Proceedings of the 16th Annual British Columbia Mine Reclamation Symposium in Smithers, BC, 1992.
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THE HENRETTA DRAGLINE PROJECT - MITIGATING THE ENVIRONMENTAL IMPACTS

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ABSTRACT

The economic recovery of over 5 million tons of high quality coking coal in the Henretta Creek Valley in South Eastern British Columbia posed significant challenges to Mine Planners, Engineers, Hydrologists, Biologists and Environmental Specialists.

The challenge was to recover the coal reserves from not only the valley flanks, but from under the main valley floor, on which runs Henretta Creek, a fish-bearing stream. The approval process, which included several Provincial Ministries under the Mine Development Review Process and the Federal Environmental Assessment Review Process, is discussed.

This case history also discusses in some detail the planning and construction of the Henretta Dragline Mining Project with emphasis on the water control structures and fisheries management works for the native Cutthroat Trout. A diversion of Henretta Creek through large diameter steel culverts nearly 1 km long, and a specialized crossing of the creek which allows fish passage were among the many innovative construction techniques. The mine reclamation plan and off-site mitigation works for both fish and big game wildlife species, are also explained.

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INTRODUCTION

Brief History

Fording Coal's metallurgical mine, Fording River Operations, is located 30 kilometres northeast of Elkford, British Columbia, in the southeast corner of the province. Fording River's primary product is high-quality metallurgical coal, used to make coke for the international steel industry. The mine also produces and sells thermal coal worldwide for use by power utilities and associated industries.

The mine began production in 1971 and made its first coal shipment in 1972. Fording's initial contract was for three-million tonnes per year of Fording Standard low-volatile coal to a single customer. Today, Fording River Operations ships more than six-million tonnes per year of its three main products - Fording Standard, Medium Volatile and High Volatile coal - to customers in 15 countries worldwide. Minor quantities of Thermal coal are also shipped.

Current Production and Equipment

Fording River Operations produces Canada's widest range of bituminous coals from a single site. This flexibility in product type allows Fording to respond to changing customer needs and market conditions. The mine's reserves consist of over 300-million tonnes of cleaned coal. Over 75 percent of these reserves are contained within Eagle Mountain.

A detailed 30-year mine plan focused on Eagle Mountain has been developed, including the consolidation of the entire truck/shovel fleet on Eagle. Eagle Mountain provides Fording River Operations with several advantages relative to the international competition: assured coal supply, flexibility of product type, large, efficient mining areas, and a steadily-declining strip ratio over the full 30 years.

A stable and dedicated work force helps Fording River achieve annual production of well over six-million tonnes of cleaned coal. High-capacity state-of-the-art equipment is used to mine over 50-million bank cubic metres of waste rock and raw coal per year - an amount equivalent to 130-million tonnes. A Marion dragline with a 46-cubic metre bucket is used to supplement the world-class truck/shovel fleet featuring a 45-cubic metre-capacity shovel and 218-tonne trucks. As the largest single piece of mining equipment operating in a mountainous environment in North America, the dragline accounts for 20 percent of the mine's total production.

The property lies along the Fording River Valley with mining on both the east and west sides of the river. The mine site is accessed by a 30 km long paved road northeast of Elkford, B.C. Total employment is approximately 970 persons.

Total mine reserves are contained in 15 main seams varying in thickness from 1 to 11 m. Seam dip varies from flat to 45°. The average insitu ash is 22%. The coals range in rank from medium volatile to high volatile bituminous. The sulphur content is relatively low since these coal seams were formed in a non-marine environment during the Jurra-Cretaceous period (120 - 160 million years ago).

The mine uses truck/shovel mining on Eagle Mountain on the east side of the Fording River and dragline mining on the west side. Due to multiple seams of varying thickness and quality, the mountain is being mined in several different stages. Using the multi-stage method, the mountain is being mined with a declining strip ratio while releasing a wide range of coal products.

The long range mine plan contains enough coal reserves to continue mining for over 30 years. There are other areas at the minesite which could greatly extend this mine life. All truck/shovel operations have been consolidated on Eagle mountain since 1990, apart from minor dragline pre-stripping. Objectives in the plan include larger, more efficient work areas, level or downhill waste hauls, improved mining conditions, and systematic release of coal products. A staged approach to mining is utilized which allows for a consistently declining strip ratio, and a balanced release of high volatile, medium volatile, and standard products. Increasing amounts of medium volatile coal and ultimately low volatile coal are produced as mining progresses through the stratigraphic sequence.

