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DESCRIPTION OF LOADING AND HAULING OPERATIONS AT GREGG RIVER MINE

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ABSTRACT

In this report, the Gregg River Mine loading and hauling operations, mining practices and equipment used in coaling and waste removal operations are described. Loading and hauling logic diagrams were developed to identify the events, such as loading, dumping, fueling, maintenance procedures, etc. The variables of truck assignments in multiple pit operation are explained and discussed and maintenance policies are evaluated and summarized. Mine equipment performance values obtained from the site personnel are categorized and summarized.

The data collected in the field and listed in this report were used to develop and validate the computer based model of loading and hauling operations.

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1. INTRODUCTION

The purpose of the in-house study of loading and hauling operations at selected Canadian surface coal mines was to identify and categorize mining and operating practices and collect data needed for development and validation of steady-state and dynamic event-based computer models.

The initial task of the study was to select representative surface coal mining operations. The selection of the mining operation was based on its location, annual production, mining method, mining equipment used and expected level of cooperation of mine engineering and management personnel.

The selected mines employed various types of mining equipment and methods and were intended to cover the spectrum of Canadian surface coal loading and hauling systems.

The loading and hauling operation logic used at the selected mine sites was investigated. The description of the truck routing alternatives was followed by the logic diagrams of events such as loading, dumping, fueling, maintenance procedures, etc. The variables influencing truck assignments in the multiple pit operations were explained and discussed. Management policies were evaluated and summarized.

Historical data on production, maintenance, delay hours, availability and utilization of equipment, and other statistical data made available by the mine, were evaluated.

All mine equipment statistics evaluated here were supplied by mining engineering and management personnel of the selected mining company. Requested information was not readily available in some cases,because of site confidentiality restrictions.

The evaluation and assessment of different policies, preferences, management practices and other significant variables of the mine loading and hauling system is presented in this report.

The collection of field data commenced in winter 1984 and was completed in May 1985. The evaluation of data was completed by the end of 1985.

2. DESCRIPTION OF PROPERTY

2.1 General

Gregg River Mine,a new metallurgical coal mine, is owned and operated by Gregg River Coal Ltd., a subsidiary company of Calgary based Manalta Coal Ltd. (60%) and a group of seven Japanese companies (40%).

The Gregg River Mine is located 40km south of the Town of Hinton in west-central Alberta. The metallurgical coal is shipped to Japanese steel mills under a 15 year agreement signed in 1981. The production was set at 2.14 Mt. per year of clean coal giving a total export of 31.5 Mt during the term of the agreement. Production commenced in April 1983 (1).

The mine is situated in the foothills of the Canadian Rocky Mountains. The Cadomin-Luscar coal bearing formation is approximately 435 m thick at the property and contains one major seam (Jewel Seam), situated in the middle of the formation. The seam thickness is 8 to 10m,but structural deformation can increase the thickness of coal to 30m in some instances. The coal is generally clean of rock partings. The mined coal is low to medium-volatile bituminous. The coal seam is overlain by sandstones, siltstones and shales, the footwall is massive sandstone, providing a competent floor base.

The Jewel seam has been given a letter of designation in each of the synclinal limbs, starting from the northeast with "A" (2,3). This repetition of the seam results in designations given to each limb of the syncline (AB syncline, CD syncline; etc.) and the pits have been named by adding a number to the syncline (CD1 Pit, CD2 Pit, etc.). A regional pit layout is shown on Fig. 1. A plan of the plant site is shown on Fig. 2. (1).

2.2 Mining Methods

During the time of site visits, two main pits were operational: "NO" pit and "CD" pit. Coal loading was from "CD" pit only. Both coal and waste were loaded by Demag H-241 shovels,loaders were used for removal of coal only. The mining practice is to use a 15 m standard bench height and a 8m wide berm. The mining plan for the estimated 15-year life of the mine calls for at least 15 open pits, having northeast limbs dipping about 45 degrees, while the southwest limbs are nearly vertical. The northeast pit slopes follow the footwall sandstone and the southwest slopes are benched into the footwall formation (2,3).

All waste material in "NO" pit is blasted and removed to a waste dump. The unconsolidated waste is not blasted in "CD" pit only. Coal is hauled to the ROM stockpile north of "AB" pit and later loaded and dumped to the ROM hopper using a Cat-992 loader.

A new "PQ" pit was opened during 1985. The access road to this pit was under construction during a field visit to the mine in March 1985.

