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REPORT

ON

TERRESTRIAL VEGETATION BASELINE

FOR THE

MUSKEG RIVER MINE PROJECT

Submitted to:

Shell Canada Limited
400 - 4 Avenue SW
Calgary, AB T2P 2H5

December 1997

972-2237

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January 28, 1998

Proj. No. 972-2237

Dr. Doug Mead
Senior Environmental Scientist
Safety and Environmental Resources
Shell Canada Limited.
400 - 4th Avenue SW
P.O. Box 100, Station M
Calgary, AB T2P 2H5

RE: Final report - Terrestrial Vegetation Baseline for the Muskeg River Mine Project

Dear Doug

Attached is the final report for the Terrestrial Vegetation Baseline for the Muskeg River Mine Project. This report provides a summary of the terrestrial vegetation resources found within the Muskeg River Mine Project local study area (LSA). Specifically, the following details are provided in this final report: a) Description and mapping of vegetation communities in the LSA; and b) evaluation of forest resources according to the standard outlined in the Alberta Vegetation Inventory Standards Manual (AVI).

Should you have any questions about this report, please contact me at 299-5640.

Yours very truly,

GOLDER ASSOCIATES LTD.

John R. Gulley, M.Sc., P. Biol.
Oil Sands Project Director

attachment

cc. Judy Smith (Shell)
Ian Mackenzie (EIA Project Manager)

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EXECUTIVE SUMMARY

This document details the Terrestrial Vegetation Resources within the Local and Regional Study Areas for Shell Canada Limited's (Shell) Muskeg River Mine Project (the Project) in support of an Environmental Impact Assessment. Terrestrial vegetation is defined as upland forest communities where the soil is not saturated for extended periods.

The main objective of the study was to describe the terrestrial vegetation in the Local and Regional Study Areas at different levels of generalization in terms of:

- species composition and coverage;
- physical structure;
- age structure;
- diversity;
- rare plants; and
- plants with traditional uses.

The terrestrial vegetation classification system process was based on the following sources of information:

- Alberta Vegetation Inventory mapping;
- the Field Guide to Ecosites of Northern Alberta (Beckingham and Archibald 1996;
- field data reported in the Aurora EIA (BOVAR 1996a); and
- field data collected for the current study.

There are six general terrestrial vegetation types classified in the Regional Study Area (RSA). Terrestrial vegetation comprises 27.9 % of the RSA or 293,353 ha. The most dominant type is the mixedwood class (Blueberry Pj-Aw, Aw-Sw; Low-bush cranberry Aw-Sw) which occurs on 115,309 ha or 11% of the RSA. On the Local Study Area (LSA) 33.1% or 3,631 ha are covered with upland vegetation. The most dominant type is the mixedwood class Low-bush cranberry Aw-Sw with 1,525 ha or 13.9% of the LSA. Collectively, the mixedwood classes of Blueberry Pj-Aw, Aw-Sw and Low-bush cranberry Aw-Sw cover 21.9% or 2,403 ha of the LSA .

Community level biodiversity can be assessed by examining community richness, diversity and polygon size. Changes in the ranges of these parameters are an expression of heterogeneity in ecosite phase polygons. A reduction in the polygon size ranges, for example, could equate to a temporary loss in biodiversity. The ecosite phases d1 and d2 low-bush cranberry and the ecosite phases e1 and e2 dogwood have the highest mean overall diversities and along with e3, the highest mean diversity in the herb layer.

Rare plants, by definition, have restricted spatial ecological and temporal distributions in a variable or diverse environment. Previous studies

(BOVAR 1996) documented the existence of 17 species of vascular plants listed as rare within the LSA. Within the RSA 25 rare species have been previously documented. During the 1997 field studies, nine rare plants were documented including three wetlands species not previously found within the LSA or RSA.

Traditional Plants occur throughout the LSA and RSA. These plants are collected for medicinal, spiritual and consumptive purposes. An investigation conducted by the Fort McKay community was used to develop a list of plants used for such purposes.

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1. INTRODUCTION

1.1 OBJECTIVES

This Terrestrial Vegetation Baseline report provides a summary of the terrestrial vegetation resources found within the Muskeg River Mine Project (Project) local study area (LSA). Specifically, the following information is provided in this report:

- descriptions and maps of vegetation communities in the LSA and the status of any rare, threatened or endangered plant species; and
- evaluate forest resources according to the standards outlined in the Alberta Vegetation Inventory Standards Manual (AVI) Version 2.2.
- describe plants used by aboriginal peoples in the area.

Terrestrial vegetation, as defined here, corresponds to upland vegetation. Uplands are defined as areas where the soil is not saturated for extended periods, and, in the study area, are vegetated almost exclusively by forest stands. Wetlands vegetation is discussed in a Wetlands Baseline Report for the Project (Golder 1997a).

The main objective of the study was to describe the terrestrial vegetation of the LSA at different levels of generalization in terms of:

- species composition and coverage;
- physical structure;
- age structure;
- diversity;
- rare plants; and
- plants with traditional uses.

This description of baseline vegetation conditions provides the basis for the subsequent assessment of the potential impacts of the Project on vegetation resources.

Scientific names of the plant species listed in this report are provided in Appendix I.

1.2 APPROACH

The existing vegetation conditions reflect the dynamic inter-relationships between landform, soils, drainage and vegetation development over time. The vegetation classification used a hierarchical system developed by Bechingham and Archibald (1996) Field Guide to Ecosites of Northern Alberta.

This approach was also used to facilitate the assessment of key vegetation impact questions and issues affecting the Project, such as biodiversity. Biodiversity can also be examined at a series of levels of generalization. These can be more readily examined within the framework of an ecological land classification (ELC) system, within which vegetation is described at the plant species, plant community and Ecosite phase levels.

In general, vegetation resources were described according to three main parameters, including: vegetation composition; vegetation structure; and vegetation function. Within the ELC hierarchy, each of these parameters were described at the landscape level of generalization according to ELC units (Ecosites, Ecosite Phases), the Plant Community level and also at the individual plant species level. This approach to vegetation description and analysis is shown in Table 1.

Table 1 Vegetation Parameters and Levels of Analysis used in the Description of Baseline Conditions for the Muskeg River Mine Project

Levels Of Analysis	Vegetation Parameter		
	Composition	Structure	Function
Landscape	ELC unit vegetation composition, relative proportions and distribution	ELC unit structural complexity; serial stage; relative proportion and distribution	landscape function, watersheds, wildlife habitat
Plant Community	species composition; species richness and diversity	tree heights and vegetation cover, proportion of dead standing and fallen tree numbers,	plant biomass and productivity
Plant Species	abundance of rare plants; medicinal and spiritual plant use	tree, shrub or herb layer	potential to support rare species, medicinal plants.

1.2.1 Vegetation Description

Vegetation plots were used to survey the Key Indicator Resources (KIRs) of representative study locations. The vegetation plot provided the framework for the measurement of vegetation composition and structure on the forest floor, and in the herb, shrub and tree layers. The percent cover, and heights of live and dead standing trees were measured in large (20x20 m) plots. For each dead fallen tree, the species, length and diametre was recorded. Shrub heights and percent cover, for each species, were determined within smaller (10x10m) shrub plots. The percent cover and height of individual herbs were measured in the herb layer within survey plots. All vegetation survey plots were distributed in a manner that ensured that sufficient information

was collected to fully characterize the various plant communities, or ELC units within the Project area.

1.2.2 ELC Linkage

ELC provides a means of integrating the diversity of vegetation types with that of landforms, soils and other ecosystem components. It also provides a means to assess different types of biodiversity at various scales. The ELC units therefore describe landscape scale biodiversity. This Terrestrial Vegetation Report addresses biodiversity at the community and species level. The ELC baseline for the Project is described in an Ecological Land Classification baseline report (Golder 1997b).

2. STUDY AREA

2.1 OVERVIEW

The Project study areas is located in the Boreal Mixedwood Natural Subregion of Alberta (Figure 1). The vegetation that characterizes this area includes aspen as the dominant overstory tree, but balsam poplar black spruce white spruce and jack pine are also common (Beckingham and Archibald 1996). Balsam fir, tamarack and white birch occur occasionally, which lodgepole pine occurs rarely. The understory is characterized by beaked hazelnut, prickly rose, low-bush cranberry, saskatoon, Canada buffaloberry, twin-flower, green alder, bunchberry, wild sarsaparilla and dewberry.

The distribution and abundance of plant species varies along a moisure gradient from wetlands, to riparian areas, to uplands. For the purpose of this study, plant communities were grouped according to their general distribution with respect to landform, soil and drainage condition, i.e., within the three main categories of these three main types: Upland, Riparian and Wetlands. The uplands consist of the above forest types which were identified during the forest inventory. Figure 2 shows the vegetation ecosite phases within the LSA. Riparian and wetlands vegetation are described in the Baseline Wetlands Report (Golder 1997a).

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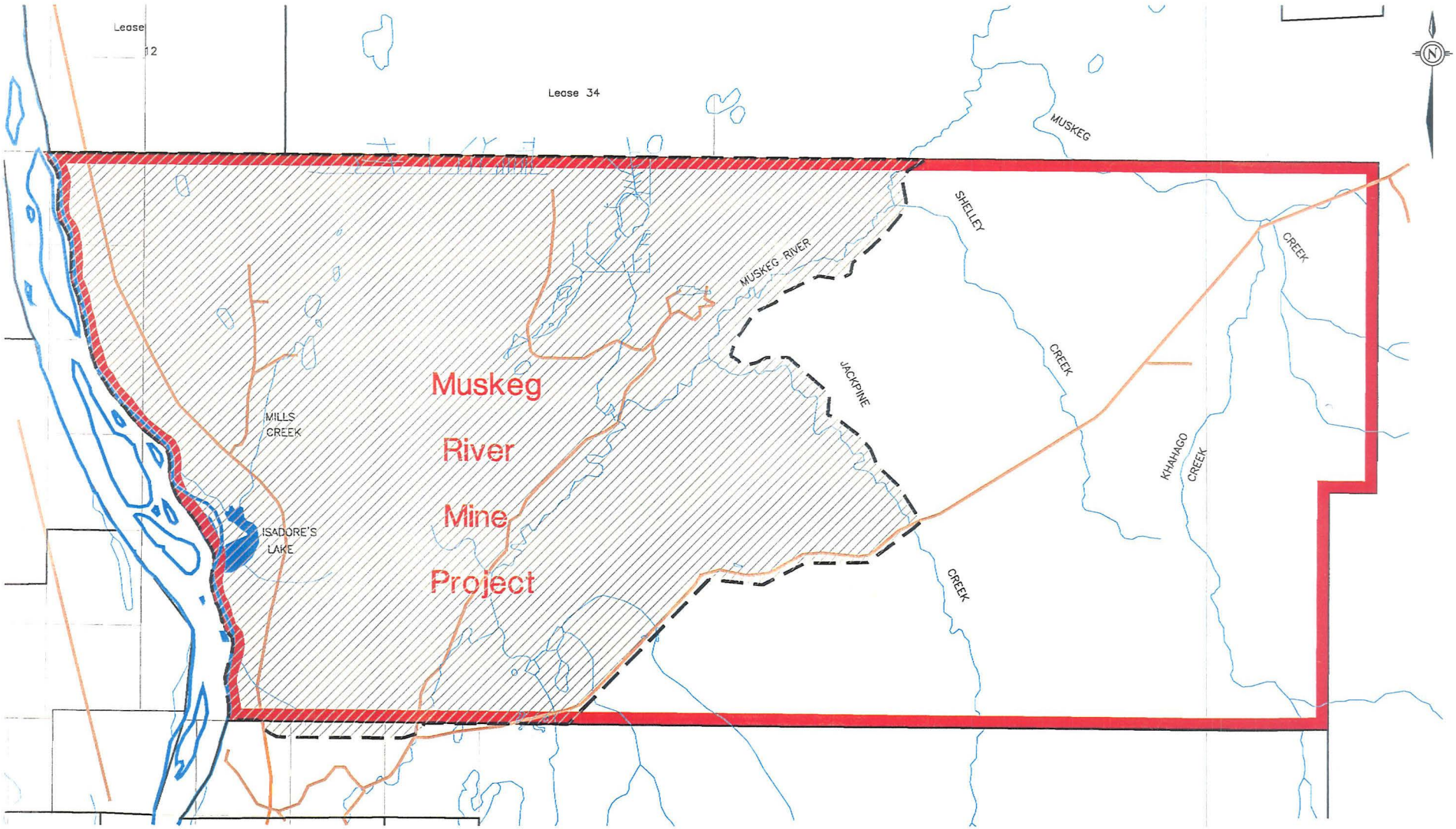

REFERENCE

DIGITAL DATA SETS 74D, 74E, 74I
84A AND 84H FROM RESOURCE DATA DIVISION
ALBERTA ENVIRONMENTAL PROTECTION, 1997.

