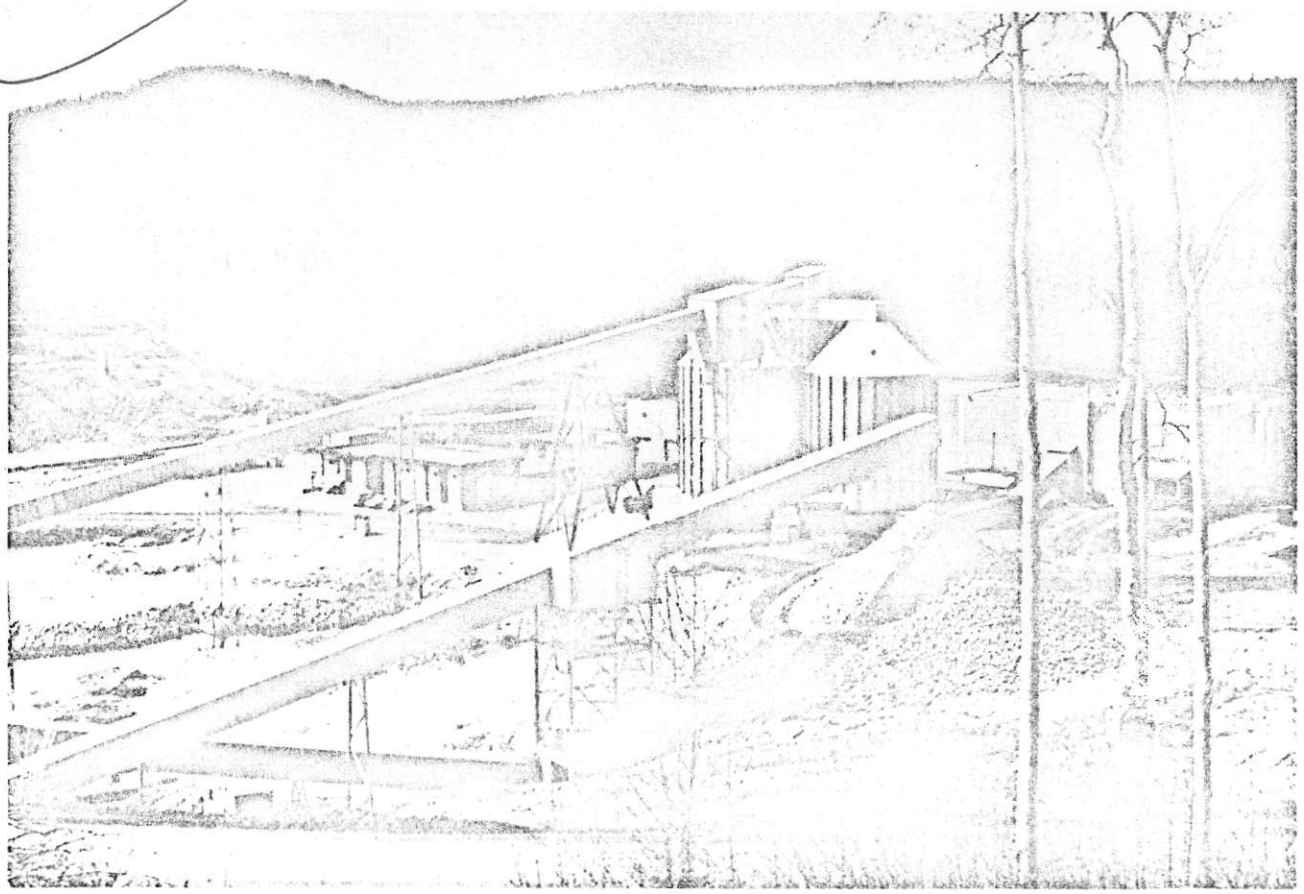
Phoenix: first train load of ore leaves for smelter, 1900