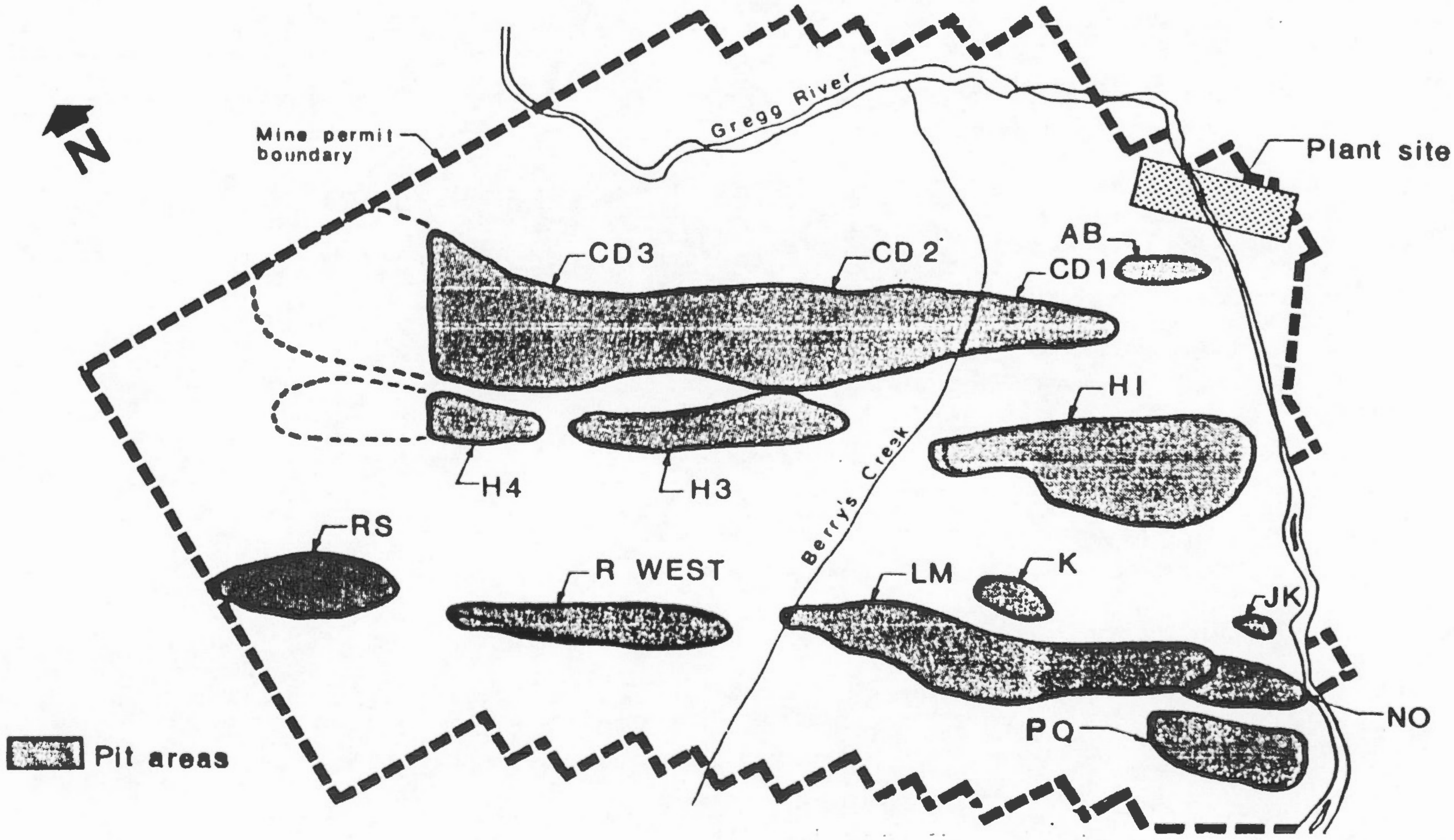

Fig. 1 - Regional pit layout

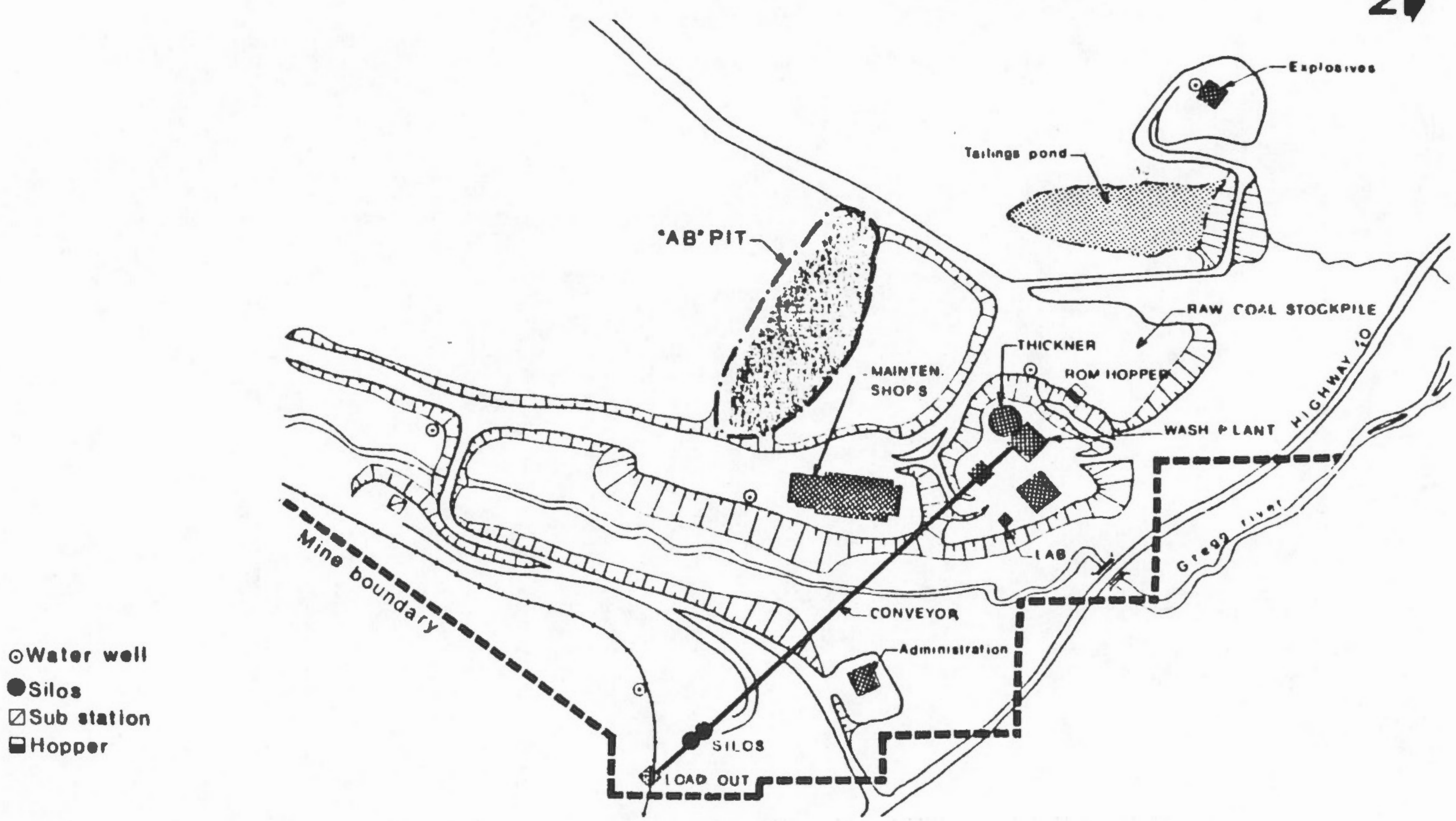

Fig. 2 - Site plan

Double loading of all material is practiced wherever possible. Also, loading of single trucks with two loaders was observed at the mine site.

Clean coal is stored in two 12 500 t capacity silos near the coal loadout facility, where it is loaded into trains.

