Terrestrial Baseline Report for the Steepbank Mine

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952-2307

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1.0 INTRODUCTION

1.1 Background

An assessment of the baseline biophysical conditions (terrain, soils and vegetation) of the proposed Steepbank Mine area was conducted by Golder Associates Ltd. during the summer of 1995. As part of this process, both a local and regional study area were identified for baseline characterization. The Local Study Area provided the basis for detailed biophysical resource description and analysis, while the Regional Study Area allowed the assessment of potential impacts to be viewed in a broader context. Cumulative impacts could also be assessed within the Regional Study Area.

Data collection and analysis of the proposed mine development, within the framework of both the Local and Regional Study Area, were used as the basis of the Environmental Impact Assessment.

An assessment of vegetation resources within the Regional Study Area was conducted using large scale terrain types (ecosections) and the relationship between landforms, soils and drainage conditions. The Local Study Area underwent a more rigorous assessment in which detailed terrain types, soil types, vegetation types and forestry resources (ecosites) were identified and mapped to form the basis of an integrated Ecological Land Classification (ELC). Both classification and mapping studies relied heavily on the use of Landsat imagery analysis. Landsat images were ground-truthed using detailed field data.

An assessment of biodiversity was made using the identified terrain, soil and vegetation resources within both the Local and Regional Study Area. This assessment reflected the extent of habitat variability, interspersion and species richness within each of the identified ecosections. In addition, utilizing a knowledge of the existing biophysical resources, Valued Ecosystem Components (VECs) were selected upon which the majority of the impact assessment decisions were based. The selection of the final VECs involved a review of existing literature, appropriate rating criteria and candidate VECs suggested by stakeholders.

1.2 Resource Management Objectives

The Draft Fort McMurray - Athabasca Oil Sands Subregional Integrated Resource Plan (AEP 1995) presents the Government of Alberta's resource management policy for public lands and resources within the area. It is intended to be a guide for resource managers, industry and the public with responsibility and/or interests in the region, without being a regulatory mechanism (AEP 1995).

Broad management objectives for the Fort McMurray-Athabasca Oil Sands ecological resources are focused on: a) protecting representative, significant and unique examples of the natural features, landscapes and ecosystems of the Boreal Mixedwood Ecoregion; b) providing for the recreational, scientific or educational use of ecological resources, and; c) ensuring that features are maintained in a natural state. Examples of the most significant features of this region, which fall within the Suncor regional study area include the karst topography north of Fort McMurray, the Saline Lake Natural Area and the extensive McClelland Lake wetlands (AEP 1995). The guideline on management of ecological resources further states that ecological resources will be identified by government agencies and individual groups through an assessment and review process whereby public land reservations will be established and maintained.

Within the Fort McMurray-Athabasca Oil Sands Planning Area, a significant portion of the Steepbank Mine falls within the southeast corner of the Mildred-Kearl Lakes Resource Management Area, (RMA). This is the second largest RMA in the region, with an area of 3 067 ha. The only Resource/Land Use activity not considered compatible in this area include permanent and seasonal residency (AEP 1995). All other uses are permitted, however with some guidelines. This is a reflection of the extreme resource potential of this RMA, the entire area being underlain by surface mineable oil sands deposits (AEP 1995). The IRP acknowledges that the impacts of open-pit mining on the natural landscape in this RMA area is considerable. Reclamation is of major importance as it should return the land to a level of capability equivalent to its previous state (AEP 1995). However, the primary management intent for this RMA is to:

> "Promote the orderly planning, exploration and development of resources with emphasis on the area's oil sands reserve."

The objectives for this RMA reflect the management intent, such that the stated objectives and guidelines express the need to provide opportunities for industry to further delineate and extract oil sands reserves as well as other mineral resources.

As such, ecological and resource based objectives and guidelines which are directed at preserving the ecological integrity of the RMA are primarily related to reclamation efforts. Long-term planning must show reclamation to a capability equivalent to a boreal forest environment capable of sustaining a variety of activities. However, several specific guidelines to development in this RMA, designed to protect sensitive areas, include, for example, a restriction on development adjacent to Saline Lake, and a guideline which advocates mitigating any disturbance to local lakes. Maintenance of moose habitat is another objective.

In addition to the Mildred-Kearl Lake Resource Management Area, the proposed location of the Steepbank Mine is located in the Athabasca-Clearwater Resource Management Area. This RMA primarily incorporates the Athabasca and Clearwater River valleys, and as such encompasses nationally significant (Athabasca) and provincially significant (Clearwater, Ells, Firebag) Rivers (Westworth and Associates 1990; AEP 1995). The McClelland Lake wetlands portion of the RMA contains McClelland Lake, an adjacent fen of significant size and character, and the adjoining upland drainage basin. These components are outside of the Steepbank Mine Local Study Area. Throughout the development of the integrated resource plan, concerns about the impact of oil sands development within the Athabasca River valley have been brought to the attention of the planning team (AEP 1995). It is also recognized that there are several very important oil sand ore bodies which lie along and extend into the Athabasca River valley, within the surface mineable portion of the river. In view of these natural and economic resources, the management intent for this RMA is defined as:

> "To protect the natural landscape, which encompasses water, wildlife habitat, ecological and geological features, to ensure aesthetic, recreation, traditional and environmental values."

The objectives defined for Mineral and Surface Material Resources include the need to explore and develop mineral and surface material resources in a manner that ensures protection of and minimizes the impacts to the unstable slopes, watershed, wildlife, ecological, historical, traditional and recreational values of the RMA. Guidelines are put forth in support of this objective. Several sites outside of the Steepbank Mine area are clearly defined as areas where in situ oil sands development will not permitted. Development within other areas, including the Steepbank Mine area will be considered on a site-by-site basis, with guidelines that require maximizing the use of existing equipment/infrastructure, and minimizing impacts to natural aesthetic, recreational and heritage resources. In addition, objectives in this RMA state that the Athabasca River Valley ecosystem and its resources and values will be protected. Exploration and development of oil sand resources will be considered only if the proponent can demonstrate that mitigation of the impacts on the resources and values identified can be achieved (AEP 1995).

To meet the objectives of sustainable resource management within Suncor's existing and future leases, an understanding of the existing biophysical resources is required to serve as a benchmark from which the reclamation progress can be evaluated and resource management objectives can be met. A phased development and reclamation approach has been developed to minimize the overall extent of disturbance at any one time in the mining operation. Biophysical resources are described in this report in an integrated fashion to help further understanding of the inter-relationships between landform, soil, drainage and vegetation and to provide a database for subsequent reclamation activities.

2.0 APPROACH

The approach used to identify and map biophysical resources within both the regional and local study areas involved that of an Ecological Land Classification. Primary data sources included Landsat TM (Thematic Mapper) imagery and a Digital Elevation Model (DEM), or terrain model, for the local study area. The combination of these two data sources, combined with detailed field investigations for vegetation and soils resources, formed the basis of the biophysical map products for both the local and regional study area. Landsat imagery analysis was used to classify and map the data, while analysis of the DEM allowed further breakdown of landform types within the local study area.

2.1 Ecological Land Classification

An ecological land classification approach to terrain, soils and vegetation mapping involves the integration of these biophysical elements into homogeneous map units at different scales or levels of generalization. The classification is hierarchical in nature, involving the recognition of broad landform associations such as river floodplains or organic/lacustrine plain uplands at the ecosection level of mapping. At a more detailed scale, ecosites are identified based on the associations of vegetation with a particular landform, soil and drainage condition. Ecosites identified in this study include, for example, a Peatland Open Black Spruce - Labrador Tea ecosite occurring within the organic/lacustrine plain Upland ecosection.

Landform information within the local study area was obtained from the DEM. This allowed the classification of landforms within the local study area to be based on significant terrain breaks, including floodplain and floodplain terraces, escarpment slopes, upland moraine, highland moraine, midland and midland drainage. The major landform types, or ecosections, identified were further verified with airphoto interpretation which involved an assessment of landform, soil and vegetation associations. Broad regional terrain types were derived using particular combinations of Landsat imagery (or band), allowing for division between the low-lying floodplain and the adjacent escarpment and upland areas. Ecosites, based largely on vegetation associations, were identified within the local and regional study areas again using Landsat imagery analysis and aerial photograph interpretation. The initial delineation of map units was verified or modified by using detailed field data. Soils were mapped according to the criteria established by the Agriculture Canada Committee on Soil Survey (1987). Soil profiles and inspection point data were used to delineate soil polygons which were integrated with the vegetation types. This allowed the integration of soil and vegetation descriptions as ecosites within the local study area.

2.2 Integrated Biophysical Impact Assessment

An Ecological Land Classification of both the Local and Regional Study Areas allows terrain, soil and vegetation resources to be examined in a holistic manner. Each ELC unit, mapped either at the broad ecosection or detailed ecosite level of generalization, reflects a unique combination of characteristics, reflecting the inter-relationships which exist between them. It is this relationship between the biophysical elements of the landscape that produces the diversity of the ecosystems within the study area.

To assess impacts which pertain to specific biophysical Valued Ecosystem Components (VEC), or issues such as biodiversity, an ELC approach to data analysis can provide a useful tool. The location of VECs and the distribution of various vegetation types with respect to landform conditions such as slope angle, slope aspect and soil type can be more fully understood when these factors are considered in an integrated fashion. The utility of this approach is also seen in the reclamation of disturbed landscapes where replacement of functioning ecosystems requires an understanding of terrain, soil and vegetation dynamics. This is particularly true when the long term goals of sustainable ecosystem reclamation are considered.

2.3 Remote Sensing Analysis

Biophysical resource mapping and analysis was performed through the use of remote sensing analysis. Landsat TM data provided the database, combined with field investigations which were used to identify and delineate ecosites. This approach was combined with analysis of the DEM layer within the local study area, to further delineate ecosites based on a combination of vegetation cover and terrain type.

3.0 EXISTING CONDITIONS - OVERVIEW

3.1 Topography and Drainage

Within the Baseline Study Area, the topography drops towards the Athabasca River from east to west, with the Athabasca River valley sloping away towards the north. Areas of higher relief include Muskeg Mountain to the east of the Athabasca River, which rises gradually to 580 m. The Thickwood Hills, southwest of the study area is a subdued highland area with gentle slopes which give rise to both northward flowing tributaries of the MacKay River, and small tributaries of the Athabasca River, to the northeast (Carrigy and Kramers 1973).

The main drainage of the region is the Athabasca River, the valley of which is generally U-shaped and incised to depths of approximately 60 to 90 m. The valley forms a broad, muskeg-dominated alluvial plain, with various floodplain terraces occurring at different elevations. The Steepbank River joins the Athabasca River in the northern portion of the local study area, opposite the existing Suncor plant site. The Steepbank River valley is even more steeply incised than that of the Athabasca and meanders in a broadly southeast to northwest direction across the study area.

