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CYPRUS ANVIL

Tulameen Coal Project
Rail Transport Costs

Project No. 3726

December 1978

SWAN WOOSTER ENGINEERING CO. LTD.

CYPRUS ANVIL CORPORATION

TULAMEEN COAL PROJECT

RAIL TRANSPORT COSTS

Project No. 3726

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December 1978

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1.0 INTRODUCTION AND SUMMARY

Cyprus Anvil Corporation are investigating the feasibility of developing the Tulameen coal deposits near Coalmont, British Columbia. Part of this assessment requires estimation of railway tariffs and loading costs. These aspects of the assessment are the subject of this report.

The proposed development will involve the mining and transporting of 420,000 tonnes per year of coal for purposes of export over a fifteen year period. In this analysis the production volume is converted to short tons (460,000 per year). All other references to tons in this report are short tons.

The rail system that will be used to transport this coal is comprised of CP Rail's branch line from Coalmont to Spences Bridge and their mainline from Spences Bridge to Port Coquitlam Yards and on into Pacific Coast Bulk Terminals at Port Moody. This routing and the general location of the development are shown in Figure 1-1.

An important consideration in the railway analysis is the condition of the trackage on the Princeton Subdivision. An inspection of the track condition and analysis of the operations indicated that the track, in its present condition, is capable of handling this relatively small volume of coal. Furthermore it appears that the track is already being improved as part of a planned upgrading program and as such this cost is not attributable to any specific traffic. These comments are predicated on the coal moving in cars of 80 tons capacity or less. One hundred ton cars and their resulting heavier axle loadings would necessitate upgrading this section of track.

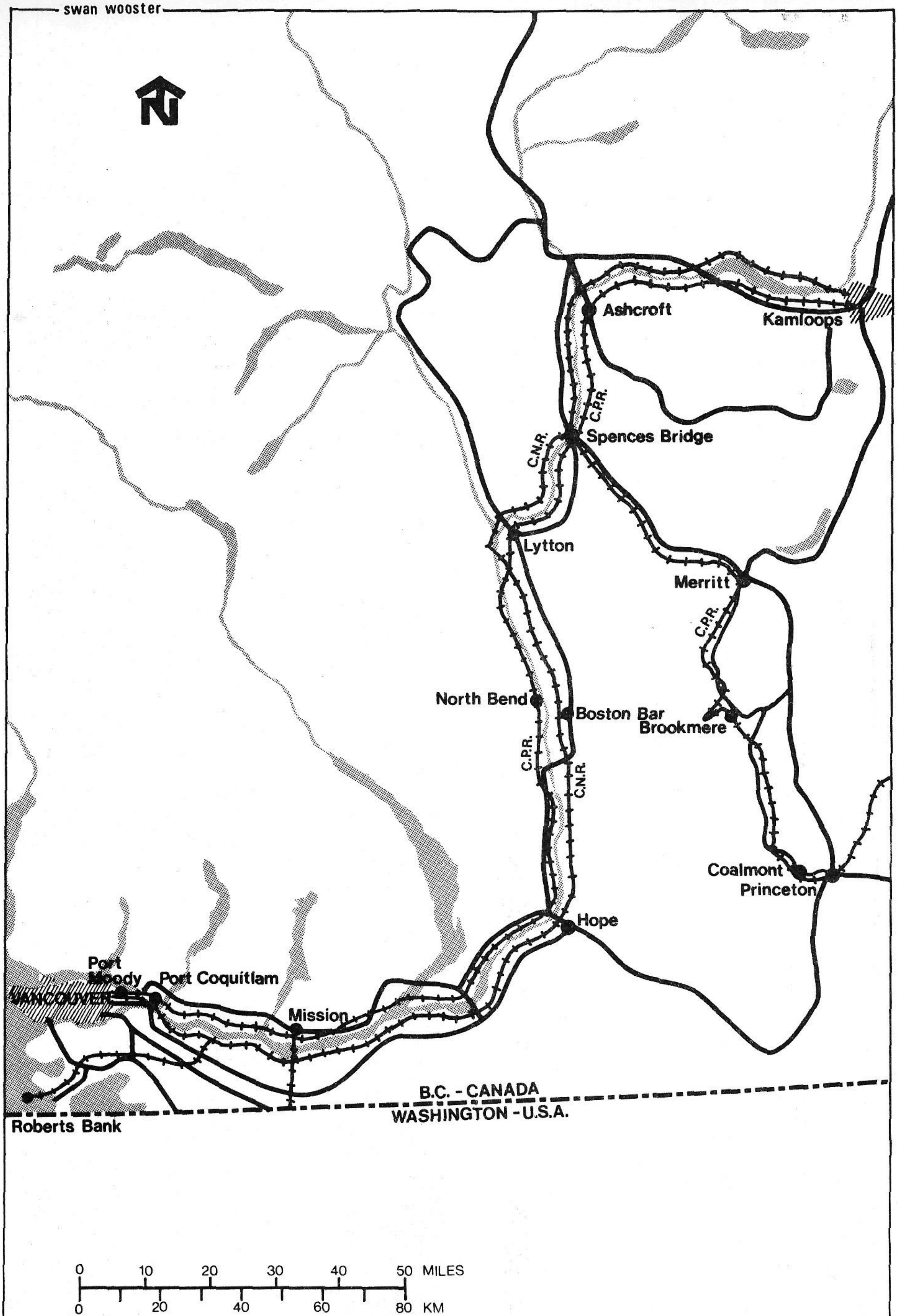


FIGURE 1-1 ROUTE LOCATION

The volume of coal considered herein could be handled by the railway as block shipments in existing trains or as solid train loads. Both systems would require similar numbers of cars and incur comparative levels of costs. Therefore the cost analysis concentrates on the solid train system.