2.3 Mining Equipment

Major mining equipment is listed in Table 1. The equipment at the mine site was used during pre-production mining by the contractor, Loram-Techman and Dominion Bridge, and was left on site after completion of the construction activities. Additional equipment was purchased for the mining and overburden removal at different mining pits. All pre-production equipment is diesel-powered, because electric power was not available at the mine till March 1983. It is expected, that in the fifth year of mining, three 19.1 m^3 shovels and sixteen 154 t trucks will be needed for waste removal. The coal mining equipment will remain about same: one 14.5 m^3 hydraulic excavator and six 109 t trucks. Two additional rotary drills in the 45 400 kg pull-down class will be needed for drilling of waste material.

3. LOADING AND HAULING LOGIC

3.1 General

The haulage network is illustrated in Fig. 3. During the field studies in 1983 and 1984: "CD" pit and "NO" pit were operating and "JK" pit was under development. Coal loading was in "CD" pit only. Euclid R-109 trucks are used for coal hauling and Euclid R-154 trucks for waste transportation. Some Euclid R-109 trucks are equipped with an extended "coal box" of much lighter construction then the waste boxes. The large Euclid R-154 trucks are favoured for the longer hauls.

Waste is generally transported to dump D4 from "NO" pit and "JK" pit, and to D1, D2 and D3 dumps from "CD" pit.

Thermal coal is stockpiled at the Thermal Coal Stockpile (TCS) close to the ROM hopper.

The mine pits are designed with benches of minimum width of 20 m and height of 15 m.

Table 1 - Summary of major equipment

ID Number	Equipment type	Manufacturer type	Units purchased	Capacity	
				Dipper (bm³)	Box (t)
6001,6002	Shovel	Demag-H241D	2	14.5	
6003	Shovel	P&H-2800	1	22.9	
6021,6022	Loader	Letourneau-L800	2	11.5	
6031	Loader	Cat-992C	1	9.6	
6051	Drill	Reedrill	1		
6052	Drill	GD-120	1		
6101-6106	Trucks	Euclid-R109	6		109
6120-6123	Trucks	Euclid-R154	4		154
6221	Dozers	Cat-D8L	1		
6250	Dozers	Komatsu-D65P	1		
6301,6302	Graders	Cat-16G	2		

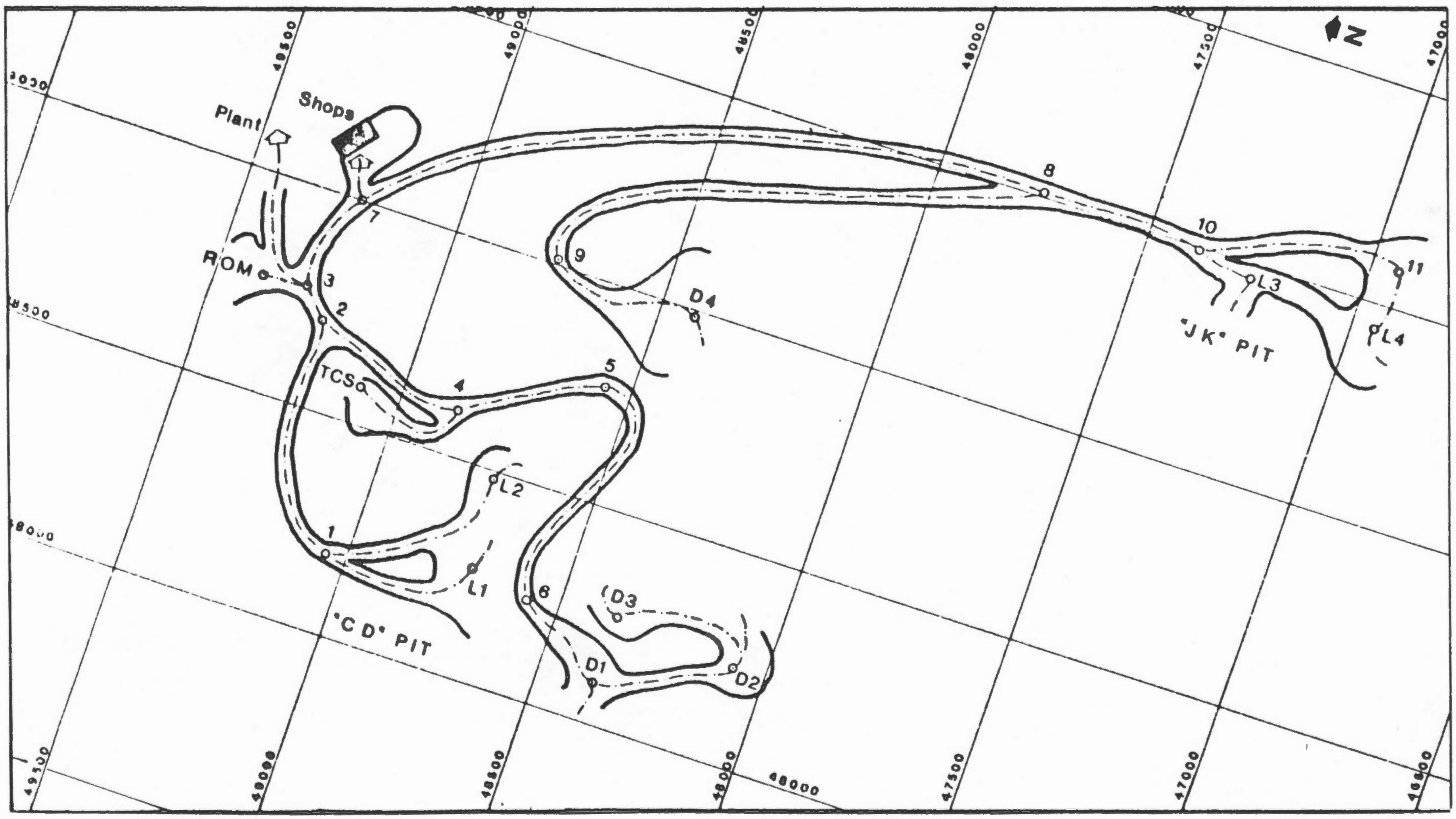

Fig. 3 - Haulage network

3.2 Loading

Loading points L1 and L2 are in "CD" pit, loading point L3 is in "JK" pit and loading point L4 is in "NO" pit. Both waste and coal is loaded at all loading points. Metallurgical and thermal coal is loaded separately and hauled to different dumping points.