3.2 Surficial Geology

Surficial deposits within the Regional Study Area are made up of the material left behind by the melting of the ice sheet which covered northern Canada to a depth of 600 m during the Pleistocene epoch. Morainal deposits are a direct result of ice transport and subsequent melting. Other landscape features are the result of erosion and deposition from discharging meltwaters; while still other sediments were deposited in ice-dammed lakes (lacustrine and glacio-lacustrine sediments). Remnants of old beach ridges, formed at various lake levels, are common around the Thickwood Hills, west of Fort McMurray (Carrigy and Kramers 1973).

Following the ice melt, the original deposits were subjected to wind erosion, forming areas of fine silt and sand deposition (loess). Dune fields were also formed during this period. With gradual climatic change, the dunes were stabilized by vegetation and the depressions on the poorly-drained glacio-lacustrine deposits were filled with mosses and sedges, which build up over time due to slow decomposition rates, forming peat bogs or muskeg.

The U-shaped Athabasca valley likely formed in part by the movement of glacial ice and may have acted as a spillway for the drainage of large glacial lakes. In addition to this major feature, many small meltwater channels can be recognized on the surface of the upland morainal plains. Most of the tributary streams to the Athabasca have cut through the unconsolidated glacial drift down into the soft Mesozoic bedrock, with some larger streams cutting into the hard Paleozoic limestone. Associated with these actively eroding streams are many active slump features, which have been noted along the Steepwater River (Carrigy and Kramers, 1973). Slumping of the Mesozoic bedrock is especially prevalent in the stream valleys which are cut into the Clearwater shale.

Surficial geology within the study area differs according to the nature, thickness and origin of glacial drift, lacustrine deposits and fluvial deposits. Four main types of surficial deposits occur within the Local Study Area.

A. **Beaverhill Lake Formation**

This formation occurs along the Athabasca River, within a narrow band extending north/south. It corresponds to the fluvial deposits within the floodplain.

B. **McMurray Formation**

This formation also extends along the upper slopes of the Athabasca River Valley, enveloping the smaller and more narrow Beaverhill Lake Formation. This corresponds with the escarpment slopes of the Athabasca River Valley.

C. **Clearwater Formation**

This is the most predominant surficial deposit type within the study area, extending east and west from the McMurray Formation, for approximately 9.5 to 32 km (Hackbarth and Nastasa 1979).

D. Grand Rapids Formation

The Grand Rapids Formation occurs along the outer east and west edges of the Local Study Area, and is composed of very thick drift or morainal deposits on slightly elevated bedrock, forming Muskeg Mountain and the surrounding terrain. It is from Muskeg Mountain (an area of relatively high relief due to thick glacial drift and elevated bedrock) that the Steepbank River and numerous smaller drainages originate. To the southwest of the study area, similar thick deposits and elevated bedrock occur in the region of the Thickwood Hills, where drainages flowing from the southwest to northeast, enter the study area and flow into the Athabasca.

3.3 Soils

A detailed soil report, documenting the soil resources of the local study area, was prepared by Can-Ag Enterprises Ltd (1996). This report forms part of the biophysical database and is briefly summarized here to provide the basis for subsequent integration of soils information in the description of ecosections and ecosites.

Soils have developed on both organic and mineral parent materials of various depth and textures. Soils identified and mapped within the local study area in 1995 included 11 soil types, strongly associated with terrain, surficial materials and drainage conditions (Can-Ag 1996). Organic deposits associated with bogs and fens were characterized by peat thicknesses of 0.5 to 1.5 m. The soils are poorly drained with water tables at or near the surface for much of the growing season. Most of the soils were Mesisols, but Humisols and Fibrisols also occur. Table 3.1 provides an approximate percentage of the different kinds of surficial material and soil groups occurring in the Regional and Local Study Areas (Can-Ag 1996).

Morainal till deposits cover a significant part of the landscape. Textures vary and include sandy loam, sandy clay loam and clay loam. Well and moderately well drained Orthic Gray Luvisolic soils are widespread in upper slopes, and a lesser extent of imperfectly drained Gleyed Gray Luvisols and poorly drained Gleysolic soils occur in lower landscape positions. Moderately productive mixedwood forests are prevalent.

Lacustrine parent materials are more extensive in the northwest of the study area and are clay to clay loam, non-stony materials on near level topography. Soil and drainage relations are identical to those described for morainal soils. Moderately productive mixedwood forests are dominant on these soils.

Coarse-textured glacio-fluvial materials occur in glacial meltwater channels and spillways on the uplands bordering the Athabasca River valley. Soils are predominantly Brunisols and Luvisols that are rapidly to well drained. Forest cover ranges from open pine stands on upper, drier sites, to mixedwood forests on lower moist locations. There are also minor occurrences of fluvial-eolian sandy deposits towards the northern end of the study area. The soils include rapidly and well drained Eutric and Dystric Brunisols. Soil textures range from sand to sandy loam. These sites typically support jack pine stands.

Table 3.1

PERCENT OF SURFICIAL MATERIALS AND SOILS IN THE STUDY AREAS

(from Can-Ag 1996)

Surficial Materials and (Soils)	Regional Study Area	Local Study Area
Organic (Mesisols)	55	65
Morainal (Luvisols)	5	20
Lacustrine (Luvisols)	20	inclusions
Glaciofluvial (Brunisols and Luvisols)	10	5
Fluvial-Eolian (Brunisols)	5	inclusions
Rough Broken	5	10

Parent materials found on the steep escarpment slopes of the Athabasca and Steepbank River are referred to as 'Rough Broken', and include morainal, colluvial and other parent materials. Various soil types and drainage categories occur within this unit (Table 3.1).

3.4 Vegetation

The Local and Regional Study Areas of the Steepbank Mine Project are located within the Mid Boreal Mixedwood Ecoregion (Strong 1992). This is the largest ecoregion in Alberta, occurring primarily north of 55° N latitude. The topography is relatively subdued although several major hill complexes and uplands, including the Thickwood Hills in the Southwest corner of the Regional Study Area, are significant components of the landscape.

Reference sites in the Mid Boreal Mixedwood Ecoregion are vegetated by aspen (*Populus tremuloides*) and Balsam poplar (*P. balsamifera*). White Spruce (*Picea glauca*) and balsam fir (*Abies balsamifera*) are the climatic climax species but are not well represented due to the frequency of fires (Strong 1992) and the prevalence of poorly drained conditions in some areas. Poorly drained depressions are dominated by black spruce (*Picea mariana*), whereas poorly drained sites with moving water are often vegetated by willows (*Salix* spp.) and sedges (*Carex* spp.). Such sites include stream and lake margins and shallow waterbodies that are stream-fed and occasionally flooded (Strong 1992). Strong (1992) reports that wetlands have a large aerial extent in this ecoregion. Table 3.2 shows common ecosystems in the Mid Boreal Mixedwood Ecoregion, arranged along an environmental gradient (Strong 1992).

The Local Study Area for the proposed Steepbank Mine is located within the IIML Ecoregion, on the east side of the Athabasca River (Strong 1992). This Ecoregion is defined as an undulating organic and lacustrine plain, dominated by wetlands and mixedwood forests (Strong 1992). The average moisture regime is rated as subhygric to mesic, and soils are typically Organic to Gray Luvisols (Strong 1992).

The Syncrude's Mildred Lake study area was located slightly northwest from the Steepbank Mine study area, and is included in the Regional Study Area. Baseline environmental conditions were assessed. The Mildred Lake Local Study Area identified seven terrain types or ecosections, including high relief uplands and lower elevation floodplain types, separated by broad organic/lacustrine uplands. Twenty-two soil associations were identified within the Local Study Area. Ten vegetation types were classified, falling within either the upland or lowland categories. Vegetation types located east of the MacKay River included black spruce, black spruce-willow, cleared, disturbed, dwarf birch-tamarack, jack pine, mixedwood, riparian, trembling aspen, aspen-balsam poplar, tall shrub, and white spruce. West of the MacKay River, habitat types identified included closed aspen mixedwood, closed aspen-white spruce, closed black spruce, closed deciduous, closed white spruce mixedwood, open black spruce, open dwarf shrub, sedge-reedgrass and tall shrubland (Concord Environmental 1992). These vegetation types were subsequently described as ecosites by considering variations in species composition and structure with respect to landform and soil conditions.

DRY/WARM

Jack Pine
Rapidly to Well Drained
Eutric and Dystric Brunisols
I
Aspen
(Successional to White Spruce and Balsam Fir)
Well Drained
Eutric Brunisols and Gray Luvisols
I
Aspen-Balsam Poplar
(Successional to White Spruce and Balsam Fir)
Moderately Well to Well Drained
Gray Luvisols and Eutric Brunisols
I
Aspen-Balsam Poplar-White Spruce
(Successional to White Spruce and Balsam Fir)
Moderately Well to Imperfectly Drained
Gray Luvisols and Eutric Brunisols
I
Black Spruce
Poorly Drained
Gleysols and Organics
I
Willows
Poorly Drained
Organics and Gleysols
I
Sedges
Very Poorly Drained
Organics

WET/COOL

Table 3.2 **Mid Boreal Mixedwood Ecoregion - common ecosystems arranged along an environmental gradient (Strong 1992).**

Stringer (1976) classified the boreal forest region according to a 10 vegetation class system. These consisted of fen, sandbar willow shrub, tall willow-river alder scrub, tall willow scrub, bottomland balsam poplar, upland white spruce-aspen, black spruce bog, semi-open black spruce-tamarack, lightly forested tamarack and open muskeg, and jack pine forest.

Other studies within the region provided similar classification schemes, including Thompson et al. (1978), Smith et al. (1992), Knapick and Westworth (1982) and The Delta Environmental Management Group (1990). These classification systems primarily included consideration of such factors as: mineral soil or non-vegetated; anthropogenic use (clear cuts, industrial activity, burn, disturbed areas); open or closed coniferous forest (closed needle, pine, mixedwood - coniferous dominant); open or closed deciduous; closed mixedwood; black spruce bog forest, tamarack bog forest; bottomland forest; closed shrub, graminoid and fen communities; and, open water.

In the OSLO Report (1991) seven vegetation associations were identified including Bog (Bowl bog, Slope bog, blanket bog); Fens (string fen, patterned fen); Riparian communities; Anthropogenic (cutlines and cutblocks); White Spruce (aspen, aspen-jack pine, climax white spruce); jack pine (jack pine-aspen, climax jack pine); and, black spruce (jack pine-aspen-black spruce and climax black spruce).

Rare Plants

A rare plant survey is typically a component of vegetation inventories conducted within the area of potential impacts. In the Mildred Lake Study (Concord 1992), no rare plant species were located. However, round-leaved sundew (*Drosera rotundifolia*), considered to be regionally uncommon, was noted at several locations in black spruce forested bogs.

