RECLAMATION STRATEGY AT CARDINAL RIVER COALS LTD.
by G.B. Acott
Cardinal River Coals Ltd.

INTRODUCTION

Resource development on the Eastern Slopes of the Rocky Mountains invariably impacts, to some degree, on existing land uses (hydrology, recreation, wildlife utilization). Intensive planning is required to reduce or alleviate these adverse effects by adopting a reclamation strategy toward a final land use objective which is:

i) compatible with the surrounding area,
ii) achievable given the topographic, edaphic and climatic conditions of the area,
iii) economically viable.

The following paper outlines the final land use objective chosen for Cardinal River Coals Ltd. and the rationale for making that choice. The methodology utilized in the implementation of these policies is discussed along with some of the field problems which have been encountered.

SITE DESCRIPTION

Cardinal River Coals Ltd. lies approximately 350 km (217 mi) west of Edmonton or 40 km (25 mi) south of Hinton. The minesite is located on the Eastern Slopes of the Nikanassin Range at an elevation of between 1650 m and 1830 m (5400 ft and 6000 ft). The area is subjected to a cool moist Montane climate characterized by relatively cold, dry winters with frequent chinooks and cool, wet summers. An average of 870.8 mm (34.28 in) of precipitation per year (water equivalent) can be expected, with approximately 75% of that total falling as rain between the months of May and September.

Current operations have the capacity to remove and process 3.3 million clean short tons per annum of Bituminous B medium volatile coking coal. The majority is purchased by Japan for use in the manufacture of steel. Coal extraction is achieved using conventional open pit methods. Rock above the coal is drilled and blasted, then removed in progressive benches by trucks and shovels. The mine currently employs some 650 individuals.

Approximately 891 ha are currently disturbed with 185 ha of that total in some stage of the reclamation process. Reclamation Certification has been received from Alberta Environment on 8.1 ha (20 ac) and these lands have been returned to the Crown. Cardinal River Coals Ltd. is the first coal development on the Eastern slopes to reclaim to certifiable standards.
RECLAMATION STRATEGY

In the selection of a final land use objective, a number of alternatives were considered. The proximity of the mining area to the Forest Management Area of St. Regis (Alberta) Ltd. brought heavy pressure from the logging industry to reclaim to commercial forest standards. However, the altitude at Cardinal River Coals Ltd. made a final land use of commercial forestry unrealistic - even with constant maintenance, average harvest rotation periods of over 100 years would be expected. Adjacent mountain ranges have been classified as critical winter range for Rocky Mountain Big Horn Sheep, thus, an opportunity was seen to dramatically increase wildlife potential of the area through a reclamation program planned in that regard. Although the creation of wildlife habitat will form the brunt of the reclamation effort, alternate strategies will be adopted on a site specific basis to yield a multiple land use concept. For example, the 50-B-6 Pit, following the mining operations, will be fed by Jarvis Creek West to form a lake. Selective backfilling and sloping operations will be conducted to create littoral zones around the perimeter establishing a viable sport fish habitat. The area will then be available for the recreational use of local anglers and campers.

DESIGNING FOR WILDLIFE HABITAT

According to a literature search conducted on our behalf by wildlife consultants, an environment suited to wildlife habitat would exhibit the following characteristics:

1. The reclaimed surface should be approximately 40% cover and 60% openings.

2. Forage crop in the openings should utilize seed varieties which are:
   - easily available
   - self-sustaining
   - high nutritional value.

3. Reforestation species planted on cover areas should provide:
   - concealment and thermal protection - minimum of 1.5 metres (4.92 ft) tall with 60-70% crown closure
   - sightline interruption on open stretches which exceed 1 kilometre (0.62 mi)
   - nutritious feed for browsing populations.