In order to determine the effect of various cycle times on railway costs, three alternative loading speeds of 16, 8 and 4 hours per trainload were considered. These loading rates when combined with train operations result in achieveable cycle times of 54, 46 and 42 hours respectively. These times when combined with the throughput tonnage result in relatively small trains of less than 40 cars. Also, a 96 hour cycle was included in the analysis to assess the impact of a larger train size. This longer cycle time requires a 70 car train to transport the annual tonnage.

Train loading systems capable of meeting the specified rates of 16, 8 and 4 hours were considered. These required the use of different sizes of front end loaders operating from a truck-dumped stockpile. A fourth system, an overhead conveyor capable of loading the train in 4 hours, was also included. The cost per ton of these four systems were $0.53 for the 16 hour loading rate, $0.43 for the 8 hour rate and $0.59 for the 4 hour rate. The overhead conveyor system had a cost of $0.60. Loading the 70 car train would have a loading cost per ton of $0.64.

Railway operating unit costs were derived from published Statistics Canada data and applied to the proposed operating systems. The resultant unit costs are summarized on Figure 5-1 while the breakdown of railway costs on a per ton basis is summarized in Figure 6-1.

The estimated fair tariff for transporting the coal ranged from a low of $5.67 for the large 70 car train system to a high of $6.42 for the 39 car train with a 16 hour load time. Combining these with the estimated loading costs indicates that the 70 car train system combined with either a front end loader (Scheme C) or an overhead conveyor (Scheme D) loading system is the most economical.

Figure 1-2 summarizes the operating characteristics, variable rail costs and loading costs as determined in this analysis.

FIGURE 1-2 SUMMARY OF REPORT RESULTS

Loading Scheme:	A	B		C		D	
Cars Per Train	39	34	70	31	70	31	70
Loading Time (Hours)	16	8	16	4	8	4	8
Cycle Time (Hours)	54	46	96	42	96	42	96
Locomotives Per Train	4	3	6	3	6	3	6
Loading Cost Per Ton	\$0.53	\$0.43	\$0.74	\$0.59	\$0.64	\$0.60	\$0.64
Rail Cost Per Ton	\$6.42	\$6.02	\$5.83	\$6.20	\$5.67	\$6.20	\$5.67
Total Cost Per Ton	\$6.95	\$6.45	\$6.57	\$6.79	\$6.31	\$6.80	\$6.31

All costs expressed in 1978 dollars.

Estimate prepared by Swan Wooster Engineering Co. Ltd.

2.0 RAILWAY TRACK CONDITIONS

The railway system considered in this analysis is comprised of the CP Rail Branch line between Coalmont and Spences Bridge (95 miles) - the Princeton Subdivision - and the CPR mainline from Spences Bridge through North Bend, Hope, Mission, Port Coquitlam Yard and then into Port Moody (165 miles) - the Cascade Subdivision.

It was assumed that the track structure of the CP Rail mainline would be more than adequate for the small volume of traffic being considered, therefore only the trackage between Coalmont and Spences Bridge was inspected in the field. To supplement this inspection, topographical mapping for the area and operating timetables for the region were analyzed.

The inspection showed that the basic track structure is built on a well located, properly drained roadbed that has been topped with pit-run gravel ballast. The #1 standard creosoted cross ties are in good condition with varying remaining life spans as would be expected. The track shows evidence of an ongoing tie replacement program, in some locations new ties are piled on the shoulders waiting installation.

The 100 pound and 85 pound rails are supported on the ties by steel tie plates. The 100 pound rail, some of which has been installed fairly recently, is second hand and is in place from Coalmont (mile 82.3) to a point just west of Brookmere (mile 113). The remainder of the rail is 85 pound in fair to poor condition. All rails are connected with 4 hole, bolted joint bars and are fastened to the ties with 4 spikes per tie (2 on each rail) on tangents and 6 on curves.

The bridges on this part of the railway are mainly steel of several types, deck plate girders, deck trusses and through trusses. There are however also some treated, pile bent, timber trestles. All of the bridges appear to be well maintained and in good condition. The bridges at miles 102.7 and 120.3 have posted slow orders and therefore may require some work in the future. The timber trestles appear to have been renewed in the last five to ten years.

