CONCEPTUAL RECLAMATION PLANNING AND THE DEVELOPMENT OF RESULTS-BASED STANDARDS AT ELK VALLEY COAL'S ELKVIEW OPERATIONS

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ABSTRACT

In the winter of 2002/2003 Elk Valley Coal, Elkview Operations updated the 20-year reclamation plan that was prepared in 1983 when the mine was operated by Westar Mining Ltd. The resulting conceptual reclamation plan provides a vision for the horizontal distribution, vertical structure, and species composition of the plant communities that will be established. Clear, measurable and objective results-based standards for assessing reclamation success were developed and incorporated into the plan. Implementation of the conceptual reclamation plan will ensure that end land use and reclamation objectives are achieved, reclamation activities are progressive, and that the reclamation program remains flexible and responsive to new ideas and information.

INTRODUCTION

In the winter of 2002/2003 Elk Valley Coal, Elkview Operations updated the 20-year reclamation plan that was prepared in 1983 when the mine was operated by Westar Mining Ltd. The update incorporates current information and was prepared to ensure that end land use objectives are achieved and to provide direction for reclamation planning and implementation into the future.

Reclamation Permit C-2 specifies a wildlife end land use for the reclaimed land at Elkview Operations at Sparwood, B.C. Elk (*Cervus elephus nelsonii*) and mule deer (*Odocoileus hemionus*) continue to be the "featured species" for reclaimed habitats. However, additional animal species are expected to benefit from the proposed reclamation treatments (Westar Mining Ltd. 1983).

The specific objectives that were determined to be critical to the success of the plan were:

1. Ensure that reclaimed slopes are geologically stable;
2. Reduce and control surface erosion by water and wind and
3. Maintain acceptable water quality standards;
4. Create acceptable habitats that, in combination with habitat adjacent to the mine property, will continue to support viable populations of elk and mule deer;

5. Create conditions that will promote the re-establishment of basic ecological functions (biogeochemical cycling);
6. Introduce habitat elements and structure that will provide habitats for a range of wildlife species in addition to elk and mule deer;
7. Create conditions that will allow for re-colonization by native plant species;
8. Monitor, within an adaptive management framework, to ensure that reclamation treatments are effective and that program objectives are achieved; and,
9. Provide a framework for life of mine costing that is easily adjusted to changing mine plans.

Reclamation Philosophy

The reclamation plan focuses on establishing geologically stable landscapes that support a mosaic of ecosystems because this approach will provide the widest range of options for the future (NRC 1981). The plan targets diversity at all levels of detail including landscape, site and micro-site. Plant species composition and establishment, spatial arrangements of plantings (size, shape, and distribution), introduction of a range of habitat elements (e.g., snags, brush piles), and maintenance or establishment of special habitats (e.g., seeps, riparian areas) will all be considered when assessing the potential to promote diversity. Ecologically based reclamation treatment units (RTU's), a simple form of capability unit (Smyth and Deardon 1998), form the link between this conceptual plan and operational treatments.

RECLAMATION PLAN CONCEPTS AND APPROACHES

Targeting Habitat Diversity

Although elk and mule deer are the featured species for Elkview's reclamation program, the reclamation plan encourages the re-establishment of local populations of a wide range of vertebrate and invertebrate species. The reclamation plan does not focus on one or two specific habitat elements for a species (e.g., distance to hiding cover) since all of the important elements must be met for an area to be used in specific seasons. Also, the optimal balance of various habitat elements to promote specific combinations of wildlife species is not known (Bunnell et al. 1999).

Elkview believes the key to successfully achieving a wildlife end land use will be establishing a variety of habitats along with specific habitat elements that are known to be important in forested settings (Bunnell et al 1999). Elkview's reclamation program will not provide all of the habitat requirements for all of the vertebrate and invertebrate species that were present prior to mine development. Habitat that will be created at the mine needs to be considered in the context of the surrounding undisturbed habitats (Black, *et al* 2001) and within the financial context of what can be expected on severely disturbed sites.

