W.A. NO. .....

NAME GREENHILLS

SUBJECT EXTERNAL PUBLICATIONS

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

FORDING MINE

FORDING COAL LIMITED

(Latitude 50° 11' N, Longitude 114° 53' W, Elevation 5,440 Feet)

LOCATION, ACCESS AND CLIMATE

The Fording Mine is located north and east of Sparwood, B.C. in the Fording River Valley, which is relatively wide considering the rugged surrounding mountains.

Access to the property from Highway 3 at Sparwood is by twenty-two miles of paved road along the Elk Valley to the townsite at Elkford and by eighteen miles of gravel road to the mine site.

There are many modern homes in the Elkford Community, which has a population of about 1,800 at present, but the townsite is still being developed. In addition to the outdoor recreation readily available, a recreation complex is under construction. A ski hill complete with tows and a 9-hole golf course are included in the planning.

Climatic records at the property have been kept only for one year commencing in 1973. These records show approximately 29 inches of total precipitation of which 18.3 inches fell as snow. A mean high temperature of 72 degrees Fahrenheit was reached in July and a mean low of 2.0 degrees Fahrenheit was recorded in January. Extreme temperatures ranged from minus 34 degrees Fahrenheit in Janury to plus 85 degrees Fahrenheit in July.

HISTORY AND OWNERSHIP

The existence of coking coal in the area has been known since the early 1900's. At that time the Canadian Pacific Railway Company, Union Pacific Railway Company and others carried out limited surface trenching and adit work but no concentrated work was done until the property was acquired by Canadian Pacific Oil and Gas Limited in 1967. In 1969 Cominco Ltd. took over responsibilities for exploration and development of the property as a 40% partner to Canadian Pacific Investments who had the remaining control of Fording Coal Limited.

The result of exploration up to the time of development singled out two primary areas for production;

1. The Greenhills deposit on the Fording River Valley Floor.
2. The Clode Creek Pit on Eagle Mountain.

The Greenhills deposit was developed for a dragline operation and the pit on Eagle Mountain was developed as a conventional truck-shovel operation. Exploration work continues to delineate other areas within the lease boundaries to enlarge the dragline and truck-shovel workings, as well as to investigate the potential for underground mining. Exploration indicates proven recoverable strippable reserves in the order of 44.0 million long tons of raw coal at a virgin strip ratio of 7.4:1.

Reclamation

At Fording as at all Cominco mining operations, the objective of the mined-land reclamation program is to restore waste disposal and disturbed land surfaces to a use and appearance compatible with the surrounding area. A base-line ecological study conducted by B.C. Research in the years 1970 to 1972 and a survey conducted under the Canada Land Inventory program have provided a basis for selection of a suitable land use plan. Cominco's own environmental control group through laboratory, growth chamber and field test plot work have been determining the suitability of mine and mill wastes as growth media, selecting suitable plant species and developing the necessary cultural techniques towards attaining the desired objective.

