Proceedings of the 2nd Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1978.
The Technical and Research Committee on Reclamation

FORDING RIVER DIVERSION

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INTRODUCTION

The Fording Coal limited minesite and processing facilities began production in 1972. By late 1976 it was estimated that approximately 1.5 years storage capacity remained in the existing tailing pond. Fording Coal therefore initiated a development program to construct a new tailing pond, tails disposal line, and clarified water return system downstream from the existing coal processing complex. The deadline for having these facilities operational was the Fall of 1978.

SELECTION OF SITE

The Fording Coal minesite is situated in the southeast corner of British Columbia, approximately 18 miles north of Elkford. The coal process and maintenance complex is located on the east bank of the Fording River at about El. 5400.

The existing open-pit mine operation extending on both sides of the Fording River presently covers an area of about 1250 acres. Exploration work is ongoing in other nearby areas totalling about 1000 acres.

The Fording River Valley and tributary areas have extensive populations of wildlife, and the Fording River has abundant stocks of cutthroat trout. Since the mines opened in 1972, improved access to many areas of the river have resulted in increased hunting and sport fishing. Thus, any construction activity proposed for the valley must consider the wildlife and recreational aspects of the area.

Some of the considerations in choosing the site for the new tailing pond have been summarized below:

(1) proximity to the coal process facilities for conveyance of tailings and return of the clarified water, (Due to the large quantities of water used in the coal process, all water is reclaimed from the tailing pond.)

(2) favourable topography to minimize the construction of dikes for the impoundment of tailings,

(3) proximity to the railway for future reclaim of the tailings as either thermal coal or possibly for the extraction of aluminum, minimum disturbance to the environment.

The site immediately downstream of the process facilities was ideal for the tailing pond as the area only required one major dike to be constructed at the south end of the pond. A low dike was also required on the west side of the pond and the other two sides were formed by the natural topography of the valley. However this site necessitated diverting the Fording River for approximately 4000 feet.

Five other tailing disposal options were also investigated but were not economically feasible due to limited storage life, or because the construction of the dikes required extensive quantities of imported material. The fill required for the impervious zone of the dikes was located in relatively thin layers in isolated locations along the west bank of the Fording River. Any major earth quantities obtained from borrow would require large areas of land to be stripped and reclaimed at a later date.

The site immediately downstream of the mine was finally chosen and an extensive geotechnical program indicated the proposed river diversion would produce approximately 80 percent of the fill materials required for the dikes. The balance of the material which consisted primarily of pervious (gravel) borrow could be obtained from the basin of the tailing pond. Other than the area required for the tailing pond and the river diversion, no other land would be disrupted.

RIVER DIVERSION - DROP STRUCTURES

The slope of the Fording River averages about one percent for a distance of approximately four miles through the mine area. In some sections, the river has natural grades of two to three percent for short distances. The portion of the river cutoff by the diversion generally was around 0.8 to 1.2 percent slope. This latter section of the river also had three or four large natural pools which were rearing and holding areas for cutthroat trout as well as good "fishing holes" for the angler.

Because the diversion was shorter than the portion of the river bypassed, nine drop structures were required to maintain the average slope of 1 percent. The criteria for design of the drop structures was basically as follows: the drop structures must not pose a barrier to migrating trout at any flow and maintenance must be minimized, or preferably eliminated.