0 1 2 3 4 5km

SCALE 1:100,000

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TERRESTRIAL LOCAL STUDY AREA FOR MUSKEG RIVER MINE PROJECT

28 JAN 98	FIGURE 1	DRAWN BY:

6 350 000 N

6 345 000 N

6 340 000 N

460 000 E

465 000 E

470 000 E

475 000 E

LEGEND

Local Terrestrial Study Area

Lease 13

Open water

VEGETATION CLASSIFICATION

- Cultural Features and Disturbed Lands
- Lichen Pj
- Blueberry
- Labrador tea-mesic Pj-Sb
- Low-bush cranberry Aw
- Dogwood
- Labrador tea-subhygric Sb-Pj
- Labrador tea/ horsetail Sw-Sb
- Shrubby bog
- Poor fen
- Rich fen
- Marsh

VEGETATION CLASSIFICATION COMPLEXES

- a1/g1
- e1/f1
- e2/f2
- j1/g1
- j1/h1
- j2/h1
- Tamarack Black Spruce
- Shrubland

SOURCE: The Forestry Corp., Golder Asscociates

1 0 1 2

Kilometers

MAP PROJECTION: Universal Transverse Mercator Zone 12

DATUM: NAD 83

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MUSKEG RIVER MINE PROJECT
VEGETATION CLASSIFICATION

23 Jan. 1998	Figure 2	PRODUCED BY: J.S./R.P. REVIEWED BY:

/data8/oilsands/972-2237/9700/9701/final/arcview/veg50fin.apr

2.2 GENERAL VEGETATION CONDITIONS

2.2.1 Uplands Plant Communities

Uplands are defined as areas where the soil is not saturated for extended periods. They differ primarily from lowlands (i.e., riparian and wetlands areas) based on the saturation of the soil and the presence of a treed canopy. Uplands may be distinguished from other plant communities on the basis of moisture and nutrient regimes, as well as on the dominant tree species, or tallest vegetation layer. The specific upland plant community type may be determined based on the understory species composition and abundance.

A typical Boreal Mixedwood forest on upland sites consists of a canopy of white spruce, jack pine, and/or trembling aspen. The understory may be composed of ericaceous shrubs, such as bearberry, blueberry or Labrador tea. Peat moss is uncommon in uplands, although other types of moss, such as feathermoss, are common.

Upland forests can be divided into ecosites according to their vegetation composition and soil properties (Beckingham and Archibald 1996). In Alberta, there are eight upland ecosites. Within the Boreal Mixedwood, each ecosite may be subdivided into ecosite phases, and each ecosite phase may be subdivided further into component plant community types. A general discussion of the characteristics of each of the ecosites, ecosite phases, and plant communities observed in the uplands of the Project LSA and Regional Study Area (RSA) for the Project is discussed. For mapping purposes, the vegetation in the LSA is classified to the ecosite phase level (Figure 2).

2.2.2 Riparian and Wetlands Plant Communities

Riparian and wetland vegetation are described in the Baseline Wetlands Report (Golder 1997a).

2.2.3 Plant Species

Vegetation was also examined at the scale of the individual plant species. Special attention was given to rare plants and the potential impacts that the Project will have on them. Plants that are used for medicinal and spiritual purposes by aboriginal peoples are also examined as part of the vegetation assessment.

3. METHODS

3.1 VEGETATION MAPPING

3.1.1 Regional Mapping

Vegetation was mapped using Landsat imagery and a geographical information system (GIS) to allow the relative abundance of plant communities to be compared within the RSA. This classification is at a coarser scale than completed for the LSA, which is reflected in slight differences in area calculations for baseline and impact values for the Project.

Landsat Thematic Mapper Satellite imagery was collected for two areas ("scenes") July 1994 and July 1996 respectively. The majority of the RSA was covered by the more recent 1996 imagery; however, due to cloud cover constraints small portions in the north and south of the RSA were covered by the 1994 imagery. A supervised classification of the imagery was undertaken that included the selection of a number of "training" or test areas determined from information collected from aerial photographs, Alberta Phase 3 Forest Inventory Maps, Alberta Vegetation Inventory Maps (AVI), Vegetation Maps produced for oil sands projects, Soil Inventory Maps of the Alberta Oil Sands Environmental Research Program (AOSERP) and a 1997 field investigation. An accuracy assessment of the classified imagery based on field data collected in July 1997 indicated a final overall accuracy of approximately 80% (Appendix 2).

3.1.1.1 LSA Terrestrial Vegetation Classification

The terrestrial vegetation classification process for the Project LSA was based on the following sources of information:

- Alberta Vegetation Inventory (AVI) mapping, which uses a forestry-based vegetation classification system;
- the Field Guide to Ecosites of Northern Alberta (Beckingham and Archibald 1996), which uses a vegetation classification system based on the principles of ecological land classification (ELC);
- field data reported in the Aurora EIA (BOVAR 1996); and
- field data collected for the current study.

There were four steps in the terrestrial vegetation classification process:

1) AVI polygons were selected as mapping units.
2) AVI polygons were classified using Beckingham and Archibald's system to provide an initial delineation of ecosite phase.

3) Ground-truthing data were collected from plots located on the basis of the preliminary delineation.

4) The preliminary delineation was finalized as necessary using field data. Polygons and plots that did not fit Beckingham and Archibald's system were defined either as complexes of Beckingham units or as new vegetation units.

3.1.1.2 Beckingham and Archibald's Classification System

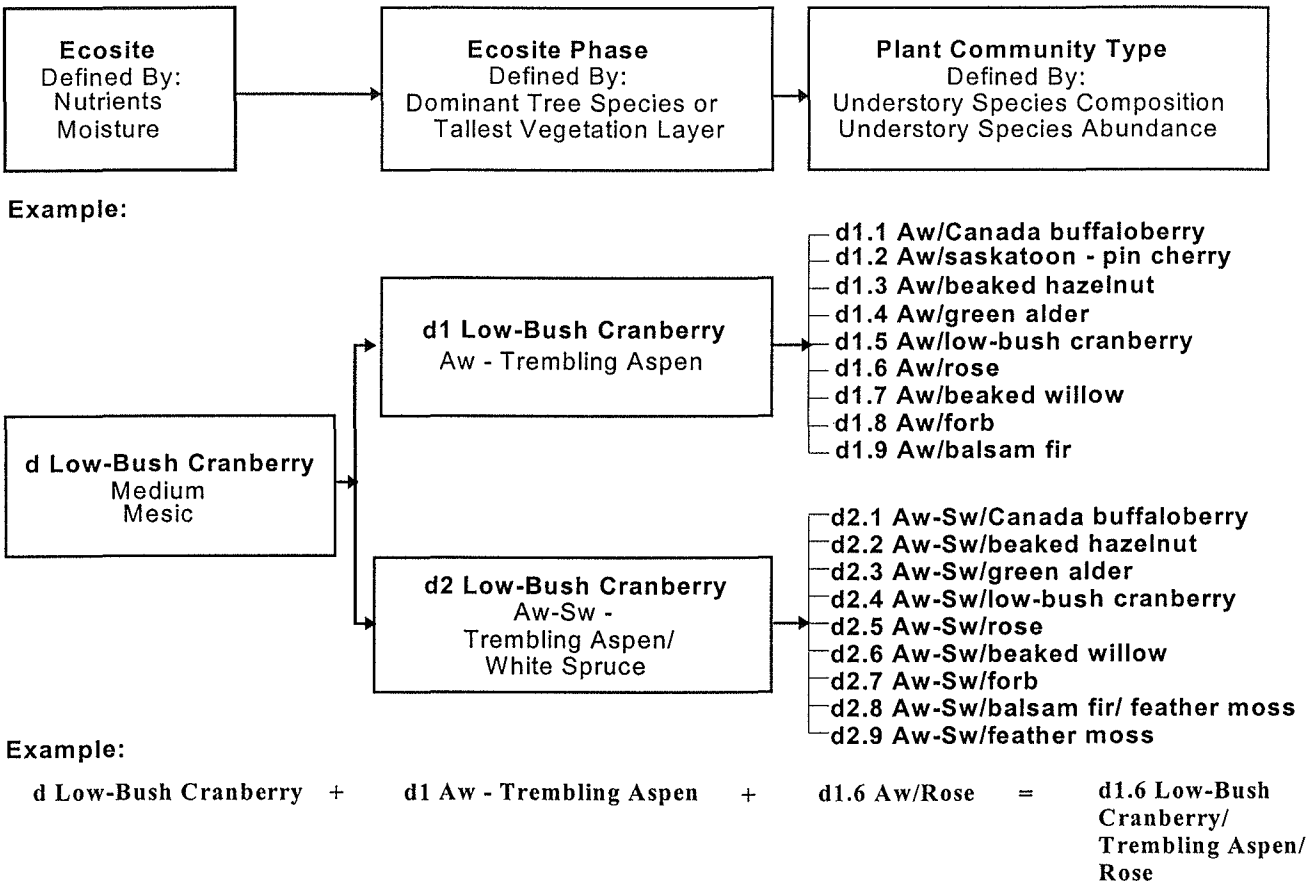
Beckingham and Archibald's system, as expressed in their Field Guide to Ecosites of Northern Alberta (1996), uses a mixture of biotic and abiotic variables to create a hierarchical, or nested, ecological classification structure. At the coarsest level of classification, ecological areas and subregions are defined on the basis of broad ecoclimatic factors. At this level of generalization the entire study area is within the boreal mixedwood forest. Differences in soil nutrient and moisture regimes are then used to differentiate ecosites. Beckingham and Archibald recognized eight upland ecosites in the boreal mixedwood forest. Ecosites are subdivided into ecosite phases according to the dominant species in the forest canopy or tallest vegetation layer. At the finest level of classification, ecosite phases are in turn subdivided into plant community types on the basis of differences in species composition within the understory vegetation (typically the shrub layer). Figure 3 summarizes the classification process, starting at the ecosite level, and works through an example for one ecosite.

Only polygons that were field verified with understory classified to the plant community level were included in the final classification. Therefore, the vegetation classification for the LSA was completed only to the ecosite phase level.

Figure 4 is an edatropic grid showing the ecological relationships, as defined by gradients of moisture and nutrient supply, of the 17 upland ecosite phases described by Beckingham and Archibald (1996). The eight wetlands ecosite phases are included for comparison. Moisture conditions, on the vertical (y) axis, range from hydric (wettest) to xeric (driest). Nutrient conditions, on the horizontal (x) axis, range from very poor to very rich. The positions of the ecosite phases shown in Figure 4 represent the mid-points of the ranges of moisture and nutrient regime reported by Beckingham and Archibald.

The end product of the AVI mapping exercise was a detailed vegetation map at a scale of 1:10,000, based on the 1997 aerial photography (Figure 2).

Figure 3 Ecosite Classification Steps



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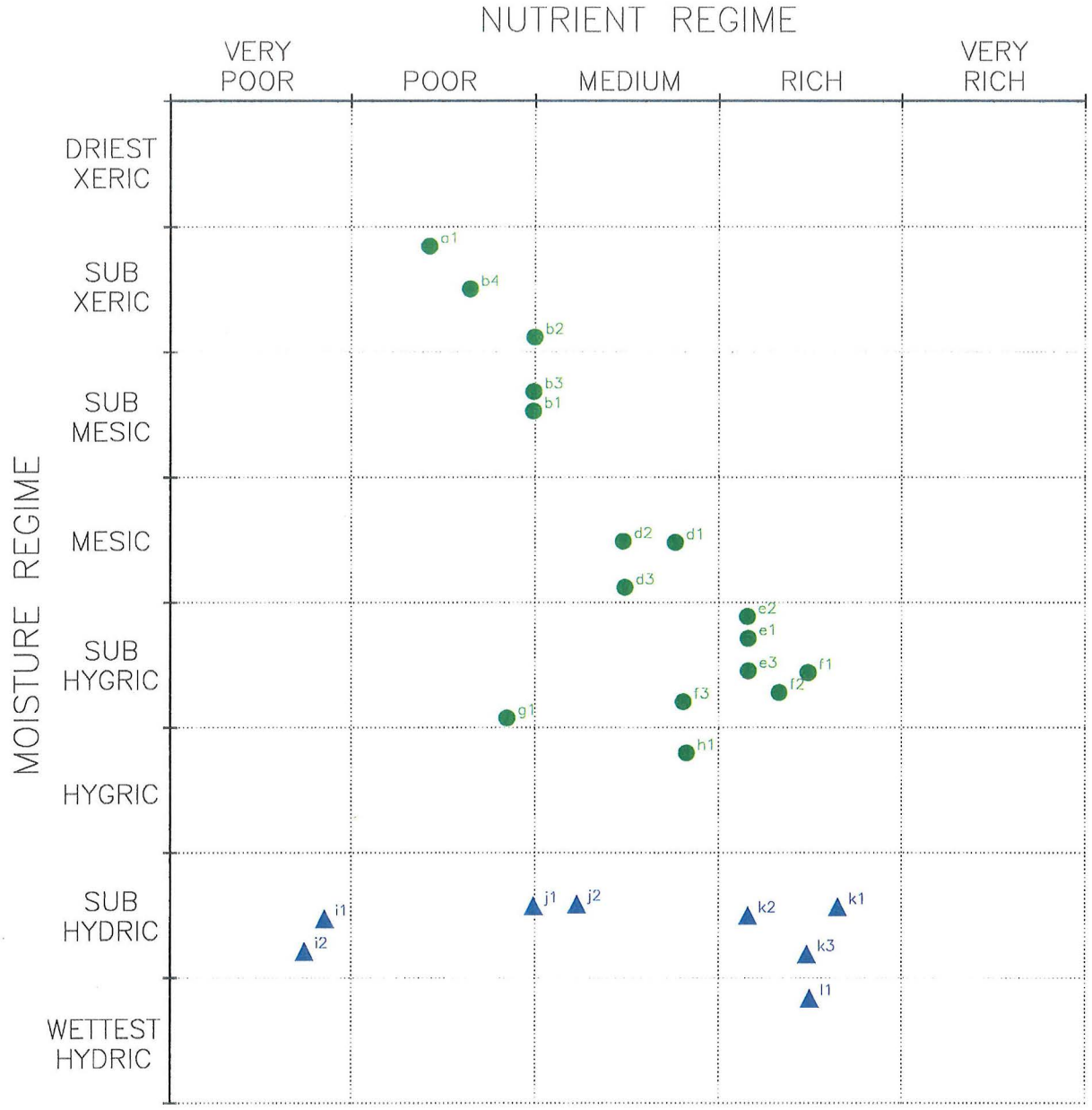

LEGEND

- TERRESTRIAL ECOSITE PHASES
- WETLANDS ECOSITE PHASES

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MOISTURE: NUTRIENT RELATIONSHIPS OF ECOSITE PHASES

26 JAN 98	Figure 4	DRAWN BY: CG

3.1.1.3 Plant Community Assessment Field Methods

Plot locations for the upland plant community assessment were determined using the initial delineation of plant communities. Plots of 20 x 20 m were randomly located in five separate map polygons representative of each ELC unit. Species composition and structural data were collected within each plot as follows:

- tree layer (>5 m high) - entire 20 x 20 m plot
  - % coverage for each species
  - average tree height
  - dbh (diameter at breast height) for all living, dead and downed trees
  - age of 3 largest trees
- shrub layer (0.5-5 m high) - 10 x 10 m subplot in one corner of 20 x 20 m plot
  - % coverage for each species
  - height of shrubs
- herb layer (<0.5 m high) - 7, 1 x 1 m plots within 10 x 10 m subplot
  - % cover for each herb, moss and lichen species.