GEOLOGY

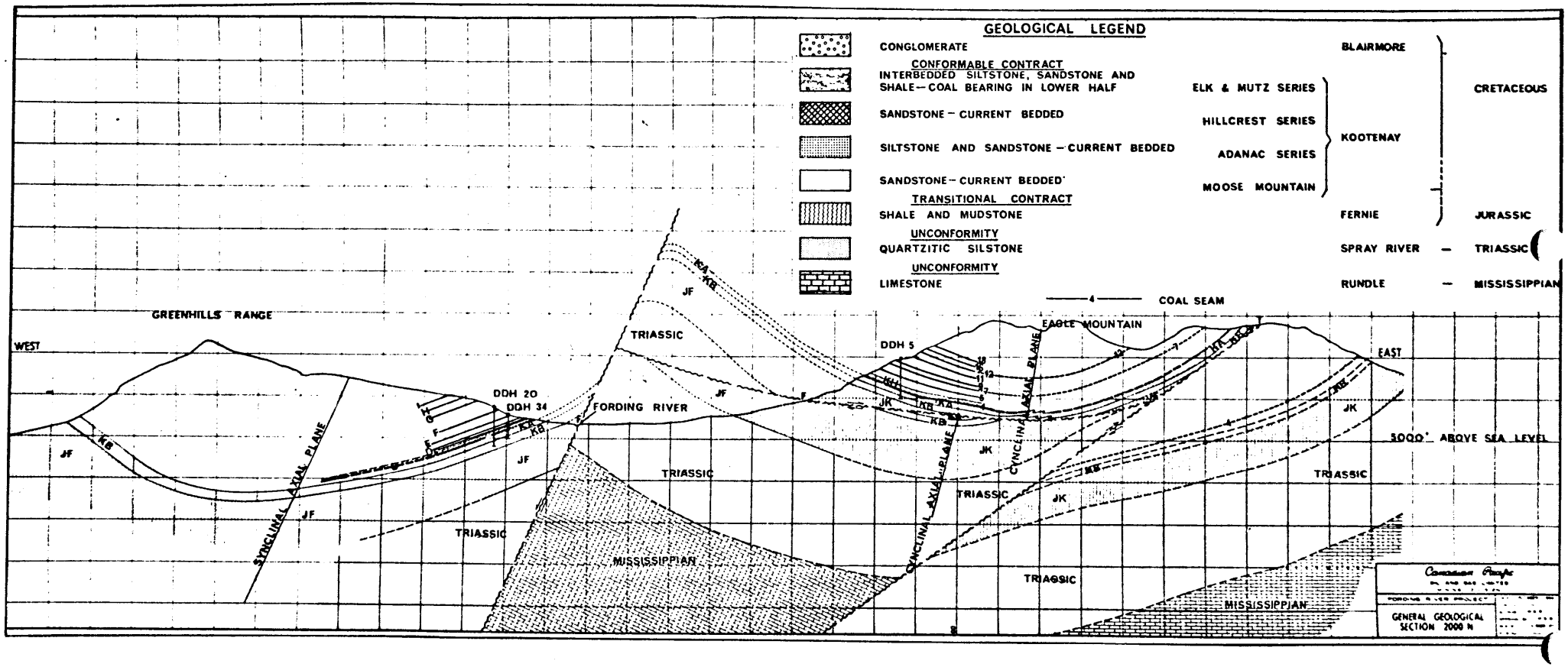
The basal member of the Kootenay formation is a medium to coarse-grained, current-bedded sandstone some 150 to 200 feet in thickness. This sandstone is common to all the Kootenay occurrences of the Rocky Mountains, and is a prominent cliff-marker in many localities. The Kootenay formation, having the Moose Mountain sandstone as its base, is an extremely variable series, and it is not feasible to correlate from one area to the next by means of detailed sections.

The coal of the Fording Mine lies on either side of the Fording River Valley in the Upper Jurassic to Lower Cretaceous Kootenay coal measures. The valley is the locus of a regional fault with coal outcrops on the up thrust east side of the valley being about 1,000 feet higher than those on the west. The separation of the deposits on the east and west sides of the valley creates in effect two mining areas.

Figure 1 illustrates the geological setting for the Fording operations.

PROPERTY OPERATION

The surface layout of the Fording operation is shown in Figure No.2. The operation is under the direction of a resident Mine Manager. The operation is classified into three divisions: a two-department production division, a maintenance (shops)/service division and an administration division. The administration division provides service to the production division to handle safety, security, purchasing, recuitment, payroll, cost control and warehousing functions. The shops and services division handles maintenance overloads, shop fabrications, small construction projects and such services as power, natural gas, sewer, air and water services for the production division. Each production department is responsible for maintenance and servicing up to the point that it can effectively use regularly assigned crews Maintenance work beyond that is assigned to the shops and services division.


GEOLOGICAL LEGEND
CONGLOMERATE
CONFORMABLE CONTRACT
INTERBEDDED SILTSTONE, SANDSTONE AND SHALE — COAL BEARING IN LOWER HALF
SANDSTONE — CURRENT BEDDED
SILTSTONE AND SANDSTONE — CURRENT BEDDED
SANDSTONE — CURRENT BEDDED
TRANSITIONAL CONTRACT
SHALE AND MUDSTONE
UNCONFORMITY
QUARTZITIC SILSTONE
UNCONFORMITY
LIMESTONE
COAL SEAM
ELK & MUTZ SERIES
HILLCREST SERIES
ADANAC SERIES
MOOSE MOUNTAIN
KOOTENAY
BLAIRMORE
FERNIE
SPRAY RIVER
RUNDLE
CRETACEOUS
JURASSIC
TRIASSIC
MISSISSIPPIAN
GREENHILLS RANGE
WEST
EAST
DDH 20
DDH 34
DDH 5
FORDING RIVER
EAGLE MOUNTAIN
SYNCLINAL AXIAL PLANE
CYNCLINAL AXIAL PLANE
3000' ABOVE SEA LEVEL
JF
JK
KB
KA
TRIASSIC
MISSISSIPPIAN
GENERAL GEOLOGICAL SECTION 2000 N

