Proceedings of the 4th Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1980.
The Technical and Research Committee on Reclamation

ENVIRONMENTAL AND ENGINEERING CONSIDERATIONS FOR WASTE DUMP DESIGNS AT THE FORDING RIVER OPERATION

by

Dermot P. Lane
Reclamation Officer
Fording Coal Limited

Proceedings of the 4th Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1980.
The Technical and Research Committee on Reclamation

ENVIRONMENTAL AND ENGINEERING CONSIDERATIONS FOR WASTE DUMP DESIGNS AT THE FORDING RIVER OPERATION

INTRODUCTION

Fording Coal Limited operates the Fording River coal mine located in southeastern British Columbia. The minesite, as shown on Figure 1, is within the medial range of the southern Canadian Rocky Mountains approximately 84 miles (136 km) north of the United States international border and 6 to 11 miles (9.8 to 17.5 km) west of the British Columbia/Alberta provincial border.

The Fording River Operations produce an average of three million tons of cleaned metallurgical coal per annum, primarily for export to Japan. Mining operations commenced in 1972 and are carried out on a basis of three eight-hour shifts, seven days per week. The operations employ both truck/shovel and dragline mining techniques in multiple seam pits. Shovels are in the 12 cubic metre range with trucks in the 120-ton to 170-ton size. The dragline is in the 60 cubic metre range. Total material moved annually is approximately 20 million bank cubic metres of waste and 4 million tons of raw coal.

DESCRIPTION OF MINE AREA

Fording's operation lies within the continental temperate climatic zone. Annual precipitation averages 85 cm, of which half occurs during the growing season. Temperature extremes range from -40°C in winter, to +35°C in summer. Table 1 gives the average climatic data recorded at the Fording River minesite from 1973 to 1977.

The area is described as the Englemann spruce - subalpine fir zone, with mining operations occurring from 1600 to 2500 metres above sea level. Vegetation cover on the valley bottom and lower slopes is