4. Forested areas should be an optimum size of 0.5 ha (1.24 ac) and be located in islands and travel corridors to encourage wildlife usage of the entire reclaimed surface.
To achieve these parameters at Cardinal River Coals Ltd., two types of reclamation materials are utilized -- topsoil and regolith. Prior to disturbance, topsoil areas are delineated by a qualified soils specialist in a pedological survey and rated as good, fair, poor, or unsuitable in terms of usefulness in the reclamation program. This classification system has been defined and adopted by the Alberta Soils Advisory Committee, based on various edaphic parameters. Only topsoil rated as good or fair is selectively salvaged. A second variety of reclamation material, regolith, is salvaged during the mining operations. It is a lower quality material, typically high in coarse fragment content, mined from the upper benches of each pit.

Following the mining activities, the recontoured overburden is spread with a 15 cm (6 in) layer of regolith. In selected locations, high quality topsoil is placed over the regolith to a depth of 45 cm (18 in). All reforestation is restricted to the islands where a 65 cm (26 in) rooting zone is available (assuming vegetation may root at least 5 cm (2 in) into the recontoured overburden) while areas adjacent to the islands are seeded with a grass/legume forage mixture (Figure 1). In topsoil island locations where erosion may be a problem, the island is also seeded and planting locations are then scalped to reduce competition for the woody vegetation. This “Topsoil Island Concept” has the added advantage that the reforestation program can be isolated to areas where it is most likely to be successful, for example, moist low lying sites or drainages. This is consistent with preferred wildlife travel routes, therefore, fits in well with the final land use objective.

The consulting study proposed a formula for the calculation of the area of a disturbance which should be covered by topsoil islands (Figure 2). Maximum coverage is generally applied when the reclaimed area lies adjacent to a point where wildlife could normally be expected to enter (i.e. a natural drainage). Heavy concentration of islands would encourage the game to spread throughout the reclaimed area. Minimum coverage would be planned for sunny south-facing slopes where grazing would occur. Intensive coverage is seen as most important on mined areas bordered by natural forest on at least two sides. This is reflected by the two alternative formulas which may be applied to maximum or minimum cover scenarios. The 0.04 relates to the 40% cover requirement and a conversion to hectares from square meters. The 366 meters (1200 ft) relates to the maximum open (non-treed) habitat that deer and elk will utilize while 120 meters (400 ft) has been suggested as a minimum. These figures were drawn from work conducted by Thomas, et. al. on elk and mule deer habitat in the Blue Mountains of Oregon and Washington. Applying these formulas, topsoil islands would cover between 0% and 30% (average about 17%) of the disturbed surface. The remainder of the required 40% cover is obtained through utilization of...
Typical Root Zone Profiles

A. Topsoil Island Early Development
- Engelmann Spruce Seedling
- Deciduous Shrub (from cutting)
- Lodgepole Pine Seedling

High Quality Topsoil 45 cm

Total Available Rooting Depth 65 cm

Regolith 15 cm
Recontoured Overburden

B. Regolith Area Between Islands
- Grass-Legume Cover Crop
- Regolith 15 cm
- Recontoured Overburden
FORMULA FOR CALCULATION OF TOPSOIL ISLAND

1. **MINIMUM COVER** - AREAS NOT INTENSIVELY USED BY WILDLIFE

   I) FOR A DISTURBED AREA FORESTED ALONG BOTH EDGES

   For every 1000 m of length
   \[0.04 \text{ (average width - 366m)}\]

   II) FOR A DISTURBED AREA FORESTED ALONG ONE EDGE

   For every 1000 m of length
   \[0.04 \text{ (average width x 1/2 - 183m)}\]

2. **MAXIMUM COVER** - AREAS INTENSIVELY USED BY WILDLIFE (DRAINAGES, TRAVEL CORRIDORS, CLOSE TO ESCAPE TERRAIN)

   I) FOR A DISTURBED AREA FORESTED ALONG BOTH EDGES

   For every 1000 m of length
   \[0.04 \text{ (average width - 120m)}\]

   II) FOR A DISTURBED AREA FORESTED ALONG ONE EDGE

   For every 1000 m of length
   \[0.04 \text{ (average width x 1/2 - 60m)}\]
the natural forest bordering the disturbances. Figure 3 shows a typical reclaimed area, indicating the approximate location and configuration of the topsoil islands. Notice the staggering of the islands to form travel corridors adjacent to the natural forest land. In a mined area wider than the one illustrated, a central island would be required which would be a minimum of 2.5 ha (6.2 ac).