During the field study, a P&H-2800 shovel was loading waste and a Letourneau L-800 loader was loading coal at L1. A Demag H-241 shovel was loading waste at L2. A Letourneau L-800 loader was loading coal at L3 and a Demag H-241 shovel was loading waste at L4 in pit "NO".

Waste was loaded to Euclid R-154 trucks and coal, both metallurgical and thermal, was loaded into Euclid R-109 trucks.

The Demag H-241 shovel could also be assigned to coal loading, and the P&H-2800 shovel was used on several occasions for stripping and removing topsoil and subsoil. The stripped material is temporarily stockpiled adjacent to each pit or near the main haul road close to the ROM hopper for later reclamation.

The loading event diagram for waste and coal loading is illustrated at Fig. 4.

3.3 Dumping

Waste from "CD" pit is dumped at D1, D2 and D3 dumps. Dumps D1 and D2, at elevations of 1680 m and 1700 m, are used as safety berms for material left at dump D3, at elevation of 1720 m and located above D1 and D2 dumps. D3 dump is used only when dumps D1 and D2 are not used. The dumping at D3 dump is controlled by a Dump Foreman. Truck drivers, entering the dump area, stop at Point 6 to request permission to enter a dump area. If a truck is dumping at D3, permission is not granted. For safety reasons, the Dump Foreman will permit another truck to enter a dump area only after dumping at D3 is completed. The dump is shown in Fig. 5.

Generally, unconsolidated waste is carried only to dump D3 and consolidated waste (blasted rock) is dumped at the lower dumps,such as D1 and D2. The logic diagram for dump D4 is similar to the one described previously.

Dump D4 is used for disposal of waste material from "JK" and "NO" pits. During the field study, only waste from "NO" pit was hauled to this dump.