Standard field techniques were used throughout. Field taxonomy followed *Flora of Alberta* Moss (1983) and Packer and Bradley (1984). Specimens of plants that could not be identified in the field were collected for herbarium identification.

3.1.1.4 Community Diversity

Community level biodiversity was assessed examining vegetation polygon or patch dynamics. Patch dynamics examines vegetation communities as mosaics of different areas (patches) in which disturbances and biological interactions proceed. A patch habitat therefore is an environment within which there are significant variations in size and quality of habitat available for particular species. Thus, the higher the variability (range) in patch size provides some indication of diversity at the landscape and community level. The number and size of vegetation polygon (patches) within the LSA quanitified in hectares.

3.1.1.5 Species Richness and Diversity

Compositional biodiversity is commonly described using measures of richness (species number), and eveness (relative abundance). Species richness is the total number of species present in an area (Krebs 1989). Species richness was calculated for herb, shrub and tree layers in each plot surveyed. Community richness was calculated by averaging the species richness recorded for each community type. Species diversity was measured using the Shannon Weaver Index. This Index is a measure of equitability (H') calculated to incorporate the sum of the proportional contributions of an individual species to the total population of a community (Krebs 1989).

Mimimal values occur when one species has a disproportionate dominance, whereas maximum values occur when all species share equally in the dominance of the community.

Accordingly, the Shannon Weaver Diversity Index, H, can be expressed as

$$H = \sum_{i=1}^{k} P_i \log P_i$$

where k is the number of categories (i.e., species) and P_i is the proportion of the observations found in category i. In this case, the percent coverage of the plot area, expressed as a decimal, was used to approximate P_i.

The mean and range of numbers of species for the ecosite phases surveyed have been presented, both for the unit (ecosite phase) as a whole and for each of the tree, shrub and herb layers.

3.1.1.6 Rare Plants

A list of rare plant species potentially present in the study area was prepared from existing literature sources. The known habitat associations of these species were considered in selecting the field plot locations. During the field studies, each rare plant occurrence was documented using the rare native plant survey form provided by the AHNIC (1996). Rare plants were photographed twice and specimens were collected if necessary.

Areas surveyed within the LSA were also scored according to their rare plant habitat potential using the following ratings:

- no potential;
- low potential;
- moderate potential;
- high potential; and
- rare plant habitat.

3.1.1.7 Plants With Traditional Uses

Plants traditionally used by local aboriginal people for food, medicine or spiritual purposes were identified using published literature and past interviews with community members (Fort McKay 1996).

4. RESULTS AND DISCUSSION

4.1 REGIONAL VEGETATION CLASSIFICATION

There are six general terrestrial vegetation types classified in the RSA (Table 2). Terrestrial vegetation comprise 27.9% of the RSA or 293,353 ha. The most dominant type is the mixedwood class (Blueberry Pj-Aw, Aw-Sw; Low-bush cranberry Aw-Sw) which occurs on 115,309 ha or 11% of the RSA. Lichen jack pine comprises approximately 1.5% of the RSA. Blueberry Aw(Bw) or trembling aspen and white birch dominant communities represent less than 1% of the RSA (1,132 ha). Low-bush cranberry (Aw) or trembling aspen dominant stands occupy 81,511 ha or 7.8% of the RSA. Low-bush cranberry Sw, Dogwood Sw, Dogwood Pb-Aw, Pb-Sw occupy 4,039 ha or less than 1%. Detailed information on each ecosite phase represented in the RSA and LSA are provided in the following sections.

Table 2 Baseline Terrestrial Vegetation and Land Cover Types in the RSA

Vegetation Types		Baseline	
Map Codes	**Ecosite Phases**	**(ha)**	**(%)**
a1 with some b4	Lichen Jack Pine	15,278	1.5
b1,b3,d2	Blueberry Pj-Aw, Aw-Sw; Low-bush cranberry Aw-Sw	115,309	11.0
b2	Blueberry Aw(Bw)	1,132	0.1
d1	Low-bush cranberry (Aw)	81,511	7.8
d3,e3	Low-bush cranberry Sw, Dogwood Sw	76,084	7.2
e1,e2	Dogwood Pb-Aw, Pb-Sw	4,039	0.4
	Sub-Total (Terrestrial Vegetation)	293,353	27.9
	Sub-Total (Wetlands)	684,449	65.1
	Anthropogenic Disturbances	30,941	2.9
	Forestry Disturbance	13,443	1.3
	Reclaimed Unit	3,600	0.3
	Sub-Total (Disturbances)[(a)]	47,984	4.6
	Water	19,216	1.8
	Unclassified	6,409	0.6
	Total	1,051,411	100.0

[(a)] Most of this area will be reclaimed; the reclamation vegetation types are not defined in this table as reclamation types are not available.

4.2 UPLAND VEGETATION CLASSIFICATION FOR LSA

4.2.1 Areas of Ecosite Phases

Beckingham and Archibald (1996) defined eight upland ecosites and 17 associated ecosite phases within the boreal mixedwood forest. Table 3 gives the baseline areas of the upland ecosite phases and complexes of ecosite phases mapped within the LSA. Included are two upland vegetation types that do not fit into Beckingham and Archibald's classification, shrublands and black spruce-tamarack forest. In total, upland forest vegetation units comprise 33.1% of the LSA.

The ecosites and ecosite phases are described below. The characteristic species of the ecosite phases are summarized in Table 4. No floristic data are available for the shrubland and black spruce-tamarack vegetation types.

4.2.1.1 Lichen Ecosite (a)

The soils of the lichen ecosite are well-to rapidly-drained, with submesic to xeric moisture regimes. The nutrient regime is typically poor. This ecosite has only one phase, the lichen-jack pine.

The canopy of the lichen-jack pine (a1) ecosite phase is dominated by jack pine. The shrub understory typically consists of blueberry, bearberry, green alder, bog cranberry, Labrador tea, twin-flower, jack pine and sand heather.

Wild lily-of-the-valley is the only common forb. On the forest floor, reindeer lichen is dominant, while Schreber's moss, awned hair-cap moss and brown-foot cladonia are also found.

4.2.1.2 Blueberry Ecosite (b)

The soils of the blueberry ecosite are moderately well-to rapidly-drained. The moisture regime is usually submesic to subxeric, and the nutrient regime is poor to medium. Three of the four ecosite phases identified by Beckingham and Archibald (1996) occur in the LSA.

The canopy of the blueberry jack pine-trembling aspen (b1) ecosite phase is dominated by jack pine and aspen (Figure 5). White birch, white spruce and black spruce may also be found in the canopy. The shrub layer is diverse, typically consisting of bog cranberry, blueberry, green alder, bearberry, Labrador tea, twin-flower, Canada buffaloberry, aspen, white spruce and prickly rose. Herbs may include bunchberry, fireweed and cream-colored vetchling. Hairy wild rye is also present. Schreber's moss,

Table 3 Baseline Areas of Ecosite Phases Within the LSA

Ecosite Phase	Code	Area (ha)	Percent Cover
lichen jack pine	a1	106	1.0
lichen + Labrador tea	a1/g1	21	0.2
blueberry Pj-Aw	b1	878	8.0
blueberry Aw-Sw	b3	67	0.6
blueberry Sw-Pj	b4	286	2.6
Labrador Tea-mesic Pj-Sb	c1	20	0.2
low-bush cranberry Aw	d1	1,525	13.9
low-bush cranberry Aw-Sw	d2	169	1.5
low-bush cranberry Sw	d3	15	0.1
dogwood Pb-Aw	e1	61	0.6
dogwood + horsetail Pb-Aw	e1/f1	66	0.6
dogwood Pb-Sw	e2	4	0.0
dogwood + horsetail Pb-Sw	e2/f2	9	0.1
dogwood Sw	e3	93	0.8
Labrador tea - subhygric Sb-Pj	g1	8	0.1
Labrador tea/horsetail Sw-Sb	h1	123	1.1
shrubland	-	119	1.1
black spruce-tamarack	-	61	0.6
total, upland ecosite phases		3,631	33.1
total, wetlands vegetation units		6,719	61.4
disturbed, unvegetated, water		604	5.5
TOTAL LSA		**10,954**	**100.0**

Table 4 Average % Cover of Characteristic Species (Presence >70% of Plots)

Species	a1	b1	b3	b4	c1	d1	d2	d3	e1	e2	e3	f1	f2	g1	h1
Tree Layer															
aspen		14	27			50	28		30	15		24	8		
balsam poplar						5	3		22	8		23	8		
balsam fir							3	6		2	10				
black spruce					13		2							31	13
jack pine	27	26		14	27									12	
white birch		3	2	3		2	3		2	5		6	13		
white spruce			20	25			22	39		26	41		36		34
Shrub Layer															
aspen		3	3			3	3								
balsam fir								6			8		3		
bearberry	10	6	14	11											
black spruce					6									8	
blueberry	11	9	18	16	6									4	
bog cranberry	7	10	6	6	10									7	7
honeysuckle									8	7	5				
buffaloberry		3				6	3								
currant									3	3	4				
dogwood									11	12		5	4		
alder		6	4	6					7		7	6			
jack pine	3														
Labrador tea		6			10									16	14
low bush cranberry						8	10	6	9	8	8	4	7		
prickly rose		3	6	3		15	9	6	14	8	8	8	4		4
saskatoon				2		3									
twin-flower		4	4	4	3	5	6	8		5	6		3		
white spruce		3	5	6			3						4		
wild raspberry												4			
willow						4			4			8	5		5
Forbs															
bishop's-cap										3	5		4		
bunchberry		4	5	4	4	6	8	7		6	4		4		
common horsetail												16	12		12
cream-coloured vetchling						3									
dewberry						4	3	3	4	6	5	4	3		
fireweed			2			5	3		4						
wild lily-of-the-valley	2		3												
meadow horsetail												13	18		6
tall lungwort								2			3		2		
wild sarsaparilla						6	5	4	8	9	6	4	7		
wild strawberry			1	2											
woodland horsetail											7				
Grasses															
hairy wild rye		3	5	1		5	4								
marsh reed grass						7	5		5	9	9	11			
Mosses															
knight's plume moss					5		3	8		4			10	9	4
Schreber's moss	8	13	10	29	42		9	15		5			15	30	24
stair-step moss		8	5	5	13		15	48		12			25	31	48
Lichen															
reindeer lichen	31	6	2	6	6									8	

stair-step moss and reindeer lichen are the characteristic non-vascular species.

Aspen and white spruce dominate the canopy of the blueberry aspen-white spruce (b3) ecosite phase. White birch and jack pine may also be present in the canopy. The shrub layer is denser than in b1 but species composition differs only in that Canada buffaloberry is not common in b3. Bunchberry, fireweed, wild lily-of-the-valley, wild strawberry and cream-colored vetchling are characteristic of the herb layer. The dominant grasses, mosses and lichens are the same as in b1 and percent coverages are similar.

The canopy of the blueberry white spruce-jack pine (b4) ecosite phase is dominated by white spruce and jack pine, although white birch and aspen are usually present as well. The shrub layer is similar to that of b3, with slightly lower average per cent cover.