Concord (1992) cite Packer and Bradley (1984), Hardy Associates (1978) Ltd. (1980) and Cottonwood Consultants (1987) for rare and uncommon vascular plant species identified within the Mildred Lake study area, and their associated habitat types within the region (Table 3.3).

Table 3.3 Rare and Uncommon Plant Species in the Suncor/Syncrude Area
(from Concord 1992)

Scientific Name	Common Name	Habitat	Category of Importance
Drosera alnifolia	long-leaved sundew	perennially wet fen	uncommon
Myrica gale	sweet gale	riparian shorelines and river backwater	uncommon
Polygala paucifolia	fringed milkwort	marshy coniferous woods	rare
Potomogeton obrusifolius	blunt-leaved pondweed	lakes and ponds	rare in Alberta
Rhamnus alnifolia	buckthorn	upland pure and mixed aspen-pine forest	uncommon
Sarracenia purpurea	pitcher plant	perennially wet fen	uncommon
Spartina pectinata	prairie cordgrass	saline shores and marshes	rare in Alberta
Woodsia glabella	smooth woodsia	moist calcareous rocks shaded cliffs	rare in N.A.

In addition, Packer and Bradley (1984) indicate species which have been located within the general study area location, and have a potential to be found in the Local Study Area (Table 3.4).

Table 3.4 Rare and Endangered Plant Species Located Within the Region

Scientific Name	Common Name	Habitat	Category of Importance
Selaginella rupestris	Little Club-moss	Dry open areas	S3
Lycopodium inundatum	Bog Club-moss	Moist depressions in sand dunes	S3
Isoetes echinospora	Braun's Quillwort	Ponds and lakes	S3
Cystopteris montana	Mountain Bladder Fern	Springy or damp calcareous places	S3
Dryopteris fragans	Fragrant Shield Fern	siliceous rocks	S3
Potomogeton obtusifolius	Blunt-leaved Pondweed	Lakes and ponds	S3
Polypodium virginianun	Licorice Fern	Moist rocky outcrops	S3
Woodsia ilvensis	Rusty Woodsia	Rock crevices	S3
Carex lenticularis	Lens-fruited sedge	Marshes and lake shores	S3
Carex pseudo-cyperus	Cyperus-like Sedge	Swamps and marshes	S3
Carex supina	Weak Sedge	Dry, gravelly, eroding slopes	S3
Scirpus cyperinus	Wool-grass	Marshy ground	S3
Juncus brevicaudatus	Short-tailed rush	Shores and marshes	S3
Juncus filiformis	Thread rush	Bogs and marshes	S3
**Cypripedium acaule*	Stemless Lady's-slipper	Bogs, wet woods and sand drunes	S3
Chenopodium leptophyllum	Narrow-leaved Goosefoot	Dry slopes	S1; N2,2
Sagina nodosa	Pearlwort	Damp rocky, gravelly, or peaty places	S1-3
Silene antirrhina	Sleepy catchfly	Dry, open areas	S3
Spergularia marina	Salt-marsh Sand Spurry	Brackish or saline muds and sands	S3
**Nyphaea tetragona*	Small White Water-lily	Ponds and quiet waters	S3
Cardamine pratensis	Meadow Bitter Cress	Bogs and swamps	S3
Potentilla multifida	Branched Cinquefoil	Open areas and gravel bars	S3
Hypericum majus	Large Canada St. John's-wort	Moist depressions in sand dunes, sandy shores	S3
Gentianella detonsa	Northern Fringed Gentian	Wet meadows, saline flats	S3
Pinguicula villosa	Small Butterwort	Sphagnum bogs	S3
Utricularia cornuta	Horned Bladderwort	Bogs and lake shores	S3
Plantago maritima	Seaside plantain	Saline marshes	S3
Lobelia dortmanna	Water Lobelia	Shallow waters and shores of ponds and lakes	S3
Aster pauciflorus	Few-flowered Aster	Saline shores and depressions	S3
Erigeron hyssopifolius	Wild Daisy	Gravelly shores and meadows	3
Tanacetum huronense	Indian Tansy	Sand dunes, sandy and gravelly shores	3
Thellungiella salsuginea	Mouse-ear Cress	Saline shores and flats	S3
Drosera linearis	Slender-leaved Sundew	Marly bogs and wet calcareous shores	N1, 1

N1 National 1 Critically imperiled; 3 Rare or uncommon (21-100);
S1 In Alberta, Critically imperiled

3.5 Significant Natural Resources

Significant natural features were evaluated for the Eastern Boreal Forest Region by Westworth (1990). Selection was based on eight criteria ranging from environmental function to uniqueness, significance, diversity, pristine state, linking functions and recognized significance. Natural features within the Suncor Local Study Area, which were considered to be of significance included the Athabasca River (rated as a nationally significant watercourse), and the Steepbank River (of Regional significance).

Within the Regional Study Area, significant natural features included the Athabasca and Steepbank Rivers as well as the MacKay, Muskeg, Dover, Ells, Tar, Horse, Hangingstone and Christina Rivers. In addition, the Thickwood and Bitumont Hills, Fort Hills, Saline Lake, McClelland Lake and associated fens and sinkholes, the Dover-McKay Moose area, Kearl Lake and area, Horseshoe Lake, Calumet Plains and areas of mature white spruce forest along the Athabasca River were rated as Regionally significant (Westworth 1990).

3.6 Biodiversity

Biodiversity is a term that has gained much popularity with resource managers, scientists and the public in recent years. Canada ratified the *United Nations Convention on Biological Diversity* at the 1992 United Nations Conference on the Environment and Development in Rio de Janeiro, Brazil. Canada has since released that *Canadian Biodiversity Strategy* in response to the convention. This strategy stipulates that the preservation of biodiversity in Canada is critical, and should be accomplished through the preservation and/or sustainable use of ecosystems.

While biodiversity is recognized as being a necessary subject for study, the methodology to effectively study it is another matter. As Egler (1977) states:

> "Ecosystems are not only more complex than we think, but more complex than we can think."

However, it is generally agreed that a description of biodiversity must include reference to the scale at which diversity is being described. Noss and Cooperider (1994) state that there are four levels of biodiversity that should be considered:

- Landscape
- Community
- Species, and
- Genetic

In describing the biodiversity which exists within the Suncor Local Study Area, the definition adopted reflects this holistic approach:

> The variety of organisms and ecosystems which comprise both the communities of organisms within particular habitats and the physical conditions under which they live (Wilson 1989).

Scientists estimate that less than 50% of Canada's species of plants and animals have been discovered, named and classified (Environment Canada 1995). Large information gaps exist for such groups as fungi, bacteria and insects. Given this realization it is generally accepted that while a detailed biophysical inventory of ecological units within a given area is valuable in terms of describing the dominant constituents of an ecosystem, species richness based on this data is not alone, an adequate measure of biodiversity. Further, there is little research to date which attempts to label the biodiversity index of various communities in the boreal forests of northern Canada. Researchers are continually upgrading knowledge as to the identification and cover of species within difficult taxonomic groups including lichens (both arboreal and terrestrial), bryophytes, fungi and various types of soil micro-flora - taxonomic groups which are both time-consuming to assess, and costly to identify and measure in a meaningful way. In recognizing this, the key to assessing and maintaining biodiversity is through the recognition and protection of diverse habitats, or through a "land-based eco-diversity approach"(Rowe 1993).

In recognition of this, one measure of biodiversity in this review was based on eco-diversity, that is, a measure of the extent of ecological diversity based on the diversity of communities and terrain within the study area. The mechanism for this assessment is through the Ecological Land Classification hierarchy of landform, soil and vegetation types. The approach assesses biodiversity at the landscape, community and species levels. In addition we focused on potential losses to biodiversity due to impacts to areas of significance, uniqueness and sensitivity (such as habitats which are unique, are highly diverse and/or have a high rare plant potential). These areas which represented biodiversity within the area at the three levels (landscape, community and species) were identified, described and formed the basis of the impact assessment to biodiversity. Subsequent mitigation/reclamation efforts can be designed to preserve those areas of greatest biodiversity and to provide reclamation planning information which will assist in returning the area to an equivalent biodiversity level.

4.0 METHODS

To understand the extent and importance of vegetation/terrain resources at both a local and regional context, the resources were first mapped and described at various scales. Vegetation was mapped using Landsat imagery analysis, whereby vegetation cover signatures were identified and modelled, based on detailed vegetation plots. This vegetation cover data combined with a detailed soils map and terrain map, formed the basis for generating an Ecological Land Classification whereby vegetation and soil relationships were described, within the various landform units identified within the Local Study Area.

Map boundaries were first drawn around clearly recognizable landforms such as the river valleys, escarpment slopes, bogs and fen wetlands, glacio-fluvial landforms and hill formations. These map units are termed "ecosections". Within these map units, the vegetation and soil conditions were described at an overview level, based on field sampling and dominant vegetation and soil characteristics. At a more detailed level of description and analysis, subdivisions termed "ecosites" focus on specific vegetation associations and dominant soil types within the ecosection. An example in the Local Study Area would be the "wetlands closed shrub ecosite" found in the Riparian Floodplain, and the particular soil, drainage and site conditions which support that vegetation type.

Within the Local Study Area, delineation of ecosites was made using satellite imagery, complimented by aerial photography and field investigations. The classification of the satellite image utilized over 300 field survey points, located using Global Positioning Systems (GPS). This allowed accurate ground-truthing information on landform, soil and vegetation conditions to be referenced directly to each map unit. Following broad landform delineations, vegetation types formed the basis for the initial map unit boundaries, at the ecosite level. Subsequent description of landform type along with soil and drainage conditions were added to the map using field data and landform modelling based on the Digital Elevation Model (DEM). At the ecosite level of description, the emphasis in map unit description was placed on the dominant vegetation cover, landform type, landform position, soil type and drainage condition. The inter-relationships between landform, soil, vegetation and drainage conditions, along with a description of ecological processes was also included in the ecosite descriptions. This terrestrial database was then used as the basis for the subsequent impact assessment.

Within the larger Regional Study Area, the vegetation map formed the basis of resource map units, with terrain differentiation being limited to the Athabasca River Valley,. and land beyond the river valley. This terrain distinction allowed for a more focussed assessment of impacts to the Athatbasca River valley component, in the EIA report.

4.1 Literature Review

A review of the existing literature included Westworth's (1990) report on Significant Natural Features of the Eastern Boreal Forest Region of Alberta, the Solv-Ex EIA (Bovar Environmental 1995), the Syncrude EIA (Concord 1992), Strong and Leggat's Ecoregions of Alberta (1992), Ecoregions and Ecodistricts of Alberta (Strong 1992), the Draft Fort McMurray - Athabasca Oil Sands Subregional Integrated Resource Plan (AEP 1995), and a brief review of existing mapped vegetation resources within the study area.