SITE PREPARATION ACTIVITIES

Two timber types are predominant on the minesite. Lodgepole pine stands are common on low elevation, well-drained sites while Engelmann spruce-Alpine fir associations are the norm closer to timberline. Under Section 148 of the Timber Management Regulations, salvage of timber is required when 25 or more green coniferous trees exceeding 15 metres (50 ft) in height are encountered on a hectare of land. If a salvage operation is required, timber is skidded, decked and hauled to St. Regis (Alberta) Ltd. in Hinton for sawlog or pulp production. Costs, including a reduction for the revenue received from the sale of the wood, is in the range of $2500/ha ($1000/ac). Should an area contain no timber which is of merchantable size, the area may be cleared with a brush rake and piled for burning. This method costs only $1250/ha ($500/ac).

As previously mentioned, all surficial soils classified as good or fair by the pedological survey are selectively salvaged in sufficient quantities to construct the topsoil islands after mining.

In the salvage of upland soils, stripping operations are normally performed by a dozer pushing downhill to a loading ramp. The dozers select the duff layer, with the A and B horizons of the luvisols and brunisols which constitute the best available topsoils. The C Horizon is typically high in coarse fragments and forms an easily distinguishable separation point for the dozer operator. Topsoil is loaded by a front-end loader or hydraulic backhoe. Scrapers have been utilized as an alternative on relatively flat areas with shorter hauls.

Organic soils are found in poorly drained low lying basins. Salvage of this type of material is normally conducted by hydraulic backhoe or dragline. The areas must be drained initially with a network of ditches and roads often have to be "rocked in" to allow the trucks to access the loading areas. The black organic material is easily distinguished from the gray gleysolic clay which underlies it.

The topsoil is then trucked to a stockpiling site. Whenever possible, topsoil salvage and placement operations are combined. The single handle operation is much more economic as it eliminates the need to
TYPICAL RECLAIMED AREA
PLAN VIEW

TYPICAL TOPSOIL ISLANDS
(opposite sides staggered)

approximately 360 metres

NATURAL FOREST LAND

GRASS/LEGUME FORAGE CROP

5 hectares, optimum size

90 metres, ideal maximum

90 metres, maximum
reload from a stockpile at a later date. Costs may vary between $2.50 and $5.00 per m$^3$ depending on drainage of the area, distance to stockpiles and type of equipment utilized.

Regolith, as described earlier, is a lower quality reclamation material salvaged during the mining operations. It is normally extracted from the upper most bench and is typically parent material on which upper horizon soil formation takes place. The shovels have been able to show a high degree of selectivity despite the large bucket size and the blasting operations which precede the overburden removal.

**THE RECLAMATION PROGRAM**

During mining operations, discarded overburden is dumped at the angle of repose in waste dumps ($37^\circ$) or as part of a backfill operation for a previous pit. Current governmental regulations call for the resloping of these dump faces to an angle not exceeding $27^\circ$. Large dozers are employed to cut material from the crest and fill the toe.

Costs on resloping are highly dependent on seasonality and dump configuration. Dumps constructed in offset lifts reduce the amount of material which has to be re-dozed. Average recontouring costs at Cardinal River Coals would be in the neighbourhood of $13,600/ha ($5,500/ ac) and is easily the single most expensive reclamation activity constituting 54 cents of each reclamation dollar.

Regolith is then placed on the resloped surface to a depth of 15 cm (6 in). The texture of the material often makes it difficult to spread evenly and, on sloped areas, the dozer has problems backing up the slope without spinning tracks.