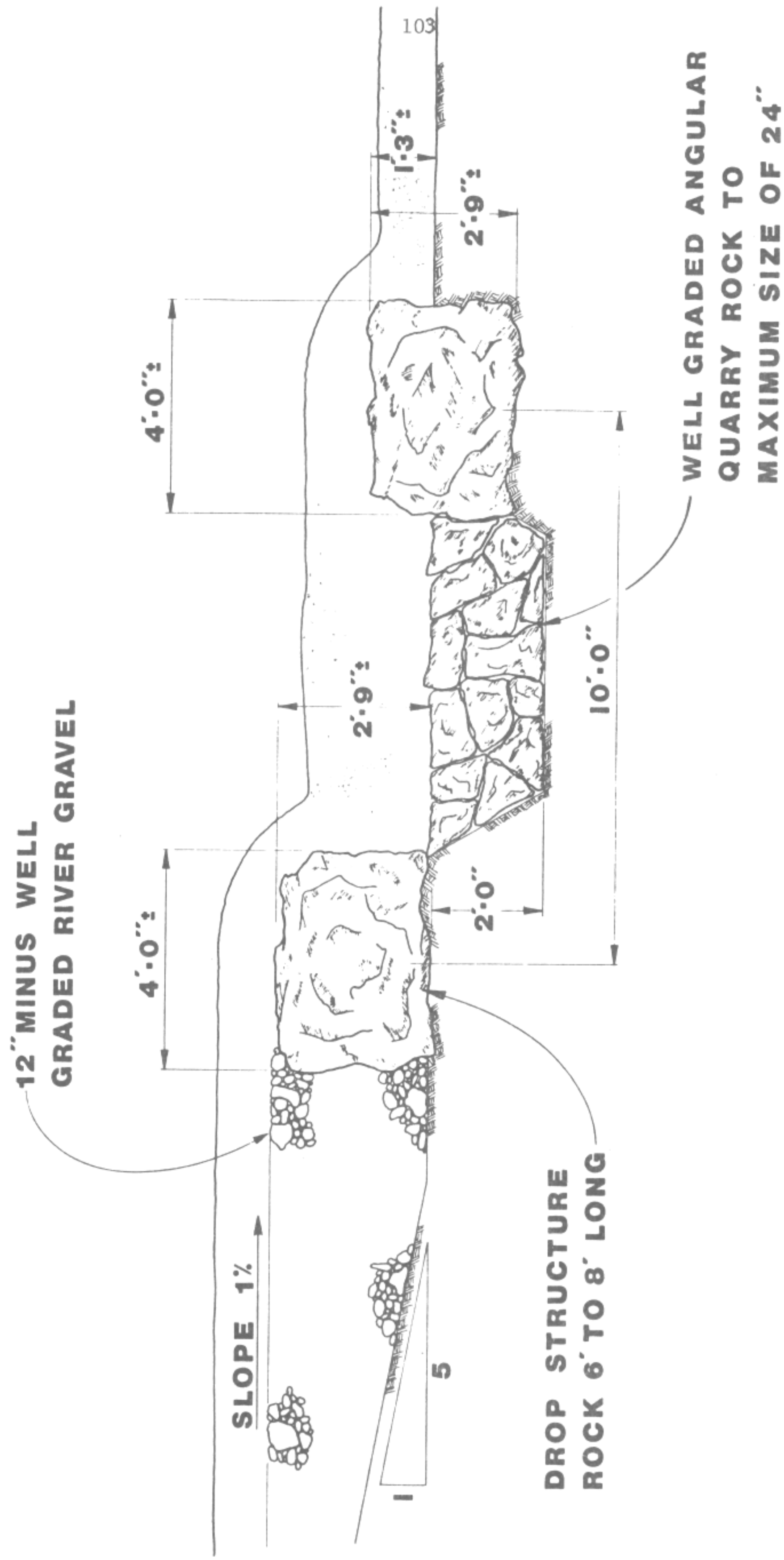
The writer has completed a number of river diversions through the Province, the majority of which were completed for the Federal Department of Fisheries in connection with their various salmon enhancement programs. Over the years many materials were used for both drop structures and channel lining. These materials included cast in place concrete, timber, quarry rock, reinforced shotcrete, precast concrete sections, and combination of reinforced concrete and structural steel. The most successful of these materials was custom quarry rock carefully selected or broken into a reasonably uniform shape.

In northern British Columbia it was found that reinforced concrete structures, when used for channel invert controls and similar water control structures, suffered ice damage as early as two or three years after being put into operation. Steel structures aggravated any frazzle ice problems and, in some cases, caused blockages of an entire river channel. On the other hand, rock structures including rock linings have operated successfully and required no maintenance after 14 years of operation.

For the Fording river diversion dense sandstone blocks were selected and stockpiled over a three month period and were used to form the drop structures and "rock islands" in the Fording river diversion. Samples of the rock were laboratory tested for durability and resistance to hydraulic erosion and were found to be ideal for the proposed application.

The sandstone boulders were obtained from the open pit overburden waste and, because of the predominance of waste shale, the selection process was carried out on a periodic basis over a three month period in order to obtain the type and shape of stone when it became available.