4.2 Study Area Delineation

An assessment, mapping and description of the biophysical resources within both the regional and local study areas required that existing biophysical information from the region be reviewed. This review allowed for the pre-field classification and selection of the two study areas (Local and Regional) to build on past research, rather than reflect an independent product. Material used included existing information as to watersheds, surficial materials, ecoregions and ecosections, Landsat TM imagery, a DEM of the local study area, and detailed field data collected for vegetation, soil and forestry parameters.

4.2.1 Local study area

Three different study areas were identified for the purposes of resource inventory and impact assessment, each one designed to meet specific needs within a particular study area size. An "Intensive Study Area" was recognized which basically represented the impact of the proposed mine footprint, at year 2020. This study area was selected for the purposes of Conservation and Reclamation Planning (C&R) and includes a detailed assessment of soil and forestry resources for the areas of direct impact. (Figure 4.1).

In addition, a "Local Study Area" was delineated within which the Impact Assessment was concentrated. The primary rationale for this study area was based on the Lease and Lot boundaries which comprise the Steepbank Mine development as well as the existing development in Lease 86/17 (Figure 4.1). An extended buffer zone was included around this area based on including environmental components within the immediate area around the existing and proposed mines and facilities. This allowed for including representative resources, locally, which would be impacted by the mine. Components within the Local Study Area included the Athabasca River, the Steepbank River and confluence with the Athabasca River, and a component of Poplar Creek, including its confluence with the Athabasca River.

Detailed biophysical sampling, including terrain, soils and vegetation, was conducted within the Local Study Area for use in area characterization.

4.2.2 Regional Study Area

A joint Regional Study Area for Suncor and Syncrude Canada Ltd. (Syncrude) existing and proposed oil sands properties in the Fort McMurray area was proposed for the purpose of regional-level impact assessment and environmental management. The regional study area was intended to provide a common basis for both companies to conduct cumulative effects assessment with respect to their proposed mine expansions and to examine impacts within a broader regional context.

The largest of the three study areas, the Regional Study Area, was selected on the basis of major landform, watershed and eco-region boundaries, as well as on the estimation of the extent of plume impact from combined Suncor and Syncrude air emissions. The criteria boundaries are shown on Figures 4.3 to Figure 4.7, and are summarized briefly below.

Airshed

A 60 km radius centered on the Suncor plant site was initially used to establish a broad zone of the project influence. This was based on a review of previous reports on SO_2 concentrations and sulphate deposition isopleths prepared for the region. The airshed boundary was subsequently refined to include the 0.2 kmol H^+/ha/a isopleth for effective acidity (Figure 4.2, 4.4).

Watersheds

The entire drainage basins of the Steepbank and Muskeg Rivers, the majority of the MacKay River basin, and portions of Athabasca and Clearwater Rivers were used to define the regional boundaries (Figure 4.3).

Landscapes (Ecological Land Classification)

The boundaries of a relatively homogeneous landscape area surrounding the Suncor and Syncrude mining operations, within which the general surficial geology, vegetation, soil and drainage characteristics are similar, was used to help identify regional boundaries (Figure 4.5).

CRITERIA EVALUATION

An evaluation of each criteria was conducted as part of the process to select an integrated regional study area boundary. The results are presented as follows:

Airshed

Based on air quality modelling for 1994 average emissions from the Syncrude and Suncor facilities, two air quality parameters were used to establish the regional study area boundaries, in addition to the other three criteria. Two figures with 10 km grids illustrating the modelled SO_2 concentration (Figure 4.2) and Effective Acidity depositions (Figure 4.3) are attached.

Predicted SO_2 Concentrations

The predicted 13$\mu g/m^3$ SO_2 concentration contour was used to set the RSA boundary. The following data was used to establish boundary limits:

- With background concentration (assumed to be 8 μg/m^3) and predicted concentrations from emissions (13 μg/m^3), the total SO_2 concentration will be the sum of these two values, in this case 21 μg/m^3.
- Current guidelines and research indicates that vegetation injury does not occur even at 30 μg/m^3 (e.g., Visible injury does not occur until exposures as high as ~ 200 μg/m^3 ; dysfunction of cellular activity, as measured by photosynthetic activity is documented in Alberta to be unaffected at concentrations of 30 μg/m^3 .
- Annual concentrations for SO_2 emissions by IUFRO standards, for good growing conditions, are 29 μg/m^3. Therefore, two-thirds of 30 μg/m^3, (i.e., 20 μg/m^3) will still leave a reasonable buffer to protect vegetation. Air quality models are usually given conservative estimates of concentrations, therefore, the two thirds value is also likely to be conservative.

Based on the analysis and geographic application of this data, the Regional Study Area boundaries of the μg/m^3 will extend approximately 45 km north, 42 km south, 12 km east and 15 km west (see Figure 4.2).

Predicted Effective Acidity (EA)

The 0.2 kmol H^+/ha/a (Figure 4.3) was used to set the RSA boundary. The following data was used:

- Alberta Environment (1990) has set interim critical acid deposition loading for sensitive soils. The Effective Acidity (EA) deposition limits are abased on a 10% reduction in base saturation over a 100 year loading period. Based on the guidelines, it has been assumed that sensitive soils receiving between 0.1 and 0.3 kmol H^+/ha/a are potentially at risk of acidification, and those receiving > 0.3 kmol H^+/ha/a area at risk of acidification. Additionally, moderately sensitive soils receiving 0.3 to 0.4 kmol H^+/ha/a are potentially at risk of acidification.

- Soils lying outside the 0.3 kmol H^+/ha/a contour (background and predicted EA from emissions), are assumed to be at no risk of acidification. Assuming a background EA of 0.07 kmol H^+/ha/a, the predicted EA from emissions for the RSA is 0.23 kmol H^+/ha/a.

$$\text{Background EA} + \text{Predicted EA from Emissions} = \text{Total EA}$$

$$0.07 \text{ kmol } H^+/ha/a + 0.23 \text{ kmol } H^+/ha/a = 0.3 \text{ kmol } H^+/ha/a$$

Using this information, the boundaries of the 0.2 kmol H^+/ha/a contour will extend approximately 55 to 60 km to the north, 45 to 50 km to the south, 10 to 15 km to the east and 25 to 30 km to the west (see Figure 4.3). The data used for the Air Quality Modelling were 1994 CSEM for mass emission rates of SO_2 for Suncor and Syncrude, and 1994 Suncor and Syncrude stack surveys for temperature and velocity of the stack (Bovar Environmental 1996).

The use of air quality and air emissions standards and data for establishing the RSA boundaries has a number of advantages, including:

- It is a simple approach, defining the regional study area based on the area of potential impacts from air emissions on soils and vegetation.
- Boundaries are based on site-specific air quality using 1994 average air emissions data from Suncor and Syncrude.

Air emissions were used as one component for selecting the RSA boundaries, by using the Effective Acidity contour for the boundary of maximum areal extent of impacts of emissions on soil and vegetation. This boundary encompasses the 13 $\mu g/m^3$ SO_2 concentrations that represents the maximum areal extent of impacts to vegetation.

Watersheds

This criteria includes those tributary watersheds to the mainstem Athabasca River which currently occur within the existing mining operations of Suncor and Syncrude, as well as those which may be affected by future development activities of the two oil sands operations. Watersheds can be delineated relatively easily on topographic maps. They represent an ecological system within which hydrologic patterns and processes can be consistently described.

The area encompassed using watershed criteria is shown in Figure 4.4. The boundaries include all of the Steepbank and Muskeg River watersheds, which are the principal watersheds affected by Suncor and Syncrude's proposed mines (respectively). To the west, the majority of the MacKay River watershed is included to address possible effects from the existing Syncrude operation. The northern boundary extends to McClelland Lake which could be influenced by the proposed Syncrude project. To the south, the boundary includes portion of the Athabasca River and of the Clearwater River.

The use of watershed as on criteria for RSA boundary definition has the advantage of providing boundaries based on the main drainages which could be affected by the existing and the proposed oil sands mine expansions. Watersheds can be delineated relatively easily using topographic contours and vegetation conditions, and provide an ecological basis for boundary delineation, which includes vegetation, soil and wildlife habitat utilization. However, large rivers and tributaries encompass extensive watersheds which cannot be included in their entirety. Therefore, in boundary designation, those watersheds which are directly affected by the existing and proposed oil sands operations for Suncor and Syncrude were used, including: the Steepbank River, the Muskeg River and portions of the MacKay, Athabasca and Clearwater Rivers.

<u>Landscapes (Ecological Land Classification Criteria)</u>

Ecological boundaries can be used as the basis for the delineation of the regional study area, utilizing those already described for northeastern Alberta by Strong (1992, Figure 4.4). At the broadest level of ecological land classification, the study area falls within the Mid-boreal Mixedwood Ecoregion which takes in most of northern Alberta. Ecodistricts, or subdivisions of the ecoregions, represent broadly homogenous areas of the landscape within which there is a recurrent pattern of landform, soils and vegetation as influenced by climatic conditions. Ecodistricts provide a generic description of landscape types which in turn can be subdivided into more detailed soil and vegetation map units used to describe each of the Suncor and Syncrude mine area. This fits well with a hierarchical approach to landscape inventory, classification and evaluation.

An advantage of adopting the ELC boundaries of Strong (1992) is that they are largely included within the existing satellite imagery coverage. The exception is to the north where an artificial boundary would have to be drawn to close off the region (Figure 4.5).

An ELC approach to delineate the regional study area has a sound basis in ecological theory, recognizing that landscapes can be described and evaluated in a hierarchical manner. This approach is well suited to cumulative impact assessment. Natural resources, ecological processes and potential impacts to these resources can be clearly examined in both a spatial and temporal context by delineating landscape types within an existing and provincially recognized ELC framework.

A balanced consideration of these criteria, including airshed, watershed and ELC characteristics, resulted in the final delineation of an RSA boundary, illustrated in Figure 4.7.

4.3 Landsat Image Analysis

4.3.1 Development of the Regional Ecological Land Classification (ELC) Map

The Regional ELC map was produced primarily from the supervised classification of Landsat Thematic Mapper (TM) satellite data, based on the combined field data of both the Suncor and Syncrude 1995 terrestrial field surveys and ancillary air photos. Data from 101 field transects were supplied by Suncor and 135 transects were provided by Syncrude. From these data, 21 classes representing vegetation, landcover and landuse were derived using a maximum likelihood classifier. In addition, the Regional Study Area was subjected to a joint ground-truthing by consultants for both Suncor and Syncrude to derive geo-referenced vegetation cover data.

The findings of an initial accuracy assessment showed the overall accuracy of the original preliminary regional map product to be approximately 62% better than random assignment at a confidence level of 95% (accuracy adjusted for chance agreement). Although the accuracy was shown to be highly significant, it was considered too low and required further refinement.