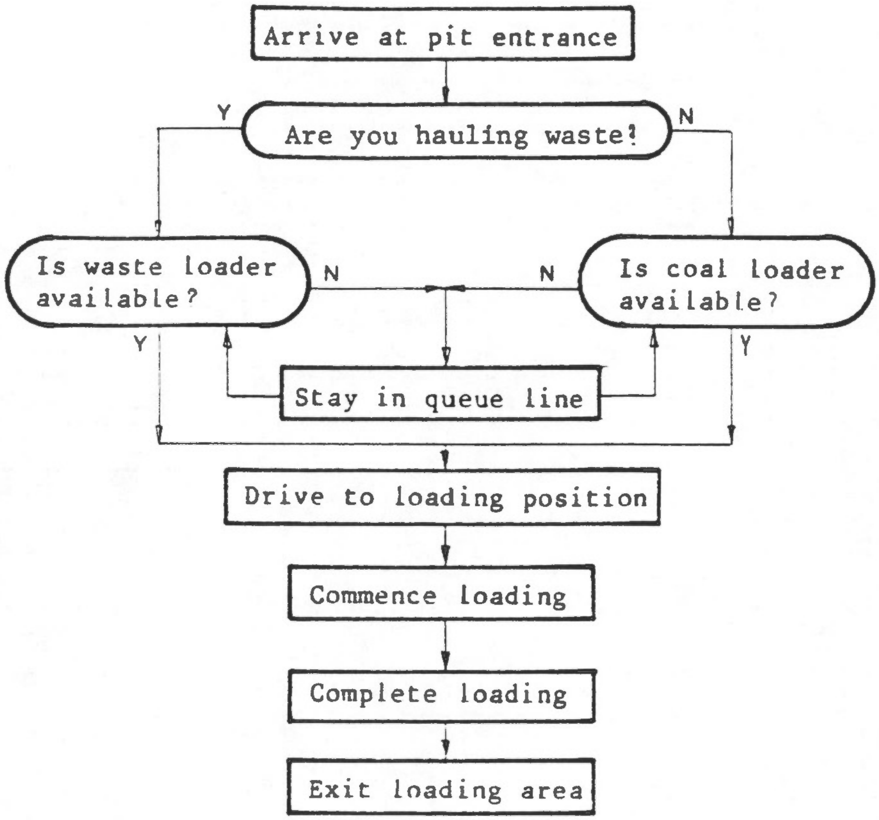

Fig. 4 - Loading event diagram

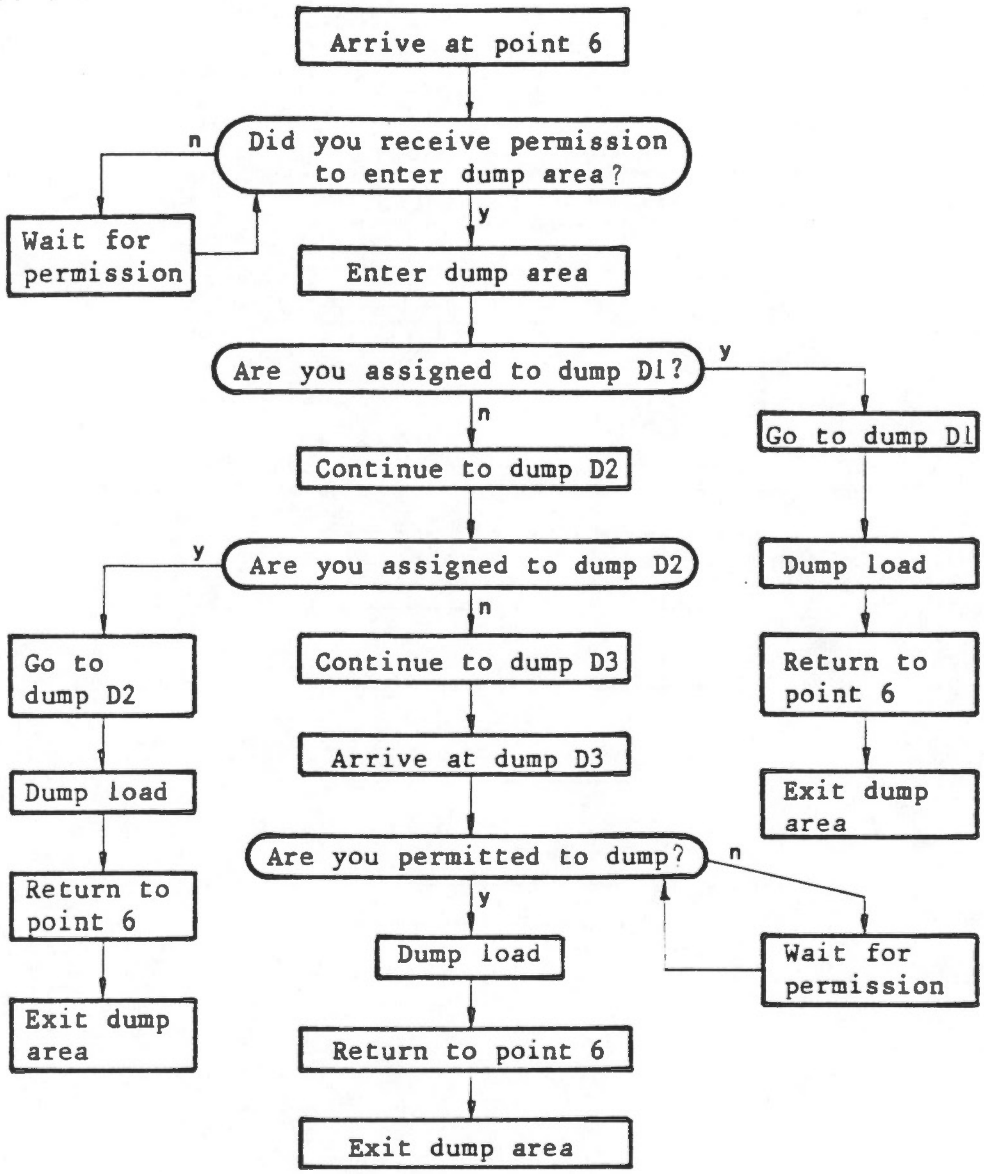

Fig. 5 - Dumping event diagram at "CD" pit dump

Metallurgical coal is transported to ROM hopper next to the Coal Preparation Plant and the thermal or oxidized coal is stockpiled in Thermal Coal Storage (TCS).

The dumping logic for the ROM hopper dump and TCS dump is presented in Fig. 6.

Trucks are returning from the ROM and TCS dumps to their pits, unless they have been reassigned by the Pit Foreman to an other pit or for preventive maintenance. The driver is usually informed in advance as to which load is the last one from the current pit, before he comences hauling from an other pit.

3.4 Truck Traffic

Waste is transported on two separate routes shown in Fig.7, as follow:

From "CD" pit: L1 - 1 - 2 - 4 - 5 - 6 - D1 (-D2,-D3)
L2 - 1 - 2 - 4 - 5 - 6 - D1 (-D2,-D3)

From "JK" and "NO" pits: L3 - 10 - 8 - 9 - D4
L4 - 11 - 10 - 8 - 9 - D4

There is no transportation of waste between points 8-7-3-ROM, 2-3 and 4-TCS.

Roads are designed for a maximum grade of 8 % and width of 30 m.

Coal is transported on same route as the waste (Fig 8). The locations of ROM hopper and the TCS dump is also shown in the Figure.

There is no coal truck traffic at dump areas, or routes 4-5-6-D1-D2-D3 and 8-9-D4.

3.5 Maintenance

The work day is scheduled separately for each pit. There are two twelve hour shifts per day. The shift commences at 7:00 in "CD" pit and at 7:30 in "NO" and "JK" pits. This 30 minutes separation allows one bus to transport all mine workers to the various pits. During the shift, the bus driver is stationed at dump D3 as a Dump Foreman.

The shift commences with a 20 minute equipment check by the operator. Preventive maintenance for all trucks and loaders is every 250 hours and servicing takes 12 hours. Each truck operator maintains a "Comments Book"

