

BRITISH COLUMBIA GEOLOGICAL SURVEY

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

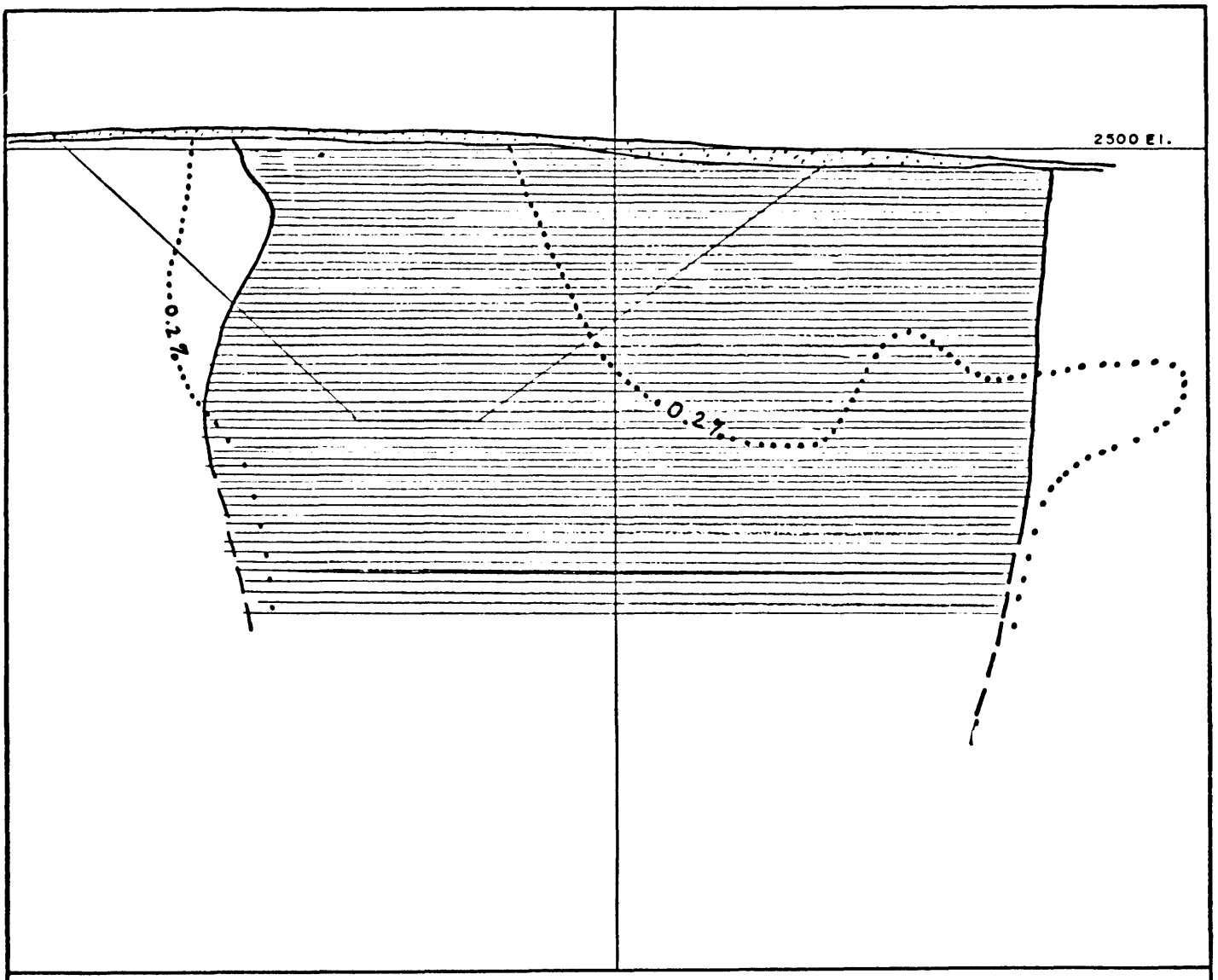
BELL COPPER

GEOLOGIC SKETCH

DRAWING NO. 1

PL 0

20/03/74



LEGEND

Scale 1" = 400'