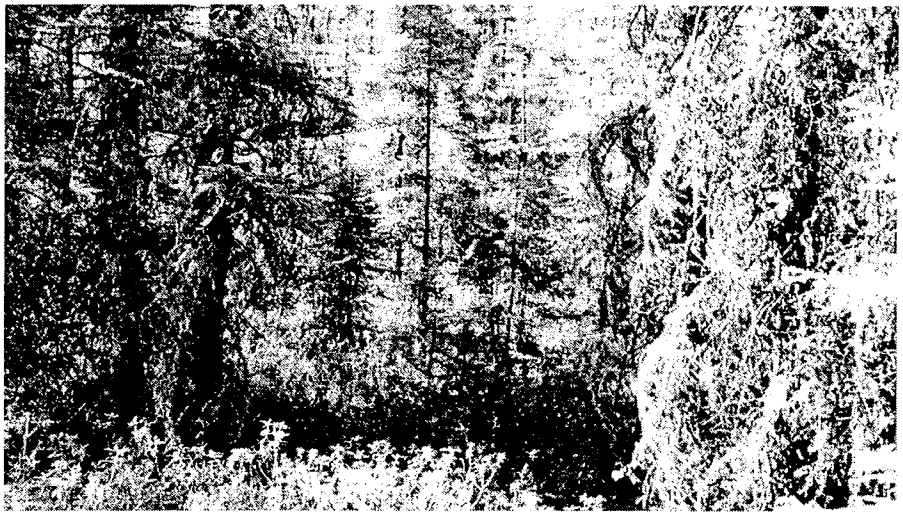
Figure 5 Blueberry Ecosite With Jack Pine - Trembling Aspen Canopy

The herb layer is characterized by bunchberry, wild lily-of-the-valley and bastard toad-flax. Hairy wild rye and reindeer lichen also are characteristic. The moss layer is better developed than in the other blueberry ecosite phases, with >30% coverage, but the species are the same.

4.2.1.3 Labrador Tea-Mesic Ecosite (c)

The soils of the Labrador tea ecosite are usually moderately well-to well-drained. The moisture regime is subhygric to submesic, and the nutrient regime is typically poor. Labrador tea-mesic jack pine-black spruce (c1) (Figure 6) is the only ecosite phase.

Figure 6 Jack Pine-Black Spruce Forest With Labrador Tea Understory



The canopy of the Labrador tea-mesic jack pine-black spruce ecosite phase is dominated by jack pine and black spruce. The shrub layer typically consists of Labrador tea, bog cranberry, black spruce, blueberry, green alder, and twin-flower. Bunchberry is the only characteristic species in the poorly developed herb layer. The forest floor is dominated by Schreber's moss, with average ground coverage exceeding 40%. Stair-step moss, knight's plume moss and reindeer lichen also are characteristic.

4.2.1.4 Low-Bush Cranberry Ecosite (d)

The central moisture-nutrient concept of this ecosite is mesic-medium, although moisture regimes may vary from submesic to subhygric and nutrient regimes from poor to rich. There are three ecosite phases.

The tree layer of the low-bush cranberry aspen (d1) ecosite phase is usually dominated by a closed canopy of aspen (Figure 7), although white birch may be locally dominant.

Balsam poplar and white spruce are the other characteristic tree species. Prickly rose and low-bush cranberry are dominant in the shrub layer. Other typical shrubs are beaked hazelnut, green alder, Canada buffaloberry, saskatoon, willow, twin-flower and aspen. The herb layer is well-developed and is characterized by wild sarsaparilla, fireweed, bunchberry, dewberry, cream-colored vetchling and northern bedstraw. Marsh reed

grass and hairy wild rye are abundant and characteristic. Stair-step moss and knight's plume moss may also be present.

Figure 7 Trembling Aspen Canopy With Low-Bush Cranberry Understory

The canopy of the low-bush cranberry aspen-white spruce (d2) ecosite phase is typically dominated by aspen and white spruce; however, balsam fir, black spruce, white birch and balsam poplar may all be locally dominant. The species composition of the shrub layer is the same as that of d1, except for the addition of pin cherry and choke cherry. The herb layer is less diverse than in d1, but grass coverage is essentially the same. Unlike d1, a moss layer is present. It is characterized by stair-step moss, Schreber's moss and knight's plume moss.

The canopy of the low-bush cranberry white spruce (d3) ecosite phase is dominated by white spruce. Balsam fir, aspen, black spruce, white birch and balsam poplar and black spruce also are characteristic. The shrub layer typically contains balsam fir, low-bush cranberry, twin-flower prickly rose, green alder and Canada buffaloberry. Sarsaparilla, bunchberry, dewberry and tall lungwort characterize the herb layer, along with hairy wild rye. Ground coverage by moss is usually >50%. The species are as in d2, with stair-step moss dominant.

4.2.1.5 Dogwood Ecosite (e)

Drainage conditions in the soils of the dogwood ecosite vary widely. Moisture regimes range from mesic to hygric and nutrient regimes from medium to rich, although the central concept of the ecosite is subhygric-rich. All three dogwood ecosite phases occur in the study area.

The tree canopy of the dogwood balsam poplar-aspen (e1) ecosite phase is usually dominated by aspen and balsam poplar, although white spruce may

be locally dominant. White birch may also be present. Prickly rose, dogwood and low-bush cranberry are the most abundant shrub species. Other characteristic shrubs are bracted honeysuckle, green and river alder, willow and currant. In the herb layer, wild sarsaparilla, dewberry, marsh reed grass and fireweed are the most abundant of the characteristic species. Ferns are also characteristic but typically have cover values <1%.

White spruce, aspen and balsam poplar dominate the tree canopy of the dogwood balsam poplar-white spruce (e2) ecosite phase. White birch is usually present in the canopy as well. The dominant shrub species are the same as in e1 and the other characteristic shrub species differ only slightly. The herb layer is also the same except that bunchberry and bishop's-cap replace fireweed. There is a moss layer with approximately 20% ground coverage. It is dominated by stair-step moss.

The dogwood balsam poplar-white spruce (e3) ecosite phase usually occurs on wetter sites than e1 and e2. The dominant tree species is white spruce, with canopy coverage averaging about 40%. Balsam fir is typically present and all three deciduous species are occasionally present. Balsam fir, low-bush cranberry, prickly rose, green and river alder, twin-flower, bracted honeysuckle and currant are the characteristic shrub species. Woodland horsetail, wild sarsaparilla, bishop's-cap, dewberry, bunchberry and tall lungwort are the most characteristic forbs. Marsh reed grass is abundant. The well-developed moss layer consists of stair-step moss, Schreber's moss and knight's plume moss.

4.2.1.6 Horsetail Ecosite (f)

Soils in the horsetail ecosite are well-to poorly-drained, with mesic to hygric moisture regimes. The nutrient supply is commonly enhanced by flooding or seepage, giving characteristically rich nutrient regimes. Typically, the forest floor is blanketed by horsetail. Two horsetail ecosite phases were documented in the LSA, but only in small patches complexed with dogwood ecosite phases.

Balsam and aspen poplar co-dominate the tree canopy of the horsetail balsam poplar-aspen (f1) ecosite phase. White birch is also characteristic, and white spruce is often present at low cover values. Willow, prickly rose, green and river alder, dogwood, wild red raspberry and low-bush cranberry characterize the shrub layer. The herb layer is dominated by common horsetail, meadow horsetail and marsh reed grass. Wild sarsaparilla and dewberry are the only other characteristic constituents. Within the LSA, this ecosite phase was typically complexed with e1.

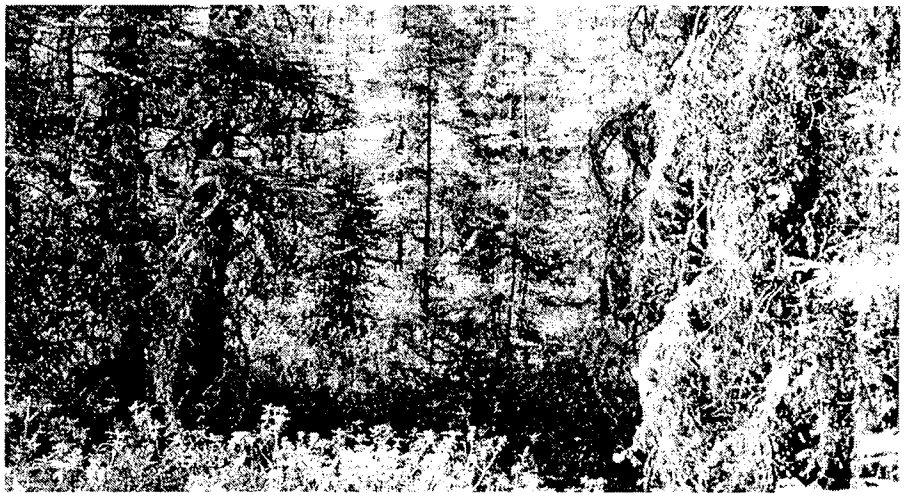
With an average canopy coverage of 36%, white spruce is the dominant tree species in the horsetail balsam poplar-white spruce (f2) ecosite phase. White birch, balsam poplar, aspen and balsam fir also are typically present. The shrub layer is characterized by low-bush cranberry, willow, white spruce, prickly rose, dogwood, balsam fir, twin-flower and white birch.

Common horsetail and meadow horsetail dominate the forb layer although wild sarsaparilla, bishop's-cap, bunchberry, dewberry, tall lungwort and palmate-leaved coltsfoot also are characteristically present. There is a well-developed moss layer consisting of stair-step moss, Schreber's moss and knight's plume moss. Within the LSA, this ecosite phase was complexed with e2.

4.2.1.7 Labrador Tea-Subhygric Ecosite (g)

The soils of the Labrador tea-subhygric ecosite are imperfectly to very poorly drained, with subhygric to hydric moisture regimes. The nutrient regime is typically poor. There is only one ecosite phase, the Labrador tea black spruce-jack pine (g1) (Figure 8).

Figure 8 Jack Pine-Black Spruce Forest With Labrador Tea Understory



The canopy of the Labrador tea black spruce-jack pine ecosite phase is usually dominated by black spruce. Jack pine, the other characteristic tree species, may be locally dominant. Labrador tea is the dominant shrub. The other characteristic species in the shrub layer are bog cranberry, black spruce, blueberry, prickly rose and twin-flower. Only one species, bunchberry, is characteristic of the poorly expressed herb layer. Moss cover is quite high, usually >50%. Stair-step moss and Schreber's moss dominate, but knight's plume moss, peat moss and tufted moss also are typically present. Reindeer lichen is usually present as well.

4.2.1.8 Labrador Tea/Horsetail Ecosite (h)

The soils of the Labrador tea/horsetail ecosite are imperfectly to very poorly drained. Moisture regimes vary widely, from mesic to hydric, although most sites are in the subhygric-hygric range. Nutrient regimes range from rich to poor. There is one ecosite phase, the Labrador tea/horsetail white spruce-black spruce (h1) (Figure 9).

The canopy of the Labrador tea/horsetail white spruce-black spruce ecosite phase is dominated by white spruce, with black spruce typically being subdominant. White birch is usually present. Labrador tea is the most abundant shrub. The other species characteristic of the shrub layer are bog cranberry, willow, prickly rose and twin-flower. Common horsetail, meadow horsetail, woodland horsetail, bunchberry and dwarf scouring rush are the only common forbs. Marsh reed grass and sedges are typically present at low cover values. The moss layer is very well-developed, with cover values averaging 70% or more. Stair-step moss and Schreber's moss dominate; tufted moss and knight's plume moss also are characteristic.

Figure 9 White Spruce Canopy With Labrador Tea and Horsetail Understory

4.2.2 Upland plant communities species richness, diversity and cover

4.2.2.1 Community Diversity

Community level biodiversity can be assessed by comparing the number of vegetation polygon (patches) within the LSA before and after the Project (Table 5). The percent loss of polygons for each ecosite phase is negligible for el/fl, e2 and e3. All other ecosite phases; however, will have a high loss of polygons (Table 5).

Table 5 Number of Vegetation Type (Ecosite Phase) Polygons or Patches

		Baseline	Closure	
Map Code	Ecosite Phase (Vegetation Types)	Number of Vegetation Polygons	Number of Vegetation Polygons Remaining	Percent Loss within Vegetation Types
a1	Pj-lichen	62	23	62.9
b1	Aw/Sw-blueberry	30	25	16.7
b3	Pj/Aw-blueberry	351	190	45.9
b4	Sw/Pj-blueberry	129	82	36.4
c1	Pj/Sb-lab-tea-mesic	9	6	33.3
d1	Aw-low-bush-cranberry	342	228	33.3
d2	Aw/Sw-low-bush-cranberry	57	39	31.6
d3	Sw-low-bush-cranberry	10	9	10.0
e1	Pb/Aw-dogwood	31	25	19.4
e1/f1	Pb/Aw-dogwood-horsetail	21	20	4.8
e2	Pb/Sw-dogwood	3	3	0.0
e2/f2	Pb/SW-dogwood-horsetail	7	5	28.6
e3	Sw-dogwood	20	20	0.0
g1	Sb/Pj-lab-tea-subhygric	4	1	75.0
h1	Sw/Sb-lab-tea-horsetail	43	23	46.5
Pj/Lt_complex	Pj/Lt-complex	7	5	28.6
Sb/Lt_upland	Sb/Lt-upland	16	9	43.8
shrub	shrub-upland	14	9	35.7
Total		1,162	728	37.3

Patch size (or polygon size) provides another measure of biodiversity (Table 6). In some ecosite phases, mean patch size changes after development but the range is constant. Changes in the range of patch size is an expression of heterogeneity in ecosite phase polygons. A reduction in patch size ranges, as a result of the Project, could equate to a temporary loss in biodiversity. Marginal reductions in patch size range are recorded in ecosite phases b3, el/fl and g1 (Table 6).