The vertical and horizontal alignment of the track structure is good by branch line standards particularly in the areas where the 100 pound rail is in place. There is some poor alignment evident in the 85 pound rail territory. This is also the area where a tie replacement program appears to be underway, new ties have been distributed and are beside the roadbed awaiting installation. Once these new ties are installed the track surface will probably be realigned.

The maximum adverse gradients on this section of track were assumed to be a 3 mile long, 1.4% grade against loaded or west-bound traffic and a 2 mile long, 1.2% grade against empty or east-bound traffic. The grades are located just east of Brookmere (about mile 102 to 105) and just south of Merritt (about mile 135 to 137) respectively. These grades are also the maximum grades between Port Moody and Coalmont and therefore are the ones that determine the locomotive power required for each train.

In general this section of branchline track was assumed to be adequate for the traffic being considered and as such would not require any specific expenditure of capital for upgrading beyond that already scheduled. The evidence as follows indicates that this branchline is already being upgraded to 100 pound rail throughout its length and the addition of this traffic should not affect this process.

a) The installation of 100 pound rail from Princeton towards Spences Bridge indicates a planned replacement program. If it were spot replacement one would expect that the track between Merritt and Spences Bridge would be renewed first as it carries the most traffic.

b) An indication of anticipated upgrading of the rail between Merritt and Spences Bridge is the recent changing of the rail in the road crossings from 85 pound to 100 pound.

c) The fact that the timber trestles have been renewed fairly recently (estimated to have been within the last 5 to 10 years) also indicates a planned continuous upgrading of the rail line.

d) The fact that there is evidence of a tie renewal program on the 85 pound territory indicates that the rail will probably be renewed in the near future. Tie renewal, track lining and surfacing are usually done just prior to changing rail.

It should be noted that the assumption of track adequacy for the proposed coal traffic is only valid if the coal moves in 80 ton carloads or less. Should heavier 100 ton capacity cars be used the track structure and probably some of the bridges would require upgrading.

3.0 RAILWAY OPERATING SYSTEM

The existing railway operations on the Princeton Sub-division (Coalmont to Spences Bridge) were assumed to be road switcher service every other day from Spences Bridge through to Penticton. This is supplemented by a further road switcher service on opposite days between Spences Bridge and Merritt so that Merritt has daily service. Most of the traffic handled by these trains would consist of forest products.

The mainline track between Spences Bridge and the Lower Mainland carries an average of some 15 to 20 trains per day with peak levels up to 50% higher. This traffic consists of 2 passenger trains, 2 local trains, 2 express or intermodal trains, 6 general traffic trains and up to 5 bulk commodity unit trains carrying either coal, potash or sulphur.

At these traffic levels there is sufficient capacity available to accommodate the additional train(s) required to transport 460,000 tons of coal per year from Coalmont to Port Moody. There could even be sufficient space in the existing trains to handle the coal cars without adding more trains to the system. The only capacity adjustment that may be required would be the extension of one or two sidings between Coalmont and Spences Bridge.

Two different types of trains could be used to transport coal from the Tulameen Mine to Port Moody. These two types, blocks of coal cars in existing trains and trainloads, are both discussed below.

Block System

For the block shipment system to be effective:

a) space must be available on a regular basis in existing trains;

b) schedules for existing trains must either be adjusted or be already such that a regular car cycle can be maintained.

Assuming a six day work week, 40 carloads of coal would enter the system on alternate days. This figure includes 10% spare capacity to allow for system delays and shut-downs.

The operation would commence as part of the regular road switcher service from Spences Bridge to Coalmont transporting the empty cars into the mine site for loading. During the next 23 hours the cars would be loaded while the road-switcher service carried on into Penticton, stopped over-night and returned.

The road switcher would then take the loaded cars and transport them to Spences Bridge. At Spences Bridge the block of cars would be set out for pick-up by the daily way-freight that operates between Calgary and Port Coquitlam. Once in the Port Coquitlam Yards the block of cars, still intact, would be transferred by switcher to Port Moody for unloading. These steps would then be reversed so that the empty cars could be returned to the mine site ready to start the next cycle.

This operation would require two car sets (80 cars total), one for the loading part of the cycle (Spences Bridge to Coalmont and return) and one for the unloading (Spences Bridge to Port Moody and return). This in effect would give a 4 day cycle for each car set. Figure 3-1 outlines a tentative schedule for a full cycle.

FIGURE 3-1 CYCLE TIME FOR BLOCK SHIPMENT OF COAL COALMONT TO PORT MOODY

Operation	Time (Hours) Loaded	Empty
Loading	23	-
Train Inspection, Switching, etc. at Coalmont	1	-
Coalmont to Spences Bridge	6	6
Switching, waiting for way freight, inspection, etc. at Spences Bridge	12	9
Spences Bridge - North Bend	2.5	2.5
Crew Change at North Bend	0.5	0.5
Northbend - Port Coquitlam	4.5	4.5
Switching, Inspection, etc. at Port Coquitlam	8.0	10.0
Port Coquitlam - Port Moody	1	1
Unloading	-	4
TOTAL	96	

Trainload System

The amount of railway equipment, required to transport a given volume of coal over a rail line is dependent on cycle time, and has a significant effect on cost. A major part of the railway equipment's cycle time spent in transit and in yards is relatively constant regardless of train size. The remainder of the cycle time spent loading and unloading will vary with train size.