The personnel on the site in mid 1974 were:

	Hourly Rated	Staff	Total
Management	0	1	1
Administration	15	40	55
Mining	260	40	300
Coal Processing	140	22	162
Shops and Services	163	18	181
Total	578	121	699

For the 12 month period ending December 31, 1973, Fording operations produced 2,206,151 long tons of clean coal.

MINING OPERATION

The mining department is responsible for production at both the Clode Pit and Greenhills operations. The Clode Pit area is mined on a mountain side by conventional truck-shovel methods while the Greenhills operation is a dragline function. Since design and operating parameters are different for both areas, it is necesary to describe each operation separately.

Clode Mine

The mine location is on a prominent ridge of Eagle Mountain. While considerable reserves exist in Eagle Mountain, the most favourable strip ratios for the down dipping seams exist on the ridges rather than on the high cirques of the mountain. The effect of ridge mining creates a high wall on the up slope of the ridges and permits spoil to be dumped on the mountain side. Both the high wall and the spoil pile have received considerable attention from the mine engineering group to ensure safe working conditions on the mountain.

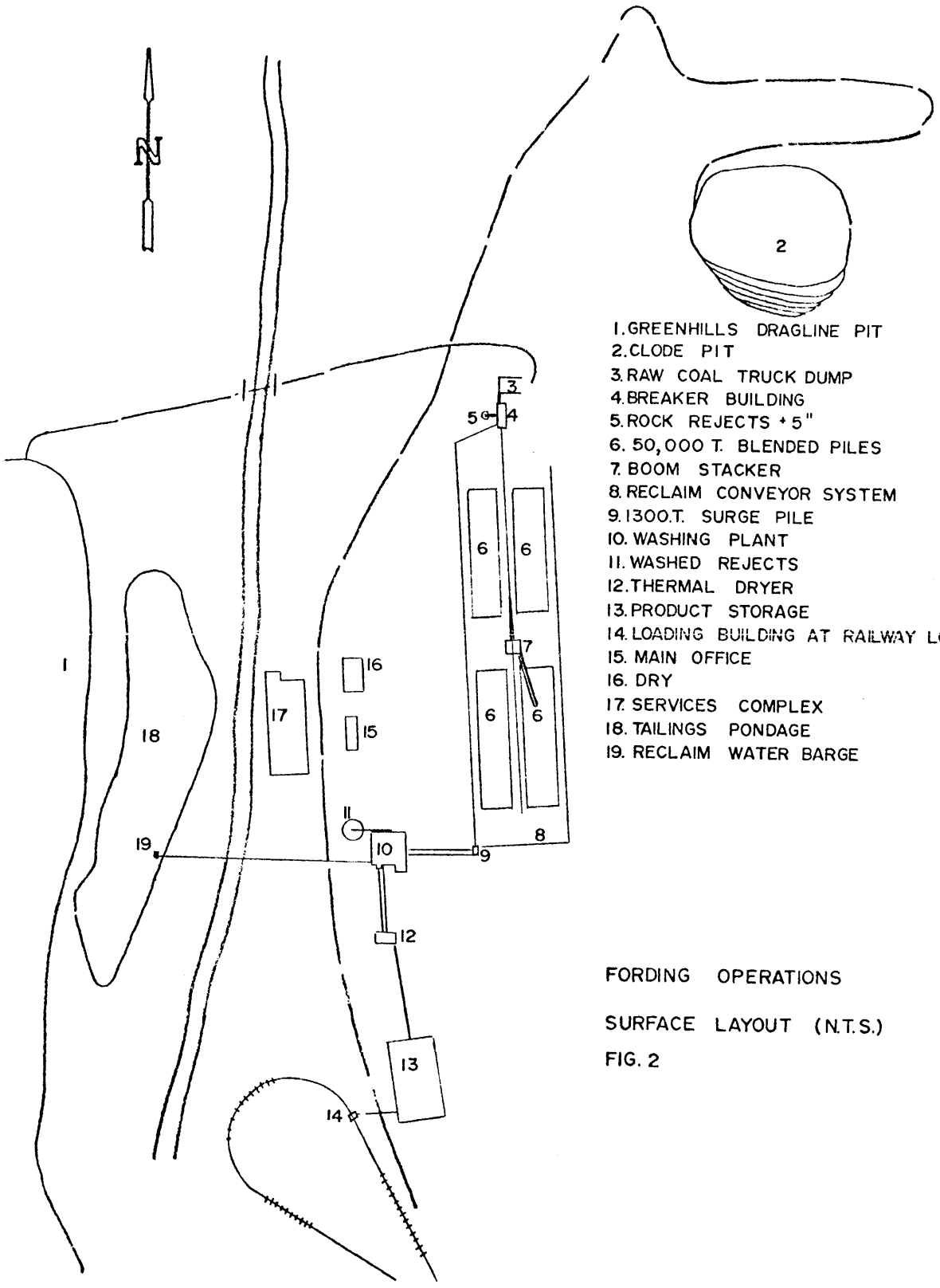
Coal haulage from the Clode Pit averages 20,000 feet on favourable grades up to 7-1/2%.