Species Richness and Diversity

Composition

Composition is assessed by examining the total number of different species present in all of the plots in each of the ecosite phases, as well as the total number of species present in each of three structural layers (tree, shrub and herb). These data, whith are presented in Table 7. represent overall species richness in each ecosite phase when taken as a whole. The sum of the species present in each of the layers does not necessarily equal the total for the ecosite phase because of species duplications between layers. Using this index, the d2 ecosite phase exhibits the greatest species richness both overall and in the herb layer. The highest shrub species richness, is in d1 and d2, and the highest tree species richness is in e1. The a1 ecosite phase has the fewest species overall as well as in each of the layers.

Table 6 Mean, Minimum and Maximum Vegetation Polygon or Patch Size

Map Code	Eco Site Phase (Vegetation Types)	Baseline		
		Mean Patch Size (ha)	Min. Patch Size (ha)	Max. Patch Size (ha)
a1	Pj-lichen	1.7	<0.1	18.8
b1	Aw/Sw-blueberry	2.2	<0.1	6.3
b3	Pj/Aw-blueberry	2.5	<0.1	15.6
b4	Sw/Pj-blueberry	2.2	<0.1	11.3
c1	Pj/Sb-lab-tea-mesic	2.3	0.2	6.6
d1	Aw-low-bush-cranberry	4.5	<0.1	47.2
d2	Aw/Sw-low-bush-cranberry	3.0	<0.1	12.2
d3	Sw-low-bush-cranberry	1.5	0.1	4.4
e1	Pb/Aw-dogwood	2.0	<0.1	7.7
e1/f1	Pb/Aw-dogwood-horsetail	3.1	0.1	10.8
e2	Pb/Sw-dogwood	1.5	1.1	1.9
e2/f2	Pb/Sw-dogwood-horsetail	1.3	0.1	2.3
e3	Sw-dogwood	4.6	0.6	19.4
g1	Sb/Pj-lab-tea-subhygric	1.9	1.0	3.3
h1	Sw/Sb-lab-tea-horsetail	2.9	<0.1	16.6
Pj/Lt_complex	Pj/Lt-complex	3.1	0.3	7.9
Sb/Lt_upland	Sb/Lt-upland	3.9	<0.1	21.4
shrub	shrub-upland	8.5	0.3	60.5
Upland Total		3.1	<0.1	60.5

The mean and range of species richness values for individual plots within the ecosite phases are also shown in Table 7. These data provide an indication of the species richness that is characteristic of small areas within ecosite phases. The highest mean and maximum of total species richness are in the d1, d2 and e1 ecosite phases. The highest mean richness in the herb layer is in d1 and d2; in the shrub layer it is in d2 and e1; and in the tree layer it is in b3. Mean richness is lowest in a1 overall and in the herb layer. The lowest mean richness in the tree layer is in d3. The lowest mean richness in the shrub layer is in h1.

Structure

In terms of structure, species richness is highest in the herb layer and lowest in the tree layer for all ecosite phases except b3, and b4. Structurally, both mean and maximum richness are lowest in the tree layer in each ecosite phase. Generally, mean and maximum richness are higher in the herb layer than in the shrub layer. The differences in relative species richness among ecosite phases, may result from differences in internal compositional variability among ecosite phases.

Table 7 Species Richness

	Total Species Richness	Total Species			Herb-Layer			Shrub-Layer			Tree-Layer		
Eco-Phase	Class Name	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
a1	Lichen Pj	9.9	4	18	2.9	0	6	5.9	2	12	1.5	0	3
b1	Blueberry Pj-Aw	15.7	8	31	6.3	1	15	7.4	5	14	2.1	0	4
b3	Blueberry Aw-Sw	14.8	13	18	5.3	4	6	7.3	5	10	3.0	2	4
b4	Blueberry Sw-Pj	14.3	12	17	4.7	3	6	8.0	7	10	2.0	2	2
c1	Labrador Tea mesic Pj-Sb	12.8	4	26	5.2	0	15	6.3	3	10	2.0	1	3
d1	Low-Bush Cranberry Aw	18.7	8	25	10.5	2	16	7.4	3	13	1.3	0	3
d2	Low-Bush Cranberry Aw-Sw	19.5	8	29	10.0	2	16	8.2	2	13	2.2	1	3
d3	Low-Bush Cranberry Sw	15.0	13	17	7.5	7	8	7.0	5	9	0.5	0	1
e1	Dogwood Pb-Aw	19.0	11	29	9.2	3	15	8.2	3	14	2.0	0	4
e2	Dogwood Pb-Sw	16.3	14	18	8.5	6	11	6.0	5	8	2.0	2	2
e3	Dogwood Sw	18.0	13	23	9.0	6	12	7.5	5	10	1.5	1	2
g1	Labrador Tea subhygric Sb-Pj	13.9	5	24	6.6	1	12	6.5	4	11	1.3	1	2
h1	Labrador Tea/Horsetail Sw-Sb	12.8	6	25	6.0	2	12	5.7	2	11	1.8	1	4

Diversity

Table 8 gives the mean and range of species diversity values for individual plots within the ecosite phases. The d1 and d2 low bush cranberry and the e1 and e2 dogwood ecosite phases have the highest mean overall diversities and along with e3, the highest mean diversities in the herb layer. The highest mean diversities are in d2, d3, e1, e2 and e3 for the shrub layer and in b3 for the tree layer. Mean diversity is lowest in g1 overall and also in the shrub. The lowest mean diversity in the tree layer is in d3 and d3. The lowest mean diversity in the herb layer is in a1. There is little difference in mean diversity between the shrub and herb layers in many of the ecosite phases and there is no discernible overall trend to higher diversity in either layer. Mean diversity is lowest in the tree layer for all ecosite phases.

Table 8 Species Diversity

Eco-Phase	Class Name	Total Species Diversity	Total Species			Herb-Layer			Shrub-Layer			Tree-Layer		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
a1	Lichen Pj	0.69	0.22	1.28	0.25	0.00	0.57	0.58	0.04	1.00	0.09	0.00	0.41
b1	Blueberry Pj-Aw	0.92	0.64	1.39	0.47	0.00	0.84	0.65	0.36	0.84	0.22	0.00	0.52
b3	Blueberry Aw-Sw	0.91	0.81	0.97	0.48	0.25	0.67	0.60	0.53	0.70	0.37	0.29	0.47
b4	Blueberry Sw-Pj	0.96	0.81	1.16	0.48	0.42	0.62	0.70	0.64	0.82	0.21	0.15	0.24
c1	Labrador Tea mesic Pj-Sb	0.68	0.38	1.13	0.31	0.00	0.84	0.52	0.20	0.81	0.23	0.00	0.29
d1	Low Bush Cranberry Aw	1.03	0.75	1.55	0.70	0.28	1.02	0.66	0.30	1.01	0.05	0.00	0.47
d2	Low Bush Cranberry Aw-Sw	1.06	0.48	1.54	0.70	0.06	1.10	0.71	0.24	0.95	0.23	0.00	0.42
d3	Low Bush Cranberry Sw	0.83	0.65	1.02	0.66	0.64	0.68	0.70	0.61	0.80	0.00	0.00	0.00
e1	Dogwood Pb-Aw	1.03	0.77	1.23	0.73	0.14	0.97	0.70	0.40	0.96	0.18	0.00	0.44
e2	Dogwood Pb-Sw	1.04	0.94	1.19	0.76	0.63	0.97	0.72	0.63	0.88	0.28	0.23	0.30
e3	Dogwood Sw	0.95	0.80	1.09	0.73	0.67	0.80	0.72	0.63	0.81	0.04	0.00	0.09
g1	Labrador Tea subhygric Sb-Pj	0.58	0.25	1.00	0.45	0.00	0.75	0.40	0.18	0.74	0.06	0.00	0.30
h1	Labrador Tea/Horsetail Sw-Sb	0.71	0.46	1.29	0.46	0.29	0.77	0.43	0.22	0.83	0.14	0.00	0.34

Species Richness and Diversity

Table 9 provides an indication of relative species richness among ecosite phases, as indicated by the mean and range of numbers of species. Of the ecosite phases for which data are available, species richness appears to be highest in h1.

Table 9 Species Richness by Ecosite Phase

Ecosite Phase	Number of Plots	Number of Species		
		Mean	Minimum	Maximum
a1	5	19	8	31
b1	4	26	23	27
c1	1	16	16	16
d1	4	23	20	27
d2	5	27	24	30
g1	6	24	11	30
h1	1	33	33	33

Table 10 shows the mean and range of numbers of species in each of the tree, shrub and herb layers in each of the ecosite phases for which data are available. In each case, the mean, minimum and maximum number of species are highest in the herb layer and lowest in the tree layer.

Table 10 Species Richness by Structural Layer

Ecosite Phase	Number of Species, by Structural Layer					
	Tree		Shrub		Herb	
	Mean	Range	Mean	Range	Mean	Range
a1	1.8	1-4	4.6	2-11	15.6	7-23
b1	2.8	2-4	7.3	3-11	20.5	18-22
c1	2.0	2-2	4.0	4-4	14.0	14-14
d1	1.7	1-2	8.8	6-12	17.8	15-20
d2	2.8	2-4	6.6	6-8	21.8	19-26
g1	2.5	2-3	7.2	4-10	19.5	8-25
h1	2.0	2-2	10.0	10-10	26.0	26-26

Neither the 1995 (BOVAR 1996), nor the 1997 studies generated enough data to identify statistically significant relationships between rare plants and vegetation units.

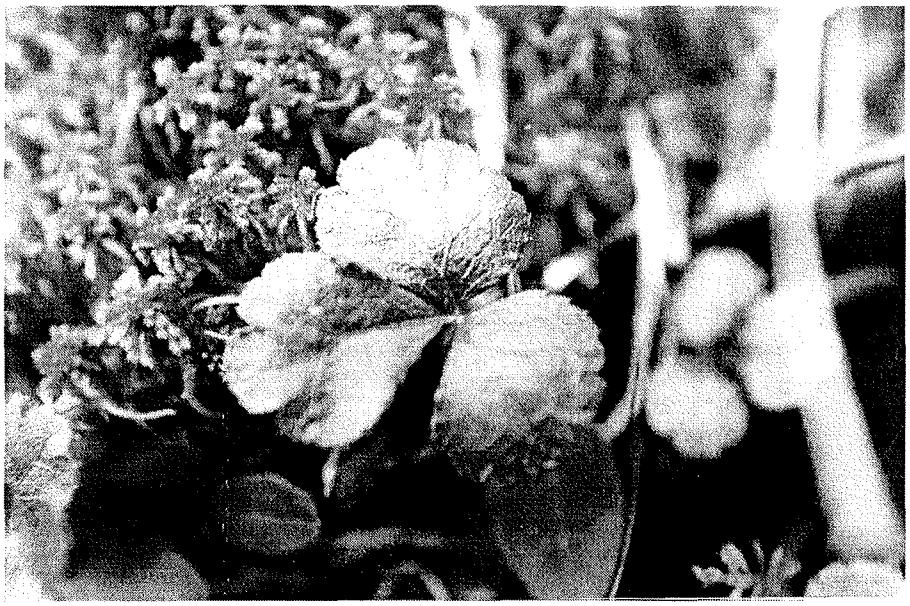
4.3 RARE PLANTS

4.3.1 Rare Plant Species

Rare plants, by definition, have restricted spatial, ecological, and temporal distributions in a variable, or biodiverse, environment (Harper 1981; Rabinowitz 1981). Their distributions are dependent upon functional processes such as succession, which is the sequential establishment of plant communities over time, following disturbance (i.e., mining). This changing, or variable, environment influences rarity by creating microhabitats that provide the specific habitats often required by rare plant species.

Plant rarity is determined by three factors: plant range, habitat specificity, and plant abundance (Drury 1974, Rabinowitz 1981). Plants can be found over wide-ranging areas, but may still be considered rare because they are not abundant within the range. These plants would typically have less specific, or more general, habitat requirements. For instance, goldthread (Figure 10) is observed in moist forest areas. Conversely, rare plants may be locally abundant, but in very specific habitat types which tend to be less abundant.

Figure 10 Goldthread (*Coptis trifolia*) Inhabits the Moist Forest of the Muskeg River Mine Project LSA



Specifically, rarity refers to the reduced abundance or numbers of plants within a range. However, the number within a local area is also important. For example, a plant may be locally common and yet rare on a provincial level. Also, a plant may be considered rare locally, even provincially, but is considered common on a national scale. Thus, it is necessary to preserve the species that appear on national lists prepared by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1996) as well as provincial lists (ANHIC 1996) relevant to the project area. The project area may represent the extremity of the plants range, specialized habitat, or a localized distribution of a plant outside of its normal range.

4.3.2 Rare plant classification systems

Rarity is typically defined for a specific range and is associated with a list for that area. The COSEWIC and the Alberta Rare Plant Classification lists were used for the rare plant study of the Project area.