The run of mine raw coal is processed in the coal preparation facility to the required specifications prior to shipping to port. The preparation plant and processes are typical of those used in Western Canada. The preparation plant has a nominal capacity of 1350 tonnes of raw coal per hour and a peak capacity of 1600 tonnes per hour.

The run of mine raw coal is first reduced in size to -150 mm in a Bradford Breaker in the raw coal receiving area. It is then conveyed to the preparation plant to be screened into four separate size fractions. Each size fraction is then processed in one of the following separation processes; heavy medium baths, heavy medium cyclones, hydrocyclones, and froth flotation.

Waste material is discarded as either coarse reject or tailings which reports to the South Tailings Pond. The clean coal product is dried in a coal-fired thermal dryer. The product is stored in the 15,000 tonne silo or the 45,000 tonne "cathedral" before being loaded onto 10,000 tonne unit trains.

Environmental control responsibilities include air quality, surface water quality, ground water quality and refuse disposal. Its functions involve monitoring, water management planning, permit applications, and design/construction and operation of environmental control facilities.

Reclamation of resloped spoils, landfills, exploration roads and other disturbed areas is carried out yearly at Fording River. An onsite greenhouse is utilized year round to produce conifer (evergreens) and deciduous (leaf shedding) seedlings. The average annual greenhouse production consists of 25,000 conifers and 15,000 deciduous seedings propagated from locally collected seed or cuttings. Over 400,000 seedlings have been planted on resloped spoils in past years. The rate of planting will increase as larger spoil areas are available for reclamation.

Description of the Area

The Fording River Operations area is situated along the lower slopes of the High Rock Range which is a subsidiary range of the Front Ranges of the Rocky Mountains. Elevations range from 2450 m at the top of Eagle and Turnbull mountains to 1600 m in the Fording Valley. These mountain ridges tend to run in an east to west direction resulting in slopes with predominantly north or south aspects. Slopes are generally steep, ranging from 25° to 30°.

The climate of the area is determined by its continental location and mountainous topography. Winters are generally dominated by cold continental Arctic air masses. Winter frontal systems moving easterly from the Pacific coast bring maritime Arctic air into the region, which modifies temperatures and results in snowfall. During cold weather, valley-based temperature inversions and extreme atmospheric stability characterize the climate.

Summer weather is generally good, reflecting the reduced influence of the mid-latitude upper level jet stream. Summer precipitation is generally convective rather than synoptic. However, in all seasons, the mountains play a major role in determining the regional and local climate characteristics of the study area.

Seasonal precipitation patterns at Fording Coal are characterized by a well defined early winter maximum, a secondary maximum in summer, and two poorly defined dry periods - late winter/spring and later summer/fall.

Rainfall at both stations shows a general trend toward a summer maximum and a winter minimum, whereas for snowfall the pattern is reversed. Snowfall can be expected in most months of the year. Total precipitation averages 760 mm per year. Temperatures range from -350 to +25°on an annual basis.

Climatic variations are reflected by three distinct vegetation sub-zones of the Subalpine Engelmann spruce-alpine fir zone. The sub-zone with seral Douglas-fir is found on the slopes of Eagle Mountain although it does occur in some seral stands. Above 2300 m on both Eagle Mountain and Mount Turnbull, the krummholz sub-zone occurs. The remaining portions of the area are classed as the sub-zone lacking seral Douglas-fir.

Major land uses in the area include Wildlife Range, Forestry and Recreation.

Project Proposal Statement

The Marion 8400 Dragline is currently slated to complete Lake Mountain Dragline Pit in early 1992. Further large scale dragline potential in the Greenhills Range is limited without a substantial truck-shovel prestrip commitment. An alternative for dragline mining is required, in order to maintain overall productivity and mining costs, while maintaining required plant feed. For these reasons, a new large scale dragline area, namely Henretta Creek Dragline, was identified to provide mining until the next dragline mining area, the final Taylor Pit footwall, is exposed in 1993 to 1994.