Current weekly production from Clode Pit is scheduled to remove 513,000 tons of rock and 36,900 tons of raw coal in 21 operating shifts. The design parameters for the Clode pit are tabulated in Table I.

Greenhills Mine

The Greenhills mine is located on the west side of the Fording River primarily on the valley floor but with seams dipping into the Greenhills mountain. The current mining plan utilizing a 60 cubic yard dragline calls for stripping of till and waste rock to a maximum depth of 180 feet over an area of 1,000 feet by 8,500 feet. Coal is removed from the seams as it is encountered and stockpiled separately from the spoil. It is then rehandled by shovels or front-end loaders into trucks for relatively level haulage some 9,600 feet to the breaker plant.

Some of the more pertinent design date for the Greenhills dragline operation is listed in Table II.



1. GREENHILLS DRAGLINE PIT
2. CLODE PIT
3. RAW COAL TRUCK DUMP
4. BREAKER BUILDING
5. ROCK REJECTS + 5"
6. 50,000 T. BLENDED PILES
7. BOOM STACKER
8. RECLAIM CONVEYOR SYSTEM
9. 1300 T. SURGE PILE
10. WASHING PLANT
11. WASHED REJECTS
12. THERMAL DRYER
13. PRODUCT STORAGE
14. LOADING BUILDING AT RAILWAY LOOP
15. MAIN OFFICE
16. DRY
17. SERVICES COMPLEX
18. TAILINGS PONDAGE
19. RECLAIM WATER BARGE

FORDING OPERATIONS

SURFACE LAYOUT (N.T.S.)

FIG. 2

Equipment Used

Numerous pieces of heavy equipment are used in both the Clode and Greenhills pit areas. Since flexibility is a desirable and economically sound practice many units serve duplicate functions and are not assigned exclusively to either Greenhills or the Clode Pit. Table No. III illustrates the units currently in use at the site. Because of the variety of uses and differences in operating conditions encountered in each mine, the statistics quoted are not necessarily explicity representative of true capacities of the units.

Tabulation of Mine Operating Statistics

1. Preproduction Phase Ending December 1972

Waste Rock - Clode	11,849,280 BCY
Till and Waste Rock - Greenhills	4,801,619 BCY
Coal	2,735,652 L.T.

2. Production of Year Ending December 31, 1973

Waste Rock - Clode	10,889,140 BCY
Clode Coal to the Breaker	1,683,540 L.T.
Waste Rock - Greenhills	4,134,696 BCY
Till - Greenhills	1,449,698 BCY
Rehandle - Greenills	2,840,326 BCY
Greenhills Coal to the Breaker	1,635,830 L.T.