The drop structures were constructed generally as shown on Figure 1. The overall drop across each structure was 2'9", generally in two equal steps. At very high flows the drop structures will simply form a relatively uniform bump in the water profile which fish will swim through. At low flows the irregularities in the rocks form a combination weir and slot type fishway which most fish will swim through at the point of



TYPICAL DROP STRUCTURE

FIGURE 1

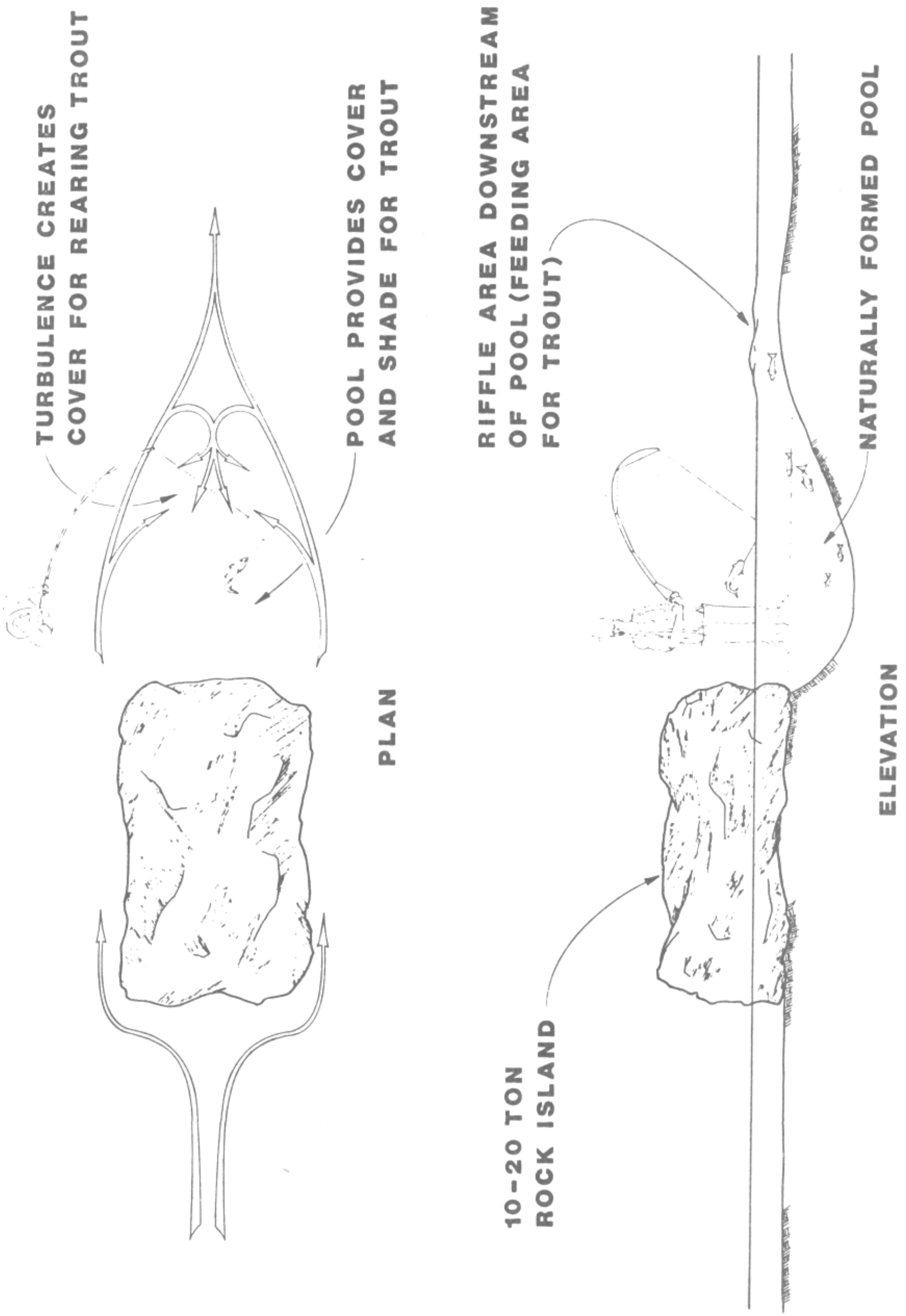
concentrated flow. However, it was noted a few hours after the river was diverted that some cutthroat trout jumped the drop structures similar to a pool and weir fishway.