RECLAMATION TREATMENTS AND RATIONALE

The reclamation plan recognizes that accomplishing the habitat objectives will require adhering to a number of basic ecological principles along with the application of specific treatments and treatment combinations that are effective and consistently successful. This functional approach to reclamation is appropriate because it aims at establishing desirable physical, chemical and biological processes (NRC 1981, Smyth and Dearden 1998) rather than simply replacing soil horizons or native vegetation.

Reclamation Treatment Units (RTU's)

Reclamation treatment units were delineated on the basis of the climatic and site characteristics that are believed to have the strongest influence on ecological processes and they reflect anticipated differences in the development of plant communities, productive soils, and wildlife habitat. The specific criteria are biogeoclimatic subzone, slope angle class, and aspect class. Figure 1 shows how the three factors were considered in defining the RTU's. Slope and aspect classes (Figure 2) were derived based on past experience with establishing vegetation on a range of post-mining conditions at Elkview Operations.

<table>
<tr><th rowspan="3">Biogeoclimatic Unit</th><th rowspan="3">Aspect Class</th><th colspan="4">Slope Class</th></tr>
<tr><th>Steep</th><th>Moderate (resloped)</th><th rowspan="2">Variable (flat-rolling, complex)</th><th rowspan="2">Steep, Untreated</th></tr>
<tr><th>(28°+)</th><th>(15° - 28°)</th></tr>
<tr><td rowspan="3">ESSF dk</td><td>Cool</td><td rowspan="2">H - 1</td><td>H - 2</td><td rowspan="3">H - 4</td><td rowspan="6">SU - 1</td></tr>
<tr><td>Neutral</td><td rowspan="2">H - 3</td></tr>
<tr><td>Warm</td></tr>
<tr><td rowspan="3">MS dk</td><td>Cool</td><td rowspan="2">L - 1</td><td>L - 2</td><td rowspan="3">L - 4</td></tr>
<tr><td>Neutral</td><td rowspan="2">L - 3</td></tr>
<tr><td>Warm</td></tr>
</table>

Figure 1. Reclamation treatment unit stratification rationale showing nine RTU's for the Elkview property.

Reclamation treatment units are simplified capability units that provide the framework for developing treatment regimes that focus on the specific ecological factors that are limiting to the establishment of target plant communities including grasses, forbs, trees, and shrubs. They also provide a formalized framework for adaptive management decision making by providing the context for establishing research trials and operational monitoring programs that will assess reclamation program assumptions and determine whether program objectives are achieved. Application of the RTU framework over the mine site will provide a focus for making many of the assessments that will be required to evaluate and improve reclamation success.

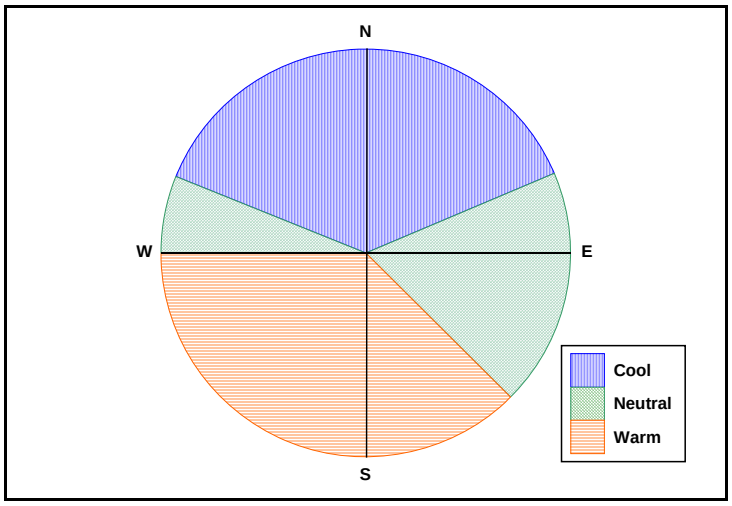

Figure 2. Aspect classes used in stratifying reclamation treatment units.