National Committee on the Status of Endangered Wildlife in Canada List

This nationally developed list (COSEWIC 1996) denotes five rarity definitions or classes:

- **Vulnerable**, any indigenous species of fauna or flora that is particularly at risk because of low or declining numbers, occurrence at the fringe of its range or in restricted areas, or for some other reason, but is not a threatened species;

- **Threatened**, any indigenous species of fauna or flora that is likely to become endangered in Canada if the factors affecting its vulnerability do not become reversed;
- **Endangered**, any indigenous species of fauna or flora whose existence in Canada is threatened with immediate extinction through all or a significant portion of its range, owing to the action of man;
- **Extirpated**, any indigenous species of fauna or flora no longer existing in the wild of Canada but existing elsewhere; and
- **Extinct**, any species of fauna or flora formerly indigenous to Canada but no longer existing anywhere.

Alberta Rare Plant Classification

The Alberta Native Plant Council (ANPC) defines rare plants as "[a] native species which, due to biological or geographical characteristics, is found in restricted areas, or at the edge of its range, or for other reasons is found in low numbers within the province of Alberta" (ANPC unpublished manuscript). The Alberta Natural Heritage Information Center (ANHIC) has developed a list of rare plant species for Alberta. This list incorporates both a rare plant tracking list for Alberta, and the national list produced by the national Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1996).

The ANHIC's tracking list denotes three classes of rarity for rare vascular plants. These classes are:

- **S1**-is a plant species few in numbers or which only occurs in restricted areas. These species are threatened with extinction or extirpation due to human actions. These species are considered endangered at the provincial level;
- **S2**, is a plant species which is few in numbers and likely to become endangered if trends in the disturbance to their habitats are not reversed. These species are considered threatened at the provincial level; and,
- **S3**, these are plant species which are currently rare and may become threatened if changes to important habitats occur. These species are considered vulnerable at the provincial level (unpublished manuscript, Saskatchewan Environment and Resource Management (SERM) document 1995).

For simplicity, all of the plants in the above classes will be referred to as "rare" in the following text.

Rare Plants in the LSA

Previous studies (BOVAR 1996) documented the existence of 17 species of rare vascular plants within the LSA (Table 11 and Table 12). Within the RSA, 25 species have previously been documented. During the 1997 field studies, nine species of rare plants were documented, including three

wetlands species -- *Sparganium fluctuans, Nymphaea tetragona leibergii* and *Carex hystricina* -- not previously found within the LSA or RSA. None of the rare plants occurring within the LSA or RSA is considered to be rare nationally.

Table 11 Rare Plant Species

Species	Community Type
Barbarea orthoceras	b1
Carex hystricina	b1
Carex lacustris	b1, e1/f1, shrub
Coptis trifolia	g1.1, b1.2
Rhamnus alnifolia	g1.1
Scirpus cyperinus	d2.3
Lycopus uniflorus	d2

Table 12 Rare Plants Observed Within the LSA During 1995 and 1997 Field Surveys

Botanical Name	Common Name	Ecosite Phase	Location Plot	
			1995 (BOVAR)	1997 (Golder)
Carex lacustris	lakeshore sedge	e2, i1	217	18, 22, 30
Clintonia uniflora	corn lily	j2	223	
Barbarea orthoceras	American winter cress	r1		18
Scirpus cyperinus[(a)]	wool-grass	d2		26
Lycopus uniflorus	northern water-horehound	e2	217	11, 26
Drosera anglica	Oblong-leaved sundew	k2	214	
Coptis trifolia[(a)]	goldthread	g1		16
Kalmia polifolia	northern laurel	k3	186	
Monotropa uniflora[(a)]	indian pipe	b1	54	
Rhamnus alnifolia[(a)]	alder-leaved buckthorn	i2, g1		10, 33
Carex tenuiflora	thin flowered sedge	j2	180	
Sparganium fluctuans		i2		30
Nymphaea tetragona leibergii	small water-lily	i1		30
Carex hystricina	porcupine sedege	r1		18

(a) Denotes rare plants found primarily in uplands (terrestrial) ecosite phases, the remainder are primarily found in wetlands.

4.3.3 Rare Plant Habitat Potential

Rare plants can require specific and infrequent habitat types. Therefore, any disturbance likely to remove or substantially alter rare plant habitat will have a negative impact on local populations. These negative impacts can also reduce the genetic variability within the entire species population, by reducing gene flow, especially in the case of highly isolated colonies or colonies with restricted gene pools (Drury 1974, Schaffer 1981).

Reduction of habitat (i.e., vegetation removal) and the direct removal of rare plants through mine development, could result in the decline or loss of rare plants throughout the project area (Lucas and Synge 1981). Some rare plant species, such as those in the orchid family (Orchidaceae), suffer a reduction and are often lost due to the disturbance of individual plants or the local environment as a result of natural (e.g., fire) or human activity, such as mining (Wells 1981).

The mixed boreal upland ecoregion has evolved under a natural disturbance regime dominated by fire (White and Bratton 1981, Elliot-Fisk 1988). Rare plants, because of their specific habitat requirements, are especially vulnerable to habitat loss through such large scale disturbances. Fire creates open forests, which negatively affect the plant species that require closed and shaded forest (Hurtt and Pacala 1995). Fire has been documented to increase the variety of plant species, but this does not necessarily assist those rare plants with highly specific habitat requirements (Harper 1981). Conversely, disturbance can provide habitat for rare plants in some cases (Bratton and White 1981).

Rare plants can be found within a variety of habitat types in northern Alberta. These habitat types range from forests through to grasslands and wooded areas. Of these habitat types, the ones that occur within the LSA and RSA include; wooded areas, wetlands, meadows, riparian areas and alkaline/saline areas. These fall under the three general plant community types (upland, riparian and wetlands), or ecosite phases, with the wooded areas occupying a large proportion of that area in the RSA.

Rare plants often require unique habitat types, a number of which were observed in the Project area. Rare plants are found in upland locations within a variety of habitat types, depending upon the species requirements. Riparian areas, which were also surveyed, provide a number of unique microhabitats for rare plants, ranging from the associated bogs and fens along the shoreline to the cliff faces exposed by erosion. As previously mentioned, habitats found within the LSA ranged from true marshes to treed bogs and fens. Each of these habitats provide the unique microhabitats required by rare plant species.

Within the RSA, a number of rare and uncommon plant species, have been identified (Alberta Environmental Protection 1995, Alberta Energy/Forestry, Lands and Wildlife 1992, Argus and Pryer 1990, Cottonwood Consultants 1987, ANHIC 1996, Moss 1994). These rare and uncommon plant species are listed in Table 13. There are currently no nationally rare plants listed for either the LSA or the RSA.

Table13 Rare and Uncommon Plants in Northeastern Alberta

COMMON NAME	BOTANICAL NAME	STATUS[a]	HABITAT
American Wintercress	*Barbarea orthoceras*	P	Streambanks, moist woods
Lakeshore sedge	*Carex lacustris*	P	Marshes, swampy woods
Few fruited sedge	*Carex oligosperma*	P	Wet meadows, bogs
Thin flowered sedge	*Carex tenuiflora*	U	Sphagnum bogs
Corn lily	*Clintonia uniflora*	P	Moist woods
Goldthread	*Coptis trifolia*	P	Damp mossy woods
Stemless lady's slipper	*Cypripedium acaule*	P	Bogs, wet woods, Pine forests, and dunes
Oblong leaved sundew	*Drosera anglica*	P	Swamps and bogs
Slender-leaved sundew	*Drosera linearis*	P	Marl bogs, wet calcareous shores
Fragrant shield fern	*Dryopteris fragrans*	P	Siliceous rocks
Sand-heather	*Hudsonia tomentosa*	P	Pine sandhills, dunes
Short-tail rush	*Juncus brevicaudatus*	U	Shores, marshes
Northern laurel	*Kalmia polifolia*	P	Peat bogs
Northern water-horehound	*Lycopus uniflorus*	P	marshy ground, and streambanks
Indian pipe	*Monotropa uniflora*	U	Rich woods
Sweet gale	*Myrica gale*	P	Swamps, thickets
Reed grass	*Phragmites australis*	P	Marshes, lakes
Seaside plantain	*Plantago maritima*	P	Saline marshes
Fringed milkwort	*Polygala paucifolia*	P	Moist coniferous woods
Blunt-leaved pondweed	*Potamogeton obtusifolius*	U	Lakes, ponds
Alder-leaved buckthorn	*Rhamnus alnifolia*	P	Moist shady woods
Pitcher plant	*Sarraccenia purpurea*	P	Peat bogs, muskeg
Wool-grass	*Scirpus cyperinus*	P	Borders of oxbow lakes
Red bulrush	*Scirpus rufus*	P	Saline marshes
Prairie cord grass	*Spartina pectinata*	P	Saline shores and marshes
Smooth woodsia	*Woodsia glabella*	P	moist places calcareous rock, shaded cliffs

[a] P= Provincially rare; U= uncommon

Sources: Alberta Energy/Forestry, Lands and Wildlife (1992); Cottonwood Consultants Ltd. (1987); ANHIC (1996); Alberta Environmental Protection (1995); and Moss (1994)

Rare plants were observed in the area of the Project in 1995 at the following sites:

- Muskeg River
- Kearl Lake
- East Jackpine Creek

Although a number of rare plants were found, as well as some provincially uncommon species, there was insufficient data to yield a detectable relationship between specific habitats (ELC units) and rare plant occurrences, based on the survey results shown in Table 12.

In the 1997 survey of the Project area, some of the same rare plant species as well as some new ones, were observed. As demonstrated in the 1995 study, there were not enough observations to determine statistical relationships between rare plant occurrence and habitat type. However, the new sightings contribute to the provincial database which should eventually yield such relationships. In some cases the abundance of the species shows an affinity for specific habitat conditions and this was documented, even if only in a qualitative sense.

An understanding of habitat requirements can facilitate prediction of the occurrence of the microhabitats preferred by rare plant species. Also, an assessment of the areal coverage of the preferred habitat facilitates the assessment of impacts. The general habitats preferred by the observed rare plants varied from upland through to wetland habitat. Some of the rare species observed preferred lakeshore edges and marshy areas. A review of the habitats of the observed rare plants highlights, moist forest, riparian areas, bogs and boggy forest and marshes as areas with high rare plant potentials in the project area.

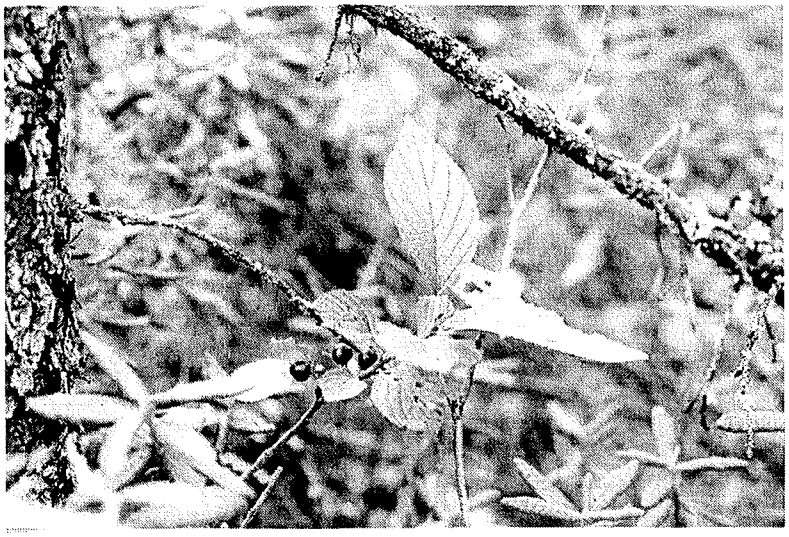
Moist Forest habitat, while not as wet as a bog, has increased moisture as a result of increased humidity. By cooling off and reducing moisture loss, these sites provide moisture rich microhabitats that are usually nutrient rich. This promotes the occurrence of rare plants. Goldthread (Figure 10) was observed in one such area.

Riparian habitats provide a variety of microhabitats for rare plants. These microhabitats are produced as a result of the varied moisture regime which occurs along riparian slopes, that are repeatedly flooded. Microhabitats are also provided by the variation in the topography that is observed along river or stream banks. This variation alters the moisture availability which in turn contributes to the variation in the microhabitat, allowing rare plants to become established. Of all the plots surveyed in 1997, four plots represented this habitat type, and all were inhabited by rare plant species. Northern water-horehound (Figure 11) was one of the most commonly observed rare plants along riparian slopes.

Figure 11 Photograph of Northern Water-Horehound Observed in the Muskeg River Mine Project Area

As mentioned, a number of rare plants tend to inhabit boggy areas, or areas with highly restricted drainage patterns. These habitat types are moist year round and are characterized by a high water table, poor drainage and an acidic substrate. Bogs are generally dominated by plant species tolerant of the acidic, poor nutrient environment. Rare plants are often found in these areas due to the specialized nature of the habitat. Alder leaved buckthorn was observed in a bog on the Project area (Figure 12). Of the bogs surveyed, a rare plant was observed in only one bog.