Figure 1

FORDING RIVER MINESITE LOCATION MAP

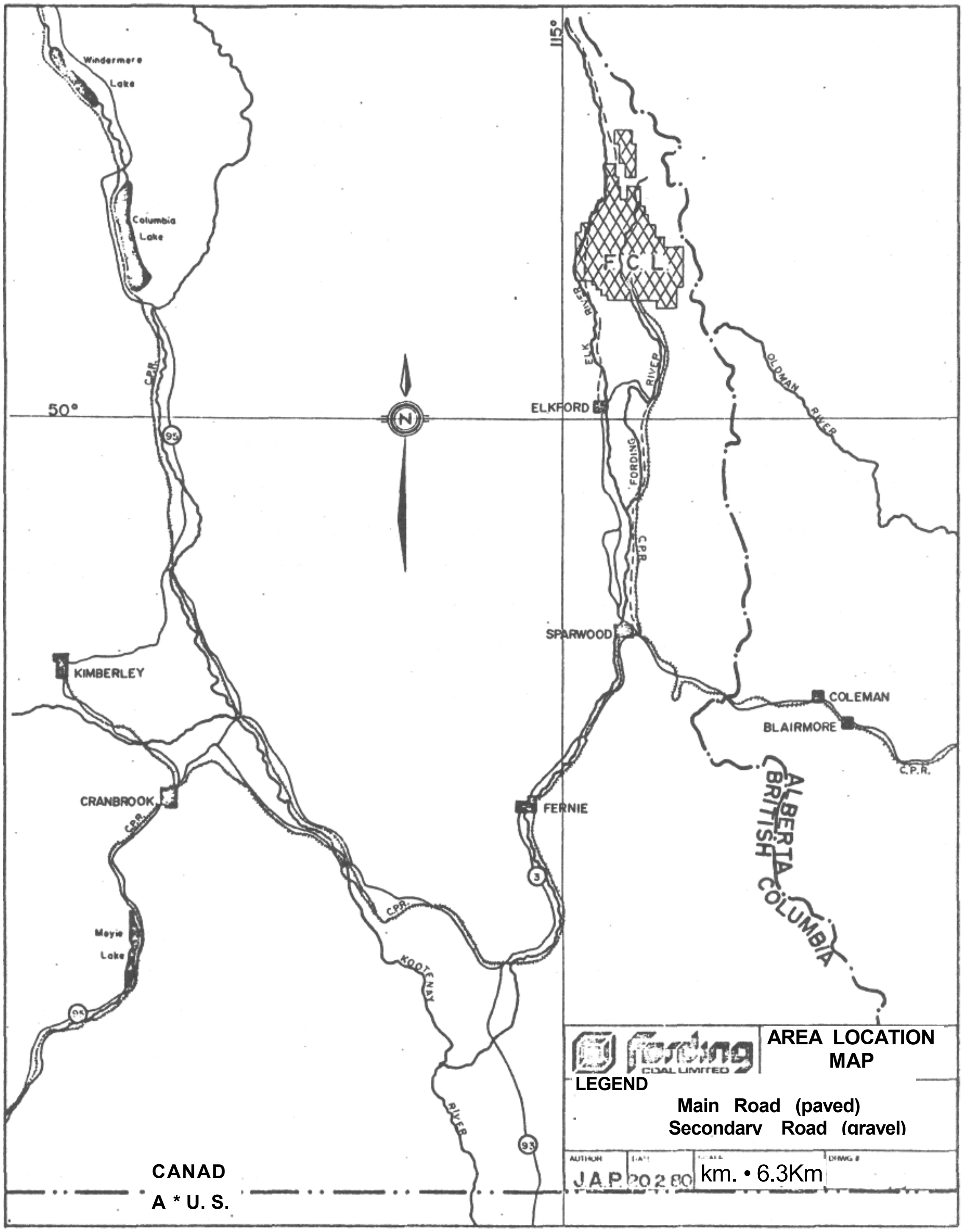


Table 1

FORDING RIVER MINESITE - AVERAGE CLIMATIC DATA, 1973 TO 1977

Mean Annual Temperature	14^{0}C
Mean Monthly Temperature	
January	-8.O^{0}C
July	13.4^{0}C
Months Above 1O^{0}C*	3
Months Below O^{0}C*	6
Months Above 4^{0}C*	5
Frost Free Days	30 to 40
Annual Precipitation	737 mm
Annual Snowfall	386 cm
Wettest Season	Winter
Driest Season	Summer

*Based on 1973, 1974 and 1975 data.

mainly forest, in which the dominant coniferous species are Englemann spruce, lodgepole pine, and minor amounts of subalpine fir and Douglas fir.

Occasionally stands of alpine larch occur on north slopes at elevations of 1800 metres or greater, and stands of whitebark pine mixed with grass-shrub communities occur on south and west aspects.

The Canada Land Inventory has classified the Upper Fording River area into its major resource capabilities. The river valley and lower mountain slopes have been classed as moderate big game range and moderate yield forest. As moderate big game range, this area has some limitations for the production of ungulates, but is important for year round or seasonal use. Moderate yield forest has a productivity that ranges from 3.6 m^3/ha/yr to 4.9 m^3/ha/yr, making it desirable for harvesting, especially in valley bottoms. This area is also valuable for recreation pursuits such as hunting, fishing and hiking.

The mid-slope to mountain peak area has been classed as moderate big game range, prime big game range, limited yield forest and highland. The prime big game range occurs on the southerly slopes of Eagle, Castle and Turnbull mountains. The limited yield forest has a productivity ranging from 2.2 to 3.5 m^3/ha/yr, making it undesirable for harvesting. The highland class is high elevation land with capabilities for both big game range and extensive recreation such as hiking and riding, mountain climbing, wildlife viewing and hunting.

GEOLOGY AND MINE LAYOUT

Metallurgical and thermal coal seams occur in the lower 600 metres of the 1300 metre Kootenay formation on both sides of the Fording River valley. Figures 2 and 3 show the existing mine layout and geological sections, respectively. The major structural features are two sub-parallel synclines; one on each side of the valley running north-south, and a regional fault along the west side of the Fording River.