The Henretta Dragline Project is planned to be in operation from 1992 to 1995 providing approximately 5.5 million tonnes of clean coal at a strip ratio of 7.2:1 (BCMW/MTCC). Three pits are planned. The South and West Pits will be mined in the early stages of development while the North Pit, still in the planning stage, will be mined in the later stages of development.

HENRETTA DRAGLINE PROJECT

Geology

The proposed mining area in the Henretta Creek valley is geologically located on the east limb of the Alexander Creek Syncline. The potential mining area is cut off to the east by subcrop, and to the west by the Erickson Normal Fault. Limits of economic mining potential will determine the northern and southern boundaries.

The dominant structural feature of the area is a tight syncline located near the western limit. The synclinal axis is also the focus of several minor thrust and normal faults. A few minor, north-south trending syncline-anticline pairs are located to the east of the dominant syncline. The extreme eastern portion of the east synclinal limb is relatively consistent; dipping to the west at 25 to 30 degrees.

The Henretta Creek area is stratigraphically divided into two separate zones with potential for mining. The eastern area contains seams 5 and 9; averaging 8.0 and 5.8 metres in thickness respectively. These seams have been traced along strike for a distance of approximately 500 metres. An additional 300 to 400 metres of strike length, with topography suitable for dragline mining, exists to the south of the currently defined area.

The stratigraphic interval between seams 5 and 9, an interval of approximately 100 metres, is essentially void of economic coal seams. Therefore, the subcrop of 9 seam defines the eastern limit for potential mining for the western area.

The proposed western mining area contains seams 9, 11, 11 upper and 12; averaging 4.9, 2.5, 7.5 and 6.1 metres thick respectively.

Proposed Mine Development

South Henretta Pit will incorporate a 1200 m long truck/shovel prestrip along the north flank of Turnbull Mountain immediately south of Henretta Creek.

The dragline cuts are to be oriented at 90° to the flow of Henretta Creek. There are 18 cuts in total and they will start with a box cut at the east end of the pit. The cuts are mainly simple turnover cuts, however extended benches will be incorporated to maintain a suitable cut width in deep cover. Coal will be lifted to the truck/shovel final cut elevation which will form the dragline pad.

West Pit will incorporate one truck/shovel bench prior to dragline mining on the north side of Henretta Creek.

North Henretta Pit is much smaller than South Henretta Pit. As the pit is located on a sidehill, truck-shovel prestripping is to be used to construct four terraces for dragline mining.

Dragline mining will commence with 6 cuts, oriented parallel with truck-shovel cuts. The dragline will start on the lowest terrace digging from east to west. Waste will be spoiled to the south and coal will be lifted to the upper terrace to the north. Most cuts will be taken with a face cut, however, some extended benches may be necessary.

Description of the Henretta Valley

The important predevelopment land uses for the proposed Henretta dragline area are wildlife and forestry. The proposed mining area is classified by the Ministry of Environment's Biophysical Classification for wildlife capability as mostly elk and moose Class 3 winter range (South Henretta Pit area) and some elk and mule deer Class 4 summer range (North Henretta Pit area).

The Biophysical Classification for vegetation in the proposed mining area is mostly a dense coniferous forest consisting of Lodgepole pine and Englemann spruce in a maturing serai ecological state, and riparian habitat of deciduous trees and shrubs in the Henretta Creek flood plain.

The long term reclamation plan for the proposed Henretta mining development includes the reestablishment of commercial forests and wildlife habitat, land uses that existed prior to mining.

Westslope cutthroat trout (Oncorhynchus clarki lewisi) is the only fish species occurring in the upper Fording River. The upper Fording River includes that portion of the watershed upstream of a series of impassable falls located about 30 km downstream of the Fording Coal Ltd. operation. Cutthroat trout fry were transplanted into this part of the watershed by residents of the area between 1928 and 1941 and have since colonized accessible areas. The fisheries resources in the upper Fording River have been the subject of several studies since 1975, most of which have been related to coal mining operations.