It was found that the misclassification of various wetlands shrub classes, in particular, was lowering the overall classification accuracy. For example, the willow signature was confused with juvenile aspen, and alder was mixing with the jack pine class. Open canopied classes such as open black spruce, tamarack and jack pine were also difficult to detect due to the dominance of their understories.

Subsequent to this re-evaluation, several classes were combined to make 16 classes and a new map was generated using a more sensitive sequential maximum a posteriori (SMAP) classifier.

The accuracy assessment was based on field visits conducted specifically for this purpose, as well as a comparison between the more accurate Local Study Area Ecosite Classification. Thirty-four field sites representing classes were selected and visited in a variety of locations throughout the Regional Study Area. The location of these sites was determined by undifferentially corrected GPS, and as a result, the positional accuracy of these locations was less than 100 m. Because the site locations were chosen in larger, homogeneous patches and carefully annotated on airphoto, it was possible to identify a more precise location of the sites by visual means using the imagery. The ground-truthing site locations were used to select larger groups of class pixels in order to obtain a larger statistical sample totaling 856 pixels between the 14 classes. In addition to this, a random sample of 5000 pixels was generated from the Suncor Local Study Area Ecosite Classification. It should be noted that the class 'Peatland: Shrub Dominated Fen/Patterned Fen' was created after the ground-truthing study was conducted, and therefore no estimates could be made of its accuracy.

An accuracy assessment using an error matrix and Kappa-hat Analysis showed the individual class accuracies (Table 4.1).

Table 4.1 Accuracy Assessment of Regional Vegetation Classification Using Kappa-hat Analysis

Class	% Errors of Omission	% Errors of Commission	Class % Correct
Closed Jack Pine	20.43	31.18	79.57
Closed White Spruce	27.45	32.94	72.55
Closed Deciduous Forest	29.52	42.29	70.48
Closed Mixedwood	39.39	34.01	60.61
Closed Mixed Coniferous, Black Spruce Dominant	20.79	20.13	79.21
Peatland: Closed Black Spruce Bog	28.52	29.60	71.48
Peatland: Black Spruce-Tamarack Fen	20.25	35.58	79.75
Closed Mixedwood, White Spruce Dominant	32.63	20.35	67.37
Peatland: Open Black Spruce Bog	28.03	22.35	71.97
Peatland: Open Tamarack Fen	34.12	47.06	65.88
Wetlands Shrub Complex	35.33	35.33	64.67
Disturbed, Herb-Grass	19.46	6.71	80.54
Industrial/Sparsely Vegetated	8.20	0.00	91.80
Wetlands Open Water- Emergent Vegetation Zone	0.00	0.00	100.00
Peatland: Shrub Dominated Fen/Patterned Fen	unknown	unknown	unknown

Errors of omission include, for example, Closed Jack Pine that has been misclassified as another class, whereas errors of commission include other classes that have been incorrectly assigned to Closed Jack Pine. It is important to distinguish between these types of errors since it is theoretically possible to achieve a 100% accurate Closed Jack Pine category by classifying every pixel as Closed Jack Pine. The overall, classification accuracy for the Regional Ecosite Classification was estimated at 74%, without adjusting for that percentage of correct assignments occuring from random chance alone. This was determined using Kappa-hat (k-hat) analysis which estimated the expected chance agreement at 9.5%. The k-hat coefficient was therefore calculated to be 72%, which means that the Regional Classification is 72% better than expected by random assignment of pixels to categories.

4.3.3 Development of the Suncor Local Study Area ELC Classification

The approach used to produce the Suncor Local Study Area ELC classification was nearly identical to the Regional Study approach, with the exception of the addition of a Digital Elevation Model (DEM) into the classification. The DEM provided the basis for a more sophisticated terrain analysis.

The highest layer in the ELC hierarchy is represented by a terrain classification which was undertaken using the DEM and ancillary air-photo interpretation. Seven broad ELC Landform classes were mapped primarily on the basis of elevation and known landscape associations. These include the following:

- Riparian Floodplain
- Riparian Terraces
- Riparian Escarpment
- Midland Organic/Lacustrine Plain
- Midland Drainages
- Upland Organic/Lacustrine Plain
- Highland Moraine

Soils were mapped at 1:50 000 and also at 1:20 000. These data were digitized and integrated with the ELC Landform classification. The integration of the landform and soil classification at this scale, again corresponds to the Ecosection Level of ELC generalization.

The highest level of resolution in the Suncor ELC is represented by the Ecosite, or map units identified according to their dominant vegetation composition. Soil and landform associations can also be included in ecosite descriptions. The ecosite map was generated using the 101 field transects which were pre-classified into 15 classes of vegetation, including:

- Wetlands Open Water - Emergent Vegetation Zone
- Wetlands Shrub Complex
- Peatland: Closed Black Spruce Bog
- Peatland: Open black Spruce Bog
- Peatland: Black Spruce - Tamarack Fen
- Peatland: Open Tamarack Fen
- Closed Mixed Coniferous, Black Spruce Dominant
- Closed Deciduous Forest
- Closed Mixedwood
- Closed Mixedwood, White Spruce Dominant
- Closed White Spruce

- Closed Jack Pine
- Closed Lodgepole Pine
- Disturbed, Herb-Grass Dominant
- Industrial/Sparsely-Vegetated (Primarily Lease 86/17)

These data sites were used to guide the selection of larger homogeneous polygons that were representative of a particular class. The resulting ELC Vegetation classification was subjected to an accuracy assessment using error matrices and kappa analysis.

An accuracy assessment using an error matrix and Kappa-hat Analysis showed the individual class accuracies (Table 4.2).

Table 4.2 Accuracy Assessment of Vegetation Classes in the Local Study Area, Using an Error Matrix and Kappa-hat Analysis

Class	% Errors of Omission	% Errors of Commission	Class % Correct
Closed Jack Pine	22.68	25.77	74.23
Closed White Spruce	27.10	14.02	85.98
Closed Deciduous Forest	17.27	17.99	82.01
Closed Mixedwood	28.14	20.96	79.04
Closed Mixed Coniferous, Black Spruce Dominant	26.67	20.00	80.00
Peatland: Closed Black Spruce Bog	14.52	26.14	73.86
Peatland: Black Spruce-Tamarack Fen	46.48	15.49	84.51
Closed Mixedwood, White Spruce Dominant	14.76	30.26	69.74
Peatland: Open Black Spruce Bog	18.29	23.58	76.42
Peatland: Open Tamarack Fen	61.54	20.00	80.00
Wetlands Shrub Complex	27.11	34.94	65.06
Disturbed, Herb-Grasses	17.50	10.00	90.00
Industrial/Sparsely Vegetated	0.00	0.00	100.00
Wetlands Open Water- Emergent Vegetation Zone	0.00	0.00	100.00

The overall, classification accuracy for the Local Study Area Ecosite Classification was estimated at 77.95 without adjustment. The k-hat coefficient was calculated to be 76, which means that the Local Study Area Classification is 76% better than expected by random assignment of pixels to categories.

Because the resulting classification was extremely visually complex, it was spatially resampled using a statistical mode-filter from 25 m^2 to 55 m^2. This 'de-speckled' the classification by removing isolated clumps or individual pixels and merged larger associations into homogeneous polygons. This also allowed for a basic measure of intra-class biodiversity to be calculated, i.e. the degree to which one class is made up of members of other classes. This information was used in subsequent interpretations and applications of the biophysical impact assessment.

4.3.4 Suncor Reclamation Mapping

Reclamation information was provided by Suncor (Tuttle 1995) in the form of detailed vegetation maps. There are a number of general reclamation prescriptions which Suncor has developed that are applied depending on the site characteristics, soil treatments, and intended long-term landuse of a particular area. For the purposes of maintaining a consistent mapping terminology and allow reclamation to be factored into the calculation of the net vegetation balance for the EIA, the reclamation vegetation classes were fit into the ELC vegetation classification.

During the conversion of Suncor's detailed reclamation mapping information it was necessary to degrade the spatial resolution of the vector polygons to conform with the ELC mapping base pixel resolution of 25 m^2. Unfortunately, it is probable that this resulted in a small but undetermined loss of spatial resolution.

4.3.5 ELC Net Balance Assessment

The calculation of the ELC net balance estimates were based on the conversion of the GIS coverages into areal estimates (in hectares). Attempts were made to report errors associated with number rounding (to the nearest integer) and spatial resampling. The raw coverage figures were imported to Microsoft™ Excel™ format and configured into appropriate tables.

4.4 Biophysical Data Collection and Analysis

The field program was designed to focus on the Intensive and Local Study Area to ensure detailed biophysical data collection for the impact area, and to put this into a local context. Based on the number of ecosites identified in the preliminary Landsat image analysis, sites were selected to sample vegetation and soil types according to their cover within the Local Study Area, such that vegetation types of higher cover would receive a higher number of sampling points. A minimum of 10 sample sites per ecosite or vegetation type was considered optimum.

4.4.1 Terrain

The use of a Digital Elevation Model (DEM) into the classification provided the basis for terrain analysis and the inclusion of variables such as elevation, slope, aspect and slope curvature to be included in the overall imagery classification.

The highest layer in the ELC hierarchy is represented by a terrain classification which was undertaken using the DEM and ancillary air-photo interpretation. Seven broad ELC Landform classes were mapped primarily on the basis of elevation and known landscape associations. These include the following:

- Riparian Floodplain
- Riparian Terraces
- Riparian Escarpment
- Midland Organic/Lacustrine Plain
- Midland Drainages
- Upland Organic/Lacustrine Plain
- Highland Moraine

4.4.2 Soils

An assessment of the soils resources within the local study area was conducted during the summer of 1995. Transects were established with sampling points placed systematically within major soil boundaries. The location of transects was designed to sample the variability of soil types within pre-established ELC types. Soils were mapped at 1:50 000 and also at 1:20 000. These data were digitized and integrated with the ELC Landform classification. The integration of the landform and soil classification at this scale, again corresponds to the Ecosection Level of ELC generalization.

A detailed description of data collection and analysis used to describe and map soil types within the area is provided in the Baseline Soil Report (Can-Ag 1996).

4.4.3 Vegetation

The focus of ELC sampling for the Suncor EIA was to collect an adequate sample of vegetation cover, including species composition, structure and percent cover, as well as soil characteristics and terrain features, to allow description of the biophysical resources of the various ELC map units. In addition, this data was used to re-classify the Landsat imagery, based on both signature and cover-composition data. Table 4.3 details the number of sites sampled for each ecosite type.