Consumed Supplies for the Year Ending December 31, 1973

1.	Blasting - ANFO	10.86 million pounds
	- Slurry and Hydromex	4.3 million pounds
	- Primers	30,000 pounds
	- Detonating Cord	1.76 million feet
2.	Diesel Fuel	2.5 million gallons
3.	Tires	$660,000
4.	Electric Power (Mining)	54 million kilowatt hours

The plant and equipment maintenance area together with the warehouse is housed in a single building measuring 162 feet by 444 feet. The building is located within the plant complex and as much mine equipment maintenance as possible is done from here. Field repairs and maintenance are carried out at both Greenhills and Clode from special fitted service vehicles.

The total mine operating crew for the operation is 260. In addition, 82 men are directly assigned to maintenance of heavy equipment. They are shown in the shops and services group list together with others who are indirectly assigned as the work load in this area increase. Some difficulty exists in tabulating maintenance people as being assigned to specific functions, for many work in a number of areas under a variety of priorities. An attempt to do this is shown in the following tabulation:

TABLE I - CLODE MINE

Final depth (elevation change)	1,167 feet
Width	1,800 feet
Length	2,000 feet
Spoil Slope	37° (using scalloped dumping)
Mountain Slope	12° - 26°
Safety Berm at Spoil Base	0 feet
Bench intervals on Highwalls	33 feet
Safety Berms on Highwalls	66 feet (alternate benches)
Working Face Slope	65°
Overall Highway Slope	45°
Roadway Widths - Two Lane Traffic	80-100 feet
- Single Lane Traffic	50 feet
Roadway Gradients	
- Permanent Roads	7%
- Temporary Roads	Up to 10%
Working Floor Slope	Level
Blasthole Spacing	9-7/8" diameter, row interval 25 feet, row spacing 25 feet
Sub-grade Drilling	7 feet
Weekly Excavation	
- Waste Removal	233,000 BCY
- Coal Removal	36,900 L.T.

TABLE II - GREENHILLS MINE

Final depth (elevation change)	180 feet
Width	1,000 feet
Length	8,000 feet
Spoil Slope	37°
Working Face Slope	60°
Overall Highway Slope	45°
Roadway Widths - Two Lane Traffic	80 feet
Roadway Gradients	
- Permanent Roads	8%
- Temporary Roads	up to 8%
Working Pad Slope	$\pm$ 2°
Blasthole Spacing	12-1/4" diameter, row interval 35 feet, row spacing 35 feet
Weekly Excavation	
- Waste Removal	183,000 BCY
- Coal Removal	38,000 L.T.

	Production		Directly Assigned Mine Maintenance	
	Hourly	Staff	Hourly	Staff
Graders	8		4	1
Dragline	8		2	1
Drilling	14	1	4	
Blasting	7	2		
Loading	32	7	6	2
Dozing	32		16	2
Hauling and Service Vehicles	90	6	32	6
Trainee Labour (69)			6	
Surveyors		3		
Engineers/Geologists		19		
Superintendents		2		

MINERAL PROCESSING

The forecast output of the processing plant is 3,030,000 long tons of cleaned coal per year from 4,470,000 long tons of raw coal with a scheduled operating time of 80.1%. While the design operating capacities of 683 long tons of raw coal per hour were achieved on occasion, start-up problems relating to mechanical availability and excessive fines above design criteria resulted in an operating time of only 66.5%.

The processing operation consists of crushing, oversize rock separation, a blended stockpiling of mill feed, washing, drying and cleaned coal storage. Figure 3 shows the flow sheet for the Fording operation diagramatically.