The total potential area available for trout distribution in the upper Fording River watershed (gradient < 3%) is 116 ha, with approximately 4.5 ha in Henretta Creek. The 4.5 ha of Henretta Creek represents 4% of the available upper Fording River watershed and 17.5% of the available tributary area (25.6 ha). The section of Henretta Creek which could be potentially impacted by the proposed Dragline Project is approximately 1.1 ha (1850 m) of lower Henretta Creek (culvert and impoundment area). This represents about 1 % of the available upper Fording River watershed and 4% of the total available tributary area.

Mean trout densities (aged 2+to 5+) in the proposed mine area of Henretta Creek were relatively similar year round during the 1990 fisheries studies (mean - 144; range 119-183). Mean trout densities determined in April, September and December, 1990 were estimated at 2.0 trout/100 m^2, 1.3 trout/100 m^2 and 1.6 trout/100 m^2, respectively. Limited sampling in the upper Henretta watershed indicated that trout densities were significantly less than the lower Henretta Creek.

By comparison, the Fording River appears to be much more productive. Mean September/October fish densities of 4.3 trout/100 m^2, 22.9 trout/100 m^2 and 10.7 trout/100 m^2 in the mainstream river upstream, within, and downstream of the Fording Coal mine area, respectively have been documented. In addition, densities in an exfiltration stream from Fording Coal's Clode settling pond system and a nearby groundwater-fed stream ("Fish Pond Creek") had trout densities of 15.6 trout/100 m^2 and 31.3 trout/100 m^2, respectively. Even if these populations have declined by 53% over the last decade, these data suggest that the mainstream Fording River and tributaries in the existing mine area are potentially much more productive than Henretta Creek.

The fishery resource in the upper Fording River provides an extremely limited contribution to angling in the region. Angling in Henretta Creek and the upper Fording River around the proposed mine site is not a common recreational activity. The vast majority of the cutthroat trout in the Fording mine area are below the legal size of 30 cm in length and no trout of this size have been documented in Henretta Creek. No angling or evidence of past angling was observed during the 1990 angling season in these areas.

In order to complete the mining in the valley bottom, Henretta Creek was temporarily diverted around the South Pit mining area using two parallel culverts approximately 1000 metres in length. A seven metre high diversion dyke was constructed to intercept all surface and subsurface flows and divert the water into the twin culverts. The entire diversion facility was designed for a floodflow with a 200-year return period (Q200). Flows exceeding Q20 would spill over the diversion dyke spillway into the South Pit, from where the water is subsequently pumped back into the culvert system. Some of the features associated with the diversion are summarized below:

- The twin culverts are 2200 and 1800mm diameter corrugated metal pipe which allowed "nesting" during shipment to the site. All joints have hugger band couplings with neoprene "O" ring seals to minimize seepage loss to the pits.

- As the mining area develops the culverts will be relocated to allow for mining of the west and north pits.

- Upon completion of mining operations the Henretta Creek channel would be restored and the twin culverts removed.

Restoration of the Henretta Creek channel will involve a lined channel reconstructed with a meander sequence, pool and riffle areas, habitat features and a large overwintering lake and hydric meadow near the downstream end of the diversion.

One of the major haul road crossings of Henretta Creek included twin culverts approximately 120 metres long with approximately 20 metres of rock mine waste as cover. Since this road will remain in service to complete reclamation operations and possibly access other mining areas, the facility was designed for fish passage complete with holding ponds, fishway weirs, and partial backwatering of the culvert invert.

OFFSITE MITIGATION

The basic approach to mitigation is that reclamation of the minesite and spoil as well as the restoration of Henretta Creek represents the long-term mitigation of impacts.

The short-term impacts, during the period of mining and subsequent reclamation, are the subject of the off-size mitigation strategy.

Cutthroat Trout Habitat Enhancement

As mitigation for removing approximately 1500 metres of Henretta Creek from natural fish production for a 6 to 7 year period, two nearby areas of the Fording River were targeted for enhancement. One of these areas was a natural ground water fed stream with a history of utilization by cutthroat trout as a prime overwintering area. The second area was on the Fording River immediately upstream of its confluence with Henretta Creek.

Fish Pond Creek is located approximately 2 km. downstream of the Henretta Dragline project. The creek originates in a groundwater fed pond and extends downstream approximately 800 metres before discharging into the Fording River. The head pond has historically been used by cutthroat trout for overwintering and was deepened about ten years ago and enhanced with natural cover (i.e. root wads and rock groupings).