Table 4.3 Sample sites for each vegetation type within the Suncor Study Area

Ecosite Type	Vegetation Sample Plot	Forestry Sample Plot
Disturbed, Herb-Grass Dominant	4	
Wetlands Closed Shrub Complex	17	
Closed Deciduous -		
Aspen Dominant	19	19
Balsam Poplar Dominant	5	
Paper Birch Dominant	2	
Closed Jack Pine	6	6
Peatland Closed Black Spruce	8	
Closed Mixed Coniferous -		
Black Spruce Dominant	4	4
Closed Mixedwood	17	17
Closed Mixedwood -		
White Spruce Dominant	13	13
Peatland Closed Black Spruce	4	
Closed White Spruce	10	10
Peatland Open Tamarack / Bog Birch	10	
Peatland Open Black Spruce - Labrador Tea	11	
Wetlands Open Water/Emergent Vegetation Zone	8	
Total	138	69

A total of 138 plots were sampled for vegetation composition, cover and structure, terrain and soil characteristics. Plots with merchantible forest were also sampled for forest height, dbh (diameter at breast height), and age. Sampling locations were dispersed throughout the study area and over different terrain types, to ensure adequate sampling of the variety of communities within a single vegetation cover class.

At each site, one 10 x 10 m quadrat was sampled for vegetation cover and composition, forestry data, site conditions and selected Habitat Evaluation Procedure (HEP) parameters. At each quadrant, information was collected to record species composition, strata, percent cover and species vigour. All vascular plant species and the dominant bryophyte and lichen species within the 10 x 10 m plots were recorded as to percent cover per strata. The following strata were used based on Daubenmire (Mueller-Dombois 1974):

- A1 - canopy tree species > 5 m tall
- A2 - understorey tree species > 5 m tall
- B1 - tall shrubs 2 - 5 m tall
- B2 - low shrubs <1- 2 m tall
- C1 - tall herbs .5 - 1 m tall
- C2 - low herbs < .5 m tall
- G - grasses and grass-like species
- D - ground cover bryophytes and lichens
- E - epiphytes

In addition to the standard parameters measured for vegetation description and classification, additional parameters for HEP analysis were collected (based on consultation with Westworth, Brusnyk and Associates, the consultants responsible for assessment of wildlife for the Suncor EIA) to facilitate models for habitat suitability for selected wildlife species. The indices evaluated included:

- mean dbh (diameter at breast height) of dominant tree size
- number standing snags
- percent cover of deadfall
- percent available browse per species (ocular estimates)
- shrub distribution type using shrub density classes
- number of conifers with mistletoe

- mean height of each species within each strata

The information collected was documented on data sheets adapted from the LISD 14B vegetation forms provided by Alberta Forestry, Lands and Wildlife.

4.4.4 Forestry

Forestry resources within the impact area of the proposed Steepbank Mine, to the year 2020, were mapped to AVI standards, based on field data collected during the summer of 1995. The AVI map and accompanying report are available in the Steepbank Mine Forestry Resources report (EnvirResource 1996).

4.5 Geographical Information Systems and Ecological Land Classification

The use of a GIS programs, GRASS 4.1 and PC-based ARC/INFO were utilized to incorporate, analyze and display the various layers of information including vegetation cover, small scale terrain classes, large-scale topography, soils resources and forestry resources. Once represented in the GIS, it was possible to overlay the various layers, extracting data including the quantitative relationship between terrain, soils and vegetation. While these relationships were recognized qualitatively, this analysis allowed for a numerical assessment.

4.6 Biodiversity

In keeping with the evolving definition of biodiversity and accepted approaches to its assessment, the existing biodiversity within the Local Study Area was considered at the landscape, community and species level.

<u>Landscape Level Biodiversity</u>

Biodiversity at the landscape level refers to the pattern of vegetation, terrain and wildlife species distributed across the landscape (Noss and Cooperider 1994). Rowe (1993) argues that landforms are the key to ecosystems and hence to biodiversity; thus there is a need to use a geographical context when describing ecosystems. In this assessment, landscape level biodiversity was assessed using several approaches. One measurement of biodiversity was based on the interspersion of habitat types across the landscape, using the rationale that areas of highly juxtaposed habitats of different types are of high plant species and, hence, wildlife diversity. These sites would be rich in edge habitat (transitions zones) as well as patches of different vegetation communities.

The vegetation coverage was sampled using filtering algorithms for each of the pattern metrics at neighbourhood resolutions ranging from 75 to 525 m at 50 m increments. This enabled trends in the size of vegetation patches to be measured as they relate to selected measures of biodiversity. Variance, interspersion and diversity were then plotted against the size of the spatial neighbourhood. Subsequent interpretation of these graphs showed the most appropriate patch size resolution(s) to quantify biodiversity. In addition, DEM analysis identified areas of high interspersion based on slope and aspect variations.

The diversity, interspersion and variance coverages were then standardized into indices ranging from 0 to 1 to remove numeric bias. These new coverages were summed arithmetically to create a new coverage representing the cumulative expression of the pattern metrics. These final maps are indications of potential biodiversity at a scale shown to be significant from the perspective of the patch dynamics. The new biodiversity maps were integrated with the ecosection coverage to allow biodiversity to be analyzed on a landform basis.

One ecological principle that was also considered at the landscape level was the importance of areas of large patch size. Impacts to these areas result in fragmentation resulting in an increase in the amount of edge, decrease in the amount of interior and an increase in the distance between patches of a critical size for some wildlife species, and for genetic flow between patches. Therefore, another approach to the evaluation of this data for biodiversity assessment was an identification of areas of large patch size. These areas also contribute to local and regional biodiversity by providing large areas of relatively uniform vegetation cover characteristics which are part of the ecological balance. An assessment of areas of low interspersion, or high patch size was based on those areas which showed minimum habitat interspersion within a maximum area, based on both vegetation signature and DEM consistency.

At the landscape level, a more qualitative assessment was based on regionally significant terrain features. These were considered to include the entire Athabasca and Steepbank River Valleys.

This approach was based on the recognition that losses to floodplain and escarpment slope terrain would result in losses to significant ecological land classes and important wildlife habitat.

An additional assessment to biodiversity at the landscape level was based on corridor presence. It was acknowledged that the Athabasca and Steepbank River Valleys contribute to biodiversity by virtue of their function as corridors for wildlife movement. Therefore, blockage or interruption of these corridors would contribute to the decline of local biodiversity values.

Community Level Biodiversity

Biodiversity at the community level was primarily assessed qualitatively, by identifying those communities or ecosites which are unique within the Local Study Area. The rationale for this approach was that impact to these communities would result in a significant loss to local biodiversity. Typically these sites exhibited both a high degree of species diversity, often a high degree of structural diversity, and/or were of limited cover within the Local Study Area.

Species Level Biodiversity

At the species level, the primary concern in terms of biodiversity is the potential for the complete or near loss of any species locally or regionally, to the extent that it may not become re-established. This has major implications for rare plants. Biodiversity at the species level was considered by identifying those communities which have the highest rare plant potential, based on past observations, the 1995 Suncor vegetation survey, and habitat mapping within the Local Study Area.

In addition, ecosites were identified which were highly diverse in terms of species richness, as well as with a significant presence of snags, deadfall and structural diversity. This assessment was based on the results of vegetation cover and composition data collected during the 1995 field program.

4.7 VEC Selection

A VECs (Valued Ecosystem Components) selection for terrain and vegetation communities was conducted, building on the literature review and on the ELC mapping units identified within the Local Study Area. A four step process was adopted including: 1) the selection of evaluation criteria; 2) the identification of candidate VEC terrain and ecosite types within the study area; 3) the assignment of importance values to candidate VECs based on the evaluation criteria; and 4) the selection of the Valued Ecosystem Components based on the overall evaluation. A component of this process also considered resources which were identified as important based on feed-back from the public during open houses and community discussions.

The evaluation criteria for VEC selection typically involves an assessment of the following characteristics: abundance, rarity, ecological importance (sensitivity to physical disturbance), sensitivity to pollutants, economic importance, recreational importance, suitability for reclamation, information availability, diversity and rare plant potential.

Scoring criteria were rated on a semi-quantitative scale using the criteria and scores shown in Table 4.4.

Table 4.4 - Scoring Criteria For Vegetation VECs

1. **rarity** (also based on relative abundance): 0 = species, group or community abundant and of no concern 1 = species, group or community uncommon, but not threatened 2 = species, group or community at extreme end of range 3 = designated rare species, group or community
2. **rare plant potential:** 1 = low potential 2 = moderate potential 3 = high potential
3. **ecological vulnerability** (sensitivity to physical disturbance): 1 = very hardy species or community, able to recover from high levels of disturbance 2 = able to recover rapidly after minor disturbance but unable to survive extensive changes to habitat 3 = unable to survive even minor changes to habitat
4. **ecological vulnerability** (sensitivity to pollutants, in terms of survival and productivity): 1 = relatively resistant to pollutant damage and highly resilient 2 = moderately susceptible 3 = very susceptible to pollutants and least likely to recover in respite periods
5. **recreational importance** (measures attractiveness to viewers, i.e., species with aesthetic or political importance): 1 = low interest 2 = moderate interest 3 = high interest
6. **diversity** (based on the number and extent of communities in a terrain type or species in a community) 1 = simple 2 = moderately diverse 3 = diverse
7. **economic importance** (measures importance to forestry): 1 = low productivity 2 = moderate productivity 3 = high productivity
8. **traditional use importance** (measures importance to traditional uses - food gathering, medicinal plants, utility species, ELC use in general): 1 = low productivity 2 = moderate productivity 3 = high productivity

5.0 THE REGIONAL STUDY AREA

The regional study area was selected primarily to investigate cumulative effects of the proposed development within a regional setting, in conjunction with impacts of other major industries in the area. The final regional boundaries were designed to combine small scale landform - vegetation types which reflect the extent and diversity of regional biophysical resources, and to ensure that the area was of adequate size to assess impacts due to air emissions, based on the plume dispersion models provided by Bovar Environmental (1996).

5.1 Terrain Types (Ecosections)

Within the Regional Study Area, the terrain types were generalized to reflect only river valley and upland vegetation types. Riparian areas include both upper and lower floodplains, and escarpment slopes of the major rivers in the region including the Athabasca, Steepbank and Muskeg Rivers. Upland areas include land located out of the river valleys. The primary purpose of this major terrain division was to enable modelling of impacts and cumulative effects within the river corridor on a regional level.

5.2 Vegetation and Soil Types (Ecosites)

Ecosites within the regional study area were derived from the classification and analysis of vegetation types identified within the Suncor and Syncrude local study areas, and an identification of cover types within the larger regional area. An identification of detailed community composition at over 250 sites within these two baseline study areas, and over 100 cover types regionally, was used to generate a classification of 14 vegetation types, located within the two broad landform units. The 14 vegetation cover types are mapped within the regional study area, for the Floodplain and Upland Terrain Classes (Figure 5.1).