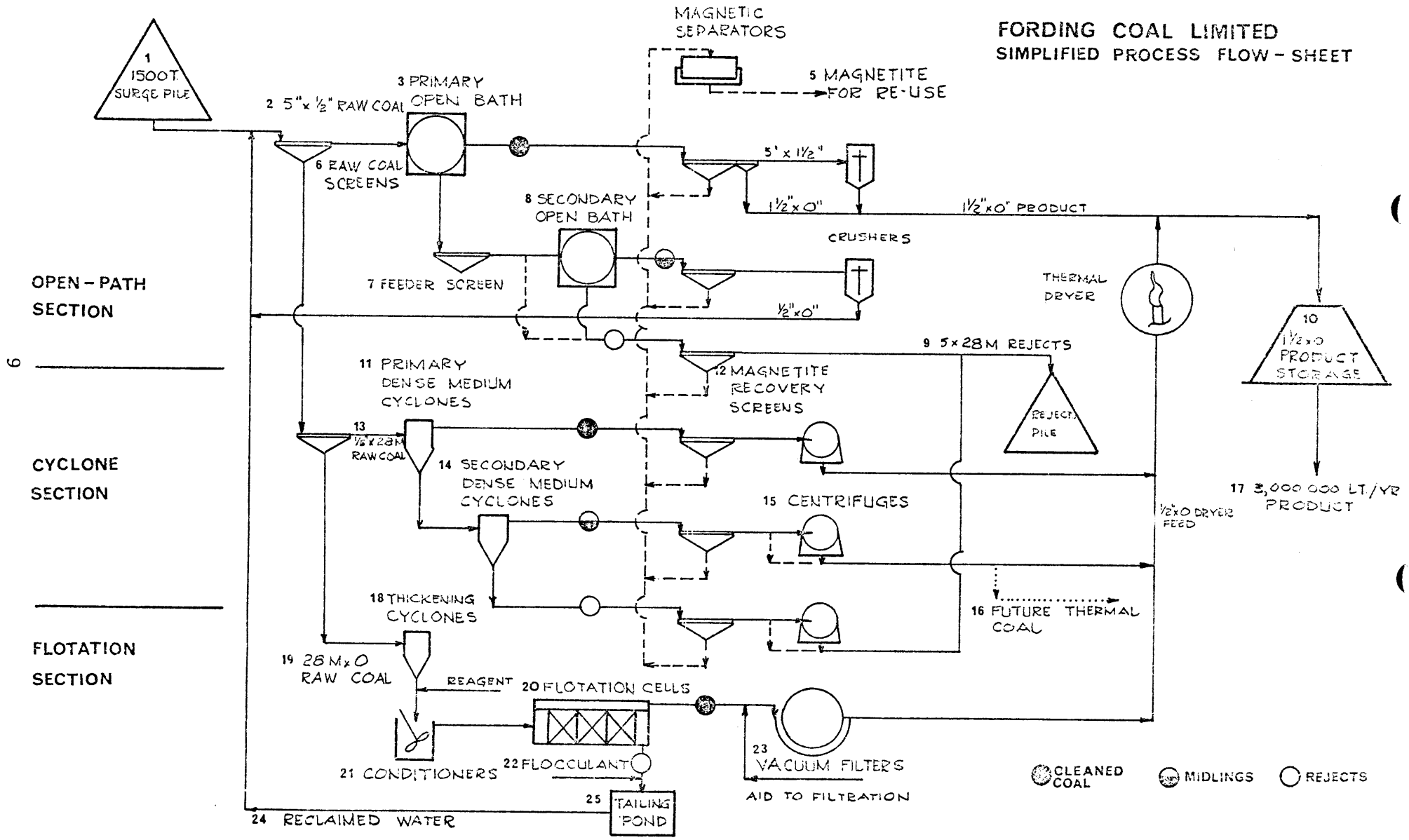
The key features of flow as shown on Figure 4, the Fording flow sheet, are as follows in sequence.

1. A crushing-oversize rejection function that reduces oversize coal to minus 5 inches and at the same time removes harder oversize (5 x 24 inch) rock reject and tramp iron. This single pass crushing is achieved by a 14 foot x 28 foot Bradford Breaker.

2. A conveying and stacking system capable of producing four 50,000 ton blended piles of minus 5 inch raw coal plant feed. The feed is recovered by a 26 cubic yard front-end loader discharging through a portable conveyor onto a system of reclaim belts.