In this analysis the impact of varying cycle times was assessed on the basis of 16, 8 and 4 hour loading times combined with a 4 hour unloading time. In this operation the unloading time was found to be relatively constant at 4 hours, within the expected train sizes. Loading times were related to three different proposed systems whereas unloading times were related to an existing operation.

The transit times were calculated using a computer model of the railway system. Yard and delay times were based on assumptions made by the consultant. The cycle times and resulting train sizes for these alternatives are summarized on Figure 3-2.

As the calculated train sizes were all relatively small, 39, 34 and 31 cars, a fourth cycle time, 4 days, was included to assess the impact on costs of large trains.

The solid train operation would commence with the dispatching of a train set from Port Coquitlam eastbound to the mine. The train would stop first at North Bend for a crew change. The crew boarding the train at North Bend would handle the train from North Bend to Coalmont and return. This would be a standard crew (engineman, conductor and 2 brakemen) for Scheme A (16 hour load) but would carry an extra engineer for the other loading schemes. The extra engineman is necessary to ensure continuous operation of the train. A similar system of crewing is used on the Canadian National Railway from Jasper Winniandy to handle unit coal trains loaded at MacIntyre Mines.

For 16 hour loading it was assumed that the crew would leave the train and be transported to Princeton for rest. On completion of loading the same crew would come back to return the train to North Bend. For all other schemes the crews would stay with the train and carry out any car moving necessary during loading.

The non-productive portion of the 4 day cycle would be spent in or near the Port Coquitlam yard. This would then ensure that the locomotives used in the transport of Tulameen coal would be used elsewhere during the non-productive portion of the cycle. If the train were held elsewhere the locomotives would either be held with the train or would have to travel empty back to Port Coquitlam as it is the only location on the system being considered that has a locomotive pool.

It should be noted that in all four schemes the train would have to be broken up so that the locomotives and cabooses could change ends. There is no provision for loop track loading in any scheme.

The locomotive requirements for these four differing trains were computed on the basis of a 1.4% controlling adverse grade. Because of the light trackage on the Princeton Subdivision 4 axle 2300 HP locomotives were assumed to be the basic power source rather than six axle 3000 HP units normally used in coal unit-train service. These locomotives should handle about 10 or 12 cars each on the controlling grade at a minimum operating speed of 12 miles per hour.

The solid train system cycle times and resulting train sizes are all summarized in Figure 3-2.

FIGURE 3-2 SOLID TRAIN CYCLE TIMES

Operation	16 Hour Load		8 Hour Load		Semi-Automated Loading		4 Day Cycle	
	Loaded	Empty	Loaded	Empty	Loaded	Empty	Loaded	Empty
Loading	16	-	8	-	4	-	8	-
Coalmont-Spences Bridge	4	4	4	4	4	4	4	4
Delay at Spences Bridge	1	0	1	0	1	0	1	0
Spences Bridge - North Bend	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Crew Change at North Bend	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
North Bend - Port Coquitlam	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Switching, Inspection, Etc.	4	4	4	4	4	4	4	52
Port Coquitlam - Port Moody	1	1	1	1	1	1	1	1
Unloading	-	4	-	4	-	4	-	6
Total Hours	54		46		42		96	
Train Size (1)	39		34		31		70	
Locomotives	4		3		3		6	