Topsoil islands are sized and located using the criteria explained earlier using a 45 cm (18 in) cap of topsoil material over regolith. Material is hauled in, generally by truck although scrapers have been utilized, and spread by dozer to the required depth.

Revegetation is normally carried out immediately after placement of regolith. The entire reclaimed surface is seeded, even if topsoil islands are to be constructed at a later date to provide interim erosion protection. In situations where the islands must be established on a slope, the topsoil is also revegetated. Due to the topography of the area, the majority of the seeding is done with a hydroteeder. A small dozer equipped with a cyclone seeder dragging a set of harrows has also been used on some of the flatter areas with excellent success.
Figure 4 indicates a typical seed mix. A balance of sod formers and bunch grasses gives a good variety of forage species. A strong legume component provides additional forage diversity as well as the important element of nitrogen fixation for long range substrate improvement. It is important to note that the seed mix proportion is set by seed number as opposed to weight or volume. A pound of Canada Bluegrass, for example, contains approximately 2.5 million seeds, while a pound of Intermediate Wheatgrass contains only 104,300 seeds. Equal weights of the two would yield 24 times as much Bluegrass.

When applied with the hydroteeder, the seed mix is combined with:

i) wood fibre or cellulose mulch at 560 to 1680 kg/ha (500 to 1500 lb/ac)
ii) fertilizer — a combination of ammonium nitrate (34-0-0) and ammonium phosphate (11-54-0)
iii) water
iv) legume innoculant
v) an organic binder for steep slopes.

During the summer of 1982, a planting program was conducted on the topsoil islands. Engelmann spruce and Lodgepole pine were supplied through a contract nursery from seed collected on-site. The two species were planted alternatively at a stocking rate of 1,335 seedlings/ha (540 seedlings /ac).

In 1983, the areas will be implanted with the varieties of native deciduous shrubs shown in Figure 5. They, too, are propagated by contract nurseries from seed and vegetative cuttings collected from the minesite area.

In order to evaluate the success of the plantings, a reforestation monitoring program has been initiated. Figure 6 is a simplified example of a "Plot Assessment Form". Plot centre is marked by a steel rod from which a 5m (16 ft) chain is extended. Each seedling within the plot is evaluated for the previously mentioned parameters to provide an indication of success and growth rates. Plot areas, to date, are equivalent to approximately 5% of the total reforested area.

Seedlings received from the nursery are stored and hardened in a shade-house. Shadecloth is installed during the summer as well as an automatic watering system. The lathe and chicken wire around the base keeps the rodents from getting to the seedlings — heavy losses, particularly in the stock of Lodgepole pine, have been experienced in the past when the area is unprotected.
**Figure 4**

**Revegetation Mix**

<table>
<thead>
<tr>
<th>Mix Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sod Grasses</td>
<td>40%</td>
</tr>
<tr>
<td>Creeping Red Fescue</td>
<td></td>
</tr>
<tr>
<td>Canada Bluegrass</td>
<td></td>
</tr>
<tr>
<td>Durhard Fescue</td>
<td></td>
</tr>
<tr>
<td>Bunch Grasses</td>
<td>25%</td>
</tr>
<tr>
<td>Intermediate Wheatgrass</td>
<td></td>
</tr>
<tr>
<td>Crested Wheatgrass</td>
<td></td>
</tr>
<tr>
<td>Tall Fescue</td>
<td></td>
</tr>
<tr>
<td>Legumes</td>
<td>35%</td>
</tr>
<tr>
<td>Rambler Alfalfa</td>
<td></td>
</tr>
<tr>
<td>Alsike Clover</td>
<td></td>
</tr>
<tr>
<td>Sainfoin Cicer</td>
<td></td>
</tr>
<tr>
<td>Milkvetch Sweet CLOVER</td>
<td></td>
</tr>
</tbody>
</table>
### DECIDUOUS SHRUB VARIETIES UTILIZED

CARDINAL RIVER COALS LTD.