The rocks used to form the drop structure weirs are large, eight - ten tons, and must be placed with a large loader. It takes a skilled operator about one and one-half to two days to construct each weir including the rip rap slope protection at each bank. The drop structures and associated rip rap bank protection are designed for the 100-year flood of approximately 2000 cfs.

RIVER DIVERSION - ROCK ISLANDS

In conjunction with the drop structures, approximately 60 large rock islands were installed along the length of the channel, roughly in the center half of the diversion. These islands create areas of concentrated flow and back eddies resulting in a non-uniform regime which results in gravel-bar formation and river sections of varying depth. It has been found with other diversions that a relatively large pool will form immediately downstream of the rock island after the first freshet, generally *as* shown on Figure 2. This area becomes a feeding and holding area for trout. The turbulent section below the pool results in cover for the fish and generally coincides with a higher velocity riffle area. Generally the fish will feed in this area and then hold in the actual pool behind the rock where the velocity is lower and often reverse to the normal direction of flow.

In time these rock islands will become favourite fishing holes for the angler. The pools formed will offset the loss of the pool area in the section of river that was abandoned. In the spring, Fording Goal's Environmental Division will seed the



TYPICAL ROCK ISLAND

FIGURE 2

area with grass and plant approximately 30,000 trees along the banks of the river diversion and adjacent slopes. This will stabilize the slopes and prevent deleterious run-off from, entering the river.

REVIEW OF OTHER DIVERSIONS

Since the Fording River was only diverted six months ago a biological assessment of the diversion cannot be finalized. However, four diversions completed in 1961 in connection with *a* Federal Salmon Enhancement project were reviewed. These diversions involved the same simple techniques as described earlier and now after 17 years, except for the rock drop structures and islands, it's difficult to tell the diverted river from the natural channel. Because this project has resident biological staff, the diversions have been monitored over the years and results indicate the river diversions to be the most productive sections of the river.

TROUT SALVAGE OPERATIONS

Immediately after the Fording River was diverted a trout salvage operation was initiated in the pools of the abandoned river channel.

Under the supervision of Fording's Environmental Division, and with assistance from numerous volunteers, approximately 10,000 cutthroat trout were carefully seined from the abandoned pools and trucked to other areas of the river. Indirectly the Fording river diversion resulted in the first numerical assessment, on a large scale, of the cutthroat population of a section of the Fording River.

CONCLUSIONS

With the use of carefully placed quarry rock or large particles of dense mine overburden waste, a river diversion can be carefully stabilized with a minimum of maintenance. The addition of large rock islands will create rearing and holding areas for resident trout as well as provide cover and shade. With some assistance from Man the river diversion can be returned to a natural state.

DISCUSSION RELATED TO J.A. WOOD'S PAPER

Lionel Jackson - Institute of Sedimentary and Petroleum Geology. How was the actual diversion carried out?

ANS. That's a good question. We did it at night for aesthetic reasons. There are a tremendous number of sportsmen on the river fishing and hunting, and when you divert a river you can't avoid silting the water. In a diversion of that size, the water would be coloured for two to three hours.

At the start only half of the river flow was channelled through the diversion. Then the old channel was slowly cut off. This allowed the fish to move into the large pools in the original river. Ray Speer from Fording then went in and pumped the pools down and removed all the cutthroat trout. There was an enormous number of trout. I was surprised that they took 10,000 fish out of roughly four pools.

Lionel Jackson - Institute of Sedimentary and Petroleum Geology. At what point, with streams the size of the Elk or Fording rivers, would you anticipate significant downstream aggravation of flooding by channel straightening? I'm thinking more of the potential diversion that may be carried out in the Elk Valley by the Elco Mining operations.

ANS. That can be assessed. It did happen on Vancouver Island when they straightened out the Cowichan River. They straightened the river towards a bridge abutment and it took the abutment out. But you can assess this.

There won't be any downstream problems if you look downstream and find out what you are actually going to create. We had to do that. The Ministry of Mines and Petroleum Resources asked us to review the downstream conditions as far as five miles both from the point of view of the stream diversion and also in case of a disaster with the tailings pond itself.

Lionel Jackson - Institute of Sedimentary and Petroleum Geology. You didn't get any significant aggravation of high flows?

ANS. No, because we duplicated the velocities coming out of the channel so that we didn't change anything. We widened the lower end of the diversion channel to 160 feet, so as far as the river knows the diversion doesn't even exist.