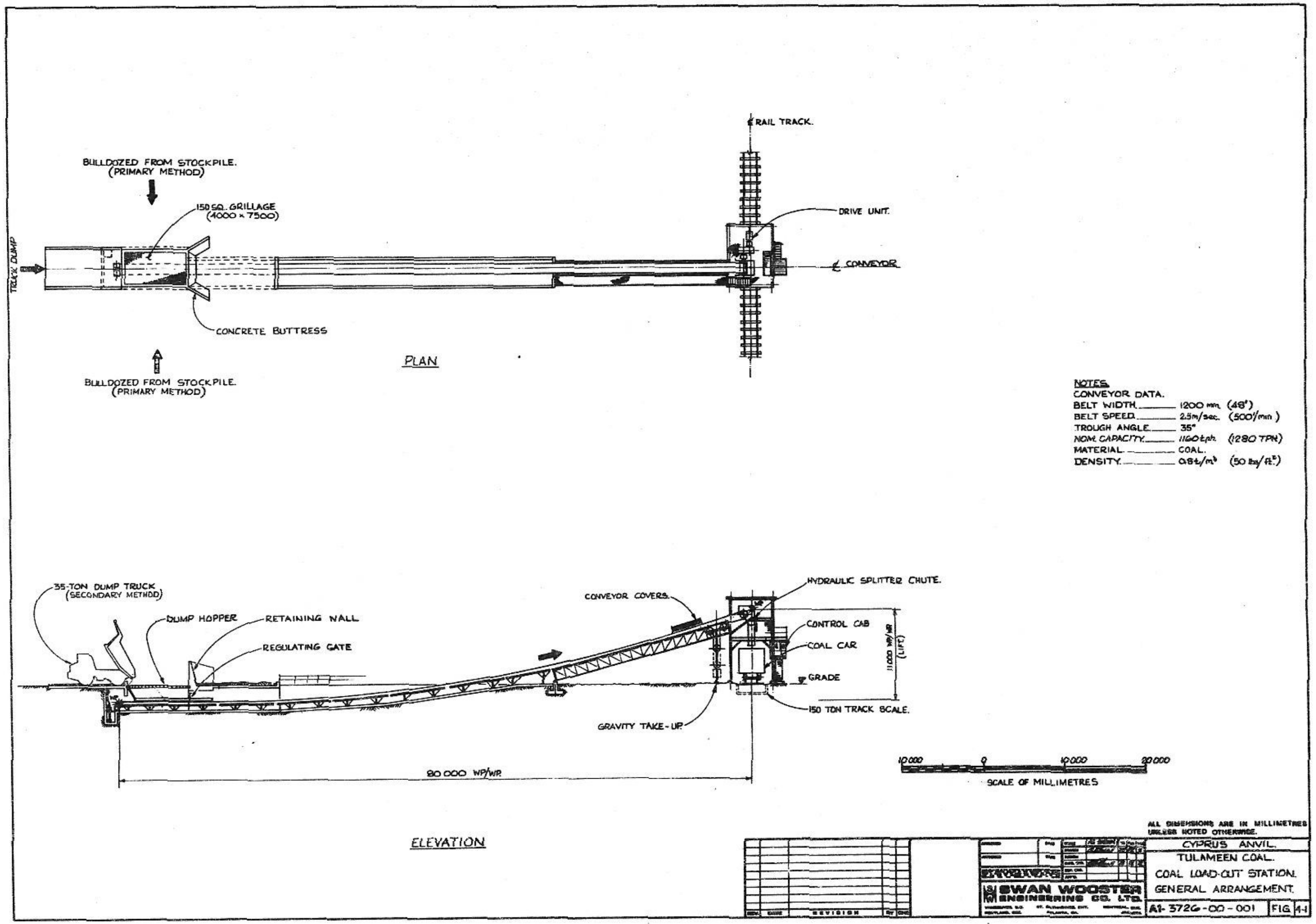
Notes: (1) Numbers of 80 ton cars calculated on the basis of a 330 day operating year.

4.0 LOADING SYSTEMS

A brief order-of-magnitude analysis of possible loading systems has been undertaken to ensure selection of a practical and economical railway system. The selected loading system directly affects loading rates which can increase train cycle time thereby affecting train sizes and car requirements. To measure the effect of loading systems on the Tulameen coal movement three different loading times and two methods were considered. The loading times were 16, 8 and 4 hours per train load and the loading methods were by either front end loader or by a semi-automated overhead conveyor system. These times have been designated as Schemes A, B and C respectively for front end loading and the Scheme D for the overhead conveyor system.

The first method consists of front loaders reclaiming from a truck dumped stockpile and loading directly into the rail cars assisted by a built up ramp. The overhead conveyor system, Figure 4-1, operates with either dozer reclaiming or direct truck dumping into a ground level hopper. The coal travels by belt conveyor from this hopper and is deposited through a pant-leg chute system into the cars. Loading is controlled by an operator in the cab at the loadout point. Both systems will require two men to operate, one to run the loader or dozer and one to check the rail car loading and generally supervise operations.

For the basic loading systems two rail track layouts are possible. These are: (1) a single track with empty car storage on one side of the loading point and loaded car storage on the other side; and (2) two tracks with a similar configuration. This first scheme requires relocation of one road/rail crossing and about two-tenths of a mile of road in order to avoid traffic obstruction during loading operations. The second scheme avoids these highway problems but requires more handling of rail cars


RAIL TRACK.
BULLDOZED FROM STOCKPILE. (PRIMARY METHOD)
150 SQ. GRILLAGE (4000 × 7500)
DRIVE UNIT.
TRUCK DUMP
CONVEYOR
CONCRETE BUTTRESS
PLAN
BULLDOZED FROM STOCKPILE. (PRIMARY METHOD)
NOTES.
CONVEYOR DATA.
BELT WIDTH. 1200 mm. (48")
BELT SPEED. 2.5m/sec. (500'/min)
TROUGH ANGLE. 35°
NOM. CAPACITY. 1160 tph. (1280 TPH)
MATERIAL. COAL.
DENSITY. 0.8t/m³ (50 lbs/ft.³)
35-TON DUMP TRUCK (SECONDARY METHOD)
DUMP HOPPER
RETAINING WALL
REGULATING GATE
CONVEYOR COVERS.
HYDRAULIC SPLITTER CHUTE.
CONTROL CAB
COAL CAR
GRADE
11 000 WP/WR (36'-1")
150 TON TRACK SCALE.
GRAVITY TAKE-UP.
80 000 WP/WR.
10 000 0 10 000 20 000
SCALE OF MILLIMETRES
ELEVATION
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
CYPRUS ANVIL.
TULAMEEN COAL.
COAL LOAD-OUT STATION.
GENERAL ARRANGEMENT.
SWAN WOOSTER ENGINEERING CO. LTD.
A1-3726-00-001
FIG. 4-1
REVISION

to move them past the loading point. A brief capital cost comparison indicated that the single track is cheaper and therefore is considered for all alternatives except the 70 car train system which requires double trackage because of the greater train length. The unit costs used in the estimates were $30 per foot for track supply and installation, $9000 for switch supply and installation, and a lump sum of $30,000 for road relocation.