The vegetation types identified and mapped are: Disturbed, Herb-Grass Dominant; Industrial/Non-vegetated; Wetlands Closed Shrub Complex; Closed Deciduous Forest; Closed Jack Pine; Peatland Closed Black Spruce-Tamarack Fen; Closed Mixed Coniferous, Black Spruce Dominant; Closed Mixedwood; Closed Mixedwood, White Spruce Dominant; Peatland

Closed Black Spruce Bog; Closed White Spruce; Peatland Open Tamarack/Bog Birch Fen; Peatland Open Black Spruce/Labrador Tea; and, Wetlands Open Water/Emergent Vegetation (Figure 5.1). These 14 cover types were mapped throughout the regional study area, based on field data and Landsat TM signatures.

The results of this mapping and vegetation cover type analysis showed that, within the regional study area the most dominant vegetation cover type is the Wetlands Closed Shrub Complex, with over 214 000 ha, almost 25% of the Regional Study Area (Table 5.1). This community is present in extensive cover within areas that represent very large bog birch-willow fen complexes, as well as in smaller patches along creeks, drainages and within wetlands complexes on the Athabasca River floodplain (Figure 5.1). The next most common vegetation type regionally, is Closed Mixedwood White Spruce Dominant, with 129 594 ha (about 12%), spread out over the study area on morainal deposits and upland areas. Other vegetation types present in about 8 to 10% cover regionally, include: Peatland; Open Black Spruce Bog; Mixed Coniferous Black Spruce Dominant; and the Closed Deciduous Forest. The least common (i.e., less than 1% of the regional study area) natural vegetation cover type within the Regional Study Area are the Wetlands Open Water/Emergent Vegetation class, with 13 501 ha, followed by Closed Jack Pine with 29 118 ha (Table 5.1). The Disturbed, Herb-Grass vegetation type is also of relatively low cover, occupying 18 073 ha.

TABLE 5.1: Regional Study Area - Vegetation Cover

ELC Vegetation/Landuse Class	Total Coverage Area (ha)
	1995 Baseline
Closed Jack Pine	29,119
Closed White Spruce	43,728
Closed Deciduous Forest	78,738
Closed Mixedwood	62,530
Closed Mixed Coniferous, Black Spruce Dominant	86,949
Peatland: Closed Black Spruce Bog	42,494
Peatland: Black Spruce-Tamarack Fen	50,720
Closed Mixedwood, White Spruce Dominant	129,594
Peatland: Open Black Spruce Bog	80,554
Peatland: Open Tamarack Fen	57,951
Peatland: Shrub Dominated Fen/Patterned Fen	58,751
Wetlands Closed Shrub Complex	214,209
Disturbed, Herb-Grass and Crop Tree Regeneration	18,073
Industrial/Sparsely-Vegetated [a]	10,387
Wetlands Open Water - Emergent Vegetation Zone	13,502
Urban Areas	2,109
Net Total Area	**979,408**

[a] Includes industrial areas and tailings ponds.

6.0 THE LOCAL STUDY AREA

The Suncor Local Study Area includes the entire proposed Steepbank Mine area, as well as a block of land west of the Athabasca River and an extended buffer zone beyond the footprint of the proposed mine (Figure 6.1). Terrain, soil and vegetation resources have been assessed in detail within this area to fully describe and map the existing resources in an ELC framework. This information is critical to completing the impact assessment, such that the full ecological significance of mining impacts to integrated ELC types can be identified, and appropriate mitigative procedures can be applied. The following sections describe the existing terrain and vegetation conditions within the Suncor Local Study Area.

6.1 Terrain (Ecosections)

Terrain types identified within the local study area are of a more detailed nature than in the regional study area due to the use and analysis of a Digital Elevation Model (DEM). Analysis of this model identified seven major terrain types or ecosections within the Suncor baseline study area: Floodplain, Floodplain Terraces, Escarpment Slopes, Upland, Highland, Midland and Midland Drainages (Figure 6.2).

6.1.1 Riparian Floodplain - Athabasca and Steepbank Rivers

Floodplain areas include both the Athabasca and Steepbank River Floodplains, including the base of the escarpment slopes and land areas extending to the river (Figure 6.2). This terrain type includes lower levees, swales, pointbars, anabranches, edges of incorporated islands and oxbows situated on the floodplain. Within the Local Study Area, this landform type includes 1474 ha of land, which accounts for 3.7% of the area (Table 6.1).

6.1.2 Upper Floodplain Terraces

Floodplain terraces include areas of upper floodplain resulting from fluvial geomorphic processes such as continued downcutting of the river, eventually resulting in upper terraces

Table 6.1 Terrain/Landuse Types within the Local Study Area

Landform (Ecosection) in Local Study	Area (ha)	Percent of Local Study Area
Riparian Floodplain	1 474	3.7
Floodplain Terraces	2 228	5.6
Escarpment Slopes	4 024	10.1
Upland Organic/lacustrine	16 792	42.0
Highland Moraine	2 030	5.1
Midland Organic/lacustrine	5 665	14.1
Midland Drainages	2 700	6.6
Suncor Lease 86/17	3 935	9.8
Athabasca River/Water Bodies	1 380	3.0
Total	40 002	100

which are rarely flooded, and the incorporation of well-developed islands through channel abandonment. In addition, some terraces maybe related to historic slumps, from the escarpment onto the floodplain, now appearing as elevated floodplain landforms overgrown with vegetation. This is particularly apparent in areas along the Steepbank River, where the deeply incised escarpment sides are prone to relatively frequent slumping. The Floodplain Terraces consist of 2 228 ha of land, which is approximately 5.6% of the Local Study Area (Table 6.1).

Together, the Floodplain and Floodplain Terraces cover an area of 3 700 ha., almost 10% of the Local Study Area.

6.1.3 Escarpment Slopes

Escarpment Slopes include the east and west facing slopes of the Athabasca River and the north, south, west and east facing slopes of the Steepbank River. Many aspects, slopes and slope positions are included in this terrain type due to river sinuosity, ravines and slope erosion/stabilization processes. This terrain type also incorporates steep-sided ravine sides and bottoms as well as slumps considered part of the escarpment and slope terraces. Escarpment slopes account for 4 024 ha of land, which is approximately 10% of the Local Study Area (Table 6.1).

6.1.4 Upland Organic/Lacustrine Plain

The Upland area is a broad, gently sloping upland plain, situated east of the west-facing escarpment slopes of the Athabasca River, and incorporating much of the area between the Athabasca and Steepbank Rivers, as well as areas north and east of the Steepbank River (Figure 6.2). This area slopes gently from east to west, resulting in a number of creeks and slow moving fens, as well as many bogs, where drainage is very slow and pools. The Upland area, which is the predominant landform type locally, covers approximately 16 792 ha of land, which is 42% of the Local Study Area (Table 6.1).

6.1.5 Highland Moraine

The highland area is formed by raised glacial till ridges in the southeast corner of the Local Study Area (Figure 6.2). Due to the relief of these hills, the vegetation cover reflects better drained conditions than in the surrounding Upland, supporting predominantly white spruce, mixedwood forests, with areas of fen in the depressions and drainageways. The Highland area covers 2 030 ha of land which is 5.1% of the Local Study Area (Table 6.1).

6.1.6 Midland Organic/Lacustrine Plain

The Midland area is located on the west side of the Athabasca River, outside the direct impact area of the proposed Steepbank Mine. This area is south of the existing Suncor mine, and extends almost 10 km to the south, incorporating the lower portion of Poplar Creek, as well as several lakes (Figure 6.2). This area is a combination of morainal hills and plateaus, dissected by creeks, lowlands and several disturbed drainages, which are part of the Midland Drainage terrain class (Figure 6.2). The Midland covers 5 665 ha of land, which is 14.2% of the Local Study Area (Table 6.1).

6.1.7 Midland Drainages

The Midland Drainage terrain class consists of glacial meltwater channels which run through the Midland area (Figure 6.2). Many of these are now disturbed, due to the placement of dams, roads and upstream mining operations, and have since succeeded to fens, lakes and bog areas. This terrain type covers 2 700 ha, of land which is approximately 6.6% of the Local Study Area (Table 6.1).

6.2 Vegetation and Soil Associations (Ecosites)

Vegetation types within the Local Study Area were classified and mapped based on field data collection, Landsat imagery analysis of dominant cover types and the Digital Elevation Model, used both to further assess vegetation types on the basis of topography, and to delineate major landform types. The results of this combined analysis identified 15 vegetation types, which were also modelled over the regional study area. These cover types vary in terms of understorey composition and soils, depending on the terrain type and moisture regime present. Vegetation communities are discussed in detail in terms of community composition, structure and succession, and soil characteristics, as they occur within each of terrain types identified within the local study area. In addition, the communities identified are related to those classified and described in the Boreal Forest Mixedwood Natural Subregion of Alberta (Beckingham 1995).

6.2.1 Ecosites Associated with the Athabasca and Steepbank River Floodplains and Terraces (Riparian Floodplain and Riparian Terrace Ecosections)

Floodplain communities along both the Athabasca and Steepbank Rivers are highly variable in response to age, frequency of inundation and distance from the river and/or backchannels. Moisture conditions are typically high, but range from mesic to hydric, varying with both lateral and vertical distance from the river and associated wetlands. Within the Deciduous Forest vegetation type alone, there are many community types - this diversity being a function of different moisture regimes, flooding history, surficial soils and successional stage. A major successional trend of floodplain communities is recognized throughout: open water-emergent vegetation to wetlands closed shrub complex to deciduous forest to mixedwood to white spruce dominated, typically with the Wetlands Closed Shrub Complex and the Wetlands Open Water/Emergent Vegetation types occurring on the least built up and often the early seral stages of development, whereas white spruce represented later seral stages and climax communities on more built-up sites.

Complications to this fundamental pattern result due to fire, catastrophic flooding, and slumping. These factors reset succession, but often from a new landform perspective due to ongoing floodplain development and the communities' relative floodplain position at the time of these events. In addition, the presence of some tree species, such as paper birch and balsam fir, appears to be highly variable. Balsam fir is inconsistently present at latter stages of succession, when white spruce is well established. However, in addition to being linked to site conditions created by mature white spruce, the establishment of balsam fir also appears to be linked to seed source availability. Paper birch is typically present in small cover as an understorey component in mid seral communities, where surficial materials are moist, but coarse in texture and well-drained.

Floodplain communities along the Steepbank River are particularly susceptible to flooding events, due to the narrower floodplain and deeply incised river valley, forcing higher water levels within a narrower margin. Extreme levels of soil deposition are apparent well back on the floodplain, and scouring at the cutbanks is often severe.

The Local Study Area ELC map identifies two major floodplain divisions, including Riparian Floodplain and Riparian Floodplain Terraces. However, sampling within these two fluvial landform types indicated that, while the Lower Floodplain supported all of the Wetlands Closed Shrub Complex and Wetlands Open Water/Emergent Vegetation communities, the other forested vegetation types on the floodplain are found within both landform types (Table 6.2). Therefore, for the purposes of this discussion, communities found within the two floodplain types will be discussed under one heading.

