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ENVIRONMENTAL MONITORING TOWARD END LAND USE OBJECTIVES AT ELKVIEW COAL

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ABSTRACT

Three land-based parameters, land capability, land status and vegetative productivity, were selected to provide the basis for monitoring and modelling the overall productivity of the prime elk winter ranges on this south-east coal mine property. Three animal-based parameters, elk behaviour, reproductive success and winter diet quality, were monitored to provide a context for the interpretation of the land-based data. This approach is expected to provide, on an annual basis, information that demonstrates achievement of the prescribed end land use as wildlife habitat. This approach is also used to demonstrate the maintenance of wildlife habitat values while active mining is underway. To date, 39 km^2 of Class 1 elk winter range have been included in the ongoing assessment.

A method to calculate and model the amount of winter forage available for elk was developed (the Model). The land status combined with forage productivity provides information on the total number of Animal Unit Months (AUMs) of winter *grazing* that is available in the Class 1 winter range areas. This calculation was used to show that there were 2,150 AUMs of grazing available in 1969, prior to extensive surface development and 2,766 AUMs in 1999. Productivity losses from ongoing development have been offset by gains from reclamation and enhancement. When long range mining and reclamation plans are complete, the Model can be used to project AUMs available at any point throughout the mine development.

INTRODUCTION

The Elkview Mine, operated by Elkview Coal Corporation (ECC), a fully owned subsidiary of Teck Corporation, is located on 255 km^2 (25,500 hectares) of privately owned land in south-eastern British Columbia. The mine is in the Elk River Valley, part of the Columbia River basin, approximately 3 kilometres east and within the municipal boundaries of the District of Sparwood. Coal mining has occurred on the property for over 100 years, with large scale surface coal mining since 1969.

The entire mining development includes 3,291 ha of active area, of which 491 ha have been reclaimed, with a net disturbance of 2,800 ha or approximately 11% of the property. This disturbance can be broadly classed into two types of areas, summer range and winter range for ungulates, with elk as the species of primary interest. To date, the focus has been on developing the assessment for prime, Class 1 winter ranges but the Model can be applied to all classes of winter and summer ranges with separate models for each. Within the 3,900 ha of Class 1 winter range there are 541 ha of disturbance related to active mining. The Model and associated monitoring program was

developed initially to demonstrate the adequacy of complex and numerous wildlife enhancement programs but will ultimately have application to assessing the achievement of end land use objectives.

The Model described in this paper is a tool to integrate land status and vegetation productivity data into a meaningful index to monitor the past, present and future ability of the property to sustain the highly visible ungulate herds dependent on the area for winter habitat. There are however, 6 components to the overall monitoring program. These are shown conceptually in Figure 1 and include 3 animal-based indices and 3 land and vegetation-based indices. The animal-based indices are not discussed in detail in this report but are fully documented in ECC's *Annual Reclamation Report.*

Land status (disturbed, undisturbed, reclaimed or mitigated) with associated vegetation productivity information provides a direct measure of the success and adequacy of reclamation and enhancement programs that have been undertaken concurrently with surface disturbance for mining. The overall effects of these activities can be evaluated in the context of the animal-based indices, reproductive success and winter diet quality as measured by fecal protein. Animal behaviour studies were completed separately involving years of radio collar and tagged animal tracking.

It is very important that the monitored components be, as directly as possible, a measure of activities under the control of the mining company. Figure 1 conceptually shows the relationship between the 6 components by the amount of overlap with the land base. A seventh component, the total number of animals on the property, was rejected as an index because this number is primarily a reflection of natural population cycles and wildlife management policies of the provincial government. In other words, the population could substantially increase or decrease regardless of the presence of the mine. The land and vegetation parameters used in the Model described in this report are:

- Land status (undisturbed, disturbed, reclaimed or managed for wildlife enhancement) is assessed each year with detailed records of changes in disturbed, reclaimed or enhanced areas tracked. A different vegetative productivity is assigned to each category. The areas continue to be refined as historical data on older reclaimed sites is recaptured and included in the overall calculations.
- Vegetative productivity is operationally defined for the Model as the total available forage for elk. Standard sampling techniques are used to measure kilograms of dry weight of live, standing herbaceous grasses and forbs in a sample unit area. This is consistent with range management techniques developed for the agriculture industry. This information is used to calculate Animal Unit Months (AUMs); the kilograms of forage required by an "animal-unit" (cow and calf) for one month based on a known forage requirement. Shrubs are measured as percent cover in a sample area on a periodic basis and assessed separately. Shrubs are estimated to account for 5% of caloric intake and the data is not in a form that can readily be included with the biomass data.
- Land Capability is a function of several parameters including vegetative cover, elevation, slope, aspect and soil type. These change with the initiation and completion of mining plans, often extending over long periods of time. Work on development of this information started in 1998 and is still underway for pre-surface mining

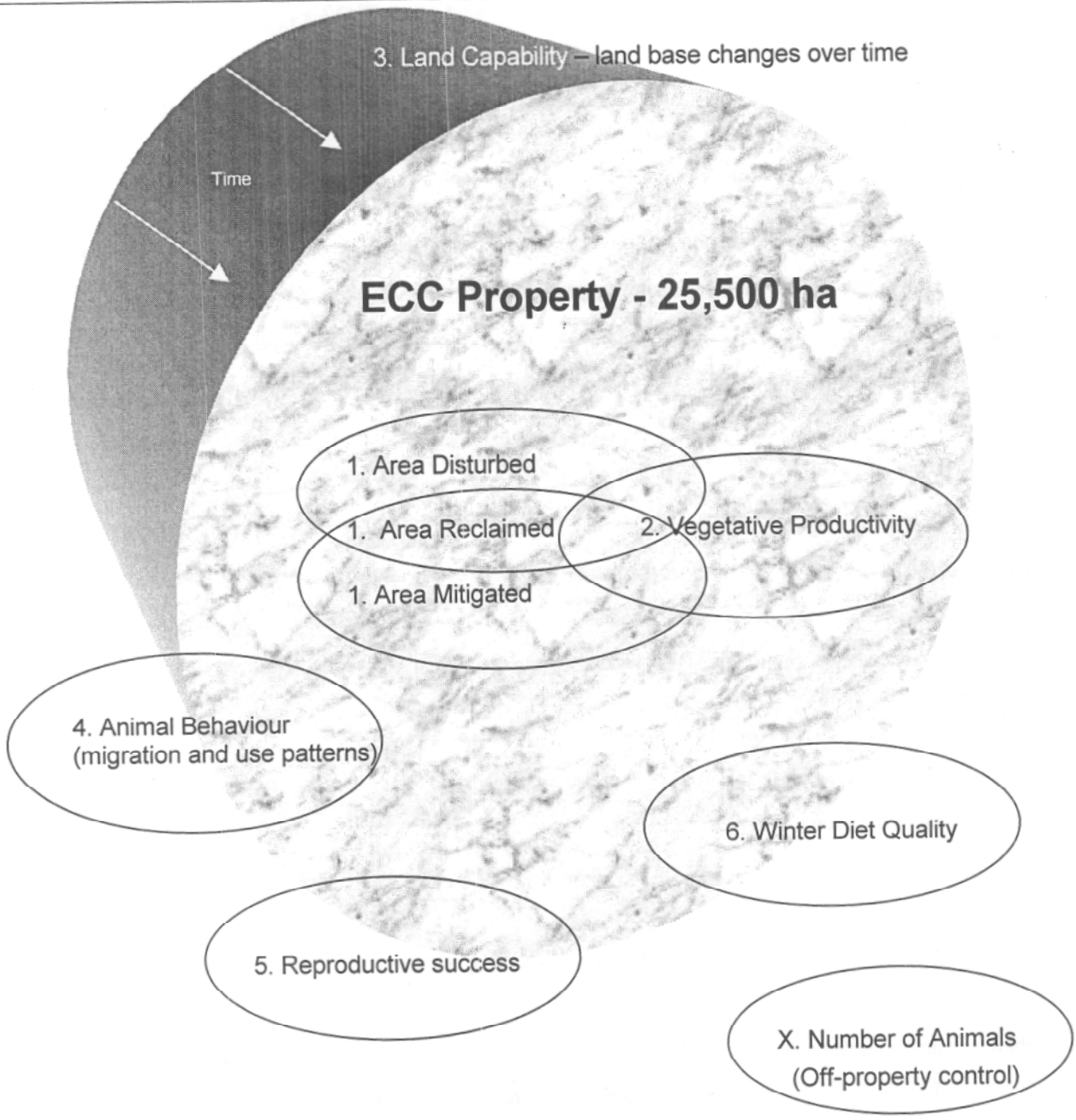

Figure 1. Conceptual Framework of Property-Wide Productivity Program Components. The diagram shows the degree of relatedness of the components by the degree of overlap of the areas. The large shaded circle represents ECC land, over time. Issues partially outside of ECC control are shown as partially outside the shaded circle.

(circa 1969) and after mining to the year 2030. The results will eventually be incorporated into the overall program.

LAND STATUS

Tracking the total area in each land status category is the most direct measure of ECC land management programs and is the first step ii calculating the total amount of forage available. Areas felling into each of the following categories can be readily tracked, and predicted as a part of ongoing mine planning:

- Areas of undisturbed soil
  - wildlife enhancement areas
  - natural areas including open and forest covered areas
- Areas of disturbed soil
  - active mining area
  - reclaimed areas

Disturbed soils, in this case, means completely removed by the process of mining and in a state of being re-established by reclamation techniques. Monitoring has shown that substantial vegetative production starts in the second year of growth. An area is generally considered productive for modelling purposes in its second year.

VEGETATIVE PRODUCTIVITY