The Soil System

Re-establishing the productivity of reconstructed mine soils is an important objective for ensuring that plant communities become self-sustaining. Resloping dumps and applying treatments that will accelerate the re-establishment of biological activity are the focus of the reclamation plan. Resloping treatments will ensure that dumps are geologically stable and redistribute fines that are required for successful vegetation establishment. Rebuilding the biologically active components of the soil resource is required for promoting self-sustaining plant communities (Whitford and Elkins 1986). The most critical component is soil organic matter due to its importance for increasing water holding capacity, contribution to the nutrient pool, initial formation of soil structure, and as a substrate for a wide array of soil organisms (Haigh 2000, Munshower 1994, Whitford and Elkins 1986). The most efficient approach to increasing organic matter is the establishment of a productive vegetation cover which will also help to improve soil infiltration capacity and reduce surface erosion (Naeth *et al.* 1991).

Revegetation

Seed mixes were designed with consideration for aspect, slope, biogeoclimatic unit, and proven success for rapid establishment at Elkview. Agronomic species have proven performance due to their quick establishment that reduces surface erosion concerns and acceptable biomass production to increase organic matter content of surface soil horizons. Legumes are included in all mixes due to their nitrogen fixing capability and to improve overall biomass production. Przeczek and Colombo (2001) found that seed mixes similar to those proposed in this plan that were established from 1980 – 1984 on the Harmer reclaim area have allowed for the reinvasion of native plant species, although they contribute relatively small amounts to the cover and biomass. Strong (2000) found similar results on 20 year old reclaimed sites at the Coal Valley Mine in west central Alberta. The plan calls for the establishment of native species islands that will function as seed sources for the long term re-establishment of native plant

dominated ecosystems where the potential for successful initial establishment is high and surface erosion concerns are low.

Establishing trees and shrubs is an important component of the reclamation plan. They will contribute to diversity at the site and landscape level and provide habitat characteristics and elements that influence a wide range of vertebrate and invertebrate species. Tree and shrub species that are native to the mine site and surrounding area have been selected for the reclamation program. Varying the planting density for various species will create conditions that approximate the spacing found in undisturbed plant communities.

Spatial Diversity (Vertical and Horizontal)

Parmenter and MacMahon (1992) suggest that deliberate inclusion of both horizontal and vertical heterogeneity in vegetation architecture will result in a landscape mosaic that is more conducive to the development of a highly diverse, self-perpetuating faunal community. Vertical and spatial diversity will be promoted at Elkview by applying general guidelines for the proportion of each RTU that will be planted to either grass and legume dominated plant communities or tree and shrub dominated plant communities. Diversity will also be promoted by vary patch size, shape and connectivity for each of the plant communities and by planting stands that range from pure coniferous through mixed coniferous-deciduous to pure deciduous. Shrubs will be intermixed with trees, planted adjacent to tree patches, and planted as separate shrub dominated islands. All plantings will be a mix of species.

Additional Habitat Elements

Habitat elements including standing dead trees, brush piles, rock piles, downed wood, and piles of fine spoil material create unique habitats that are used by specific vertebrate species (Thomas *et al.*1979, Bunnell *et al.* 1999). Most of the information available on the importance of these habitat elements has been generated in the context of their response to timber harvesting activities in temperate forests. There is no information regarding the optimal number or distribution of many of these habitat elements in reclaimed environments or their relative importance. However, they can be created relatively easily during reclamation activities and will add to the diversity of potential wildlife habitats. The planned intent is to create them at a variety of densities and distributions and then to monitor wildlife use and apply the findings to modify prescriptions as additional information becomes available.

RECLAMATION TREATMENT UNIT REGIMES

RTU regimes include a basic set of treatments that will be applied wherever a significant area of a specific RTU occurs in the landscape. Variations in RTU treatment regimes will be required to account for availability of seed mixes, planting stock (trees and shrubs), or additional habitat structures. Each RTU is defined by its general management intent, specific objectives, and, in some cases, unique management issues. Management intent is framed with a focus on the featured species (elk and mule deer). However, the mosaic of habitats over the mine site should be considered when evaluating the

overall plan objective for providing a wide range of wildlife habitat diversity. Table 1 defines specific RTU objectives and Figure 3 provides an example of the prescription details for one RTU.

Table 1. Reclamation treatment unit description and objectives.