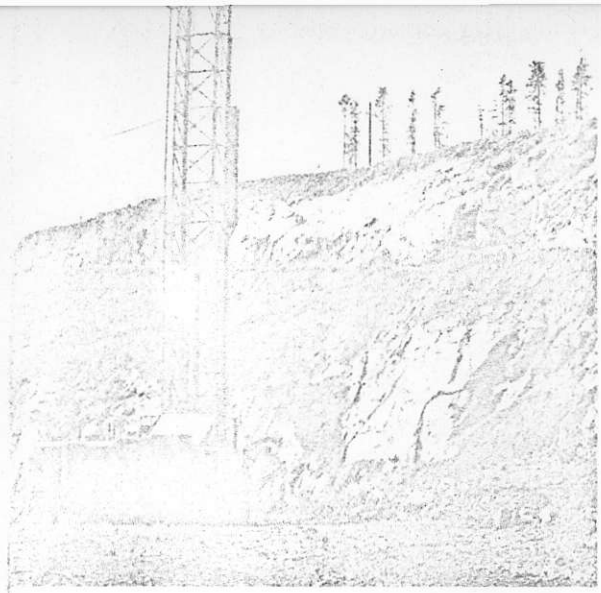
Granby

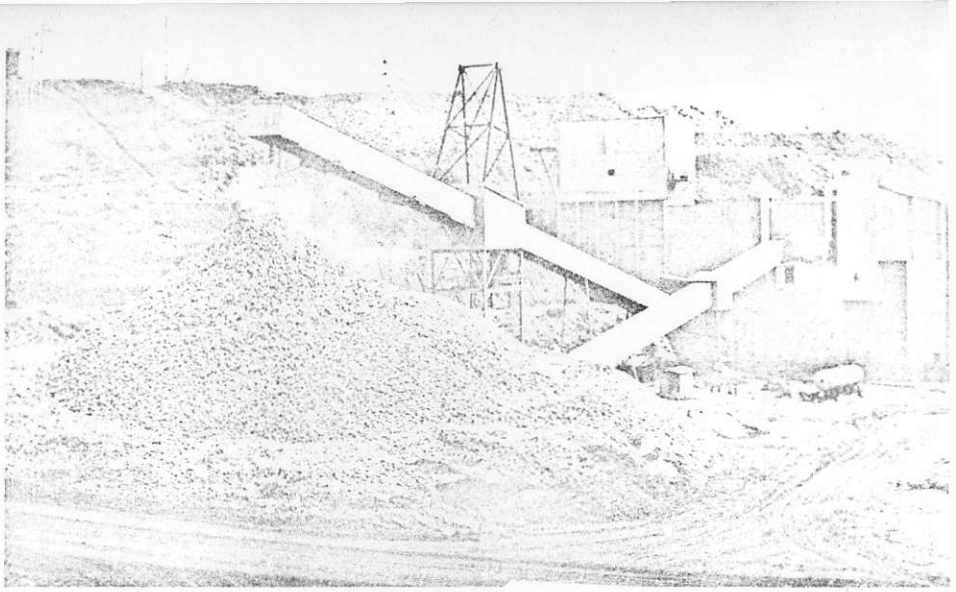
1899 to 1974 and beyond

This is the story of Granby Mining, a pioneer company that has been active in British Columbia since the late 1890s, celebrating its 75th anniversary in June 1974. Reviewed here are the present-day operations, some past events, and the skills and outlook that assure Granby's future

Granisle







Babine Lake in north-central British Columbia is the location of the 13,000 ton/day open-pit mine of Granisle Copper Limited.

Granisle is located thirty miles north of Topley, 175 miles west of Prince George on Highway 16. From the village nestled on the western shore of Babine Lake, it is an eight-minute barge crossing to the minesite on McDonald Island. During the months from December to May, the ferry channel is kept ice-free with an underwater bubbler system pioneered and perfected by Granisle Copper. Several bubbler systems, based on this design, are now operating in Western Canada.

The climate of the Babine Lake area is typical of the interior of British Columbia. Although the lake exerts a moderating influence, winter temperatures can drop to well below zero, but prolonged periods of low temperatures are rare. The annual precipitation averages 20 inches and the normal snow depth is three feet.

Mineral Deposit

The 1913 annual report to the British Columbia Minister of Mines recorded the first work on the mineralization of McDonald Island. Chas Newman and H J McDonald were the discoverers. Scant information followed, but in 1927 Douglas Lay persuaded Cominco Limited to bond the property. Under the guidance of Hank Giegerich, Cominco drilled several long holes, but due to the recession of 1929, work was discontinued and the property returned to McDonald and Newman.

Through the thirties the property lay dormant. Then, in 1943 Dr Victor Dolmage reported that, in spite of the low tenor of the ore, there was hope for high grade mineralization. A small company was formed and 1700 feet of core were logged. The average grade came to only 0.60% Cu so work was once again stopped.

Finally, in August of 1955 the property was examined by Granby. Before freeze-up, additional claims had been staked and eight drill holes sunk. The following summer 49 more holes were drilled and a remarkable continuity of copper values was demonstrated. Subsequent findings, like the favourable results from thirty additional holes in 1959, enhanced the property so that by 1963 work included preliminary flotation testing. After this the pace quickened. A feasibility report was completed in April 1964, and in mid-November 1966 production started at 5000 tons/day.

Mining brought added geological information. A deeper drill programme and a lower cut-off grade indicated increased reserves, and in 1971 it was decided to expand. By the summer of 1973 a production rate of 13,000 tons/day was achieved.

During the summer of 1965, N C Carter, of the Provincial Government Mines Branch, studied the mineralization of McDonald Island. His report gives an excellent picture of the local geology. (See list of references.)

The Granisle mineral deposit comprises a system of veinlets and disseminations of copper sulphide minerals localized in a vertical cylindrical mass by fracturing and porphyry intrusive bodies. The mineralized mass exhibits lateral zoning from a higher grade core to gradational boundaries with surrounding waste rock. Vertical continuity is pronounced, and the planned mining limit with depth is based upon the economics of mining and safe mining practice rather than lack of mineralization.

The mineral deposit is centrally located on Copper Island. The outline of the ore zone is about 1000 by 1500 ft in dimension with a north-east elongation. The ultimate mining floor planned is at elevation 1500 ft, about 800 ft below lake level. To attain this depth the pit opening would be about 2500 ft across.