Vegetation biomass monitoring provides a quantifiable and generally reproducible measure of the overall productivity of the property towards the identified end land use objective of wildlife habitat. Vegetative productivity assessments are completed each year on reclaimed, enhanced and undisturbed areas, in the prime winter range and adjacent areas. However, it is not necessary or feasible, given the large size of this property, to sample each sub-component of the entire winter range each year. Sampling is periodic at each of the transects located throughout the approximately 39 km^2 area of winter range. Productivity data is collected most frequently in areas where rapid change is anticipated; such as in areas that are undergoing reclamation or enhancement. Undisturbed areas change at a very slow rate, if at all, as shown by past monitoring, and are therefore monitored less frequently once baseline data is established.

Field studies on ECC property endeavoured to estimate shrub biomass by clipping in order to combine the data with measures of grasses and forbs (Simmerling, 1984). Clipping shrubs has been deemed undesirable, ineffective and difficult to interpret. Estimating the percent cover of shrubs is now the standard methodology for describing and rating suitability/capability of ungulate forage in habitat (Luttmerding, 1990). Changes in the amount of shrubs, and in species composition occurs at a slower rate than productivity changes in grasses and forbs therefore, species composition is also sampled less frequently.

The overall monitoring program is in a developmental stage and a number of new sites were established in 1999 to improve the breadth of the Model application. In due course, the Model can be applied to the Class 2 and 3

(poorer) winter ranges as well as the summer range portions of the property. Productivity totals for each class have to be assessed separately as they are not directly comparable. In other words, Class 1 AUMs are not equivalent to a specified number of Class 2 AUMs.

The amount and location of forest cover on winter range is important for thermal-cover for wildlife during cold weather. The land capability study will determine changes in thermal cover as a result of forest growth. Timber harvest is monitored in the Elkview and Crestbrook Forest Industries (CFI) managed forests on ECC land and recorded annually. The release of under-story vegetation, post forest harvest, has been well documented to enhance forage availability for ungulates. The productivity changes in the Harmer Wildlife Enhancement Block, on ECC property confirm this. CFI and ECC are working together to manage this aspect of the property due to the dual nature of the ownership (trees belong to CFI, land belongs to ECC).

During the Government Agencies' review of the Model development, concern was expressed regarding the utility and comparability of reclaimed vegetation to vegetation from undisturbed sites, from a nutritional perspective. To address this concern, vegetation from 4 undisturbed sites and 9 reclaimed sites (old and recent) were assessed in August 1999. Plant tissue analysis was conducted for digestible nutrients, digestible energy and protein (Interior Reforestation, 2000).