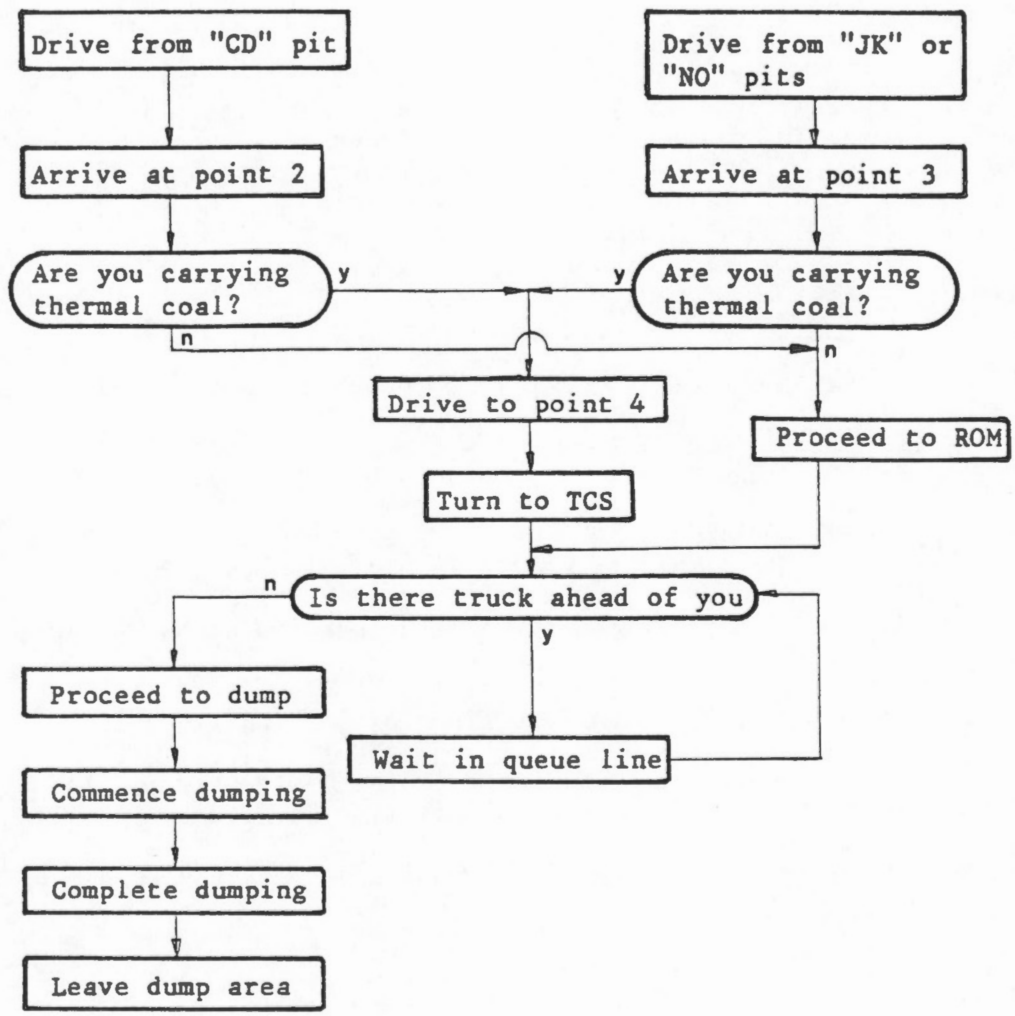

Fig. 6 - Coal dumping event diagram

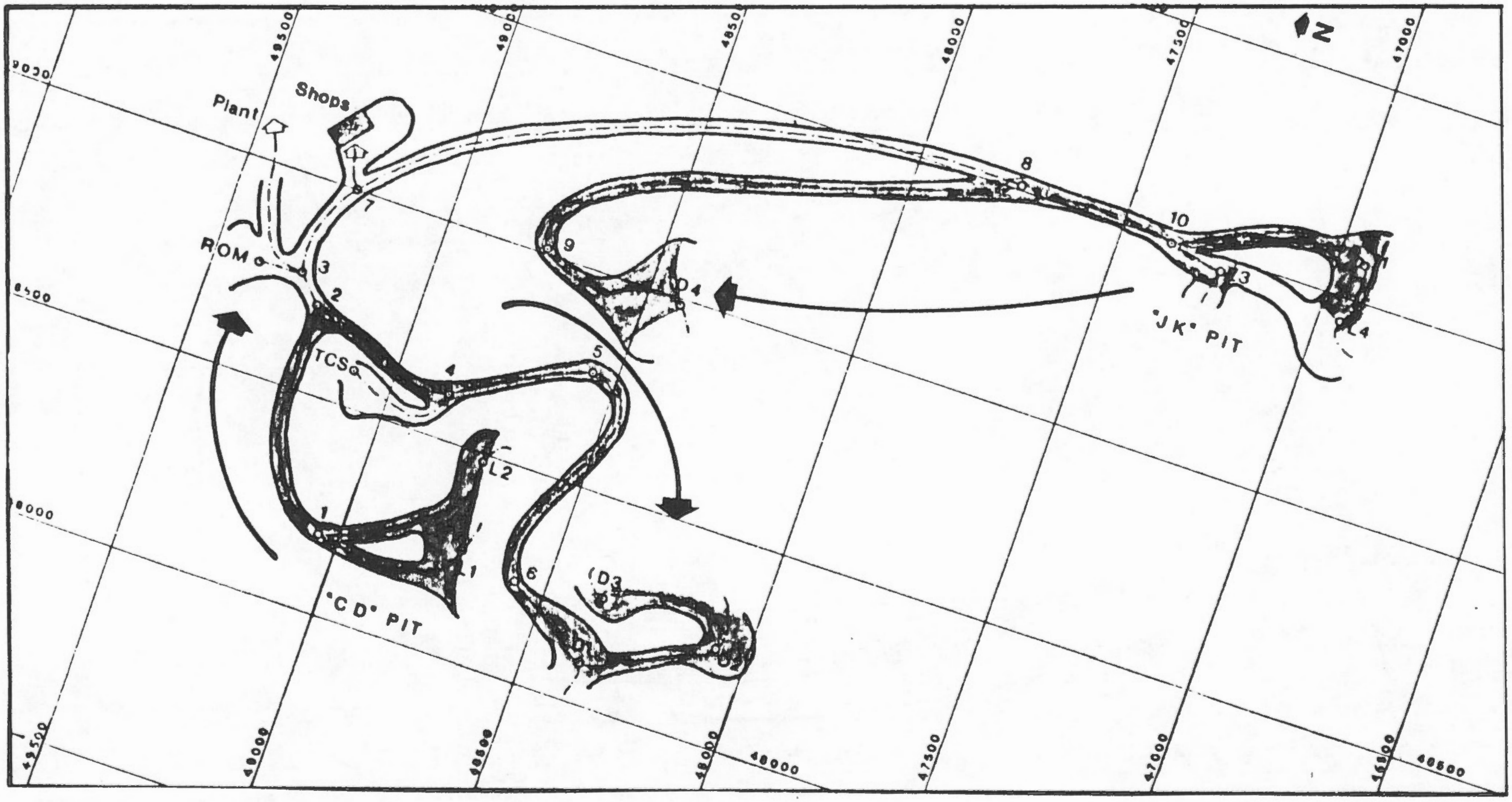

Fig. 7 - Routing logic for waste trucks

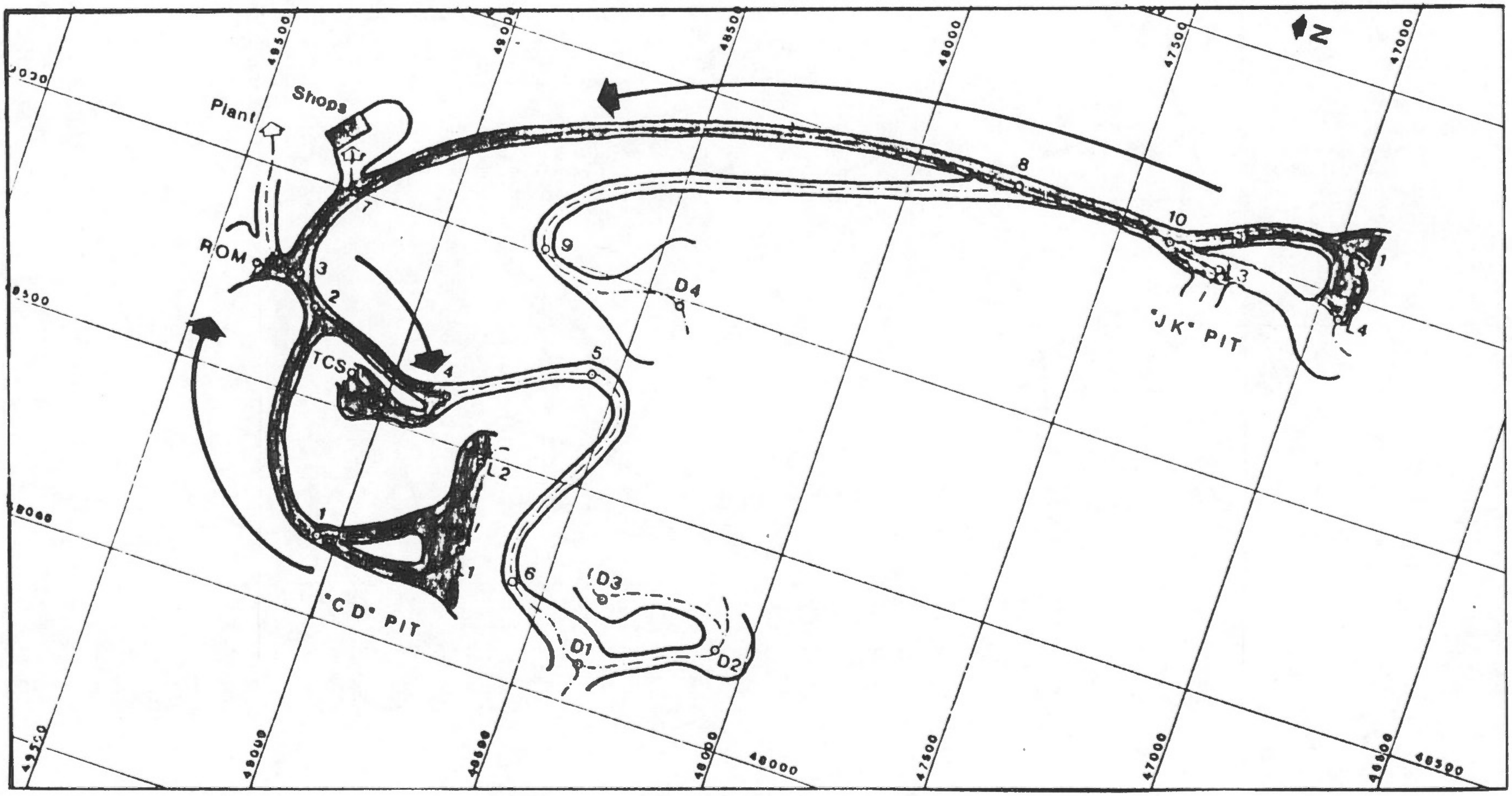

Fig. 8 - Routing logic for coal trucks

where he writes down his comments, demands for maintenance, service, problems, etc.

Truck and loader repairs are done in the shop and the shovels are serviced in the pit. Shovel maintenance is on weekly basis, with 8 hours scheduled maintenance on each odd week and 12 hours on each even week. Drills are also serviced in the field.

The weekly maintenance schedule for equipment serviced in the field during the mine visit in early 1984 was as follows:

Monday: No.1 drill (Reed drill)
Tuesday: No.1 Demag shovel diesel (H-241D)
Wednesday: No.1 Demag shovel electric (H-241E)
Thursday: P&H-2800 shovel
Friday: No.2 drill (GD-120).

Equipment operators are notified of scheduled maintenance two days before the event. A copy of the note goes to the Planning Office and to the Pit Foreman.

3.6 Fueling Policies

There are two fuel/lube stations at the mine, close to the main haulage road, at which waste and coal trucks can stop for refueling at anytime.

Mobile equipment and diesel shovels are refueled in the pit by the fuel/lube truck which visits each pit twice per shift. During the field study no problem with refueling was observed.

3.7 Non-Productive Events

The following are non-productive events that may delay mine production:

Power outages.

Production from the two electric shovels will be disrupted when electric power is not available. Coal and waste can be loaded by the diesel powered shovels and loaders when the electric shovels are down. The trucks could also be assigned to other loading points. There is no provision in mine planning for delays due to the power outages.

Shift changes.

Twenty minutes are lost at the beginning of the shift and another twenty minutes at the end of the shift. The first twenty minutes are charged to mechanical down time and the twenty minutes at the end of the shift are reported as a delay due to shift change. This represents 236 hours in the year (354 working days) or 2.8 % of the total productive time.