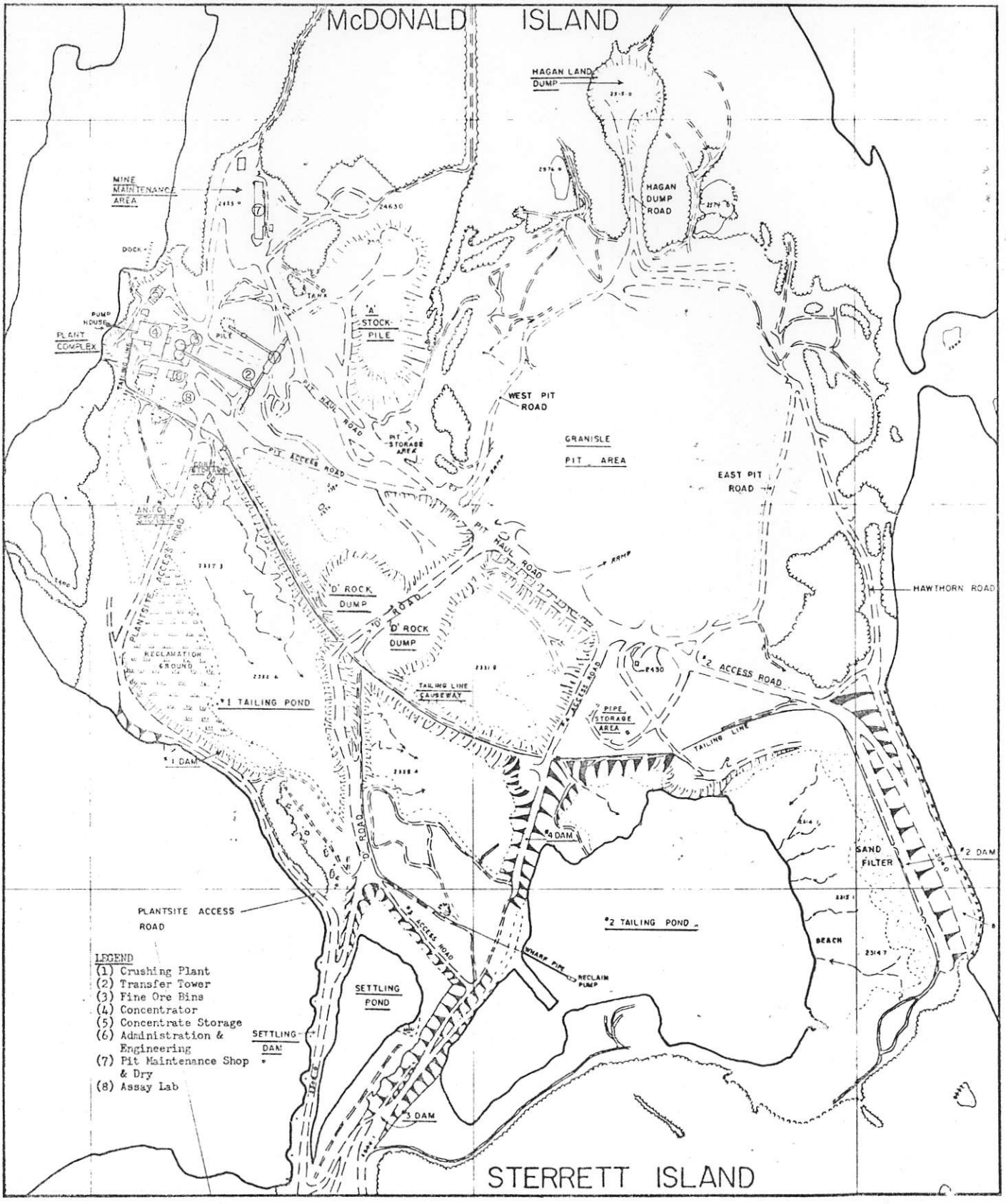
The principal mineral is chalcopyrite, but appreciable bornite also occurs, especially in higher grade areas. Small but significant quantities of gold and silver occur. Traces of molybdenite, zinc sulphide, and lead sulphide have been noted but no recovery is attempted. Ore reserve calculation at 1 Oct 1973 showed 78,168,000 tons of a grade of 0.433% copper to be in place.

Late in 1972 a mill expansion to a nominal 14,000 tons/day was completed at Granisle. During 1973 average rate of production was 11,475 tons/day. The projection is for 13,000 tons/day but it is realized that variations in hardness in various parts of the pit can change milling rate from a low of 11,000 to a high of 17,000 tons/day.

The general arrangement of the Granisle minesite is shown in the accompanying diagram.

Management at the mine is provided by a resident manager who oversees the work of four functional divisions: Mining, Milling, Plant, and Accounting. Contained within these are the associated services such as; Engineering,