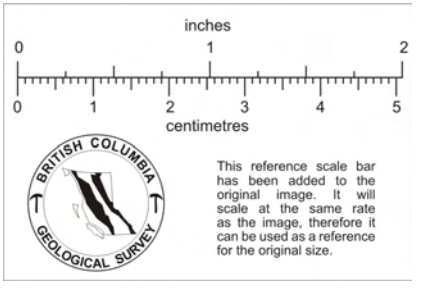
Quaternary - silt and varved clay

Tertiary - Biotite Feldspar Porphyry

Jurassic - Cretaceous Hazelton Group
Siltstone, Tuff, Porphyrytic volcanic

Geologic Contact

...0.2%... 0.2% Cu isopleth



BELL COPPER

SECTION A-A'

PL 0 DRAWING NO. 2 20/03/74

GEOLOGY

The minesite is underlain by sediments and pyroclastics attributed to the Jurassic-Cretaceous Hazelton Group. This group underlies extensive areas of the interior plateau. The group has been faulted, folded and intruded by Tertiary dykes and stocks. Fluvio-glacial and lacustrine sediments 10 to 120 feet blanket the deposit with silt and clay.

The Bell Copper is an elliptical intrusion of biotite feldspar porphyry, 2400 feet by 1200 feet, dated at 48 my. Copper mineralization occurs overlapping the western and northern contacts of the stock giving the deposit a crescent shape in plan. The sediments and volcanics are generally hornfelsed, and all units have undergone intense hydrothermal alteration.

The mineralization is primarily chalcopyrite which occurs in a dense quartz stockwork, as disseminations, and as fracture fillings. Pyrite forms from eight to fifteen percent of the rock in the ore zone. A zone of supergene enrichment exists with chalcocite common as much as 200 feet below surface. Assorted copper oxides and carbonates make up to 5 to 10 per cent of the total copper content of the upper part of the deposit. Gold occurs associated with chalcopyrite with tenors in the range of 0.01 to 0.02 ounces per ton.

Hydrothermal alteration has been well documented. The ore generally coincides with a zone of intense quartz-sericite-pyrite alteration which usually obliterates all original rock textures. The abundant pyrite in the alteration halo responds well to several geophysical prospecting methods.