The protein data summarised in Table 1, shows that reclaimed vegetation is generally similar to, or better than, vegetation from undisturbed sites. Forbs from all reclaimed sites were higher in protein than any of the undisturbed sites. Grass from reclaimed sites and native sites were very similar. The grass in the native Erickson forest under-story was the highest at 11.5% followed by grass from reclaimed areas of the Bodie mined rock pile at 11.2%.

Table 1. Comparison of Protein Content in Vegetation from Undisturbed and Reclaimed Sites.

Site Description (No. Sites)	**Percent Protein Content**					
	Grass			Forb		
	Mean	Minimum -	Maximum	Mean	Minimum -	Maximum
Reclaimed (9)	9.3	7.5 -	11.2	19.3	15.3 -	24.0
Undisturbed (4)	9.7	8.4 -	11.5	12.6	9.5 -	14.4

Animal	**Percent Protein Requirement**	
Cow Elk	Pregnant (Dry)	5.5
Deer	Maintenance	7 - 10
Deer	Optimum Growth	16
Domestic Cow	Pregnant (Dry)	5.9
Domestic Cow	Lactating	9.2

Habitat Enhancement

Habitat enhancement programs, first initiated in 1985, are on-going with the objective of maintaining forage and forest cover values for wildlife, concurrent with active mining. Enhancement work has been required on a proportionate "hectare of enhancement for hectare of disturbance". Unfortunately, over time, this approach has proven to be difficult to track relative to ongoing development. As well, this doesn't provide any measure of the total or cumulative achievement from enhancement work toward the overall objective of the programs. Tracking the total area treated does not permit an assessment of net habitat gains or losses. In particular, the substantial productivity gains from reclamation are ignored. All enhancement and reclamation programs are now monitored and incorporated into the productivity figures used in the Model.

Vegetation Monitoring Sites

Table 2 summarises the forb, grass and shrub productivity data over the past 5 years from all the vegetation sample sites, including those in areas enhanced for wildlife. Data in the shaded squares represents baseline information. There are 4 significant indications from this data:

- A strong similarity is evident in the undisturbed grassland sites throughout the property. As well, the productivity varies more between years than it does between sites at the north, central or southern portion of the property;
- Reclaim sites are substantially more productive than undisturbed sites, with some exceptions;
- There was no response from the native grasslands to fertilization; and,
- Forage values nearly double in each of the first two years after timber harvest, with most sites approaching undisturbed grassland productivity values within this time frame.

PROPERTY WIDE CALCULATION - MODEL

The Model uses land area and land productivity data as well as elk utilisation and consumption rates (how much a cow-calf pair eats each month) to calculate AUMs of grazing, which can be tracked over time. AUMs are calculated by multiplying the amount of forage, in kilograms per hectare (kg/ha), by the area in a given state of productivity (ha) to determine the total tonnes of forage. This number is reduced by a "utilisation factor" which is the proportion of the total forage that is eaten (animals do not usually graze a whole site to less than 2 cm.). The result is then divided by the amount of forage each cow-calf pair require in a month.

Table 2. Summary of Biomass of Grasses; and Forbs (kg/ha) and Percent Cover of Shrubs at Sample Sites throughout Prime Elk Winter Range on Elkview Coal Property.

Site No. & Polygon No.		Size	Description and Comment	Year Treated	Biomass of Forb & Grass (g/ha) and Percent cover for Shrubs (%)									
					1995		1996		1997		1998		1999	
#	#	ha			kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
West Harmer Ridge Areas														
6-Mile Pond	1	10	Clearing around ponds	1972							2,480			
C1-2	8	5	Deciduous dominant	Timber harvest 1995	267	52	481	68	918	63	1,105			
C5	9	1	Deciduous dominant reference site	none	188	62	328	92	246	124				
H1	9	4	Grassland conifer Encroachment	Timber harvest 1995	233	12	1,059	27	1,417	24				
H2	9	5	Grassland reference site	none	962	11	1,214	18	997	28	708			
CFI-1	8	5	Conifer dominant	Timber harvest 1996/7									534	
I3	8	3	South slope conifer encroachment	Conifer slash 1997	429	35	290	40	296	*30*				
J2	9	4	South slope conifer shading	Conifer slash 1997	594	40	715	37	573	*28*	530			
L1*	8	7	Conifer dominant	Timber harvest 1995	161	33	285	27	1,145	60	841			
M2	9	7	Conifer dominant	Conifer slash 1997	60	9	101	4	105	8	1,095			
Last Stand	*	-	Conifer dominant	Conifer slash 1986							482			
Hop-mans Field	*	45	No second hay crop taken	1986							1,209			
North Coarse Refuse	8	21	Reclamation	1994/97							839		1,075	0
Goddard Coarse Refuse	*	15	Reclamation	1994/99							482		1650	0

Table continued on next page.