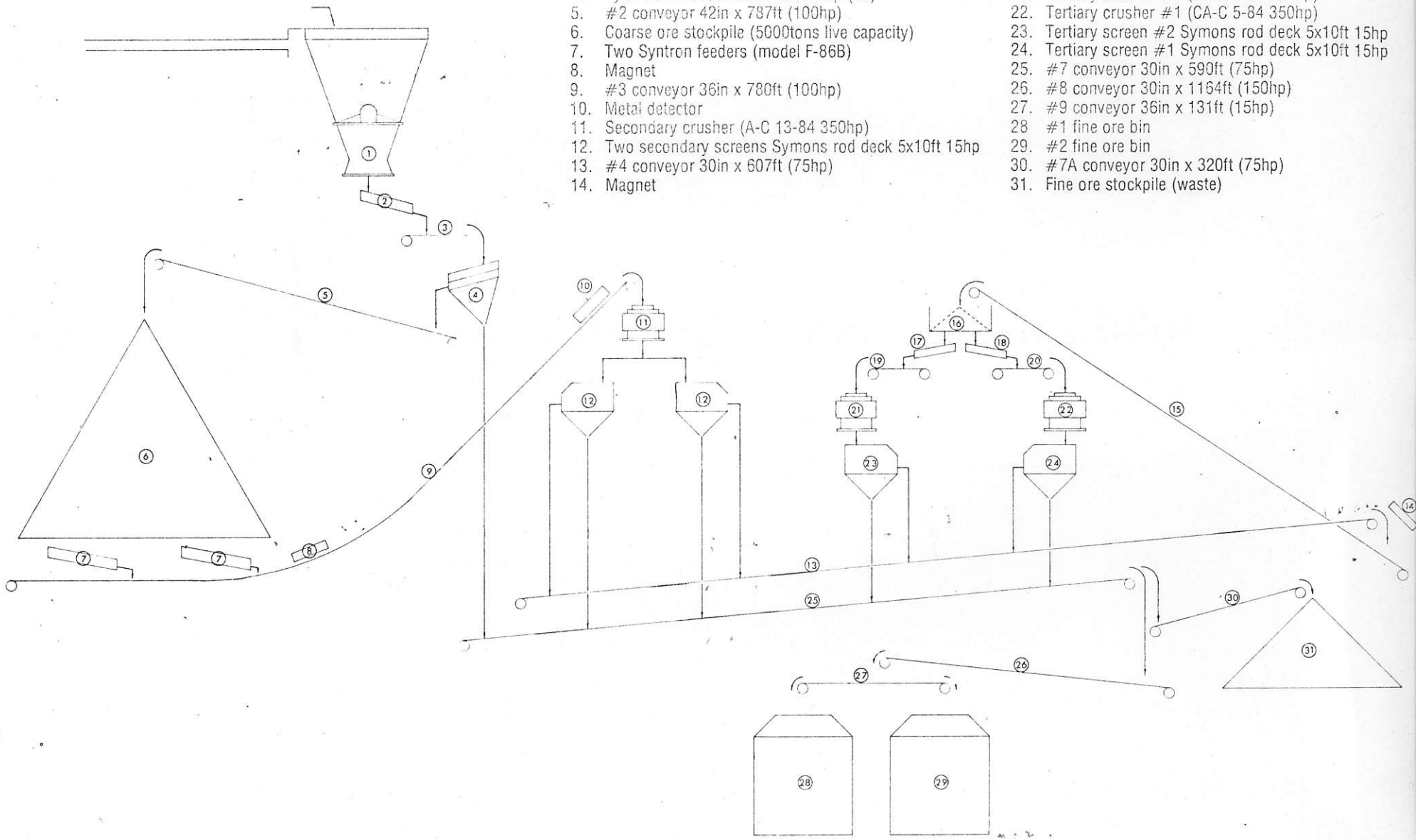
to P19



GRANISLE

crushing plant flowsheet

1. Primary crusher (A-C 42-65 350hp)
2. Syntron feeder (model F-86)
3. #1 conveyor 42in x 78ft (20hp)
4. Tyler doubledeck screen 6x16ft hp (40)
5. #2 conveyor 42in x 787ft (100hp)
6. Coarse ore stockpile (5000tons live capacity)
7. Two Syntron feeders (model F-86B)
8. Magnet
9. #3 conveyor 36in x 780ft (100hp)
10. Metal detector
11. Secondary crusher (A-C 13-84 350hp)
12. Two secondary screens Symons rod deck 5x10ft 15hp
13. #4 conveyor 30in x 607ft (75hp)
14. Magnet
15. #5 conveyor 30in x 523 ft (75hp)
16. Surge bin (500 ton)
17. Tertiary feeder #2 (Vibranetics)
18. Tertiary feeder #1 (Jeffrey model 5 DL)
19. #6A conveyor 36in x 72ft (5hp)
20. #6 conveyor 36in x 40ft (5 hp)
21. Tertiary crusher #2 (CA-C 5-84 350hp)
22. Tertiary crusher #1 (CA-C 5-84 350hp)
23. Tertiary screen #2 Symons rod deck 5x10ft 15hp
24. Tertiary screen #1 Symons rod deck 5x10ft 15hp
25. #7 conveyor 30in x 590ft (75hp)
26. #8 conveyor 30in x 1164ft (150hp)
27. #9 conveyor 36in x 131ft (15hp)
28. #1 fine ore bin
29. #2 fine ore bin
30. #7A conveyor 30in x 320ft (75hp)
31. Fine ore stockpile (waste)