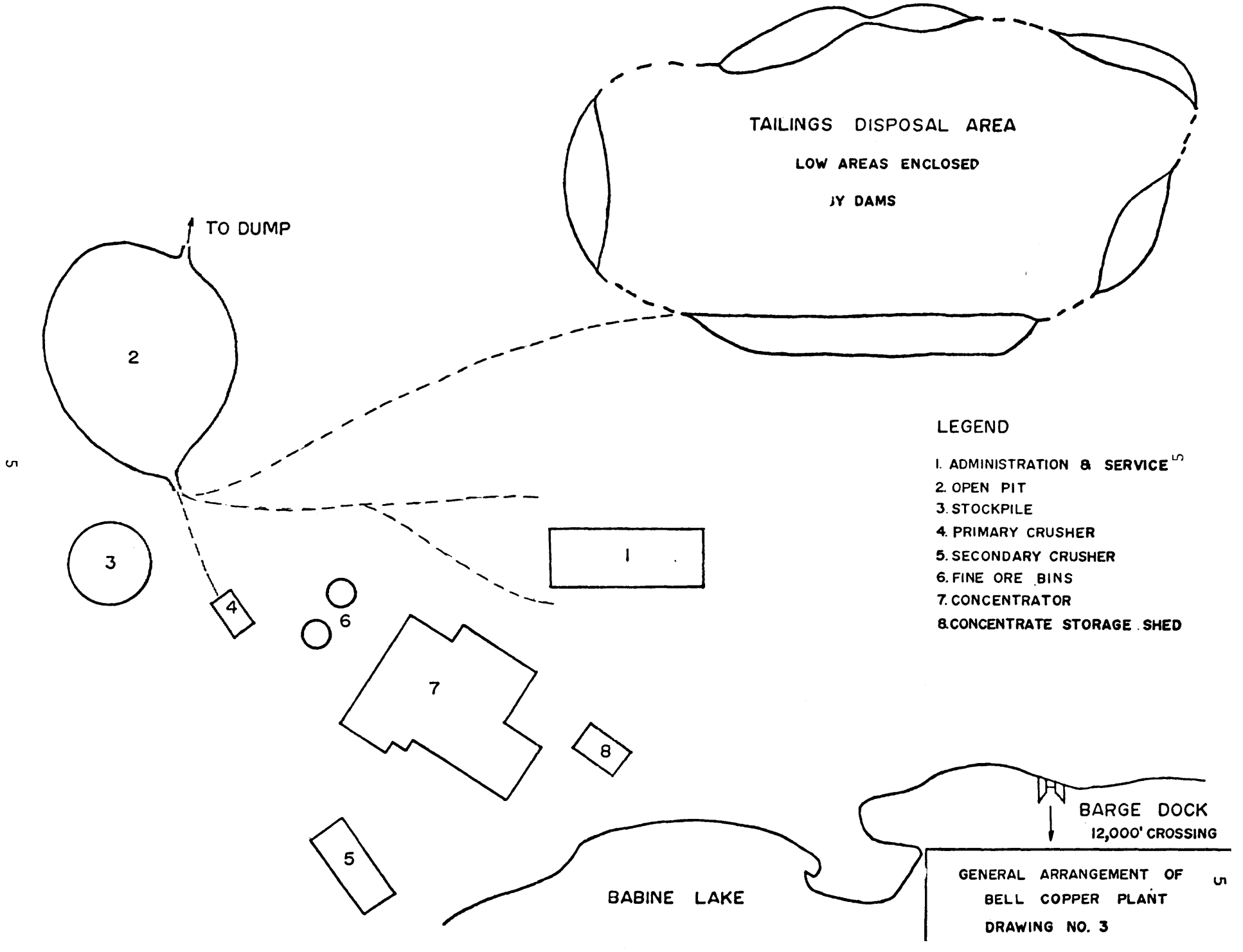
PROPERTY OPERATION

The surface layout of Bell Copper is shown in Drawing No. 3 "General Arrangement of the Bell Copper Plant". Under the direction of a mine manager the mine operations are divided into three operating departments (Mine, Concentrator and Plant) and three administrative departments (Accounting, Warehousing and Personnel). Maintenance of production equipment and plant services are all under the direction of a Plant Superintendent.

As of March 31st, 1974, the total operating crew strength was distributed as below:

	Hourly Rated	Staff	Total
Property Management	-	1	1
Administration	-	28	28
Mining	47	14	61
Concentrator	50	22	72
Maintenance & Services	81	17	98
Totals	178	82	260

For the twelve month period concluding December 31st, 1973, the Bell Copper Concentrator processed 4.1 million tons of ore grading 0.58% Cu.



GENERAL ARRANGEMENT OF
BELL COPPER PLANT
DRAWING NO. 3

MINING OPERATION

As of January 1st, 1974, the open pit excavation encompassed an area of 120 acres and extended to a depth of one hundred and sixty feet below the original surface. The major portion of the waste rock removed from the pit is used for the construction of tailings impoundment dams.

Currently, weekly pit production, accounting for the removal of a total of 158,000 tons of ore and waste and scheduled over twenty-one shifts, is achieved in accordance with the following design parameters:

Overburden Bank Slope	26°
Safety Berm at Bottom of overburden	30 feet wide
Bench Interval Height	40 feet
Safety Berms in Rock	25 feet wide each bench
Working Face Slope	65°
Roadway Widths	60 feet
Roadway Gradients	8%
Minimum Pit Wall Curvature	radius not less than 90 feet
Working Floor Slope	flat
Blast Hole Spacing	9-7/8 inch diameter holes for ore blasts - burden 20 feet, spacing 23 feet. In waste- burden 22 feet and spacing 26 feet. All patterns are staggered.
Sub-Grading Drilling	8 feet

Pit production equipment required for the removal of 12,500 tons of ore and 10,000 tons of waste per day, and the performance of that equipment is presented by Table No. 1 "Mine Production Equipment".