Notes:

Shading indicates values of untreated-reference or pre-treatment areas.

Blank areas indicate no sample taken at that location and year.

Unit Ll is 37 ha. The prescribed treatment is to harvest of 20% of total unit in small patches (0.2 - 0.35 ha) every 20 years. 7.4 ha completed.

* Indicates site not in Prime (Class 1) winter range. These sites in Class 2 winter range, unless noted.

Polygons are ordered generally from the north end of the property to the south.

Table 2. (continued) Summary of Biomass of Grasses and Forbs (kg/ha) and Percent Cover of Shrubs at Sample Sites throughout Prime Elk Winter Ranges on Elkview Coal Property.

Site No. & Polygon No.		Size	Description and Comment	Year Treated	Biomass of Forb & Grass (g/ha) and Percent cover for Shrubs (%)									
					1995		1996		1997		1998		1999	
#	#	ha			kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Table continued from previous page.														
Michel Slopes Areas														
Gravel Pit	31	18	Reclamation	Various to 1999									1,537	0
Old Baldy	31	10	Reclamation	1975									590	0
Bodie1	31	-	Reclamation – angle of repose	1997/99									2,140	
Bodie8	43	-	Reclamation – angle of repose	1998									1,071	
Bodie8-T1	43	-	Reclamation – soil cover	Spring 1998							1,034		2,839	
Bodie8-T2	43	-	Reclamation – mod. soil cover	Fall 1997							3,448		2,032	
Erick-T1	*	-	Erickson Fertilization	1995-8	1,286		1,221		1,214		1,122			
Erick-T2	*	-	Erickson Fertilization	1995-8	979		1,241		949		969			
M1	47	-	Michel - Reference	none	1,229		1,332		938		993			
M2	47	-	Michel Fertilization	1995-8	1,261		1,458		852		1,095			
M3	47	-	Michel Fertilization	1995-8	1,027		933		982		976			
M4	43	-	Michel Fertilization	1995-8	1,110		1,061		1,501		1,129			
M5	43	-	Michel Fertilization	1995-8	1,089		1,181		1,185		1,367			
UC-1	Summer range		Upper C Reclamation site	Circa 1978									2,341	0
SP-T1	46	-	South Pit Reclamation Terraced	1986							2,648			
SP-T2	46		South Pit Reclamation 26^0 resloped	1986							3,659			
EE-1	57	17	E. Erickson Conifer dominant	Timber Harvest 2000									260	76
Alexander Creek Areas														
FR-1	55	5	Fir Roberts	Timber harvest circa 1995									717	92
Alex-T2	63	25	Alexander timber harvest	Timber harvest circa 1998									745	29
Alex-T1	74	160	Alexander grasslands	Cattle removal 1995									1,139	0

Assumptions Made in the Model

Any Model, particularly one of this scope, must make certain assumptions in order to extrapolate the data over the area being modelled. The effect of any violation of the assumptions is discussed where appropriate. The assumptions and rationale for this Model are:

- A decrease in forage production results in a decrease in carrying capacity of the winter range;
- Similar areas have similar productivity. Measuring vegetative productivity at a number of similar sites with very consistent results tested this assumption;
- Herds are not currently exceeding the carrying capacity or depleting range values. The use of animal exclosure cage vegetation sampling established actual utilisation rates, which confirms this assumption;
- Utilisation rates are constant over time. This is not believed to be true as utilization was generally known to be very high in the 1980s and the property still shows evidence of overgrazing from that time. To address this the Model compares the years 1969 and 1999, which bracket the period of overgrazing. As well, the Model uses a "light" utilisation rate for all time periods to avoid confusing mining effects with the combined effects of population cycles and government wildlife management practices. Using a higher utilisation rate, which would approximate heavier utilization periods, would result in a greater increase in AUMs between 1969 and 1999 than the current calculation and possibly overstate the gains from reclamation and enhancement;
- Areas in a winter range class can only be compared with areas in the same class. Different classes of winter range must be calculated separately as they have different spatial and temporal availability;
- MOELP habitat classifications (based on slope, aspect, elevation and other variables) is the same before and after mining development such that the total land area in a given classification remains the same. This is not believed to be true. However, as mining generally lowers overall elevation, some summer range areas may become winter range areas, after mining. Conversely, no Class 1 winter ranges are believed to be altered to the point where they are no longer Class 1. The total winter range area is held constant until the land capability assessment is completed;
- Productivity increase, as a result of forest under-story release, is the same regardless of the timber harvest practice used. Measuring productivity in timber Irarvest areas, as well as areas where the trees were cut for wildlife enhancement will be used to assess this assumption. In both cases, native soils are assumed to be intact (as compared to mining) and will return to a, productive state for forage;
- Reclaimed vegetation is at least as "good" as !undisturbed vegetation for wildlife forage. Tests of this assumption indicated that reclaimed vegetation actually had higher protein values than vegetation from undisturbed sites; and
- Range is contiguous for wildlife access. This means that all areas included as productive are accessible by wildlife and there are no migration barriers. This is true for all the Class 1 winter range areas and was assessed using information reported in the Natal Ridge Elk Study (Gibson and Sheets, 1997).

Model design considerations are related to the rationale for the Model and are considered concurrently:

- The output must be conceptually understandable and at an appropriate scale for the species of interest;
- It must use non-destructive measures that are directly related to the program objectives; and,
- Results must be consistent with related information. For example, if results show an abundance of forage then fecal protein levels should confirm that the animals are not starving.

Utilisation and Consumption Rates Used in the Model Calculations

Utilisation rate refers to how much of the available vegetation animals are using. Actual utilisation was measured (using animal exclosure cages) in 1998 at close to 50% (moderate level) (Interior Reforestation, 1999). To maintain conservativeness in the calculations, this Model is based on an overall 20% utilization, a light level for wildlife ranges. If a 50% utilisation level is used in the Model, there is a substantial increase in the calculation of total available forage and therefore the number of animals that the property could sustain. The gains from habitat improvements over the last 30 years are also increased.

Consumption rates refer to how much the animal needs to consume in a given period. These rates were taken from the literature and are 135 kg/month. By comparison a domestic cow-calf pair consumes 350 kg/month.

Description of Areas Used in the Model Calculations

The prime winter range area on Elkview Coal property is divided into polygons that are similar or homogeneous units based on the Ministry of Environment, Lands and Parks *Biophysical Classification for Wildlife Capability Map* (MOELP, 1980). The areas included in the Model, to date, are all Class 1, prime, winter range for elk. The classifications for other ungulate species are different between the 15 polygon areas used in the Model. The use of this polygon structure will allow better flexibility to assess other ungulate species as the Model is developed further.

The area within each polygon is categorised into sub areas that are either disturbed, reclaimed, enhanced, forested or undisturbed grassland. These land categories were chosen as they account for virtually all of the variation in land productivity over time. As the size and productivity of these sub-areas change, changes in total winter range productivity can be cumulatively assessed. Annual variations are minimal relative to differences between these categories, as can be seen by the data in Table 2. Variations can also occur outside of any mining or enhancement activity and the intent is to identify cumulative effects of ECC land management activities not short-term climate cycles.

DISCUSSION OF RESULTS FROM THE MODEL

The objective of all the enhancement programs, was to provide additional winter forage in the proximity of cover, for ungulates, elk in particular. The objective of reclamation programs is to restore the land for the designated land use as wildlife (ungulate) habitat. If these objectives are being achieved, the available AUMs, in winter range areas, would remain constant before, during and after mining. The Model was developed as a method of calculating and demonstrating whether these objectives are being achieved.