The remainder of Fish Creek was enhanced in the fall of 1991 and basically consisted of the development of four (4) reaches. The upper reach (Reach A) included the construction of two major overwintering pools, five pocket pools, addition of spawning gravel above and below selected pools and the addition of cover. The cover included the following types:

- Large organic debris (LOD), such as clean root wads, timber debris and extensive planting of riparian vegetation such as willow clusters and evergreens along the perimeter of the channel and pools.

- Submerged rock groupings in the deep pools to provide avoidance areas from merganser predation.

- Man-made floating cover for the larger pool areas which was installed in conjunction with LOD and riparian vegetation.

Reach B, with a length of approximately 120 metres, had a relatively steep gradient and was developed utilizing a combination of pocket pools, stabilized spawning gravel areas, rock wing spurs and transplanting of riparian vegetation. LOD was installed in all pocket pools to provide cover for rearing and spawning trout.

Reach C was developed as a natural lake area complete with islands and peninsulas to maximize the perimeter margins that could be planted with riparian vegetation. The lake or pool areas are approximately 2 metres deep and include floating cover over selected areas of the pond. It is anticipated that these areas will be used for overwintering and possible summer rearing as well. Depending on food supply, the area may produce larger fish, similar to the fish rearing in other isolated pond areas within the mine property.

Reach C in Fish Pond Creek is relatively steep, has excellent natural cover and was enhanced with rock spurs and the addition of spawning gravel by natural distribution.

The slides presented with this paper show the construction details of the habitat complexing as well as current information on fish utilization. Over the next seven years a biological assessment program will study and report on the productivity of the habitat complex used in Fish Pond Creek.

In addition to Fish Pond Creek, a 450 metre length of the Upper Fording River was also targeted for enhancement. This section of the Fording River was steep (in excess of 5 percent slope) with natural substrate consisting of cobbles and boulders with some finer gravel in isolated areas. There were very few pools and no instream LOD cover. The riparian vegetation was generally good but the utilization by cutthroat was low, possible as a result of limited holding areas and virtually no instream cover.

In general, it was proposed to develop this area as mitigation for the loss of riffle-glide habitat in Henretta Creek. As a result of the steep gradient in this area of the river, pool and holding areas were constructed using large rock clusters and islands, root wads cabled to selected trees and rock spurs located on river bends. It was anticipated this treatment would provide greater stability during flood flows. If habitat complexes moved or were broken up by high velocities, it is likely the resultant formation would still provide useful habitat.

Wildlife Range

Mitigation for ungulates during the interim period between mining in the Lower Henretta Valley and the final reclamation was carried out with the enhancement of two areas in the vicinity of the mining area. Hening Flats, which lies directly west of the Henretta Creek and Fording River Confluence was upgraded for wildlife by creating approximately 14 hectares of openings by harvesting merchantable timber and slashing remaining timber in narrow irregularly shaped blocks. This enhancement allowed for the upgrading of about seventy hectares in this location to a higher carrying capacity for both moose and elk. Similarly five hectares in the Upper Henretta watershed were slashed, upgrading the carrying capacity of an area of about twenty hectares.

The areas, before enhancement, had a carrying capacity of two to three moose per km^2 Class 3 winter range and 3 to 7 elk per km Class 3 winter range. The enhanced work carried out should increase capability by 42% and 24% respectively.

The enhanced areas are now made up of approximately 40% to 60% available forage area within immature and mature timber which provides both thermal and hiding cover. Debris piles remaining in the blocks after clearing are planned to be burned in 1992. Some selected piles near clearing edges will be left for small mammal habitat.

RECLAMATION PLAN

Henretta Creek Restoration

After mining is completed in the Henretta Valley, the creek channel will be restored and will closely approximate the original creek length and gradient. When the south pit is infilled with rock mine waste, the proposed subbase of the relocated channel will be lined with glacial till to a depth of one and half metres. A defined meander pattern will be constructed within the impervious envelope of the channel subgrade.

The impervious liner will be constructed a minimum of 2 metres below the channel invert and located approximately 16 metres from the top edge of the creek bank. This will allow natural erosion processes to occur without damaging the liner.