TABLE NO. 1

MINE PRODUCTION EQUIPMENT

FUNCTION	TYPE OF UNIT	NO. OF UNITS	SCHEDULED PER SHIFT	SHIFTS PER OPERATING DAY	OPERATORS PER UNIT	UNIT PERFORMANCE PER SHIFT
Blast Hole Drilling	Electric Rotary Drill 45-R Bucyrus-Erie	1	1	3	2	420 feet of 9-7/8" Diam. Hole
Loading of Ore & Waste	Electric P & H - 1600 7 yd bucket	2	1-2	3	2	6500 tons
	Diesel powered Front-end loader Caterpillar 992 10 yard bucket	1			1	
Haulage	Diesel 65 ton rear Dumptrucks Terex 65-R	10	5-8	3	1	1,950 tons
Dump Maintenance & Shovel clean-up	Tracked Dozers D-8 Caterpillar	2	1-2	3	1	
	Rubber tired dozer 824 - Caterpillar	1	1	3	1	
Road Maintenance	Road Grader 14 - E Caterpillar	1	1	3	1	
	Water Truck	1		As required	1	
	Sanding Truck	1		As required	1	
Blasting	Explosive Blending	1	1	1	3	

Tabulation of Mine Operating Statistics:

Production

1. Pre-Production Phase

Overburden	5.7 million tons (5.6 M removed by contractor)
Waste Rock	7.0 million tons (5.1 M removed by contractor)
Stockpiled Lowgrade & Millfeed	0.8 million tons

2. Production Phase (October 1972 through December 1973)

Overburden	0.1 million tons
Waste Rock	2.8 million tons
Stockpiled Lowgrade	1.2 million tons of 0.41% Cu.
Millfeed	5.1 million tons of 0.60% Cu.

3. Production for year ending December 31st, 1973

Waste Rock	2.4 million tons
Stockpiled Lowgrade	1.0 million tons of 0.42% Cu.
Millfeed	4.2 million tons of 0.58% Cu.
Total Mined	7.6 million tons

Consumed Supplies for year ending December 31st, 1973

1. Blasting

ANFO	4.0 million pounds
Primers	10,000 pounds
Packaged Scurry Explosives	630,000 pounds
Detonating Cord	440,000 feet

2. Diesel Fuel — 2,400 tons

3. Tires — $260,000

4. Electric Power — 92.6 million kilowatt hours

The Administrative Offices, Warehouse, Mine, Dry and Mobile Equipment Service Ship are all housed in one three story building 264 feet in length by 110 feet wide.

The Mine Crew Strength of 61 (including supervision and engineering staff) for the 21 shift per week operation is distributed as follows:

	Hourly-Rated	Staff	Total
Drilling	6	-	6
Blasting	3	-	3
Loading	10	-	10
Haulage	22	-	22
Road Maintenance & Clean-up	6	-	6
Pit Supervision	-	5	5
Professional Engineers/Geologists	-	3	3
Clerical & Technical Staff	-	5	5
Superintendent	-	1	1
Totals	47	14	61

MINERAL PROCESSING

The 10,000 DST per day design capacity plant is operated continuously and in 1973 achieved a production rate of 11,272 DST per day operating for 92.3% of the available time.

The material flow through the nominal 800 ton per hour crushing plant, and concentrator is shown in Drawing No. 4 and a brief description follows:

1. Broken pit run ore is delivered to the primary crusher nominally rated at 1000 tons per hour. The crushed rock is screened at 3/4" the oversize going to the coarse ore stockpile and the undersize to the fine ore bins.