Figure 12 Photograph of Alder Leaved Buckthorn Observed on the Muskeg River Mine Project Area



Boggy forest is much like the previous habitat, and was also found to support rare plant species. Like the two previous habitat types, this habitat is a moisture rich habitat type. The increase in moisture level here results from drainage imperfections and from reduced evapotranspiration. This increased moisture provides favourable microhabitats for rare plant species. Of all the plots surveyed during the 1997 field survey, only one such area showed evidence of rare plants. Alder leaved buckthorn was observed in this area.

The last of the common habitats for rare plant occurrences, on the Project area, is the marsh habitat. Marshes are characterized by a high and fluctuating water table which creates unique habitat characteristics, further promoting the establishment of rare plant species. These wet environments promote the development of a specially adapted community of partially to fully submerged vegetation. Two of the plots surveyed fall into this habitat type. Rare plant species were observed in a third marsh, however a vegetation plot was not established because the marsh in question was relatively inaccessible.

These locally observed rare plants could potentially be observed across the regional study area. The ELC units of the LSA and the RSA were each assigned a rare plant habitat potential Table 14. Those ELC units in which rare plants were observed were given higher ratings than those without. Those ecosite phasese that are characteristic rare plant habitat, but were not inhabited by rare plants were assigned higher ratings than those that are not typical rare plant habitat. The general habitat types that were identified and the more specific habitats presented above were assigned rare plant habitat potentials ranging from 'low potential' to 'rare plant habitat'.

Table 14 Rare Plant Habitat Potentials for the 1995 Survey Plots

Plot Number	Plant Community Type[a]	Rare Plant Habitat Potential
3	a1.1	low potential
15	a1.1	low potential
32	a1.1	low potential
31	a1.2	low potential
36	a1.2	low potential
19	b1.1	low potential
13	b1.1	moderate potential
21	b1.1	moderate potential
29	b1.2	rare habitat potential
14	b2.1	low potential
27	c1.1	low potential
42	d1.2	low potential
25	d1.2	low potential
1	d1.2	high potential
4	d1.4	moderate potential
23	d2.1	moderate potential
26	d2.3	moderate potential
35	d2.4	low potential
24	d2.5	moderate potential
20	d2.7	low potential
17	g1.1	low potential
16	g1.1	low potential
33	g1.1	rare plant habitat
2	g1.1	moderate potential
38	g1.1	low potential
39	g1.1	low potential
12	h1.1	rare plant habitat
9	i1.1	low potential
10	i1.1	rare plant habitat
5	i1.1	moderate potential
28	i1.1	moderate potential
6	j1.1	moderate potential
7	j1.1	high potential
41	j1.1	rare plant habitat
8	j1.1	moderate potential
40	j1.1	rare plant habitat
37	l1.1	moderate potential
30	l1.1	rare plant habitat
18	riparian	rare plant habitat
22	riparian	rare plant habitat
34	riparian	rare plant habitat
11	riparian	rare plant habitat

[a] See Appendix 2 for description of plant community type codes.

In the 1995 survey, the rare plants that were identified were located in similar habitat types to those observed during the 1997 study. Riparian areas and moist wooded areas were documented as having rare plant occurrences (Table 14).

4.4 TRADITIONAL PLANT USE

This report includes an account of the traditional and current uses of the forest vegetation on the Project area. Many aboriginal people still gather a considerable quantity of plants from the forest for use as food and medicine as well as for spiritual uses. The plant species that are currently being used for food, and medicinal and spiritual purposes are discussed below. Further detail of traditional plants are described in Appendix 1.

Aboriginal peoples utilize the area for food and medicine. The plants that provide these resources occupy a variety of habitat types. Thus, all of the habitats within the forest are valued because each has unique characteristics and supplies the aboriginal people with a variety of important resources. These plants have been used for generations and provide a link with the past by connecting the aboriginal communities with their culture as well as with the forest.

A variety of plants within the boreal forest have traditionally been collected. While meat and fish were traditionally the primary source of food for many aboriginal peoples (95 to 97%), berries were the primary vegetation that was eaten (Johnson et al. 1995). Other plants that are still in use as a source of food include cattail, rose hips, beaked hazelnut and white birch. The aboriginal people who live in the area of the Project also harvest a number of plants for their medicinal properties such as rat root or sweet flag mint and Labrador tea (Fort McKay 1996).

4.4.1 Traditional Use Plant Species

A variety of plants are used in the area of the Muskeg River Mine, for medicinal, spiritual and consumptive purposes. An investigation conducted by the Fort McKay community was used to develop a list of plants used for such purposes. This information, in addition to recently acquired information, was used to create a summary table of plant species that are currently used or may be used in the future (Table 15).

Table 15 Plants Gathered for Food, Medicine, and Spiritual Purposes in the area of the Muskeg River Mine Project

Plant	Food	Medicine	Spiritual	Habitat
Balsam Fir		x		Mixedwood boreal forest
Bearberry	x		x	Open woods, sandy soils and on gravel terraces
Black Poplar		x		Riparian
Blueberry	x			Primarily found in moist montane wood
Cranberry (Lowbush and Bog)	x			Found in a variety of forest habitats
Labrador Tea		x		Found in acidic bogs, swamps and moist woods
Mint	x	x		Boreal forest species most commonly occur in wet places, including, bogs, marshes, lakeshores and fields
Moss		x		A variety of habitats but abundant in bogs
Rose hips	x	x		Found in open forest and on river banks
Senega Snakeroot		x		Limestone soils in the dry woods or rocky slopes of the boreal forest
Spruce (White and Black)	x	x		Common throughout boreal forest
Strawberry	x	x		Open areas, meadows and alpine areas
Sweet flag		x		Found in swampy, marshy areas or where there is still water
Sweet Grass		x	x	Open meadows and moist areas
Tamarack		x		Bogs and moist forest areas
Birch (White and Bog)	x	x		Well drained but moist sites
Buffaloberry	x	x		Sparsely wooded areas
Common Juniper	x	x		Throughout the boreal forest
Currants (Gooseberry Red and Black)	x	x		Moist woods
Twisted Stalk	x			Moist woods
Dogwood	x			Common in wooded areas
Frying Pan Plant		x		Unknown
Green Frog Plant		x		Unknown
Hazelnuts	x			Found in thickets and woods with well drained soils
Nettles	x	x		Disturbed areas
Pin- and Chokecherry	x	x		Often found on dry and exposed sites with sandy soils
Raspberry (Dwarf and Trailing)	x	x		Shady woods
Saskatoon berry	x	x		Found in dry to moist forests in thickets and on open hillsides with well drained soils
Fungi (Puffball and Willow)		x		Found in variety of forest habitats
Cattail	x			Found in marshes, ponds, lakes and along the edges of slow moving streams

Information from Fort McKay Environment Services 1996.

Balsam fir has been used by aboriginal peoples primarily for medicinal purposes (Willard 1992). The multipurpose resin has been used to make ointments and decoctions to relieve symptoms ranging from colds, asthma, tuberculosis and other pulmonary ailments. The resin has been described to have stimulant, diuretic, laxative, and diaphoretic properties (PMAPC 1997) ,(Johnson et al. 1995). Resin from this species has been used by aboriginal peoples to treat a variety of ailments. It is currently used for commercial purposes to seal microscope slides (PMAPC 1997) ,(Johnson et al. 1995).

Bearberry still maintains its traditional use as a treatment for cystitis and pyelitis. New uses for the plant have been discovered. For instance, it can be used to treat diarrhea and dysentery (PMAPC 1997). Bearberry may also be used as a food. Its mealy berries are not flavourful, but improve upon being cooked (Willard 1992). Medicinal purposes include the healing of the kidneys, bladder and urinary tract. Spiritual uses of this mixture involve smoking the plant in conjunction with various other plants.

There are several species of berry in the boreal forest that are used by aboriginal people. Traditionally, blueberries were the most important fruits gathered by indigenous people. Berries were preserved by cooking them in lard or drying and then eating them over the winter. They are an excellent source of vitamins A, B and C and contain calcium, phosphorus and iron (Johnson et al. 1995). This very palatable berry is widely used by aboriginals across Alberta (Willard 1992). The berries are prepared as sauces or incorporated into dough in the preparation of bread or muffins.

There are several types of cranberries within the boreal forest: low bush-cranberry, high bush-cranberry, small bog cranberry, and bog cranberry. Traditionally each of these species has been part of the Cree and Chipewyan diet and today they are used to make jams, jellies and pies (Johnson et al. 1995).

Labrador tea is widely used to make tea. This tea is used in moderation because it contains andromedotoxin which can cause headaches, cramps, and indigestion if taken in too high of a dose. The Cree use this tea as a sedative and to treat stomachaches, headaches, colds and fevers. Chipewyan people used the tea made from this plant to relieve stomach flu and diarrhea. It can also be used to clean wounds and relieve itchiness (Johnson et al. 1995).

Mint has been used by all of the northern aboriginal peoples. Mint has various medicinal uses depending on the species. It is important as a medicine and is used to make tea and to flavour foods. Mint tea is used to treat several maladies including bad breath, upset stomachs, headaches, fevers, and has been used as a calmative agent. It is also prepared in various forms to wash the pus from infected gums, relieve toothaches and stop nosebleeds (Johnson et al. 1995).

Mosses do not have a well-developed vascular system. Consequently, they either grow in moist areas or have developed poikilohydry, a form of drought tolerance. The special characteristics of certain species make them useful for pollution monitoring, while others are valued because of their water-holding capacity, acidity, resistance to decay and chemical components.

Mosses, such as peat moss, serve in medicinal uses such as in bandaging wounds. These mosses are absorbent and will readily soak up fluids. Peat moss has traditionally been used as chicken litter, an insulator and a soil conditioner. More recently, horticultural uses have increased. Moss is also used as packing material for fruit and vegetables, and as a natural deodorant (Johnson et al. 1995). Peat moss can be used for monitoring air pollution because it absorbs and retains impurities in the air.

Traditionally rose hips were an emergency food that was important for survival in the winter. They are an excellent source of vitamins A, B, C, E and K and can be eaten raw or used in jam, jelly or syrup. The liquid that remains after rose hips are boiled is used as a beverage and the juice extracted from them can be made into wine (Johnson et al. 1995).

Senega snakeroot is a medicinal plant used by indigenous people. It contains saphonins which are toxic in large doses, but in small doses can be helpful in treating pleurisy, pneumonia, asthma and most commonly, snakebites (Stark 1996).

The oil extracted from black spruce is anti-spasmodic, anti-infectious, anti-inflammatory and anti-fungal. It produces effects similar in the body to hormones and cortisone and will benefit bronchitis, acne and eczema, rheumatic pain, immune depression and kills fungus like candida (PMAPC 1997). Spruce gum has also been used to heal cuts but can also be boiled and ingested to treat colds or the vapours and inhaled to treat bronchitis (Willard 1992).

Strawberries are highly palatable berries that are primarily used as a food source. Strawberry leaves and roots, however, may be boiled and used for medicinal purposes, such as an astringent, diuretic, tonic or to relieve diarrhea (Willard 1992).

The herb rat root or sweet flag (Figure 13) is used as a medicine for several ailments including, colds, coughs, stomach disorders, fevers and burns. It is also used by some tribes to induce abortion (Stark 1996). Sweet flag contains a halucinogenic chemical called asarone (Bucher and Kuhlemeier 1993). Rhizomes of this plant were so widely used as medicine by indigenous people, that they became a medium of exchange between some groups (Johnson et al. 1995).

Figure 13 Rat Root or Sweet Flag

Source: Stark 1996

The sweet smelling perennial, sweet grass is important to indigenous people for holy ceremonies and as a medicine (Willard 1992). In ceremonies the grass is woven and burned as an offering. The Blackfoot Indians would gather it in late summer to be used as incense. The smoke was used as a spiritual cleanser and medicine men were said to have burned it twice a day. It can also be chewed to prolong fasting. As a medicine it is used to relieve coughing, vomiting, bleeding, saddle sores and hair loss. A tea made from this plant was used to treat sore throats. The stems were soaked to create an eyewash that could also be used to treat wind burn.

The gum and bark of tamarack are used for medicinal purposes (Willard 1992). For instance, the gum may be chewed to soothe indigestion and to treat liver ailments (e.g., enlarged or hardened liver). The bark can be used to make a poultice that will alleviate skin disorders such as eczema, psoriasis and bruises.

White birch is considered by most aboriginal people to be the most useful of all trees. Its hard wood is used to build several useful items and its paper-like bark has a multitude of uses. In spring this tree species can be tapped in a fashion similar to a maple tree. Birch sap is collected and used as a syrup. Traditionally this syrup was used on bannock and fish. Today, there is a small cabin industry that produces birch syrup for commercial sale (Johnson et al. 1995).

Buffaloberries may be eaten, but taste bitter. The berries can be whipped to produce a foaming pudding. However, it has also been claimed to serve as a blood thinner and should consequently be consumed in small quantities.

Juniper can be used for food or medicinal purposes. The edible berries can eaten or dried and added to meat for flavour. The berries may also be used as a diuretic or to produce a disinfectant tea that was used to treat sore throats, colds and tuberculosis.

These berries are edible and have been used as a food source, however, they also have medicinal purposes (Willard 1992). A liquid exctracted from the roots, by the Blackfoot indians, was used to treat kidney ailments and uterine problems. The juice of black currants can be used to soothe sore throats and as a diuretic.

Twisted stalk is gathered from the Project area for use as a food source. Specifically, the red berries can be eaten, but also serve as a laxative (Willard 1992).