After the channel is exposed to one season's high flows, a secondary meander pattern will be initiated, and a thalweg established, and natural erosion will create scour and deposition areas. In time, pools will form on the outside of curves and fine material will be deposited on the inside of bends. Undercut banks and gravel bars would be allowed to form naturally.

All major erosion and scour areas would be stabilized with selected rip rap. This phase of the work would be completed after the channel has been in operation for at least one year. In this manner only seriously eroding areas would be stabilised and any natural undercut banks and riffles would be allowed to develop naturally. The rip rap would be sized and placed to have a secondary role of providing habitat for rearing trout. The openings in the rip rap provide cover and avoidance areas for trout rearing in the adjacent glides and riffles.

The Henretta floodplain would be planted and reclaimed with vegetation propagated in Fording Coal Limited's on-site greenhouse. Local species such as willow, cottonwood, Engelmann spruce and lodgepole pine intermixed with grasses and legumes would be used to restore the area disturbed by mining.

The relocated creek channel will discharge into a lake which will be created in the most westerly cut of the south pit. The depth of the lake will vary between 5 and 7 metres. The approximate volume of the proposed Henretta Lake is 286,000 cu.m.

Circulation within the lake will be maintained by discharging Henretta Creek into the southeast corner to promote cross flow before discharging diagonally opposite at the downstream end of the lake.

The outlet into the lake will be stabilized with a rock invert control grouted with concrete. The invert control will prevent down cutting and/or ravelling of the channel upstream.

After the reclaimed channel is stabilized, additional improvements will be completed in the channel including the addition of processed spawning gravel, rock spurs and clusters and large organic debris. A biological monitoring program will be carried out after the channel is complete to determine fish use and productivity of the various types of natural and man made habitat in the channel.

Mine Reclamation Plan

Fording Coal Limited's fundamental reclamation objective is to establish important pre-mining land uses on a property average basis. The preparation of a final reclamation plan for the Henretta mining disturbances which will achieve this objective requires that prior land uses be quantified and that the physical appearance of the completed mining areas be estimated. The post mining landforms are then assigned a final end land use based on their suitability to such features as aspect, exposure, dump height and proximity to drainages.

It is planned that other disturbances, such as the main access road, interceptor ditches and the powerline corridor will be revegetated with a seed mix composed of species noted on Table 1. A 12-51-0 fertilizer will be used with the seeding of the grass-legume mix. Previous research has shown that the grass-legume mix does not require maintenance fertilizer if high phosphorous content fertilizer is used in the initial application. The seed application rate is 55 Kg/hectare and the fertilizer application is 225 to 400 Kg/hectare, depending on the type of disturbance. This mix has been widely used on other construction disturbances and waste dumps at the minesite and has shown to be used extensively for forage by ungulates.

The major component of the reclamation plan, both in time and cost, will be the slope modification of waste dumps and the South Pit backfill spoils and the reclamation of the Henretta Creek channel. The West and East Spoils will have an outer layer of rock containment with the overburden and till layer behind the rock. These dumps will be partially resloped to an angle of 28° with a short portion of the toe of these dumps remaining at 37°. Reworked spoil will not be placed over the toe in order to ensure that drainage through the dumps will not be impaired. The truck/shovel and dragline backfill spoils within South Pit are planned to be resloped with a complete 28° toe. The reclamation of the Henretta Creek channel will require the stockpiling of till during the mining sequence in South Pit. Till is planned to be placed during the post mining period by the dragline, dozers and a compactor.

Forestry is the end land use objective for the resloped landforms in South Pit and the East waste dump. The pit highwall will not be revegetated although the highwall may provide an opportunity for habitat for mountain goats, bighorn sheep and raptors. The flat areas of the dump and pit backfill areas will be ripped with a dozer to break compaction, prior to revegetation. The sloped portions will be recontoured in such a way as to provide undulations creating a variety of micro sites. Both the flat areas and 28° sloped areas will be planted with prime commercial tree species to create a viable future merchantable timber stand. Lodgepole pine and Engelmann spruce seedlings, grown in Fording Coal Limited's on-site greenhouse from local seed stock, are the two target species to be used in planting these areas. Spruce will be planted in the wetter areas and on available north aspects. Pine will be planted on the drier ridges and open, exposed sites. Each seedling will be planted with a slow release fertilizer tablet (20-10-5 formulation).