<table>
<thead>
<tr>
<th>PROPAGATED BY:</th>
<th>SEED</th>
<th>HARDWOOD CUTTING</th>
<th>ROOT CUTTING</th>
<th>SOFTWOOD CUTTING</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>1. PREFERRED VARIETIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salix spp. - Willow</td>
</tr>
<tr>
<td>Alnus crispa - Green Alder</td>
</tr>
<tr>
<td>Populus balsamifera - Balsam Poplar</td>
</tr>
<tr>
<td>Populus tremuloides - Aspen</td>
</tr>
<tr>
<td>Potentilla fruticosa - Shrubby Cinquefoil</td>
</tr>
<tr>
<td>Rosa woodsii - Common Wild Rose</td>
</tr>
<tr>
<td>Shepherdia canadensis - Canadian Buffaloberry</td>
</tr>
<tr>
<td>Elaeagnus commutata - Wolf Willow</td>
</tr>
<tr>
<td>Sambucus melanocarpa - Black Elderberry</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. SECONDARY VARIETIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctostaphylos uva-ursi - Kinnikinnick</td>
</tr>
<tr>
<td>Betula pumila - Swamp Birch</td>
</tr>
<tr>
<td>Cornus stolonifera - Red Osier Dogwood</td>
</tr>
<tr>
<td>Juniperus communis - Ground Juniper</td>
</tr>
<tr>
<td>Juniperus horizontalis - Creeping Juniper</td>
</tr>
<tr>
<td>Ledum groenlandicum - Common Labrador Tea</td>
</tr>
<tr>
<td>Menziesia glaberra</td>
</tr>
<tr>
<td>Rubus strigosus - Wild Red Raspberry</td>
</tr>
<tr>
<td>Symphoricarpus albus - Snowberry</td>
</tr>
<tr>
<td>Viburnum trilobum - Highbush Cranberry</td>
</tr>
</tbody>
</table>
REFORESTATION MONITORING
SAMPLE PLOT CARD

PLOT LOCATION

<table>
<thead>
<tr>
<th>TREE #</th>
<th>SPECIES</th>
<th>PLANTED OR NATURAL</th>
<th>CONTAINER TYPE</th>
<th>CURRENT AGE</th>
<th>TOTAL HEIGHT (cm)</th>
<th>LEADER LENGTH (cm)</th>
<th>ROOT COLLAR DIAMETER (mm)</th>
<th>VIGOR</th>
<th>CAUSE OF DEATH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SEEDLING LOCATION WITHIN THE PLOT

OVERALL PLOT EVALUATION:

RADIUS - 5 m
AREA - 78.54 m²
CONCLUSION

To date, our reclamation efforts have been rewarded through a constant increase in the resident Rocky Mountain Bighorn Sheep herd. During the 1982 rut, our population census indicated a total of 213 individuals made up of:

- 46 Lambs
- 123 Ewes
- 48 Rams (15 over 7 years old)

Annual population surveys will continue to determine long range trends in the population structure. Future plans will diversify the census to include other ungulate species. These surveys will provide a solid assessment of the success of the reclamation program in achieving the final land use objective.
REFERENCES

Soil Quality Criteria Subcommittee (Stage II) - 1981.
"Soil Quality Criteria for Reclamation of Disturbed Lands".
Prepared on behalf of the Alberta Soils Advisory Committee -
Alberta Agriculture, pp 52.

"Guidelines for Maintaining and Enhancing Wildlife Habitat in
Forest Management in the Blue Mountains of Oregon and Washington",
pp 452 - 476, Transactions of the 41st North American Wildlife and
Natural Resources Conference.

"Literature Review of Considerations for Reclaiming Lands as Wild-
life Habitat".
Report prepared by Cotton Consultants Ltd. as requested by Cardinal
River Coals Ltd. pp 43.