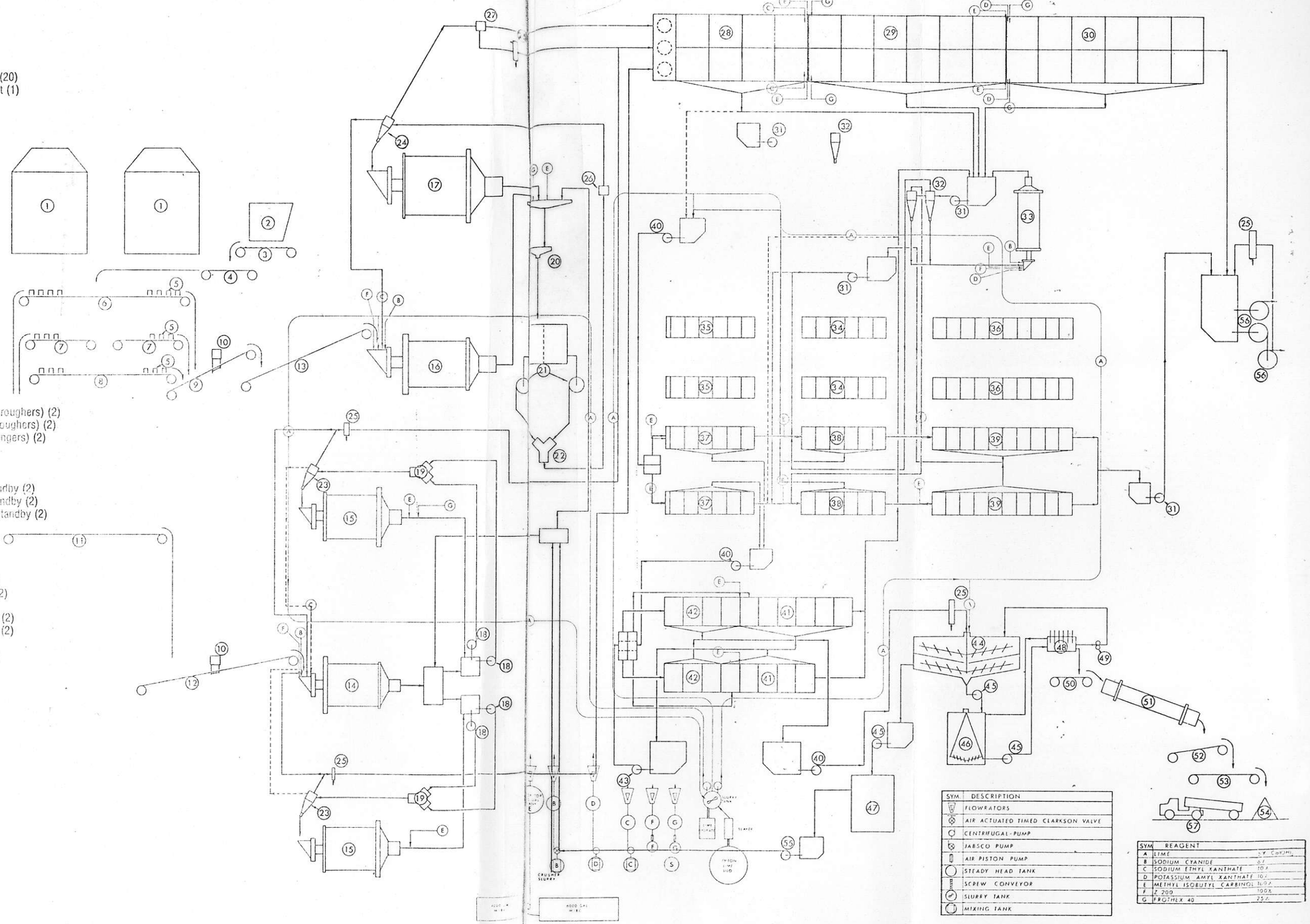


Concentrator flowsheet legend
Shows key number, item, and number required

1. 8000-ton fine ore bins (2)
2. Outside feed hopper (1)
3. Apron feeder (1)
4. Conveyor 30in x 59ft (1)
5. Mexican feeders with hydraulic lump breakers (20)
6. Variable speed reversible conveyor 36in x 158ft (1)
7. Variable speed conveyor 36in x 71 ft (2)
8. Variable speed conveyor 36in x 158 ft (1)
9. Conveyor 30in x 141ft (1)
10. Merrick E310 Weightometers (2)
11. Conveyor 30in x 110ft (1)
12. Conveyor 30in x 81ft (1)
13. Conveyor 30in x 141ft (1)
14. Dominion 12x15ft rod mill (1)
15. Dominion 12x15ft ball mill (2)
16. CA-C 13x18ft rod mill (1)
17. CA-C 16.5x20ft ball mill (1)
18. ASH 10x10 pumps (4)
19. Teck-Taylor 12in valves (2)
20. Moveable launder (1)
21. GIW 16x16 pumps (2)
22. Teck-Taylor 20in valve (1)
23. Krebs D20B cyclones (8)
24. Krebs D20B cyclones on Cyclopac (9)
25. Automatic samplers (5)
26. Nuclear density gauge (1)
27. Particle size monitor (1)

28. Banks of Denver (4) DR600 flotation cells (1st roughers) (2)
29. Banks of 6 Denver DR600 flotation cells (2nd roughers) (2)
30. Banks of 6 Denver DR600 flotation cells (scavengers) (2)
31. SRL pumps 6x6 (3)
32. Krebs D10B cyclones (3)
33. CA-C 6x14ft regrind mill (1)
34. Banks of 6 #48 Agitair cells (1st cleaners) standby (2)
35. Banks of 6 #48 Agitair cells (2nd cleaners) standby (2)
36. Banks of 10 #48 Agitair cells (scav-cleaners) standby (2)

37. Banks of 6 #48 Agitair cells (1st cleaners) (2)
38. Banks of 6 #48 Agitair cells (2nd cleaners) (2)
39. Banks of 10 #48 Agitair cells (scav-cleaners) (2)
40. SRL pumps 5x5 (3)
41. Banks of 4+3 #24 Denver cells (3rd cleaners) (2)
42. Banks of 6+5 #24 Denver cells (4th cleaners) (2)
43. SRL pump 3x3 (1)
44. Dorr-Oliver-Long 30ft concentrate thickener (1)
45. SRL pumps 2x2 (3)
46. D-O-L concentrate storage agitator (1)
47. Settling tank (1)
48. D-O-L 6x6ft disc filter (1)
49. Nash vacuum pump (1)
50. Conveyor 24in x 10ft (1)
51. Lochhead Haggerty 4x28ft dryer (1)
52. Conveyor 18in x 109ft (1)
53. Conveyor 18in x 143ft (1)
54. Enclosed concentrate stockpile (1)
55. Caligher 2.5in vertical pump (1)
56. SRL-C 16x14in tailings pump (1)
57. Contract trucking 41 miles to railroad



Maintenance, Safety, Training, Warehousing, and Purchasing.

The total Granisle Copper employment is 289, with the administration and operating crews distributed as follows:

Administration	9
Mining	94
Milling	71
Mechanical	39
Surface	36
Electrical	9
Engineering	14
Accounting & Warehousing	17
	289

During the 1973 fiscal year, Granisle Copper processed 4,188,483 tons of ore grading 0.46% Cu with the cost per ton of ore milled distributed as shown:

Mining	$1.022
Crushing	0.173
Concentrating	0.539
Tailings	0.049
Indirect	0.606
Administration	0.243
Total unit cost	$2.632

Mine planning

Detailed cutting plans are drawn for five years with a broad mining plan for ten years. These plans are updated once a year as mining progresses. A rolling twelve months forecast is prepared to show tons mined and milled, mill head grades, mill recoveries, tons concentrate produced and unit working costs.