TABLE 1

SEED MIX AND SPECIES COMPOSITION USED IN RECLAMATION

AT THE

FORDING RIVER MINESITE

SEED MIX NO. 8
(below 1900 meters elevation)

SPECIES	% OF MIX BY WEIGHT
Alfalfa	34
Intermediate wheatgrass	20
Alsike clover	10
Boreal creeping red fescue	10
Chinook orchard grass	8
Meadow foxtail	5
Hard fescue	5
Climax timothy	4
Canada bluegrass	2
Red top	2
Total	**100**

The selection of the type of wildlife habitat to be restored on the Henretta disturbances is largely determined by the physical and/or biological features presented by the post-mining landforms. Two general classes of wildlife habitat, vegetation based habitat and water based habitat, are considered in the restoration program. The wildlife end land use objective for the Henretta disturbances is to be addressed by these two major components: elk winter habitat (vegetation based habitat) on south exposures and moose habitat (mostly riparian habitat) in the restored flood plain zone. Wildlife habitat reclamation is adaptable to a wide range of reclamation situations and can be successfully achieved through minor changes to standard planting procedures and site contouring to provide windrows with various degrees of microsites. The reclamation plan for the valley bottom disturbances and the West Spoil in Henretta is designed to focus on key wildlife species, primarily elk and moose, in the early stages. As the reclaimed areas mature, natural succession and growth will benefit a wide variety of wildlife species, including many of those utilizing the pre-mining landforms.

A general synopsis of the elk habitat requirements include grasslands and shrublands interspersed with forested area. The disturbances from the formation of the West Spoil will be reclaimed to an elk winter range end land use with these habitat criteria as the objective. This area, once successfully reclaimed, will provide the basic needs of food, water and cover for elk. A tree/shrub mix make up the components of the vegetation-based habitat type to be used in reclaiming the flat and non-south aspects of the west dump to wildlife habitat. The deciduous component of this vegetation type will offer some foraging opportunities for elk and also provide shade. The conifer component will provide escape cover and thermal cover. It is planned to establish pioneer plant communities with species that have been successfully propagated at Fording Coal Limited's facilities. A list of these species is summarized in Table 2. Conifer species to be planted will be primarily Lodgepole pine and Engelmann spruce and lesser amounts of Douglas-fir. Planting will be done in irregular patterns which will greatly increase the habitat diversity by providing more edge habitat and hiding cover for elk. Planting densities will vary to allow for small openings in the canopy as the plants mature. Shorter shrub species such as trembling aspen, saskatoon and willow will be arranged around the conifer core. The ratio of cover to forage will be in the approximate range of 40% to 60% respectively. This concept of clump planting in specific areas of the west dump site will be carried out where the plants' needs for slope, aspect, exposure to sun, wind and moisture regime are met. Subsequent natural invasion of local plants and the spreading of the introduced plants would then slowly complete the habitat development process.

Another vegetation type to be used to reclaim this dump to wildlife range will be an upland meadow vegetation type. This vegetation type will be established on the dry south-facing slopes of the west dump where a high degree of exposure to wind and sun is expected to occur. Large open areas will be seeded to grasses and legumes such as Bluebunch wheatgrass, Idaho or Rough fescue and alfalfa, which have high protein and energy content and are highly palatable to elk.

Typical moose habitat has been defined as deciduous shrublands and forest edges with generally flat to gently rolling terrain and flat bottomed drainage channels with wide floodplains. Moose respond favourably to regenerating logged areas and should show a similar response to the well-planned reclamation site comprising the riparian zone along the recreated Henretta channel. The reclamation of this area into moose habitat will also provide habitat for small herbivores, game birds and song birds.