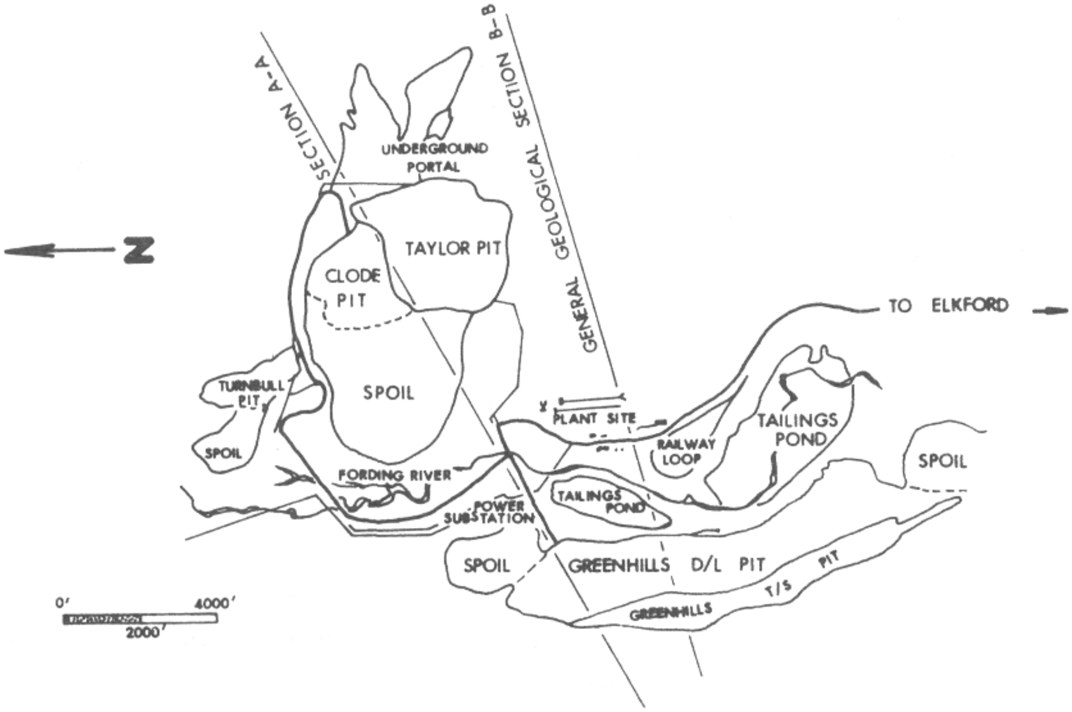


FIGURE 2 FORDING RIVER OPERATIONS SURFACE PLAN

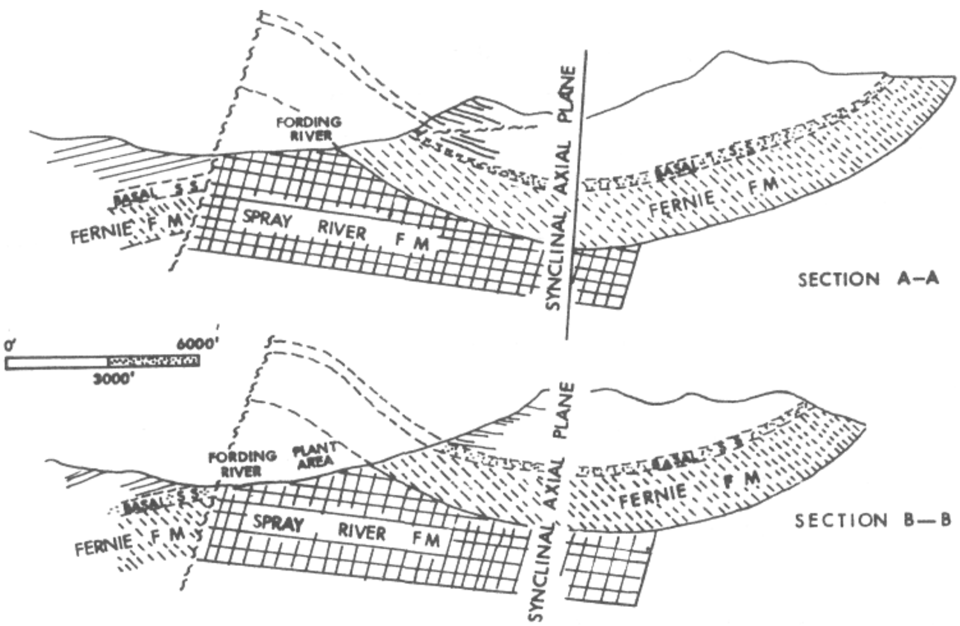


FIGURE 3 GENERAL GEOLOGICAL COAL SECTION

Truck-shovel operations exist on the eastern side of the valley. Drag-line mining with truck-shovel prestrip exists on the western side. Both operations create massive quantities of waste which will require extensive site preparation for reclamation purposes. Mining operations also intercept numerous secondary drainage patterns leading to the Fording River.

WASTE DUMP DESIGN - GENERAL CONSIDERATIONS

Multi-seam coal mining in mountainous terrain creates more waste volume per unit of surface area than single seam operations. The narrow and steep Fording River valley and the lateral and vertical extent of the coal formations in the area, both create problems in fitting large spoil volumes into the available non-resource areas. These two factors make spoil dump designs one of the more critical components of mine planning.

The major factors that must be considered in waste dump design are: location and extent of coal reserves in the dump area, volume of spoil to be accommodated, haulage distances, stability of spoil, hydrology and drainage of the dump area, proximity to the Fording River flood plain, and the resloping requirements to permit adequate reclamation.

All economic open pit coal reserves must be recovered prior to coverage by waste material, and spoil volume must be maximized because of the limited surface area available for waste dumps at the Fording River operations. Haul distances must be optimized with consideration being given to both the vertical and horizontal components of the route.

Stability of the spoil must be assured by giving consideration to both the surface materials on the natural topography and the spoil material itself. The spoil area hydrology must be investigated to ensure that spoil stability is not adversely affected by subsurface or surface drainage. Drainage systems must be established above, below and through the spoil to ensure that water quality can be maintained at an acceptable level. All waste dumps at the minesite are planned above the 1,000-year flood level and away from the "meander belt" of the Fording River. And, finally, adequate room must be left at the base of the spoil to ensure that it can be resloped to 26°.

CASE STUDY - "C" SPOIL EXPANSION IN THE SOUTH GREENHILLS

Fording Coal proposes to extend the "C" spoil waste dump located at the southern end of the Greenhills mining zone (Figure 4). This waste dump is being expanded to accommodate future spoiling from the Greenhills Truck/Shovel 1 and 2 pits.

The proposed spoil area is located on the west side of the Fording River valley on a moderate to gently sloping east facing slope. Most of the area has been disturbed by logging activities in the past. The remaining forested section consists of over-mature Englemann spruce mixed with subalpine fir and lodgepole pine. Swift Creek, a major drainage basin, will be affected by the spoil as well as a number of ephemeral streams on the east facing slope (Figure 5).

GREENHILLS SPOILING - GENERAL INFORMATION

The truck/shovel dumps in the Greenhills area have been developed on gently sloping ground above the west side of the Fording River. The maximum slope on the natural ground surface within the spoil foundation area is approximately 17°. With the exception of peat-filled areas, the foundation material is glacial till mantled by a thin veneer of topsoil. The till is dense and relatively incompressible and exhibits high shear strength making it capable of providing adequate foundation support for waste dumps. Peat and organic soil deposits occur in isolated depressions in the upper surface of the glacial till. Thickness of these deposits can extend to a depth of 6 metres.