The Model results indicate that total forage production has not declined and there is actually a substantial surplus of forage production from 30 years ago. This is primarily the result of the combined effects of increased vegetative

productivity from reclamation and enhancement, including under-story release from timber harvest replacing the production lost from all mining disturbances in Class 1 winter range areas. In 1969, there were 2,150 AUMs of winter range grazing available on the property. In 1999 there were 2,766 AUMs of winter range grazing available, a 617 AUM increase.

Table 3 summarises the circa-1969 and 1999 calculations by polygon area, for AUMs on the prime winter range area of Elkview property. Samples individual calculation details,for 2 of the 15 polygons are shown on Tables 3a and 3b.

Table 3 shows the spatial distribution of the gains and losses throughout the property. There were productivity gains in the areas north of the Elkview Coal Wash Plant (polygons 1, 8, 9 and 27) primarily as a result of timber harvest with the expected increase in growth of under-story vegetation. Gains in the southern half of the property were primarily in the Alexander Creek area (polygon 63 and 74) as a result of cancellation of cattle *grazing* leases. The losses in the immediate Bodie, Gate and South Pit areas (polygons 31, 43 and 46) were minimised by the substantially higher forage productivity on reclaimed sites in these areas as compared to undisturbed sites.

The Model provides a calculation of forage values for elk, and other ungulates, over a large area and it provides detailed information on smaller areas as well. The Model can be used to quantitatively characterise the property in the past, present or future. This report indicates that habitat enhancement and end land use objectives for the target wildlife species, ungulates, are being met and exceeded on the Class 1 winter range areas.

Table 3. Comparison of Forage Area and Forage Productivity Assessments on Prime (Class 1) Elk Winter Range Pre- Surface Mining (circa 1969) with Current (1999) Mining Development.

(Information is considered accurate but as a work in progress, is subject to change when detailed forestry status data is incorporated in the future)

Class 1 Elk Range - polygon name and number		Size of the (polygon)	Area Disturbed 1969	Area Disturbed 1999	AUMs[1] 1969	AUMs[1] 1999	Change 1969 1999	Elk Winter Forage 1969	Elk Winter Forage 1999	Elk Winter Forage Change 1969-1999
(#)	*(Name)*	*(ha)*	*(ha)*	*(ha)*	*(AUMs)*	*(AUMs)*	*(AUMs)*	*(animals/ winter)*	*(animals/ winter)*	*(animals/ winter)*
1	Six mile ponds	89	0	1	24	56	33	7	16	9
8	Harmer W / Coarse Ref.	440	40	60	107	237	130	30	68	37
9	Harmer W - upper	483	0	0	151	350	199	43	100	57
27	Above Plant	220	14	20	119	217	98	34	62	28
31	Bodie area	463	63	173	379	318	(62)	108	91	(18)
43	Gate area	273	0	110	260	198	(62)	74	57	(18)
46	South Pit	366	20	112	359	284	(75)	103	81	(21) [2]
47	Lower Michel slopes	149	0	1	186	198	12	53	57	3 [3]
55	West Side of Michel Cr.A	254	11	11	106	105	(1)	30	30	(0)
56	West Side of Michel Cr.B	168	21	21	125	126	1	36	36	0
57	Erickson East	311	0	0	160	160	0	46	46	0
63	Alexander - Main	269	8	8	44	167	123	13	48	35
73	South of Hwy. #3	173	14	14	64	64	0	18	18	0
74	Alexander South	192	5	5	51	271	220	15	77	63
92	Corbin turn off	50	5	5	15	15	0	4	4	0
Total		**3,900**	201	541	2,150	2,766	**617**	614	790	**176** [4]

Note 1: 1. 1 AUM = 135 kg which a cow elk and calf (elk unit) consumes per month.
Note 2: 2. Mitigation for South Pit done in Class 2 winter range area so does not show in this calculation.
Note 3: 3. The Michel Slopes, encompassing an area much larger than this polygon, was extensively fertilized for mitigation purposes, with no effect. There was significant disturbance in the Michel Valley in 1969 that is not shown. Reclamation will have increased AUMs in area adjacent to Class 1.
Note 4: 4. Mitigation commitments were to have no net change whereas there has been an overall increase.