The bench height is 35 ft. Working slope angles are 40° and 45° and ultimate slope angles will be 40°, 45° and 50° on different sides of the pit.

Bench faces stand at approximately 60° with present blasting techniques. A safety berm 30-ft wide is maintained on every second bench. Ramps are 80-ft wide with a gradient of 10%.

Drilling and blasting

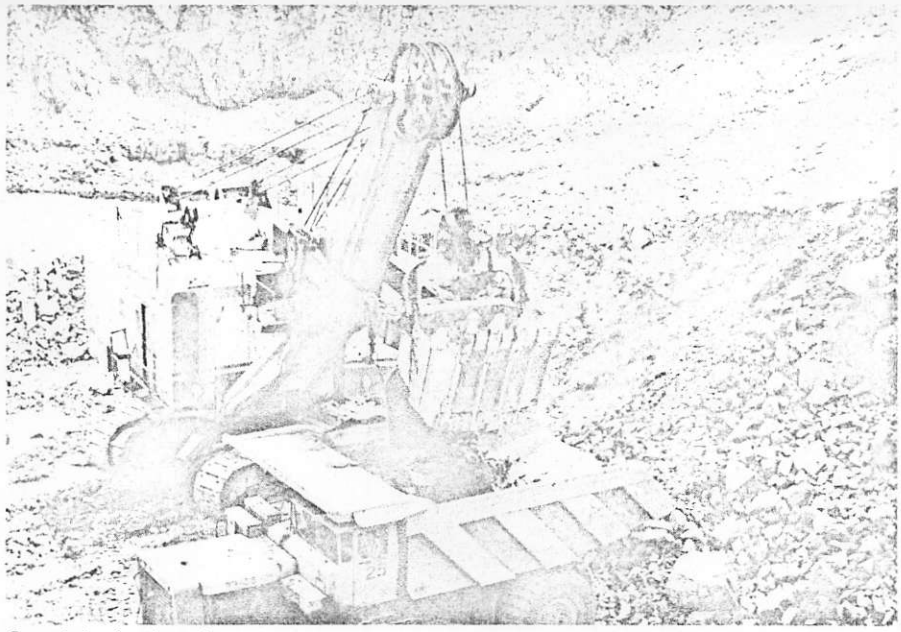
Standard staggered patterns are 14 ft by 28 ft and 15 ft by 30 ft for the Bucyrus-Erie 40R and 45R respectively, with a subgrade of five feet.

Dry holes are loaded with a toe-load of 13% aluminized ANFO and a column load of ANFO to a 15-ft collar.

Where possible, wet holes are pumped dry and lined with a plastic liner and loaded as above.

Blast holes in sinking cuts and the initial production rounds from bottom benches cannot be dewatered. These holes are loaded with bagged TNT slurry and bagged aluminized ANFO.

Holes are stemmed with drill cuttings. Holes are primed with two Procore 111 primers on a single downline of Reinforced primacord. Holes are connected with Scufflex primacord with 15 and 25 ms delays between rows. Safety fuse with a No. 6 blasting cap is used to initiate the primacord.



Granisle: in the pit

Pit production

Production from the pit is approximately 400,000 tons of ore and 540,000 tons of waste per month. The present mining ratio is 1.35:1. The operation runs continuously with a six day on and two days off shift schedule.

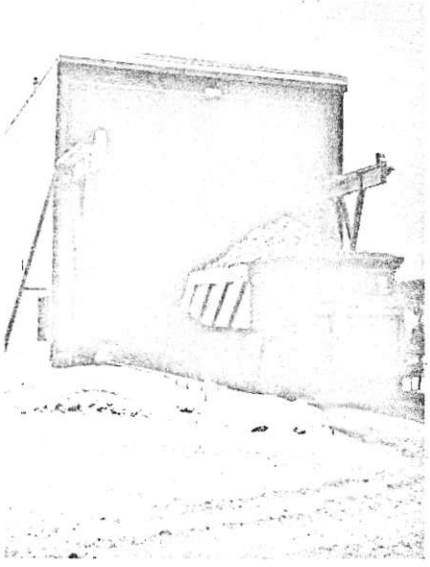
Waste rock is used for the construction of roads, causeways, and tailings dams. Overburden is stockpiled on a separate dump for possible future reclamation projects.

Pit maintenance

The pit repair shop, pit offices, changehouse and shop warehouse are housed in a single structure with an overall floor area of 21,000 square feet.

All maintenance work is carried out by a thirty-five man maintenance crew and a staff of four, under the direction of the plant superintendent.

Granisle: about to dump into the primary crusher



Crushing & concentrating

The 800 tons/hour crushing plant is shown in the accompanying diagram. First-stage crushing is through a gyratory, followed by a double deck-screen which separates the ¾-in fines to

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Table 1. Mine equipment

Drilling: One each electric rotary drills: BE40-R (45.5ft/n), BE45-R (43.2ft/h); each requires one operator per shift, three shifts a day.

Loading: Electric shovels: two P&H 1400 5yd (one operator per shift, 519 tons/h); two Marion 151 9yd (two operators per shift, 861 tons/h); each on three shifts a day. One Cat 992 wheel loader (433 tons/h); three shifts.

Hauling: Eight Terex R-50 trucks (177 tons/h); six Terex R-65 (228 tons/h); nine operators per shift; three shifts a day.