Figure 4
"C" SPOIL WASTE DUMP - GREENHILLS MINING ZONE

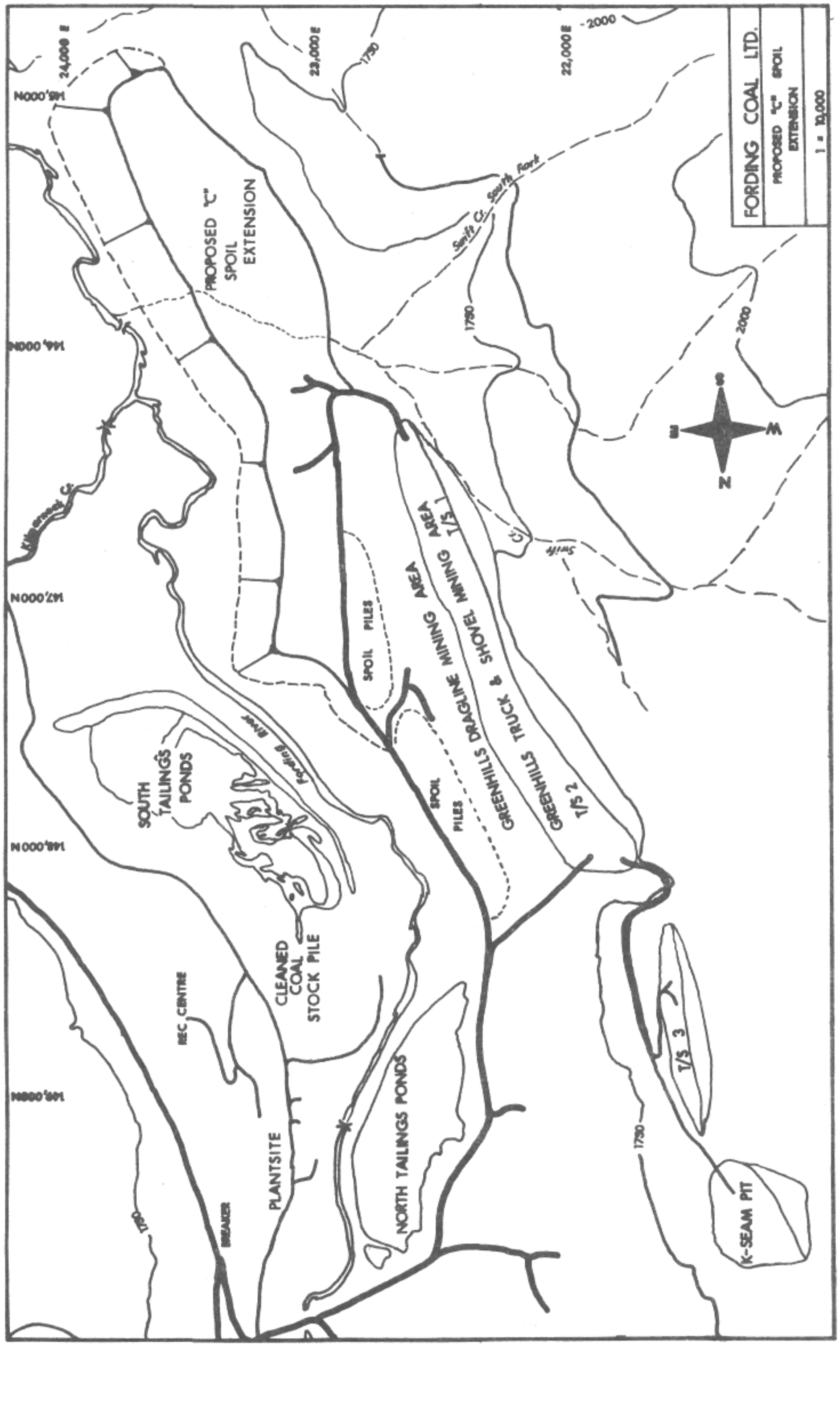
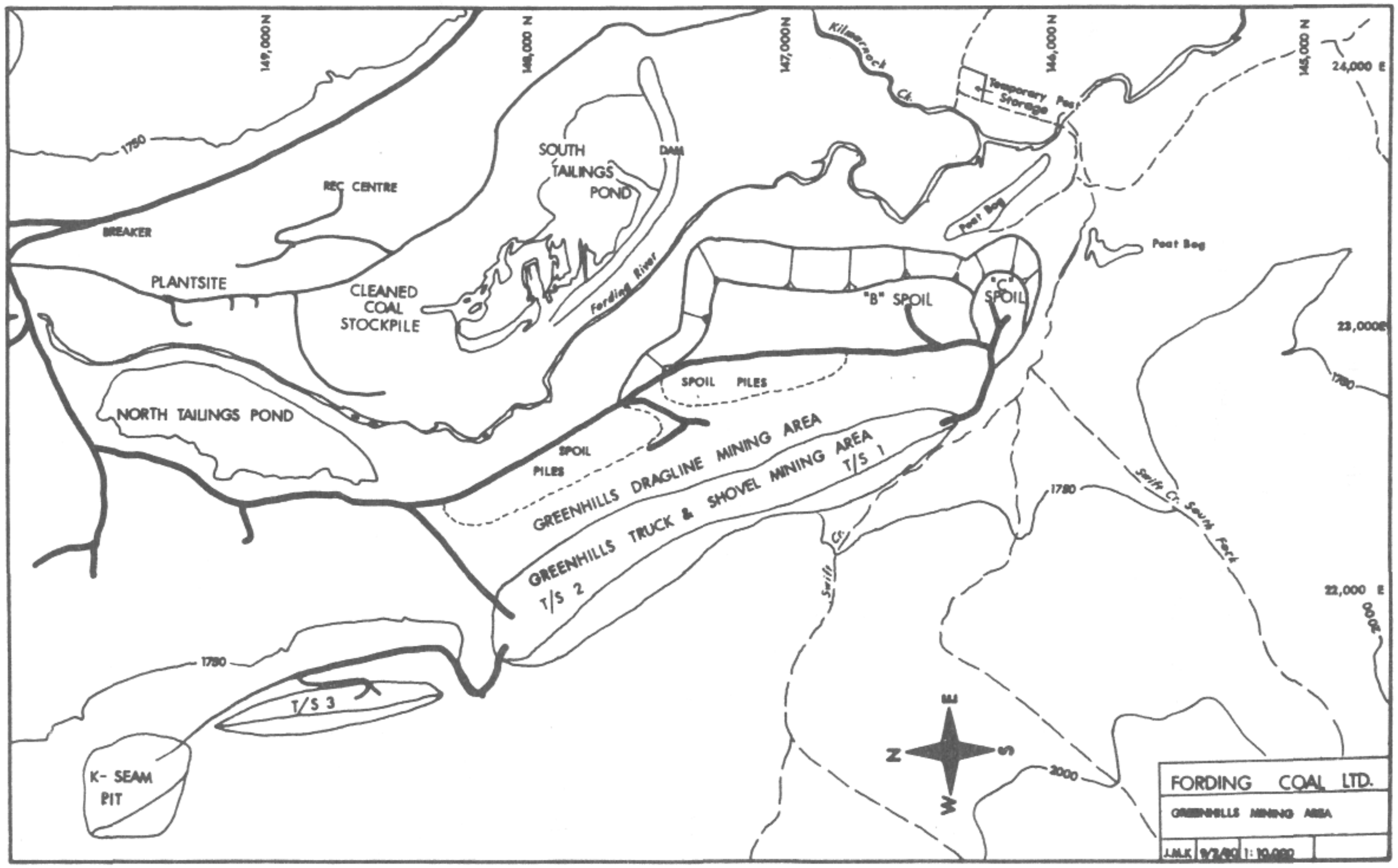