Meal breaks

The meal breaks are scheduled separately for each pit:

"NO" and "JK" pits:	10:00 - 10:15	coffee
	13:15 - 13:45	lunch
	16:00 - 16:15	coffee
"CD" pit :	9:30 - 9:45	coffee
	12:45 - 13:15	lunch
	15:30 - 15:45	coffee

A total of one hour is allocated for meal breaks during a 12 hour shift at each pit, representing a total of 708 hours per year or 8.3 % loss due to meal breaks.

Traffic Delays

Loaded trucks have the right-of-way. Trucks entering a main haulage road must yield to trucks on the main road, whether they are loaded or empty. Trucks from L3 or D4 will always yield to empty coal haulers returning from the ROM to TCS dumps or to fully loaded coal or waste trucks coming from the "NO" pit. All trucks coming from the "CD" pit will yield to coal haulers coming to the "TCS" dump. Empty coal haulers entering a main haulage road at point 4 will yield to waste trucks driving in both directions to or from the "CD" pit waste dumps.

There is no provision in the mine plan for non-productive delays due to traffic.

Blasting

There is no provision for blasting delays in the mine plan. The blasting is scheduled at most three times per week and always during the afternoon break. During a blast, trucks and other equipment must remain outside a "limit circle" and trucks are reassigned to other pits.

Weather

The mine plan allows for five lost days due to bad weather during December to March. This represents 120 hours per year of 1.4 % of the total scheduled productive time.

Personal delays

Ther is no provision in the mine plan for personal delays. No safety, union or instructional meetings are planned during regular working hours.

4. EQUIPMENT PRODUCTIVITY STATISTICS

The mine uses the following definitions to calculate availability and utilization of equipment(s):

Mechanical Availability: MA = (SH-DT)/SH

Utilization Factor: VF=NOH/(SH-DT)

Effective Utilization: EU=NOH/SH(=MA * UF)

Scheduled Utilization: SU=SH/AH

Operating Efficiency: OE=NOH/AH(=MA * UF * SU)

Where

AH = available hours - total number of hours available (24 hrs./day).