3. A 1,300 ton surge pile in the reclaim conveyor system to even out flows to the wash plant.

4. Washing screens to separate minus 3/8 inch material in two separate identical circuits.


FORDING COAL LIMITED
SIMPLIFIED PROCESS FLOW - SHEET
OPEN - PATH SECTION
CYCLONE SECTION
FLOTATION SECTION
1 1500T. SURGE PILE
2 5" x ½" RAW COAL
3 PRIMARY OPEN BATH
MAGNETIC SEPARATORS
5 MAGNETITE FOR RE-USE
6 RAW COAL SCREENS
5" x 1½"
1½" x 0"
1½" x 0" PRODUCT
8 SECONDARY OPEN BATH
CRUSHERS
7 FEEDER SCREEN
½" x 0"
THERMAL DRYER
9 5 x 28M REJECTS
10 1½ x 0 PRODUCT STORAGE
11 PRIMARY DENSE MEDIUM CYCLONES
12 MAGNETITE RECOVERY SCREENS
REJECTS PILE
13 ½ x 28M RAW COAL
14 SECONDARY DENSE MEDIUM CYCLONES
15 CENTRIFUGES
17 3,000 000 LT/YR PRODUCT
½" x 0 DRYER FEED
18 THICKENING CYCLONES
16 FUTURE THERMAL COAL
19 28M x 0 RAW COAL
REAGENT
20 FLOTATION CELLS
21 CONDITIONERS
22 FLOCCULANT
23 VACUUM FILTERS
AID TO FILTRATION
25 TAILING POND
24 RECLAIMED WATER
CLEANED COAL
MIDLINGS
REJECTS

5. The fines circuit for minus 3/8 inch material. This material is washed through desliming screens to produce a minus 28 mesh to 0 material which is conditioned with pine oil and kerosine, floated in 24 Wemco 300 cubic foot cells at a pH of 6.7-7.4 then filtered before going to the thermal dryer.

   The coarser fraction of the fines circuit (3/8 inch to 28 mesh) is passed through heavy media cyclones with the underflow becoming reject and the overflow product going to centrifuges for dewatering before being sent to the thermal dryer along with the filter cake.

6. The coarse circuit. Here the oversize (3/8 inch to 5 inches) from the washing screens goes to an open bath primary Tromp containing magnetite media. The float from the Tromp passes on to a crusher which reduces the material to 1-1/2 inches to meet contract specifications before going directly to the cleaned coal storage. The sink from the primary Tromp passes to the secondary Tromp. The float from the secondary Tromp passes to the "midds" crusher where it is reduced to 1/2 inch minus then enters the fines circuit. The sink forms the secondary Tromp reject material which joins the fines reject for disposal by truck and loaders.

7. The thermal dryer capable of evaporating 70 tons of water per hour from the minus 3/8 inch and filter cake products. Specifications call for a combined 6% moisture content.

Tailings flow by gravity through a 30 inch line to a 40 acre pond. The 100% reclaim water is recycled from a floating barge pumping station within the pondage area. Covered storage is provided for 40,000 tons of cleaned coal product, which is reclaimed by two paddle wheel feeders discharging onto collector belts, thence to a single railroad loading belt which discharges into a 150 ton surge hopper.

Coal is shipped via 88 car unit trains carrying 105 tons per car to Roberts Bank near Vancouver. Currently coal is being shipped to Japan. This is the second year of a 15 year contract agreement to supply three million tons per year of high grade metallurgical coal to a consortium of Japanese steel manufacturing companies.

The coal product produced is a high quality, medium volatile, bituminous, heavy coking coal. The inherent ash and external impurities can be released by crushing and processing to provide a clean coal of approximately 9.0% ash. The volatile matter averages 22%, the sulphur content averages 0.33%, while the free swelling index averages 6.0. The current yield of clean coal from this raw coal feed is in the order of 67%.