Figure 5

LOCATION OF SWIFT CREEK IN THE GREENHILLS MINING ZONE



Stability of the Greenhills waste dumps is governed by the shearing resistance of the near surface foundation soils on which the dump is constructed, the shear strength of the materials comprising the dump itself, and by water pressures within the spoil pile. Observations at older spoil areas along the Greenhills dragline waste piles show that when the toe of a waste dump advances onto peat deposits, the organic soils undergo large horizontal displacements resulting in failure and slumping at the toe. To guard against further failures, the organic deposits have been encircled by the dump or have been removed. This prevents the organic deposit from spreading beyond its boundaries, because the waste rock zone around its perimeter serves as a confining dyke for the material placed over it.

Disposal of waste material over the advancing face of the waste pile will produce segregation of the waste rock. The largest and most durable fragments of waste rock come to rest at the base of the spoil. This coarse rock zone at the base of the spoil will preclude the development of pore pressures within the spoil pile.

"C" SPOIL WASTE DUMP DESIGN

The proposed waste dump extension will cover an area of approximately 80 hectares and accommodate a spoil volume of approximately 40,500,000 cubic metres. No mineable coal reserves occur in the spoil area as it lies stratigraphically below the basal sandstone of the coal bearing sequence.

The remaining forest cover and any surficial materials which affect the stability of the dump will be removed from the spoil area prior to construction. Two deposits containing peat have been identified and are presently being removed (Figure 5). The largest of these peat deposits is located near the outside edge of the spoil in the vicinity of the Fording River where the occurrence of a spoil failure could have severe effects on the river. This deposit contained 90000 LCY of peat. The other, much smaller deposit, is located adjacent to Swift Creek where a spoil failure could have long-term effects on the water quality of the stream.

In the initial development of the spoil, a ramp will be constructed across the Swift Creek drainage basin to access the spoil area south of the creek (Figure 6). In the final stages of development, the spoil will completely cover the lower portion of the Swift Creek channel immediately above its outlet to the Fording River.