All loadout systems require a level stockpile area. For purposes of this study the level empty ground on the south side of the CPR tracks at the west end of the existing Coalmont townsite was assumed to be the loadout site. In the front end loader alternative a ramp is included for easier rail car loading. The stockpile site work consists of provision of stockpile base, drainage ditches for run-off water and a settling pond. This civil work will be required for all systems.

Furthermore, a load cell type track scale is included for all loading systems, however, it may not be necessary. It is possible that car loading by volume may be acceptable. To establish loading limits the first few train sets could be weighed by the railway on their scales. Continuous checks could be accomplished by periodic random weighing of train sets.

Front end loaders were sized to match the loading rates required for Schemes A, B and C. The equipment sizes considered - 950, 966C and 988B - are based on Caterpillar Tractor Specifications. Other equipment models with comparable operating characteristics could also be used. All three of these are rubber-tired loaders equipped with oversize buckets, 4.5, 6 and 10 cubic yard capacity. The overhead conveyor system, designated Scheme D, does not require a rubber-tired front end loader but does require a dozer for stockpile reclamation. It was assumed that a D7 type crawler tractor would suffice.

Mobile equipment is necessary at the loadout site one shift per day, 330 days per year for either loading or stockpiling. For the 16 hour load time, 1 extra shift for each train cycle (150 shifts per year) was also included.

In Scheme A, 16 hour loading time, the locomotives and crew are not available for car moving. To overcome this it was assumed that the loader would be used to pull cars past the loading point.

The capital and operating costs for the four different schemes considered are summarized in Figure 4-2. These costs show that Scheme A, the longest loading time (16 hours), has a cost per ton of 53¢, Scheme B, 8 hours, costs 43¢ per ton, while Schemes C and D, the 4 hour systems (front end loader or overhead conveyor) cost 59¢ and 60¢ per ton respectively.

Loading the 70 car trains can be done by either Scheme B over a 16 hour period or Schemes C and D over an 8 hour period. This would cost an extra 32¢ using Scheme B for a total of 75¢ per ton. Using Schemes C or D would cost a total of 64¢.

FIGURE 4-2

SUMMARY
RAIL CAR LOADING SYSTEMS
(460,000 tons per year)

Item	SCHEMES						
	A	B		C		D	
Cars per train	39	34	70	31	70	31	70
Average Loading Time (Hours)	16	8	16	4	8	4	8
Average Loading Rate (Tons Per Hour)	200	350		650		650	
Front End Loader[1]	950	966C		988B		D7	
Capital Costs[2]							
Loader	$120,000	$145,000	$120,000	$315,000	$315,000	$650,000	$650,000
Stockpile Site	50,000	50,000	50,000	50,000	50,000	-	-
Rail Trackage	165,000	165,000	295,000	165,000	295,000	165,000	295,000
Track Scale	100,000	100,000	100,000	100,000	100,000	75,000	100,000
TOTAL	$435,000	$460,000	$565,000	$630,000	$760,000	$890,000	$1,045,000
Cost Per Ton[3]	0.15	0.16	0.20	0.22	0.27	0.31	0.37
Annual Operating Costs[4]							
Loader/Dozer	42,000	40,000	80,000	87,000	87,000	50,000[5]	50,000[5]
Loader/Dozer Operator	63,000	40,000	80,000	40,000	40,000	40,000	40,000
Foreman/Scale Operator	70,000	45,000	90,000	45,000	45,000	45,000	45,000
TOTAL	175,000	125,000	250,000	172,000	172,000	135,000	135,000
Cost Per Ton	0.38	0.27	0.54	0.37	0.37	0.29	0.29
Total Cost Per Ton	$0.53	$0.43	$0.74	$0.59	$0.64	$0.60	$0.64

NOTES:
(1) Caterpillar tractor model numbers.

(2) All cost figures in 1979 last quarter Canadian Dollars.

(3) Amortized over 15 years at a 14% interest rate.

(4) Operating costs assume minimum hours of 1 shift (8 hours) per day, 330 days per year. 16 hour load time requires additional shift for each cycle.

(5) Includes operating and maintenance of loading system at 2% of capital cost.

5.0 RAILWAY OPERATING COSTS

Railway operating unit costs used in this analysis were derived from data published by Statistics Canada using the methodology described in this section of the report. These unit costs were then applied to the basic unit train operating schemes described in Section 3.0. The unit or solid train system was selected for costing over the system utilizing blocks of cars in existing trains as it will be more representative of the costs incurred regardless of the system used.