2. Material is reclaimed from the coarse ore stockpile through vibrating feeders and crushed in a 7' Standard secondary crusher. The secondary product is combined with the tertiary crusher product and split between two secondary screens. The oversize (+3/4") from the secondary screens is fed to the two 7' Shorthead tertiary crushers. Undersize from the secondary screens is conveyed to the fine ore bins.

3. The minus 3/4" material is discharged from the fine ore bins and fed to two parallel grinding circuits each capable of treating up to 300 tons per hour of new feed. Each circuit consists of one rod mill in open circuit feeding one ball mill in closed circuit. Motor horsepowers are 1650 hp and 3600 hp respectively. Classified product from each circuit nominally at 60% passing 74 microns and 40% solids by weight is fed to separate banks of rougher-scavenger flotation cells. The tailings from both banks are combined before being pumped to the tailings impoundment area. Scavenger concentrates are combined and returned to a pulp distribution ahead of the rougher cells.

4. Rougher concentrates from both banks are combined and pumped to a regrind circuit consisting of a ball mill in closed circuit with cyclones. The product of this circuit nominally 90% passing 43 microns and 20% solids by weight is split down to two first cleaner banks. The tailings of the first cleaner banks is

fed to first cleaner scavenger cells, which are a continuation of the bank, the concentrate from which may go either with the second cleaner tail or be combined with first cleaner concentrate. The tailings of the first cleaner scavenger can be returned to the rougher bank distribution or be sent to final tail.

5. The first concentrate from both banks of cleaners is split down two banks of second and third cleaners. Concentrate from the second cleaner cells are split between the two sets of third cleaner cells while tailings from the third cleaner goes to the head of the second cleaner. Second cleaner tailing can either be returned to first cleaner or to the regrind circuit.

6. Third cleaner concentrates are pumped to the concentrate thickener the overflow from which goes to tailings. The thickened concentrate nominally 55% solids are filtered and dryed to produce a concentrate assaying approximately 25% Cu with a 7% moisture content.

Transportation of concentrate from minesite to railhead is by nominal 33 ton capacity self dumping truck and trailer combinations, loaded by front-end loader from the concentrate storage shed. After a 2 mile lake crossing by barge the haulage units have a road trip of 39 miles to the rail siding where the load is dumped. Rail cars are loaded by front-end loader for dispatch to the smelter at Noranda, P.Q. or diverted to overseas markets through Vancouver, B.C.

Spare pumping capacity is installed on each pump box to ensure shut-downs are not necessary because of pump failure. Instrumentation includes the usual high low level indicators on pump boxes, flow indicators for critical water additions, tonnage indications in crushing, grinding and drying circuits, interlocks for failure of equipment, power monitoring equipment for larger machinery and pulp density gauges for grinding circuits and thickener underflow. Operation of the grinding-flotation section of the plant is carried out from a central control room in which all the equipment is monitored and from which service functions such as dust collectors, water supply pumps and power supply can be monitored. Primary and secondary crushing plants each have their own control rooms while the filtering and drying section has its own panel.

Tailings disposal is performed by spigotting the pumped tailings along the face of a dam constructed using waste rock from the mining operation. The spigotted sands are used to seal the dam face, and where this is impractical glacial till is used. Reclaim water is pumped from a barge pumphouse, floating on the impoundment, to a head tank which feeds the plant. Dam seepage is collected in ditches and channelled to a pond from where it is returned to the impoundment area. Spigotting of tailings is carried out on a year round basis.

Tabulation of Mineral Processing Operating Statistics

Period Year 1973	
Total Mill Feed	4.114 Million tons assaying 0.587% Cu.