SH = scheduled hours or planned hours of operation. Overtime would be classified as a scheduled hour. The difference between available hours and scheduled hours are unscheduled hours (unscheduled shifts, statutory holidays).

NOH= net operating hours, amount of time spent doing productive work.

DT = Down time, amount of time spent repairing equipment during a scheduled shift.

Other delays are classified as:

- Fixed delays (FD) - shift change, rest period, meal break, servicing.
- Other delays (OD) - time lost due to blasting, weather, moving equipment and waiting. The delay must be greater than 30 minutes in any given shift to be recorded.
- Idle (I) - machine is available for work but is not being utilized due to lack of work.

Tables 2 and 3 summarize the equipment productivity for the 1984 year. Delays are presented for each piece of equipment and also summarized for each group of equipment. Shovels, loaders and trucks only are included in the overview. The loading equipment summary is in Table 2, hauling equipment summary is in Table 3. Table 4 summarizes the operational and down times and availability and utilization data.

Mechanical availability of electric shovels is quite high (90.1 %). Also, the Cat-992C loader has high availability of 85.1 %. The mechanical availability of trucks is in an acceptable range over 80 %. The mine did not yet develop criteria for the elements of the cycles of loading and hauling events.

5. CONCLUSION

The Gregg River Mine was selected for the study because at the time it was Canada's newest metallurgical mine in full operation, its location in the Mountain Region of Alberta and use of Euclid trucks for hauling of coal and waste. The mine scheduling and planning and data collection is fully computerized and mine engineering and management personnel were most helpful in providing information for the study.

The data provided on mechanical availability and performance of equipment are from a short period of operation only and are quite high when compared with most of the Canadian surface coal mines. The loading equipment availabilities are from 74 to 90 %. Insufficient data was available for hauling equipment.

Additional statistical information is summarized as follows:

- Loading equipment productivity in 1984 for Demag H-241D was 627.0 bcm/h for waste, 1236.0 t/h for coal; for Demag H-241E was 748.0 bcm/h for waste and 965.0 t/h for coal; for P&H-2800 shovel was 899.0 bcm/h for waste only; for L-800 loader was 685.0 bcm/h for waste and 1501.0 t/h for coal; for Cat-992C loader was 190.0 bcm/h for waste and 442.0 t/h for coal.

- Hauling equipment productivity in 1984 for Euclid R-109 trucks was 147.0 bcm/h for waste, 320.0 t/h for thermal coal, 296.0 t/h for metallurgical coal; for Euclid R-154 trucks was 207.0 bcm/h for waste, 430.0 t/h for thermal coal and 193.0 t/h for metallurgical coal.

6. ACKNOWLEDGEMENT

The author is indebted to Mine Engineering Department and Management of Gregg River Mine for providing background information for this study and for their help during data collection and evaluation. Special thanks are

Table 2 - Loading equipment productivity summary

Equipment	Material handled		Production (bm^3) or (t)	NOH (hr)	Productivity (bm^3/hr) or (t/hr)
	Type	Unit			
Demag-H241D	Waste	bm^3	2 135 102	3403.0	627.0
	Thermal coal	t	0	0	0
	Metallurgical coal	t	534 438	432.5	1347.0
Demag-H241E	Waste	bm^3	3 204 227	4284.5	748.0
	Thermal coal	t	1 100	1.5	733.0
	Metallurgical coal	t	209 425	217.0	965.0
P&H-2800 shovel	Waste	bm^3	383 114	426.0	899.0
	Thermal coal	t	0	0	0
	Metallurgical coal	t	0	0	0
L-800 loader	Waste	bm^3	1 057 165	3072.0	685.0
	Thermal coal	t	81	0.5	161.0
	Metallurgical coal	t	1 022 563	1368.0	1501.0
Cat-992C loader	Waste	bm^3	38 193	194.5	196.0
	Thermal coal	t	0	0	0
	Metallurgical coal	t	45 936	104.0	142.0

Table 3 - Hauling equipment productivity summary

Equipment	Material handled		Production (bm^3) or (t)	NOH (hr)	Productivity (bm^3/hr) or (t/hr)
	Type	Unit			
Euclid-R109	Waste	bm^3	2 966 817	20 118.4	147.0
	Thermal coal	t	320	1.0	320.0
	Metallurgical coal	t	1 662 377	5 613.0	296.0
Euclid-R154	Waste	bm^3	3 850 982	18 603.5	207.0
	Thermal coal	t	861	2.0	430.0
	Metallurgical coal	t	149 984	777.5	193.0

Table 4 - Summary of operational and delay times

Equipment	AH (hr)	SH (hr)	DH (hr)	FD (hr)	OD (hr)	I (hr)	NOH (hr)	MA (%)	UF (%)	EU (%)	OE (%)
Shovels:											
Demag-H241(D)	8784.0	7704.0	2001.4	969.0	806.5	20.0	3906.0	74.0	68.5	50.7	25.7
Demag-H241(E)	8376.0	7320.0	723.8	1093.5	938.5	19.5	4544.5	90.1	68.9	62.1	38.6
P&H-2800	1152.0	864.0	128.5	115.0	157.5	37.0	426.0	85.1	51.9	49.3	24.3
Total	18312.0	15888.0	2853.7	2177.5	1902.5	76.5	8876.5	82.0	68.1	55.9	31.2
Loaders:											
L-800 loaders	17568.0	15429.0	3463.0	1541.5	1171.0	2798.6	6453.0	77.6	54.0	41.8	17.5
Cat-992C loader	8784.0	7707.0	1146.6	945.0	101.5	853.7	4659.5	85.1	71.0	60.5	36.6
Total	26352.0	23136.0	4609.6	2486.5	1272.5	3652.2	11112.5	80.1	60.0	48.0	23.1
Trucks:											
Euclid-109	52704.0	46236.0	9268.6	5877.0	621.5	1912.4	28550.4	80.0	77.2	61.7	38.1
Euclid-154	32664.0	28440.0	3858.0	4075.0	624.5	269.3	19610.5	86.4	79.8	69.0	47.6
Total	85368.0	74676.0	13126.6	995.0	1246.0	2181.7.	48160.9	83.2	78.5	65.4	42.7

extended to B.McConechy, G. Sutherland and J. Chalmers for their direct involvement in the study.

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