DRAINAGE

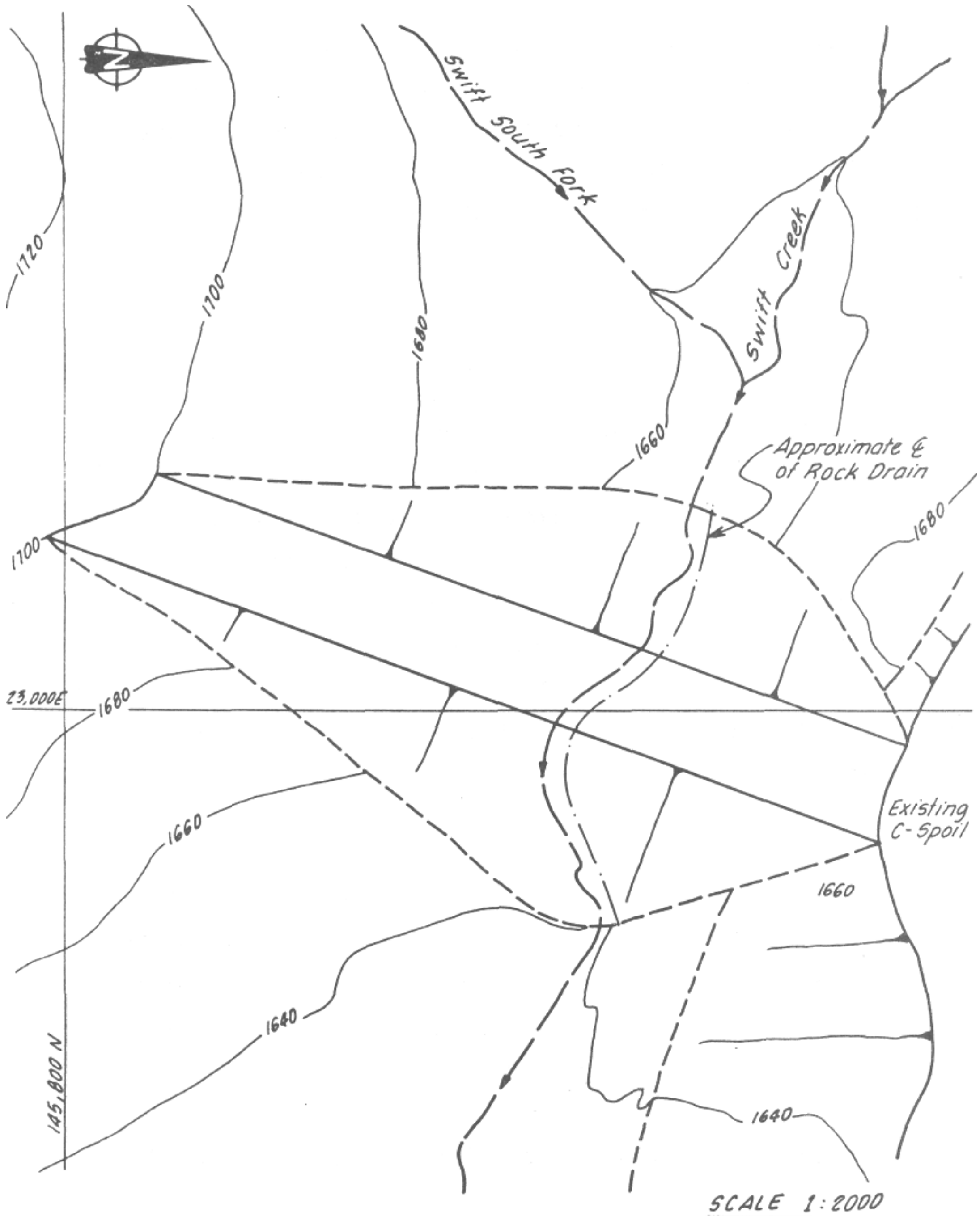
There are three alternatives being considered to deal with the Swift Creek drainage. The first, is to divert the entire flow of Swift Creek around the spoil area and discharge it into the next drainage system to the south. Diversion ditches have been used extensively at the Fording River minesite, and experience has shown that these structures are costly to construct and maintain. Diversion ditches represent only a short-term solution to the drainage problem due to the regular maintenance requirement and because, historically, they have been a problem with regard to water quality.

The second alternative is to construct a coarse rock drain through the spoil along the original Swift Creek drainage course. The advantages of a rock drain over a diversion ditch are that the drain is virtually maintenance free and it represents a final long-term solution to the drainage problem. However, the effectiveness of rock drains through spoil dumps has yet to be tested in B.C.

The third alternative is to place a large culvert through the spoil to allow Swift Creek to flow through.

To determine the best alternative, a study is being undertaken to assess the hydrology and stability of a rock drain through the proposed

PLAN SHOWING PROPOSED SWIFT CREEK CROSSOVER **Figure 6**



ramp over the Swift Creek channel. A preliminary design for the rock drain structure is shown in Figure 7. The rock drain will be constructed using sandstone rocks of the 0.6 to 1.0 metre size. The topsoil will be stripped frotn the area covered by the rock drain. A base pad of 8 inches (0.2 metre) thickness minus rock material will be constructed under the rock drain to prevent scouring of the natural ground below the drain structure. When the rock drain structure has been constructed, the spoil will be advanced southward to form the cross-over rarnp.

The rock drain and existing creek channel will be situated parallel to each other along the bottom of the creek basin, to test whether or not an adequate rock drain is produced by end dumping material from the crest of an advancing spoil. If the hydraulic conductivity of the normal spoil base is insufficient to handle the water flow, the excess flow will go through the rock drain. Monitoring stations will be set up at both ends of both the rock drain and the natural water channel to determine the water flows through each structure.

CuIverting has been dismissed as a solution to drainage through the spoil due to maintenance problems, the high risk of structural failure, and the preparation requirements in the drainage location.

Considerable time and money will be saved if it can be demonstrated that rock drains are effective in channeling drainage through a waste dump. Further studies are needed to examine alternative methods of constructing rock drains. Such studies would be particularly applicable for the Swift Creek drainage where it will be possible to simultaneously spoil-over the creek channel from both sides. This will result in not only a rock drain over the original channel but also a coarse rock core up through the spoil itself (Figure 8), thereby further reducing a possible blockage of water flow which could impair waste dump stability.