Dump maintenance and shovel clean-up: One Cat D9G tracked dozer on three shifts plus one Cat D8H as required; one Cat 824 rubber-tired dozer.

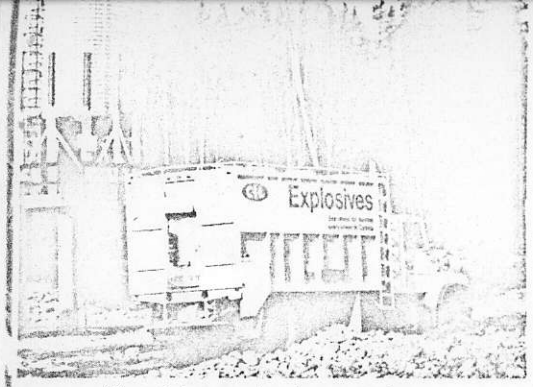
Road maintenance: One Cat 16 grader on three shifts plus one Cat 12 as required; one EUC F91 sand/water truck.

Blasting: One Ford F900 Anfo mix truck; one Ford F250 truck for blasthole dewatering.

Table 2. Consumption of key items per 12-month period

Blasting supplies: Anfo 4,113,000 lb; aluminized Anfo 1,750,000 lb; packaged slurry 717,000 lb; plastic liners 57,000 ft; primers 396 cases (50/case); Primacord 712 rolls (1000ft/roll).

Diesel fuel: 805,000 gal
Tires: $370,000
Power: 8,400,000 kWh.



Granisle: explosives centre

Table 3. Operating crew for continuous operation

	Staff	Hourly
Administration	2	—
Equipment instructor	1	—
Shift foreman	4	—
Shovel operators	—	12
Shovel oilers	—	4
Drillers	—	8
Support equipment operators	—	16
Haulage truck drivers	—	40
Blasting crew	—	4
Miner helpers and trainees	—	3
	7	87

Table 4. Mining costs
Unit costs, $/ton mined

	$/ton
Drilling	0.034
Blasting	0.072
Loading	0.045
Hauling	0.135
Pit repair shop	0.020
Support equipment	0.054
General services & supervision	0.015
	0.375

Table 5. Repair and maintenance costs
Unit costs, $/ton mined

Drilling	0.007
Loading	0.014
Hauling	0.060
Support equipment	0.014
Pit shop operation	0.020
Powerline maintenance	0.002
	0.117

Table 6. Maintenance manpower

	Staff	Hourly
Administration	1	—
Shop foreman	3	—
Welders	—	5
Mechanics	—	21
Lubrication servicemen	—	7
Warehouse clerk	—	1
Janitor	—	1
	4	35

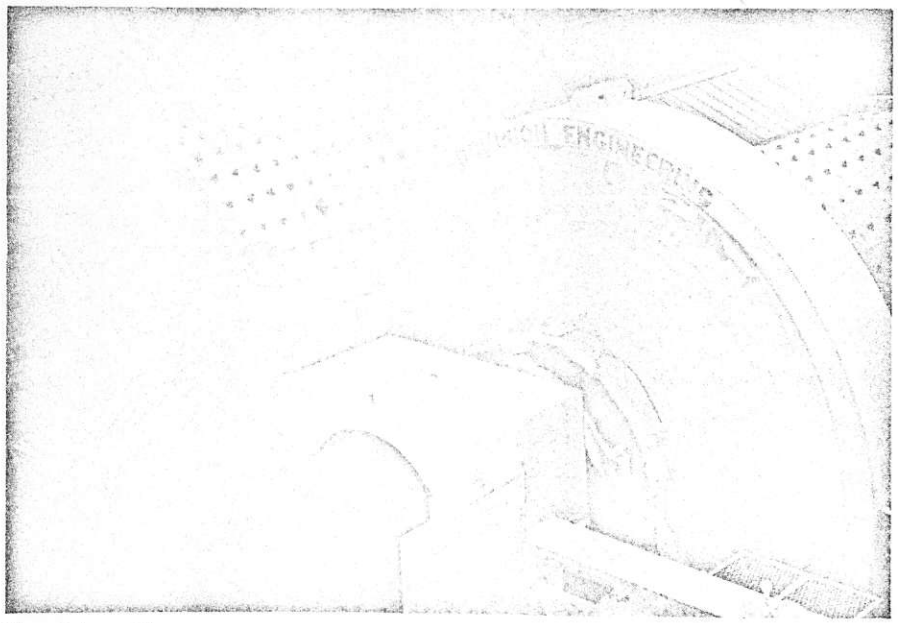
the fine ore bins, while the screen oversize is directed to an open air stockpile. Secondary crushing is done by a single cone crusher, and tertiary crushing by two cone crushers. Secondary screens are in open circuit with the crusher and the tertiary screens in closed circuit. Crushed ore is stored in two fine ore bins of a nominal capacity of 8000 tons each. The crushing plant is not heated.

The grinding and flotation circuits are shown in the concentrator flowsheet. Crushed discharge from the two fine ore bins is fed to two non-identical grinding circuits. The original circuit is described first. This circuit consists of a single open-circuit rod mill powered by a 1100-hp motor and operating at an average feed rate of 235 dry short tons per hour.

The rod mill discharge is split to two identical, overflow type ball mills powered by 1100-hp motors and operating in closed circuit with 20-in cyclones. The classified product at a nominal density of 35% solids by weight and a 60% −200 mesh is fed to the rougher-scavenger flotation cell bank where it joins the pulp from the second grinding circuit. Grinding circuit No. 2, fed at an average rate of 320 dry short tons per hour, consists of an open circuit rod mill powered by a 1650-hp motor. Rod mill discharge feeds a single overflow type ball mill powered by a 3400-hp motor and operating in closed circuit with 20-in cyclones. The nominal specification of classified product is the same as for No. 1 circuit.