Each of the following major expense categories; Road Maintenance, Equipment Maintenance and Transportation, has an associated indirectly variable overhead cost. The overhead expenses include supervision, injuries to persons, maintenance of non-operating plant and other miscellaneous expenses directly related to the expense category but not to the operating unit. These costs are allocated on the basis of percentage markup.

It should be noted that none of the overheads nor any of the following variable operating costs include depreciation. Recovery of investment in equipment is allowed for in the amortized capital costs while that for plant is allowed for in plant ownership.

The basic road maintenance cost was derived from Statistics Canada data and includes an allowance for work equipment maintenance. The major accounts include track and roadway maintenance expense associated with repairing or renewing small sections of the basic plant. Major replacement or renewal is a capital expense and as such is allowed for in the plant ownership costs.

Once the basic road maintenance costs were derived they were increased to allow for the effects of greater than average curvature and gradients. They were not increased to allow for heavier than average carloads as the 80 ton net loads are not that different from the average loads of other traffic on the system.

Equipment supply costs include ownership costs for locomotives, cars and cabooses. Locomotive costs were based on a current supply cost of some $700,000 for a basic 2300 HP four axle engine weighing 250,000 lbs. Heavier 3000 HP engines were not considered because of their adverse impact on the light trackage on the Princeton Subdivision. It was assumed these engines would be available from the existing locomotive pool in Vancouver and would be returned to it for use elsewhere on arrival at Port Coquitlam. Basic pool locomotive availability was taken as 6000 hours per year. Using the purchase price, a 12% cost of money and a 15 year economic life, an hourly ownership cost was derived.

Car supply costs were based on supply of new 80 ton gondola cars at $37,000 each. As it was assumed these cars would be in dedicated service the annual ownership cost was then computed based on a 20 year economic life and a 12% cost of money.

It is recognized that these cars are less expensive than standard 80 ton triple cross hopper bottom dump cars, which have a current replacement value of some $43,000. However the cost of new gondolas was considered more applicable because the bottom dump feature is not required as Pacific Coast Bulk Terminals rotary dump the cars. Also the existing fleet of CPR triple cross hoppers only has sufficient cubic capacity to handle some 70 tons of coal per load at an average density of 50 pounds per cubic foot. If required, new 80 ton solid bottom gondola cars can be either purchased or leased by the shipper.

Caboose supply costs were included as an hourly charge based on a replacement cost of $80,000 each and a 20 year life and 12% cost of money.

Locomotive maintenance costs were derived from Statistics Canada data and were included on a locomotive unit mile basis. Car maintenance costs, on a car mile basis, were based on current leased car maintenance prices for equipment in unit train coal service. Caboose maintenance costs were assumed to be the same.

Fuel costs were calculated using an estimated current cost of fuel of $0.61 per gallon including overhead. Fuel consumption was calculated by the consultant's Railway Operations/Cost Model.(1)

Crew wages were computed for each of the basic systems described in Section 3.0, i.e. basic crew North Bend to Coalmont with crew stopover at Princeton and basic crew plus extra engineman North Bend to Coalmont and return. The basic pay rates assumed for the crews were 53.1¢ per mile for enginemen, 48.61¢ per mile for conductors and 42.98¢ per mile for trainmen. These basic units were then adjusted for extra units, terminal time, overtime and an allowance for vacation, sick time and holiday pay.

Train and enginehouse expenses, which include train locomotive supplies not included under locomotive maintenance and other locomotive associated expenses, were computed on a locomotive unit mile basis from Statistics Canada data.

Other train expenses and dispatching expenses, also computed from Statistics Canada data, were included on the basis of train miles generated.

(1) See Report on Railroad Access to the Peace River Coal Fields prepared by Swan Wooster Engineering in March 1977.

Switching expenses include a portion of all yard expenses as well as yard crew wages and associated locomotive operating expenses. Switching is required in the yard at Port Coquitlam to allow for car servicing as well as for transferring the cars from Port Coquitlam to Pacific Coast Bulk Terminals and back.

The other railway operating expenses included in this analysis are percentage markups to allow for traffic and general expenses, fixed overhead and plant ownership. All of these are allocated on the basis of dollar values of business, i.e. percent markup. Traffic and general expenses include the overall railway administration expenses, i.e. headquarters, staff, traffic solicitation, pensions, etc. Fixed overhead expenses (the costs designated as non-variable) must, however, be recovered from traffic handled and include fixed maintenance-of-way expenses, allowances for taxes, etc. The other category, plant ownership costs, is included as a markup on costs and is intended to cover profits, return on investment and recovery of capital invested in fixed plant.

The percentage markup for Traffic and General expenses was calculated by taking the 10 year average of the results of dividing the report expenditures in those categories by the total rail expenses excluding traffic and general, tax provision, depreciation and fixed overhead.

The fixed overhead allocation percent was derived also from a ten year average of a figure calculated by totalling the non-variable fixed overheads and dividing by the total rail expenses excluding fixed overhead and depreciation. The fixed overhead costs include maintenance of fences, snow-sheds, and signs, dismantling retired property, removing snow, ice and sand, crossing protection, drawbridge operations, other railway taxes and the 36% fixed portion of track structure and road maintenance expenses.