Table 3 A. Pre-Surface Mining (Circa 1969) Mine Area and AUM calculations (Data under ongoing review)
Sample Sheet Showing 2 of the 15 Calculations

Class 1 Elk Range (polygon number, see reference map)	Area Description	Portion of Polygon (percent)	Portion of Polygon (ha)	Vegetative Productivity (kg/ha)	Total Productivity (kg)	Light Utilization (20%) (kg)	Animal unit mo. (135 kg/ mo) AUM	Wintering Elk Potential (animals/ winter)
8	**Harmer W / Coarse Ref.**							
Disturbed	Coarse Refuse	9%	40	-	-	-	-	
Reclaimed	Coarse Refuse, Seeded 1994/97	0%	-	-	-	-	-	
Enhanced	Harmer W. Mitigation Timber Harvest logging	0%	-		-	-	-	
Enhanced	CFI harvest area 1995	0%	-		-	-	-	
Undisturbed grassland	Cleared, above Coarse Refuse.							
Undisturbed Forest	Unharvested	91%	400	180	72,000	14,400	107	
Total		100%	440		72,000	14,400	107	30
Notes: Area includes plant operations prior to surfce mining starting in 1969.								
31	**Bodie area**							
Disturbed	Bodie Mined Rock Pile	0%		-	-	-	-	
Reclaimed	Bodie 26O Seeded in 1997-99	0%			-	-	-	
Reclaimed	Bodie 370 Seeded in 1997-99	0%			-	-	-	
Enhanced	Gravel Pit	0%			-	-	-	
Disturbed	Six Mile Road	14%	63		-	-	-	
Reclaimed	"Old-Baldy" upper	0%			-	-	-	
Reclaimed	"Old-Baldy" lower	0%			-	-	-	
Undisturbed grassland	Michel Slopes	43%	200	1,100	220,000	44,000	326	
Undisturbed Forest	Forest Cover	43%	200	180	36,000	7,200	53	
Total		100%	463		256,000	51,200	379	108
Notes: Six Mile road assumed to be same disturbance footprint as in 1999.								

Table 3 B. Current (1999) Mine Area and AUM calculations (Data under ongoing review)
Sample Sheet Showing 2 of the 15 Calculations

8	**Harmer W / Coarse Ref.**							
Disturbed	Coarse Refuse	0.136407	60	0	0	0	-	
Reclaimed	Coarse Refuse, Seeded 1994/97	0.047742	21	1300	27300	5460	40	
Enhanced	Harmer W. Mitigation Timber Harvest logging	0.109126	48	1100	52800	10560	78	
Enhanced	CFI harvest area 1995	0.011367	5	534	2670	534	4	
Undisturbed grassland	Cleared, above Coarse Refuse.	0.054563	24	1100	26400	5280	39	
Undisturbed Forest	Unharvested	0.641113	282	180	50760	10152	75	
Total		1.000318	440		159930	31986	237	68
Notes: 6 sample sites in this block								
31	**Bodie area**							
Disturbed	Bodie Mined Rock Pile	0.237581	110	0	0	0	-	
Reclaimed	Bodie 26O Seeded in 1997-99	0.051836	24	2000	48000	9600	71	
Reclaimed	Bodie 370 Seeded in 1997-99	0.023758	11	200	2200	440	3	
Enhanced	Gravel Pit	0.038877	18	1200	21600	4320	32	
Disturbed	Six Mile Road	0.136069	63	0	0	0	-	
Reclaimed	"Old-Baldy" upper	0.107991	50	400	20000	4000	30	
Reclaimed	"Old-Baldy" lower	0.021598	10	800	8000	1600	12	
Undisturbed grassland	Michel Slopes	0.194384	90	1100	99000	19800	147	
Undisturbed Forest	Forest Cover	0.187905	87	180	15660	3132	23	
Total		1	463		214460	42892	318	91
Notes: Three sample transects in this block, 1 for recent and 1 for older areas reclamation and 1 for the gravel pit which is relatively unique.								

Total for Areas 8 and 31 - Current (1999) Calculations		555	158
Total for Areas 8 and 31 - Pre-Surface Mining		486	139
Net Change	(Current minus "original" for these two areas only)	69	20

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