Milling Statistics

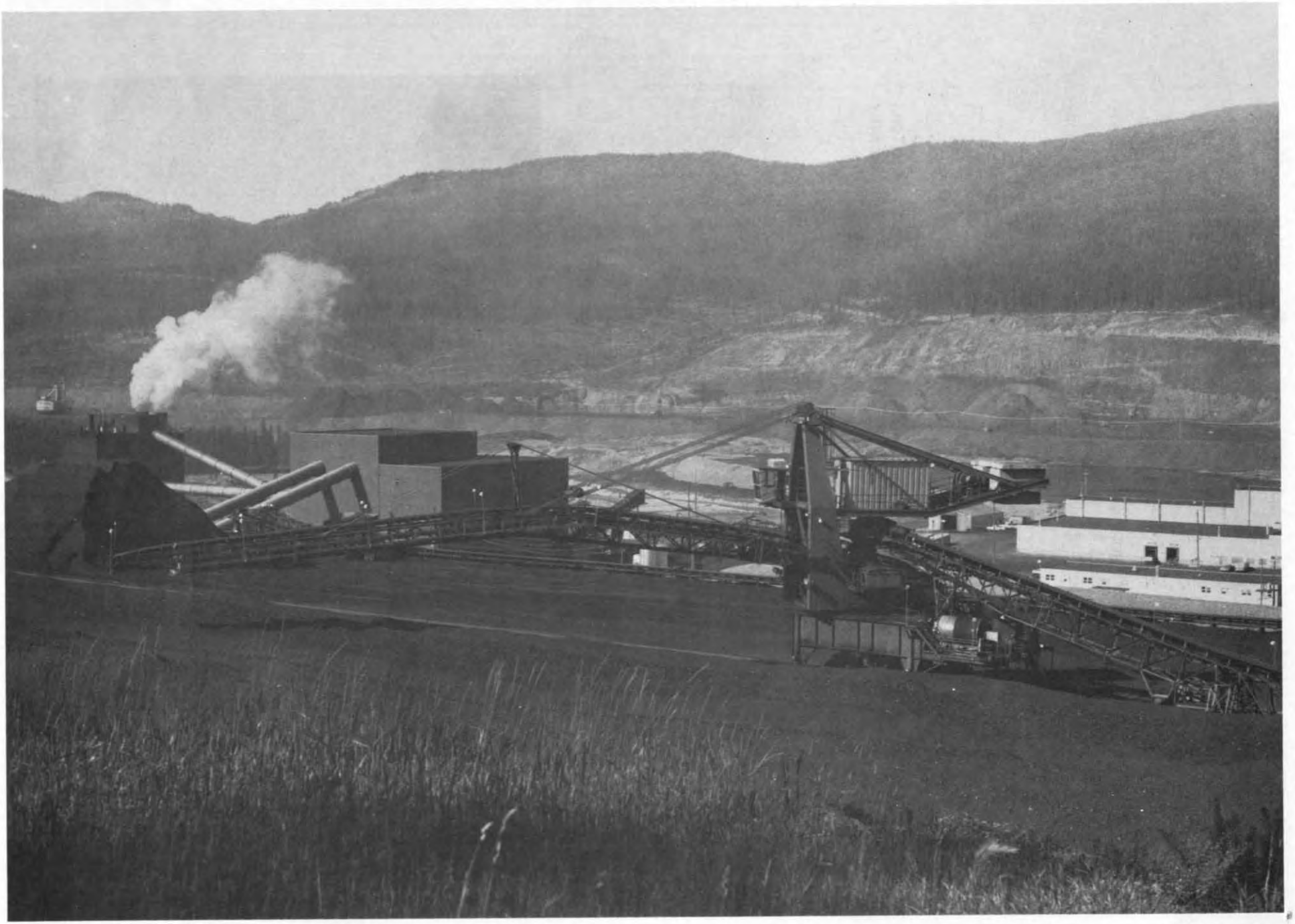
The milling statistics for the twelve month period ending December, 1973, are as follows: (It should be noted that the first three months of the year were considered a start-up phase with lower than full rated tonnages).

Total raw coal processed	3,501,062 L.T.
Total clean coal produced	2,206,151 L.T.
Overall plant yield	63.6%
Power consumption	36,000,000 K.W.
Natural Gas	1,300,000 Cubic Feet
Magnetite used	9,300 Tons
Reagents used - Pine Oil	66,000 Imperial Gallons
- Kerosine	280,000 Imperial Gallons
- Filter Aid	12,000 Lbs.

Process Plant Operating Crew = 160

	Hourly Rated	Staff
Operators	69	
Maintenance	51	12
Metallurgy and Assaying	12	6
Project Engineering		3
Supervisors		4
Superintendents		3
Total	132	28

At Fording, product coal is loaded out onto unit trains from this storage building.



Boom stacker at Fording Coal Limited operations near Sparwood, B.C. (Cominco Ltd.).

Photo courtesy of Cominco Ltd.