Plant ownership markups were estimated by taking the ten year average of the results obtained from dividing total rail revenues minus total rail expenses (excluding depreciation) by total rail expenses (excluding depreciation).

The basic unit costs derived for this analysis are summarized in Figure 5-1.

FIGURE 5-1

ESTIMATED UNIT COSTS FOR COAL TRAINS
CP RAIL - COALMONT TO PORT MOODY, B.C., 1978

Cost Classification	Output Unit	Directly Variable	Indirectly Variable	Total
Track Structure and Road Maintenance	Thousand Gross Ton Miles	56.0¢	11.8¢	67.8¢
Rolling Stock:				
.Locomotive Supply	Loco.Unit Hour	$17.13	NA	$17.13
.Locomotive Maintenance	Loco.Unit Mile	$ 0.86	$ 0.15	$ 1.01
.Coal Car Supply	Per Year			$ 4,954
.Coal Car Maintenance	Per Car Mile	3.1¢	0.5¢	3.6¢
.Caboose Supply	Caboose Hour	$ 1.79	-	$ 1.79
.Caboose Maintenance	Caboose Mile	3.1¢	0.5¢	3.6¢
Transportation:	Per Cycle			
Crew Cost	(16 hr. load)	$1,988 (1)	$ 356	$2,344
	(8 hr. load)	$2,120 (2)	$ 382	$2,502
	(4 hr. load)	$2,041 (3)	$ 367	$2,408
Fuel	Per Gallon	50.0¢	11.0¢	61.0¢
Train, Locomotive and Enginehouse Supplies	Loco.Unit Mile	23.5¢	5.2¢	28.7¢
Other Train Expenses	Train Mile	$ 0.88	$ 0.19	$ 1.07
Dispatching	Train Mile	43.3¢	9.5¢	52.8¢
Switching	Switch Engine Mile	$ 8.25	$ 1.82	$10.07
% Allocations:				
Traffic and General	Of Sub-Total	-	16.8%	-
Fixed Overhead	Of Sub-Total	-	9.0%	-
Plant Ownership	Of Sub-Total	-	18.2%	-

Note: All costs in 1978 fourth-quarter Canadian dollars.
(1) 16 hour loading time and crew stay over at Princeton.
(2) 4 hour loading time.
(3) 8 hour loading time.

6.0 CONCLUSIONS

Figure 6-1 shows the railway operating costs in dollars per ton for each of the four trainload operating systems considered. These costs show that the large train size, 70-eighty ton cars, loading every four days, was the least cost alternative at $5.67 per ton assuming an 8 hour loading time.

When the loading costs calculated in Section 4.0 of this report are added to the estimated train costs, the ranking does not change. The 70 car train is still the least cost at $6.31 when combined with the least cost loading system.

Therefore the most economic system combines either of the loading systems designed as Schemes C and D with the 70 car train operating on a 4 day (96 hour cycle). The loading systems are either a large front end loader loading cars from a stockpile or the overhead conveyor semi-automated system shown on Figure 4-1. The latter system would be the best alternative because it is the most efficient in terms of reliability and thereby minimizing costly delays in the railway system.

It should be noted that the $5.67 shown here as railway cost represents what is felt to be a fair, all-in tariff for coal transport from Tulameen to Pacific Coast Bulk Terminals, excluding any loading charges.

FIGURE 6-1 RAILWAY OPERATING COSTS

Item	Operating Data				
Train Size:					
Cars	39	34	31	70	70
Locomotives	4	3	3	6	6
Loading Time (hours)	16	8	4	8	16
Cycle Time (hours)	54	46	42	96	96
	Operating Cost ($ Per Ton)				
Track Structure and Road Maintenance	0.46	0.43	0.44	0.44	0.44
Locomotive Supply	0.88	0.60	0.58	0.59	0.73
Locomotive Maintenance	0.67	0.58	0.64	0.56	0.56
Car Supply	0.42	0.36	0.33	0.75	0.75
Car Maintenance	0.23	0.23	0.23	0.23	0.23
Caboose Supply	0.02	0.02	0.02	0.02	0.02
Caboose Maintenance	0.01	0.01	0.01	0.01	0.01
Crew	0.75	0.92	0.97	0.45	0.42
Fuel	0.47	0.47	0.47	0.47	0.47
Train and Enginehouse Supplies	0.19	0.16	0.18	0.16	0.16
Other Train	0.18	0.20	0.22	0.10	0.10
Dispatching	0.09	0.10	0.11	0.06	0.06
Switching	0.09	0.10	0.11	0.10	0.10
Sub-Total	4.46	4.18	4.31	3.94	4.05
Traffic and General	0.75	0.70	0.72	0.66	0.68
Fixed Overhead	0.40	0.38	0.39	0.35	0.36
Plant Ownership	0.81	0.76	0.78	0.72	0.74
TOTAL	$6.42	$6.02	$6.20	$5.67	$5.83

Note: Based on 80 tons per car.