RTU	Description	Spatial Diversity Objectives (% of RTU)						Additional Structural Elements	Productivity Objectives (kg/ha)		
		Tree and Shrub Dominated			Grass and Forb Dominated						
		Tree	Shrub	Total	Agronomic	Native	Total		Elev. (m)	Target*	Min.**
H – 1	High Elevation, Steep Slopes, Warm and Neutral Aspects	0 – 5	0 – 5	0 – 5	95 – 100	0	95 – 100	No	> 1850	500	250
									1650-1850	A – 2000 N – 1000	A – 1000 N – 500
H – 2	High Elevation, Moderate and Steep Slopes, Cool and Neutral Aspects	40 – 55	10 – 30	50 – 70	25 – 45	5	30 – 50	Yes	> 1850	500	250
									1650-1850	A – 2000 N – 1000	A – 1000 N – 500
H – 3	High Elevation, Moderate Slopes, Warm Aspects	5 – 10	5 – 10	10 – 20	75 – 85	5	80 – 90	Yes	> 1850	500	250
									1650-1850	A – 2000 N – 1000	A – 1000 N – 500
H - 4	High Elevation, Flat – Rolling Complex Terrain, Variable Aspects	15 – 20	15 – 20	30 – 40	50 – 60	10	60 – 70	Yes	> 1850	500	250
									1650-1850	A – 2000 N – 1000	A – 1000 N – 500
L – 1	Low Elevation, Steep Slopes, Warm and Neutral Aspects	0 – 5	0 – 5	0 – 5	95 – 100	0	95 – 100	No	< 1650	A – 3000 N - 1500	A – 1500 N – 500
L – 2	Low Elevation, Moderate and Steep Slopes, Cool and Neutral Aspects	40 – 55	10 – 30	50 – 70	25 – 45	5	30 – 50	Yes			
L – 3	Low Elevation, Moderate Slopes, Warm Aspects	5 – 10	5 – 10	10 – 20	75 – 85	5	80 – 90	Yes			
L - 4	Low Elevation, Flat – Rolling Complex Terrain, Variable Aspects	15 - 20	15 - 20	30 - 40	50 - 60	10	60 - 70	Yes			
SU - 1	Steep, Untreated	Includes highwalls footwalls, rock, and talus. These areas will be seeded after they have been left to weather for a few years and should be considered non-productive.									

Notes:

*Target productivity represents the average above ground dry weight productivity that will be achieved over the area in each RTU averaged on a property-wide basis five years after the cessation of fertilizer treatments.

Numbers preceded by an A are for agronomic legume dominated swards (>50% ground cover of legumes).

Numbers preceded by an N are for non-agronomic and native swards (≥50% ground cover of agronomic grasses or native species).

**No area larger than 2 hectares will have average above ground dry weight biomass levels below this minimum.

RESULTS BASED STANDARDS

Elkview Coal Corporation believes that there is a need to develop clear, measurable and objective criteria that can be used to set specific results based standards for assessing reclamation success. Table 2 provides a summary of the results based criteria and specific indicators that Elkview will use to assess reclamation success. There are additional criteria that can be used to support the results obtained when assessing results based standards but they cannot be used to define standards because they are subjective or there is not enough information currently available.

Table 2. Results based criteria and indicators of reclamation success at Elkview Coal Corporation.

Criteria		Indicators of Success
Geological Stability		Progressive annual dump resloping No significant dump failures
Minimize and Control Surface Erosion		No active rills > 30 cm deep and 30 cm wide 3 years after resloping treatments have been completed Provincial air quality standards (fugitive dust) Provincial water quality standards (TSS)
Vegetation	Productivity	Productivity targets specified in Table 1 for grass and legume swards
	Spatial Diversity	Spatial (area based) objectives outlined in Table 1 Variety in patch size distribution
	Species Diversity	Establishment of native species islands as outlined in Table 1 Successful establishment and acceptable growth of native trees and shrub species as outlined in Table 1

CONCLUSIONS

Elkview Operations believes that reclamation efforts that are focused on ecological factors that directly affect biogeochemical cycles and ecological diversity will provide for a mosaic of self-sustaining plant communities. Targeting diversity at all levels of detail including plant species composition, spatial arrangements of plantings and introduction of a range of habitat elements will ensure that an effective mosaic results. Implementation of the conceptual reclamation plan will ensure that end land use and reclamation objectives are achieved, reclamation activities are progressive, and that the reclamation program remains flexible and responsive to new ideas and information.

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