Bunchberry is another food that has medicinal properties (Willard 1992). The berries may be eaten raw or cooked. Ingested berries have been claimed to reduce the potency of poisons.

Beaked hazelnut nuts can be eaten as a snack or they can be collected and eaten later. They are either eaten raw, or roasted, or ground into flour and used for baking (Johnson et al. 1995).

Despite their stinging hairs, nettles can be used for food as well as for medicinal purposes (Willard 1992). Young leaves can be boiled and eaten like spinach; or they can be used to make tea, wine, or beer. The stinging effect is completely removed by cooking. The tea made from the nettles can actually be used to alleviate the sting the sting as well as a diuretic, astringent and antispasmodic. It has also been used to stop internal bleeding. Older nettle plants become tough and fibrous, and the fibers can be used to make rope, paper, or a very durable cloth.

Choke cherries traditionally were added to pemmican, or were cooked with meat or stew. Today they are harvested from the wild and used in making jellies, syrups, sauces and wine (Johnson et al. 1995).

These tasty berries can be used as food. They may also be used as a medicine in the treatment of diarrhea, nausea and vomiting (Willard 1992).

In some regions saskatoon berries were the only fruit that was available in large quantities. They were spread out and dried separately or mashed and formed into blocks for drying. Once dried they were eaten raw, rehydrated or pounded into meat to make pemmican. Today, they are still a popular

fruit and are used for pies, pancakes, muffins, syrups or eaten raw on deserts and cereals (Johnson et al. 1995). Saskatoon berries are used in sauces and jellies, but may also be dried and thus preserved to last several years and later incorporated into soups, puddings or vegetable dishes (Willard 1992). The juice has been used by the Blackfoot Indians medicinally as a laxative, to soothe upset stomachs and as eye and ear drops. The bark was also used medicinally; a disinfectant was boiled from the inner bark.

Cattails have been used by the first nations people as a source of food for generations. In the spring, new shoots can be eaten raw, but, later in the year when they become tough they have to be boiled, or roasted. The rhizomes can be peeled and eaten raw or roasted and ground into a powder for use as flour or to make porridge. When they are young cattail flowers can also be used for food. Pollen from the male flowers can be mixed with flour and used for baking and the female flower can be eaten off the spike when they are green (Johnson et al. 1995).

4.4.2 Traditional Use Plant Habitat Potential

A variety of plants are used in the area of the Project, for medicinal, spiritual and consumptive purposes. An investigation conducted by the Fort McKay community was used to develop a list of plants used for such purposes. Appendix 1 lists the traditional plants known to be used in the Fort McMurray area. This information, in addition to recently acquired information, was used to create a summary table of plant species that are currently used or may be used in the future (Table 15).

A literature review, and past interviews were used to identify the use of plants in the area by aboriginal people. Plants identified included those used for food, medicinal or spiritual purposes (Table 16). Each plant species was ranked as high (H), high-medium (MH), medium (M) or low (L), according to importance (Table 16). Ranking was based on a review of traditional land use completed by the Fort McKay First Nations (Fort McKay 1996). High, medium or low were assigned to each species based on the number of times a species was indicated within a specific region of the traditional land use area.

Beckingham and Archibald's (1996) classification system was used to assign ecosites to each identified plant species. The ecosites listed for each traditional plant are based on the list of dominant vegetation species for each ecosite. As such, a traditional plant species may not always be found in the assigned ecosites, although the probability is high that they will. Conversely, traditional plant species may be found outside of the assigned ecosites. In short, assigning ecosites to each plant species is a tool to approximate the area where traditional plants may be found.

It is possible to quantify impacts on traditional plant species, by assessing ecosite losses associated with high, moderate and low traditional plant rankings (Table 16 & Table 17).

Most of the traditional use plants identified can be found in multiple ecosite phases within the LSA. Accordingly, many of the plants can potentially be found over large areas within the LSA. For example, rose hips, which are used for food or medicinal purposes, may be found in 30% of the LSA (Golder 1996). A few traditional plants, including mint, strawberry, pin- and chokecherry and cattail are found in only one ecosite. In addition, seven of the plants are only found in a small area (<5%) of the LSA (Table 17).

Table 16 Plants Gathered for Food, Medicine and Spiritual Purposes in the Area of the Muskeg River Mine Project

Plant	Score
Balsam Fir	high
Bearberry	high
Black Poplar	high
Blueberry	high
Cranberry (Low-bush and Bog)	high
Labrador Tea	high
Mint	high
Moss	high
Rose hips	high
Senega Snakeroot	high
Spruce (White and Black)	high
Strawberry	high
Sweet flag	high
Sweet Grass	high
Tamarack	high
Birch (White and Bog)	high-medium
Buffaloberry	low
Common Juniper	low
Currants (Gooseberry Red and Black)	low
Twisted Stalk	low
Dogwood	medium
Frying Pan Plant	medium
Green Frog Plant	medium
Hazelnuts	medium
nettles	medium
Pin- and Chokecherry	medium
Raspberry (Dwarf and Trailing)	medium
Saskatoon berry	medium
Fungi (Puffball and Willow)	medium-high
Cattail	high

Table 17 Traditional Plant Species and Associated Ecosites Within the Muskeg River Mine Project LSA

Plant	Importance[a]	Ecosite	Baseline LSA	
			Area (ha)	% LSA
Balsam Fir	H	d1, d2, d3, e2, e3, f2, f3	1,815	16.6
Bearberry	H	a1, b1, b2, b3, b4	1,337	12.2
Balsam Poplar	H	d1, d2, d3, e1, e2, e3, f1, f2, f3	1,942	17.7
Blueberry	H	a1, b1, b2, b3, b4, c1, g1	1,365	12.5
Cranberry (low-bush and bog)	H	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2	5,091	46.5
Labrador Tea	H	b1, b2, b3, b4, c1, g1, h1, i1, i2, j1, j2, k1	4,413	40.3
Mint	H	l1	85	0.8
Moss	H	a1, b1, b2, b3, b4, c1, d2, d3, e2, e3, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1	6,700	61.2
Rose hips	H	b1, b2, b3, b4, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1	3,304	30.2
Senega Snakeroot	H	n/a		
Spruce (white and black)	H	b1, b2, b3, b4, c1, d1, d2, d3, e2, e3, f1, f2, f/3, g1, h1, i1, i2, j1, j2, k1	6,228	56.9
Strawberry	H	b3	67	0.6
Sweet flag	H	Shallow open water, j1, j2, k1, k2, k3, l1	5,340	48.7
Tamarack	H	j1, j2, k1, k2	5,147	47.0
Birch (white and bog)	MH	b1, b2, b3, b4, d1, d2, d3, e1, e2, e3, f1, f2, f3, h1, j1, j2, k1, k2	8,443	77.1
Buffaloberry	L	b1, d1, d2, d3	2,587	23.6
Common Juniper	L	a1, b1, b2, b3, b4, c1, d1	2,903	26.5
Currants (gooseberry, red and black)	L	e1, e2, e3, f3	233	2.1
Twisted stalk	L	b1, b2, b3, b4, c1, d1	2,776	25.3
Dogwood	M	e1, e2, e3, f1, f2	233	2.1
Frying Pan Plant	M	n/a		
Green frog plant	M	n/a		
Hazelnuts	M	d1, d2	1,694	15.5
nettles	M	shrub/variable	590	5.4
Pin- and Chokecherry	M	d2	169	1.5
Raspberry (Dwarf and Trailing)	M	e1, e2, e3, f1	233	2.1
Saskatoon berry	M	b4, d1, d2	1,980	18.1
Fungi (puffball and willow)	MH	variable		
Cattail	H	l1	85	0.8
TOTALS			4,751	43.4

[a] H = high, MH - medium-high, M = Medium, L = Low.

5. CLOSURE

We trust that this report presents the information that you require. Should any portion of the report require clarification, please contact the undersigned.

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APPENDIX I

PLANT SPECIES SCIENTIFIC NAMES

Common Name	*Scientific Name*
VEGETATION	
awned hair cap	*Polytrichum piliferum*
balsam fir	*Abies balsamea*
balsam poplar	*Populus balsamifera*
beaked hazelnut	*Corylus cornuta*
bearberry	*Arctostaphylos uva-ursi*
bishop's cap	*Mitella nuda*
blueberry	*Vaccinium angustifolium var. myrtilloides*
bog cranberry	*Vaccinium vitis-idaea*
bracted honeysuckle	*Lonicera involucrata*
brown moss	*Drepanocladus spp.*
brown-foot cladonia	*Cladonia gracilis*
buck-bean	*Menyanthes trifoliata*
bulrush	*Scirpus spp.*
bunchberry	*Cornus canadensis*
Canada buffalo-berry	*Sheperdia canadensis*
cattail	*Typha latifolia*
choke cherry	*Prunus virginiana*
cloudberry	*Rubus chamaemorus*
common horsetail	*Equisetum arvense*
common pink wintergreen	*Pyrola asarifolia*
cotton grasses	*Eriophorum sp.*
cream-colored vetchling	*Lathyrus ochroleucus*
creeping spike-rush	*Eleocharis palustris*
currant	*Ribes spp.*
dewberry	*Rubus pubescens*
dogwood	*Cornus stolonifera*
dwarf birch	*Betula pumila*
dwarf scouring rush	*Equisetum scirpoides*
feathermoss	*Pleurozium spp.*
fireweed	*Epilobium angustifolium*
golden moss	*Tomenthypnum nitens*
green alder	*Alnus crispa*
hairy wild rye	*Elymus innovatus*
jack pine	*Pinus banksiana*
knight's plume moss	*Ptilium crista-castrensis*
Labrador tea	*Ledum groenlandicum*

Common Name	*Scientific Name*
lichens	*Cladonia sp., and Cladina sp*
low-bush cranberry	*Viburnum edule*
marsh cinquefoil	*Potentilla palustris*
marsh marigold	*Caltha palustris*
marsh reed grass	*Calamagrostis canadensis*
marsh skullcap	*Scutellaria galericulata*
meadow horsetail	*Equisetum pratense*
midway peat moss	*Sphagnum magellanicum*
northern reed grass	*Calamagrostis inexpansa*
northern willowherb	*Epilobium ciliatum*
oak fern	*Gymnocarpium dryopteris*
palmate-leaved coltsfoot	*Petasites palmatus*
peat moss	*Sphagnum spp.*
peat moss	*Sphagnum angustifolium*
peat moss	*Sphagnum fuscam*
pin cherry	*Prunus pensylvanica*
pitcher plants	*Sarracenia purpurea*
prickly rose	*Rosa acicularis*
ragged moss	*Brachythecium spp.*
reed grass	*Phalaris spp./Phragmites spp.*
reindeer lichen	*Cladina spp.*
river alder	*Alnus tenuifolia*
rushes	*Juncus sp., Luzula sp.*
sand heather	*Hudsonia tomentosa*
saskatoon	*Amelanchier alnifolia*
Schreber's moss	*Pleurozium schreberi*
scorpion feathermoss	*Scorpidium scorpioides*
sedges	*Carex spp.*
shield fern	*Dryopteris carthusiana*
shore-growing peat moss	*Sphagnum. riparium*
showy aster	*Aster conspicuus*
slender hair-cap moss	*Polytrichum strictum*
small bog cranberry	*Oxycoccus microcarpus*
snowberry	*Symphoricarpos albus*
stair-step moss	*Hylocomium splendens*
stiff club-moss	*Lycopodium annotinum*
sweet gale	*Myrica gale*

Common Name	*Scientific Name*
sweet-scented bedstraw	*Galium triflorum*
tall lungwort	*Mertensia paniculata*
tamarack	*Larix laricina*
three-leaved Solomon's seal	*Smilacina trifolia*
trembling aspen	*Populus tremuloides*
tufted moss	*Aulacomnium palustre*
twin-flower	*Linnaea borealis*
water smartweed	*Polygonum amphibium*
white birch	*Betula papyrifera*
white spruce	*Picea glauca*
wild lily-of-the-valley	*Maianthemum canadense*
wild mint	*Mentha arvensis*
wild red raspberry	*Rubus idaeus*
wild sarsaparilla	*Aralia nudicaulis*
wild strawberry	*Frageria virginiana*
willow	*Salix spp.*
woodland horsetail	*Equisetum sylvaticum*
algae	*Selenastrum capricornutum*

APPENDIX II

REGIONAL VEGETATION ACCURACY ASSESSMENT

Regional Vegetation Accuracy Assessment

Pix Value	Class	Beckingham Ecosite Phase	% Accuracy
0	unclassified	unclassified	null
1	water	water	98%
2	jack pine forest	a1	82%
3	mixedwood forest	b1,b3,d2	86%
4	spruce forest	d3,e3	82%
5	aspen (poplar) forest	d1	93%
6	graminoid fen	k3	79%
7	wet shrublands	e1,e2	79%
8	marsh	l1	80%
9	disturbances	disturbances	98%
10	cloud	cloud	null
11	wooded peatland	j1,j2,k1,k2,and limited i1,i3	81%
12	paper birch forest	b2	DNE
13	recent burn fen	j1,j2,k1,k2 with recent burn	81%
14	recent burn fen	j1,j2,k1,k2 with recent burn	duplicate
15	forestry cutblocks	forestry cutblocks	98%