The reclamation plan for the Henretta Valley bottom is to restore a stable stream with habitat features similar to that which existed prior to mining. The water based landform largely determines the selection of the habitat type to be established in this zone of the disturbed area. Shrub/meadow and shrubland vegetation types are the main targets in revegetation selection for reclamation in the valley bottom. Also, the establishment of deciduous tree/shrub mix or shrublands adjacent to the water course and lake will provide an adequate source of food for moose and other wildlife. The recontouring of the dragline spoil benches which will contain the restored channel will be done with the intention of creating many undulations and windrows. Thus the reclaimed channel will provide a variety of habitat types (microsites) and will recreate similar habitat diversities which will develop naturally with time. In addition to a restored creek channel, a lake and a hydric meadow will be part of the reclamation plan. Planting of shrubs and deciduous species such *as* trembling aspen, willow and cottonwood we a key component in the reestablishment of the riparian zone. The shrubs currently selected to form part of the vegetative cover and forage include chokecherry, buffalo-berry and such nitrogen fixers as alder. These species are well suited for ungulate use as the majority of their biomass falls well within the browsing range of these animals. The area surrounding the lake will be resloped to 28° and revegetated with willow and other site specific shrubs to provide cover for fish along the shore line. The hydric meadow will be planted with sedges along with occasional shrubs including transplants of local bog birch and potentilla providing an immediate diverse habitat within the riparian zone. Another candidate species for the hydric meadow is reed canary grass.

TABLE 2

LIST OF NATIVE SPECIES THAT HAVE BEEN PROPAGATED

AT THE FORDING RIVER OPERATIONS

Trees	Picea engelmannii	Engelmann spruce
	Pinus contorta	Lodgepole pine
	Pinus albicaulis	Whitebark pine
	Abies lasiocarpa	Alpine fir
	Larix lyallii	Alpine larch
	Pseudotsuga mensiesli	Douglas-fir
	Populus tremuloides	Trembling aspen
	Populus spp.	Cottonwood
Shrubs	Alnus sinuata	Mountain alder
	Salix spp.	Willow
	Rosa spp.	Wild rose
	Arctostaphylos uva-ursi	Kinnikinnick
	Shepherdia canadensis	Scoopolallie
	Sumphoricarpos albus	Snowberry
	Sambucus racemose	Elderberry
	Amelanchier alnifolia	Saskatoon
	Rubus idaeus	Raspberry
	Rubus parviflorus	Thimbleberry
	Lonicera involucrata	Black twinberry
	Ribes spp.	Current
	Cornus stolonifera	Red-Osier dogwood
	Acer glabrum var. douglasii	Rock Mountain maple
	Berberis aquifolium	Oregon grape

Recreation is an end land use objective for the reclaimed mining disturbances in the Henretta Valley. After reclamation activities are complete it is planned to provide access through the site to the Upper Henretta Valley and to reinstate the area into the allowable hunting zone. The reclaimed sites with forest values and wildlife habitat end land uses will also provide sites with future hiking, hunting and trapping potential. Short term mitigation for the loss of access "through the valley during the mining and reclamation events was accomplished with the construction of a trail access through the upper Fording Valley and East of Henretta Ridge to the upper limits of the Henretta Valley. Also, a new campsite was constructed at a location approximately two kilometres west of the present campsite near the confluence of Henretta and Fording River. The new reclaimed creek channel for Henretta Creek will flow into a man-made lake at the west end of the former South Pit, potentially providing greater angling opportunities than existed before mining in this region of the valley.

CONCLUDING REMARKS

The Henretta Dragline Project involved several years of exploration, planning and development, and is a vital component of the long-term viability, stability and economic competitiveness of Fording Coal Limited.

The approval process, initiated under the Mine Development Review Process (MDRP) in 1990, was greatly complicated by the late involvement of the Federal Department of Fisheries and Oceans (DFO) in 1991, and by the changes in legislation and court decisions in 1990 and 1991. Ultimately, Approval-in-Principle was received in 1991 which allowed for predevelopment work in 1991, and the commencement of mining in 1992.

Within this changing and uncertain environment, Fording Coal Limited and the review agencies jointly developed an environmental strategy incorporating assessment, mitigation and final reclamation requirements. Fortunately, the final economic strength of the project allowed for incorporation of the extensive environmental requirements.

The lengthy and complex nature of the review process, the uncertainty of changing legislation, expectations of review agencies and the associated increased costs are a major concern for any development proponent. Fording's Henretta Dragline Project was no exception. Much improvement of the approval process is required if British Columbia is to remain a location of choice for orderly, sustainable resource development.