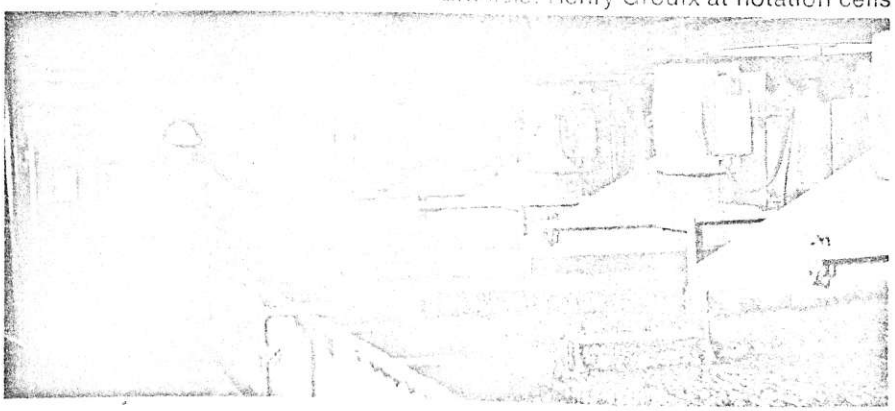
Pulp from the grinding circuit is fed to two parallel banks of 300-cu.ft rougher-scavenger flotation cells arranged back to back in rows of sixteen cells each. Tailing from the scavenger cells, averaging less than 0.045% copper, enters a common sump before being pumped to tailing disposal. Total rougher-scavenger concentrate is reground by an overflow type ball mill powered by a 300-hp motor and operating in closed circuit with 10-in cyclone before passing to the first stage of cleaning. Further progress may be followed on the flowsheet.

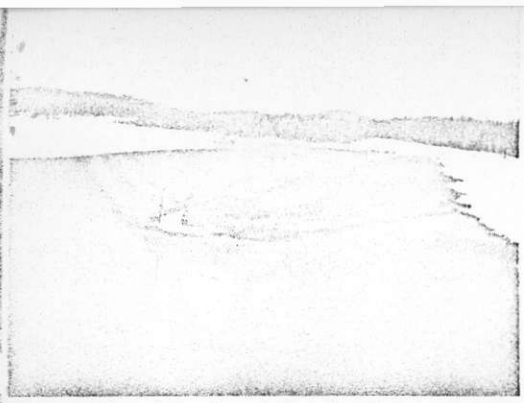
Final concentrate (average 33% copper) is dewatered in a thirty-foot, unbalanced tray thickener to 70-73% solids by weight. Thickener underflow is



Granisle: mills

Granisle: Henry Groulx at flotation cells





Granisle: in winter the ferry crosses the stretch of water kept open by the unique bubbler system

pumped to an 18,000-gallon stock tank from where it is pumped to a six-disc filter and dewatered to 12-14% moisture. Filter cake is dried to 7-8% moisture in a 4 ft x 28 ft rotary drier fired by light fuel oil, then stockpiled under cover for shipment by truck to the railhead at Topley, and finally to Vancouver for shipment to Japan.

GRANISLE: Concentrator statistics

Milling data for the 12-month period ending 30 Sep 1973

Total mill feed: 4.19-million tons 0.47% Cu

Concentrate produced: 52,269 short dry tons 33.406% Cu

Overall copper recovery: 89.99%

Material consumption (lb/ton-milled)

Grinding rods (3.5 & 4 in)	1.01
Grinding balls (2 & 2.5 in)	0.83
Regrind steel (1.25 in)	0.034

Reagent consumption (lb/ton-milled)

Lime (CaO)	0.451
Sodium ethyl xanthate	0.010
Potassium amyl xanthate	0.003
Collector Z200	0.018
Frother (MIBC)	0.050
Frother Frothex 40	0.004
Sodium cyanide	0.005

Power consumption for crushing and concentrating is 18.7 kWh/ton, of which 16.4 kWh consumed in the concentrator

Mineral processing personnel (crushing & concentrating)

	Hourly rated	Staff
Operations	33	6
Maintenance (millwrights/welders)	15	1
Apprentices	4	—
Maintenance planning	—	2
Metallurgy & assaying	3	5
Training	—	1
Superintendent	—	1
Total	55	16

Granisle: trucking concentrate on to the ferry on the way to railhead

Tailings disposal

Babine Lake is one of British Columbia's largest fresh water lakes and an important salmon spawning ground. The location of the mine on an island makes tailings disposal a costly and challenging task. Granisle has solved this problem, while assuring protection for the land and water, by joining McDonald and Sterrett Islands with a system of causeways. The net result is the creation of one island. The causeways are rock-fill constructed with a gradation of facing from +18 inch to slimes. The final upstream faces are built with cycloned sands. At the end of 1973 the tailing area included 240 acres and was forty-five feet above the level of Babine Lake.

Scavenger tailings at 35% solids is pumped by a 16 x 14 SRL-C Denver to nine, fifteen-inch cyclones at the dam face. Underflow product is 86% of +200 mesh at 75% solids. Two parallel pumping and piping systems ensure there are a minimum of production problems associated with the disposal.

A barge-mounted pump station is utilized to return tailings water to the mill. An emergency process water source is provided by a fresh water pumphouse at the lake.

As the tailing area is completed, the land will be reclaimed by planting grass and shrubs indigenous to the area. Rock dumps will be contoured and covered with overburden. Reclamation is discussed in more detail in a separate section.

Granisle: plastic pipe conveys tailings to pond