FIGURE 7

PRELIMINARY DESIGN FOR THE ROCK DRAIN STRUCTURE

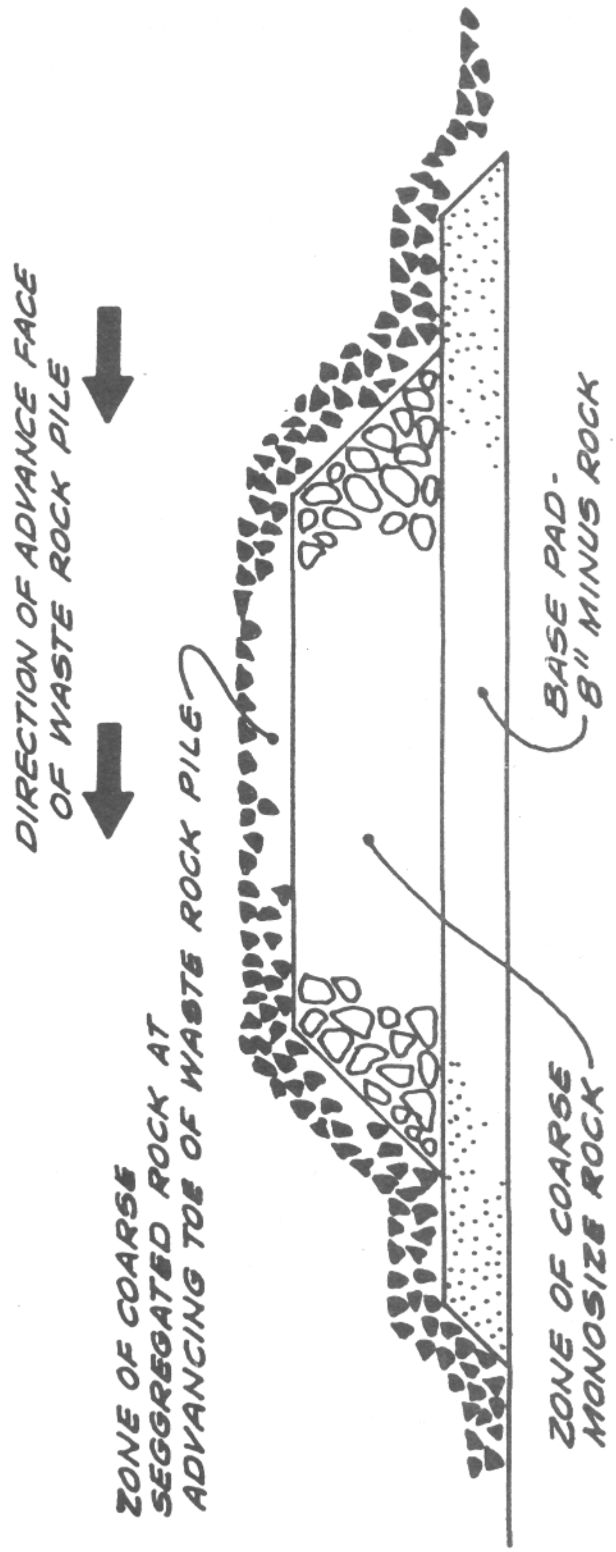
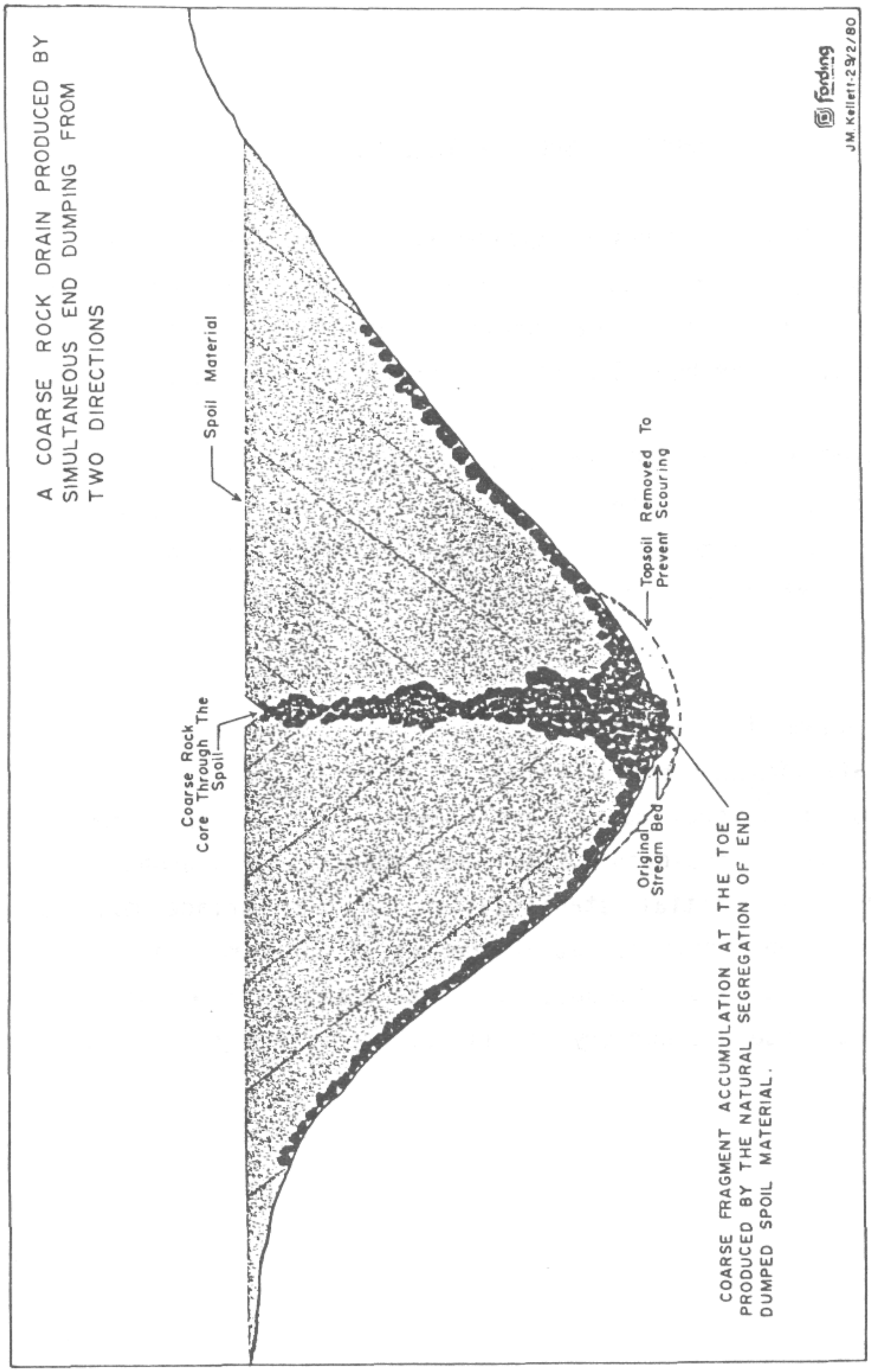