Concentrate Produced		77,863 DST assaying 26.10% Cu.
Overall Copper Recovery		84.1%
Power Consumption	Grinding	12.2 Kwh/ton
	Overall	21.3 Kwh/ton
Grinding Media	Rods	0.86 lb/ton Balls 1.85 lb/ton
Reagent Dosages	Lime	1.59 lb/ton
	Collector	(Areofloat 238) 0.06 lb/ton
	Frother	(MIBC) 0.03 lb/ton
	Flocculant	(Separan MGL) 0.001 lb/ton
	Dewatering	(Aerodri 100) 0.013 lb/ton

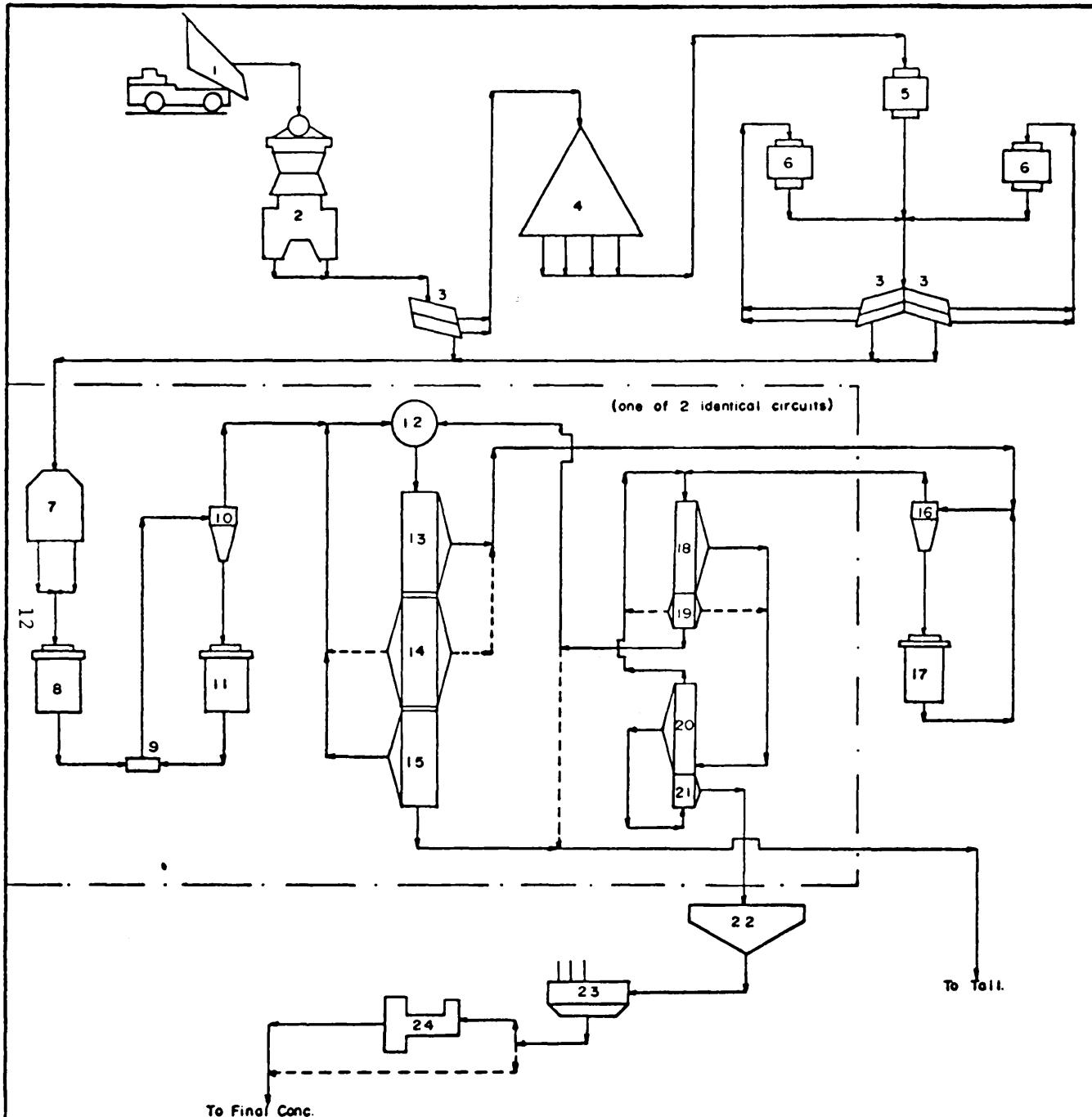
The Mineral Processing Crew Strength of 72 (including supervision and process control personnel) for the continuous operation is distributed as follows:

	Hourly Rated	Staff	Total
Crusher Operation	20	-	20
Concentrator Operation	30	-	30
Supervision & Training	0	7	7
Metallurgy & Assaying	0	14	14
Superintendent	-	1	1
Totals	50	22	72

PLANT DEPARTMENT

The Plant Department is responsible for the maintenance of all mobile equipment, process plant facilities and plant buildings. Routine maintenance and equipment servicing schedules are controlled through a maintenance planning group. Mobile equipment maintenance is carried out on a continuous schedule 3 shifts per day, 7 days per week under the supervision of a shift foreman. Process plant maintenance is divided at the top of the fine ore bins between the crushing plant and the remainder of the concentrate facilities. Each section falls under the supervision of a foreman and maintenance is normally carried out on day shift, Monday through Friday. Electrical maintenance is provided under the supervision of a foreman on day shift Monday through Friday, plus 1 electrician per operating shift.

Services such as operation of the steam boiler, maintenance of access roads and plant yards, operation of tug-barge water transportation, provision of sundry carpentry work, maintenance of the Noranda owned accomodation in the Village of Granisle and provision of a labour pool for general housekeeping duties are supplied by the Plant Department.



LEGEND

1. 65 Tons Cap. Terex Truck.
2. 42" X 65" A.C. Primary Crusher.
3. 8' X 20' A.C. Double Deck Screens.
4. 20,000 Tons Live Cap. Coarse Ore Stockpile.
5. 7' Standard Symons Cone Crusher.
6. 7' Shorthead Symons Cone Crusher.
7. 4,000 Tons Live Cap. Fine Ore Bin.
8. 13' X 18' D.E.W. Rod Mill.
9. 14 X 12 S.R.L. Cyclone Feed Pump.
10. Cyclopak 8-20" Krebs Cyclones.
11. 13'6" X 28' D.E.W. Ball Mill.
12. 10'7" X 10' Diam. Conditioner.
13. 4 No. 120 Agitair Cells Rougher.
14. 4 No. 120 Agitair Cells.
15. 5 No. 120 Agitair Cells Scavenger.
16. Cyclopak 6-10" Krebs Cyclones.
17. 9' X 14' A.C. Regrind Mill.
18. 6 No. 60 Agitair Cells First Cleaner.
19. 6 No. 60 Agitair Cells First Cleaner Scavenger
20. 8 No. 24 Denver Sub A Cells Second Cleaner.
21. 4 No. 24 Denver Sub A Cells Third Cleaner.
22. 12' X 60' Diam. D.O.L. Thickerer.
23. 8 Disc 8'10" Elmco Filter.
24. 40' X 70" Diam. Koppers Dryer.

NORANDA MINES LIMITED
BELL COPPER DIVISION
GRANISLE, B.C

CONCENTRATOR FLOWSHEET

SCALE: N. T. S.	DATE: 7/73
DRAWN: R. CHAN.	DWG. NO. 4

The Total Plant Department Crew Strength of 98 (including all maintenance, plant services, supervision and maintenance planning personnel) is distributed as follows:

	Hourly Rated	Staff	Total
Mobile Equipment Maintenance	28	4	32
Process Plant Maintenance	20	3	23
Electrical Maintenance	12	2	14
Plant Services	31	2	33
Maintenance Planning	-	5	5
Superintendent	-	1	1
Totals	81	17	98

George Hunter photo

BELL COPPER 1972
Noranda Mines Limited
10,000 T.P.D. Copper,
Babine Lake, B.C.