FIGURE 8


A COARSE ROCK DRAIN PRODUCED BY SIMULTANEOUS END DUMPING FROM TWO DIRECTIONS
Spoil Material
Coarse Rock Core Through The Spoil
Topsoil Removed To Prevent Scouring
Original Stream Bed
COARSE FRAGMENT ACCUMULATION AT THE TOE PRODUCED BY THE NATURAL SEGREGATION OF END DUMPED SPOIL MATERIAL.
Fording
J.M. Kellett: 29/2/80

Drainage through rock drains in the spoil is expected to yield better water quality than that presently obtained in the existing diversion ditches.

RECLAMATION OF PROPOSED SPOIL EXTENSION

The Canada Land Inventory System has classed the proposed spoil area as moderate yield forest. The area is not an important wildlife habitat as it is used only occasionally by elk, moose and black bear. Area activities have been limited to logging and some exploration.

The reclaimed toe of the proposed spoil will be well above the 1,000-year flood level of the Fording River. A buffer zone of adequate width will be left between the toe of the spoil and the Fording River so that any runoff generated from the spoil face will not contaminate the river.

The reclamation objective for this waste dump will be to re-establish moderate yield forest, although southfacing slopes will be reclaimed to provide additional summer and winter range for ungulates. The spoil face will be resloped to 26° and seeded with agronomic grasses and legumes for initial stabilization of the surface material. After initial stabilization, native species of coniferous and deciduous trees and shrubs will be introduced. These native species will be propagated in greenhouse and nursery facilities from locally collected materials.

COMBINED DISCUSSION RELATED TO R. BERDUSCO, C. PELLETIER AND D. LANE'S PAPERS

Paul Christie - Talisman Land Resource Consultants: I'd like to ask Mr. Lane what you're doing with peat material?

D. Lane - Answer: In our present program for removing peat material, we have tried, where possible, to separate the surface foot and the bottom foot of the peat. The surface material tends to get soil and live vegetable matter mixed in with it. It has been stored on one stockpile, and the good peat of commercial value has been separately stockpiled. Some of the peat may be kept for reclamation purposes, but I think that if we can sell it, we will. Peat is not a good surface dressing because it tends to blow away when it gets dry. It's a rather expensive process to mix peat with till, sand, or some other medium. At the present time we try to salvage the good material.

Questioner Unidentified: I'd like to ask about moving that material at (?) Mile Creek. Uo you have any ballpark cost figure?

R. Berdusco - Answer: The question perhaps relates to the cost of moving four hundred thousand yards last summer and, unfortunately I don't have a specific cost. We used three D9 dozers for the better part of four and one half months to move the equivalent of ten thousand gross TOH. At current operating costs, that's around one million dollars.

MeI Cochrane - Ministry of Lands, Parks and Housing: I have a question for Mr. Pelletier. Can you give an idea of what might be done with the pit at Island Copper. Can you expand Driefly on your beach improvement studies?

C. Pelletier - Answer: An answer to your first question, we've had discussions with various government departments, and I think the tentative plan is to open up a channel and grade a deep submarine basin, which would be the pit. For your second question on the dump area, the major impact on Grouper Inlet has to be the taking of the shoreline out of biological production. If we leave the dump the way it is, it's unstable because there's a fourteen-foot tide plus wind action hitting against it as well as continued slumping and undercutting. You need a relatively stable environment for the flora and fauna to grow on. That's why we developed our research plot, which is about 200 to 250 feet wide. We're working from the south tidal area to the top of the high tide mark by setting up a grid system and monitoring the floral and faunal colonization of the area. Successional development of the fauna is also being watched, to find out which group starts first and how it develops. It's basically an opportunistic research project because that part of the dump is going to be buried in a year or two.