The most predominant vegetation types within the Lower Floodplain area are the Wetlands Closed Shrub Complex and the Closed Deciduous Forest (balsam poplar dominant) (Table 6.2). Also common on the floodplain is Closed Mixedwood: White Spruce dominant, and Closed

TABLE 6.2 SOIL AND VEGETATION COVERAGE (%) WITHIN THE SUNCOR LOCAL STUDY AREA: RIPARIAN FLOODPLAIN AND RIPARIAN TERRACES

VEGETATION TYPE	RIPARIAN FLOODPLAIN					SOIL TYPE						
	KNS%	MLD %	MMY %	MUS %	RUT%	RB1 %	RB2 %	RB3 %	GLMMY %	WATER %	RIVER %	VEGETATION TOTAL %
Closed Jack Pine	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Closed White Spruce	0.0%	1.5%	1.0%	1.4%	0.0%	0.6%	1.4%	0.1%	7.2%	0.0%	0.3%	13.5%
Closed Deciduous Forest	0.0%	3.0%	5.5%	0.1%	0.0%	13.7%	7.7%	1.7%	2.2%	0.0%	4.0%	37.8%
Closed Mixedwood	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Closed Mixed Coniferous Black Spruce Dominant	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Closed Black Spruce Bog	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Black Spruce-Tamarack Fen	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Closed Mixedwood White Spruce Dominant	0.0%	0.7%	2.0%	0.1%	0.0%	1.5%	1.3%	0.3%	0.2%	0.2%	2.0%	8.3%
Peatland: Open Black Spruce Bog	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Open Tamarack Fen	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wetland Shrub Complex	0.0%	6.3%	4.0%	0.4%	0.0%	2.8%	3.1%	0.5%	6.7%	4.1%	3.6%	31.5%
Wetland Open Water/Emergnt Veg.	0.0%	0.0%	0.2%	0.0%	0.0%	0.7%	0.1%	0.1%	0.0%	0.1%	5.1%	6.1%
Disturbed/Herb, Grass Dominant	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Industrial, Sparse Veg.	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	2.6%
Soils Totals	**0.0%**	**11.6%**	**12.8%**	**2.0%**	**0.0%**	**19.3%**	**13.6%**	**2.6%**	**16.4%**	**4.4%**	**17.3%**	**100%**

VEGETATION TYPE	RIPARIAN TERRACES					SOIL TYPE						
	KNS %	MLD %	MMY %	MUS %	RUT %	RB1 %	RB2 %	RB3 %	GLMMY %	WATER %	RIVER %	VEGETATION TOTAL %
Closed Jack Pine	0.0%	0.3%	0.1%	0.8%	0.0%	0.1%	2.6%	0.2%	0.0%	0.0%	0.0%	4.0%
Closed White Spruce	0.0%	2.2%	1.7%	14.4%	0.0%	0.4%	2.5%	1.7%	3.0%	0.0%	0.6%	26.5%
Closed Deciduous Forest	0.1%	1.4%	8.3%	2.7%	0.1%	8.6%	17.6%	9.0%	2.1%	0.0%	0.5%	50.4%
Closed Mixedwood	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Closed Mixed Coniferous Black Spruce Dominant	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Closed Black Spruce Bog	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Black Spruce-Tamarack Fen	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Closed Mixedwood White Spruce Dominant	0.0%	0.1%	0.3%	2.2%	0.0%	0.2%	5.2%	1.1%	0.1%	0.0%	0.1%	9.3%
Peatland: Open Black Spruce Bog	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Open Tamarack Fen	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wetland Shrub Complex	0.0%	2.4%	0.4%	1.2%	0.0%	0.5%	0.2%	0.7%	0.3%	0.0%	0.1%	5.9%
Wetland Open Water/Emergnt Veg.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Disturbed/Herb, Grass Dominant	0.0%	0.2%	0.1%	1.3%	0.0%	0.2%	0.0%	0.9%	0.7%	0.0%	0.0%	3.4%
Industrial, Sparse Veg.	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
Soils Totals	**0.1%**	**6.6%**	**11.0%**	**22.6%**	**0.1%**	**10.3%**	**28.1%**	**13.6%**	**6.2%**	**0.0%**	**1.3%**	**100%**

FIR, HRR, DL, ALG, GLKNS soils are not represented in these terrain types

White Spruce. The Riparian Floodplain Terraces support a much lower cover of Wetlands Closed Shrub (Table 6.2). The more common vegetation type on the terraces is the Closed Deciduous Forest, followed by Closed White Spruce, and Closed Mixedwood: White Spruce Dominant. Other vegetation types present are of low cover on the Floodplain landforms. The dominant floodplain communities are discussed in more detail below.

The soils in the Riparian Floodplain include the following soil units; McMurray (MMY)and Gleyed McMurray (GLMMY); McLelland (MLD); Muskeg (MUS) and Rough Broken (RB1). Soils of the McMurray group are formed on postglacial fluvial deposits on floodplains of creeks and rivers. The soils are moderately well drained to imperfectly drained (can also be poorly drained). The McMurray soils occur on the higher well drained positions while Gleyed McMurray soils occur in depressional areas, usually meander scars. The McMurray soil group belongs in the Regosolic order. The subgroup most prevalent in the McMurray soil group is Cumulic Regosol. Associated with Cumulic Regosols are Orthic Regosols, Gleyed Regosols and Gleyed Cumulic Regosols (GLMMY). Another group associated with Cumulic Regosols and Orthic Regosols is the peaty Gleysols (Turchenek and Lindsay 1982).

Soils of the McLelland soil group are dominated by moderately to well decomposed fen peat deposits, and are associated with drainage courses. Soils of the McLelland group belong to two subgroups; Typic Mesisol and Terric Mesisol. The soils of both subgroups have the general properties specified for the Organic order and Mesisol great group. Typic Mesisol are composed mainly of organic materials at an intermediate stage of decomposition. Terric Mesisol soils differ from Typic Mesisols by having a terric layer (an unconsolidated mineral subtratum at least 30 cm thick) beneath the surface tier. The McLelland Typic Mesisol soils have peat deeper than 100 cm, whereas Terric Mesisol soils have 40 to 100 cm of peat over unconsolidated mineral substratum (Can-Ag 1996).

Soils of the Muskeg group are developed on bog peat deposits, from 40 to 150 cm thick. The soils belong to the Organic order and are composed largely of organic materials. Organic soils are saturated with water for prolonged periods of time. The soils occur in poorly and very poorly drained depressions.

Soils of the Muskeg group belong in the subgroup Terric Mesisol and Typic Mesisol. Soils of the Terric Mesisol differ from the Typic Mesisol by having an unconsolidated mineral substratum at least 30 cm thick beneath the surface tier.

The soils of the Rough Broken (RB1) group occur on the valley floor in association with the McMurray and Firebag soils. The Rough Broken (RB1) soils are shallow over bedrock, whereas the McMurray soils are deep on recent fluvial materials. The soils belong to the Brunisolic order. The subgroup most prevalent in the Rough Broken (RB1) group is Orthic Eutric Brunisol. They occur mainly on parent material of high base status under forest vegetation.

The most common soils in the Riparian Terrace Ecosection include the following soil units; McLelland, McMurray and Gleyed McMurray, Muskeg, and Rough Broken (RB1 and RB2). The soils are somewhat similar to those found on the Riparian Floodplain with the exception that the Rough Broken (RB2) is included in the ecosection. The Rough Broken (RB2) occur on ridges within the valley sides. The soils belong to two orders, the Brunisolic and Luvisolic orders. The subgroups most prevalent in the Rough Broken (RB2) group include the Orthic Eutric Brunisol and Orthic Gray Luvisol. These soils develop in well to moderately well drained sites, in shallow fluvial over weathered residual sandy loam parent materials under forest vegetation.

Closed Deciduous Forest

Deciduous forest community types on the Athabasca and Steepbank River floodplains are primarily dominated by balsam poplar. Younger stands are typically a pure deciduous stand of balsam poplar and shrubs, while older stands are successional to white spruce/balsam fir, succeeding to mixedwood, mixedwood-white spruce dominant and eventually to a closed white spruce forest. Balsam poplar forests constitutes 372 ha on the Riparian Floodplain, and 937 ha on the Riparian Terraces (Table 6.3).

The predominant soils in the deciduous forest (Table 6.2) within the Riparian Floodplain Ecosection include the McLelland (3.0%), McMurray (5.5%) and Gleyed McMurray (2.2%), Rough Broken (RB1, RB2 and RB3), and Muskeg (0.1%). The McLelland soils are associated

TABLE 6.3 **Vegetation Coverage (ha) within the Local Study Area: Riparian Floodplain and Riparian Terraces**

ELC Terrain Class	ELC Vegetation Class	Coverage Area (ha) 1995
Riparian Floodplain		1474
	Closed Jack Pine	26
	Closed White Spruce	177
	Closed Deciduous Forest	372
	Closed Mixedwood	
	Closed Mixed Coniferous, Black Spruce Dominant	
	Peatland:Closed Black Spruce Bog	
	Peatland: Black Spruce-Tamarack Fen	
	Closed Mixedwood, White Spruce Dominant	255
	Peatland: Open Black Spruce Bog	
	Peatland: Open Tamarack Fen	
	Wetlands Shrub Complex	560
	Disturbed, Herb-Grass	1
	Industrial/Sparsely-Vegetated (Primarily Lease 86/17)	41
	Wetlands Open Water/Emergent Vegetation Zone	44
	Subtotal Area	**1474**
	Subtotal Cumulative Rounding & Interpolation Error	**0**

ELC Terrain Class	ELC Vegetation Class	Coverage Area (ha) 1995
Riparian River Terraces		2228
	Closed Jack Pine	130
	Closed White Spruce	665
	Closed Deciduous Forest	937
	Closed Mixedwood	
	Closed Mixed Coniferous, Black Spruce Dominant	
	Peatland:Closed Black Spruce Bog	
	Peatland: Black Spruce-Tamarack Fen	
	Closed Mixedwood, White Spruce Dominant	308
	Peatland: Open Black Spruce Bog	
	Peatland: Open Tamarack Fen	
	Wetlands Shrub Complex	124
	Disturbed, Herb-Grass	57
	Industrial/Sparsely-Vegetated (Primarily Lease 86/17)	7
	Wetlands Open Water/Emergent Vegetation Zone	1
	Subtotal Area	**2227**
	Subtotal Cumulative Rounding & Interpolation Error	**0**

with drainage courses. The sites are very poorly to poorly drained, consequently, the forest cover over McLelland soils are non-productive because of poor growth due to wetness. The McMurray soils occur on the floodplains of the Athabasca River. These soils are developed primarily on postglacial fluvial deposits. The soils support excellent tree growth. The Rough Broken (RB1, RB2 and RB3) soil unit dominates the deciduous forest. The soils cover approximately 23% of the Riparian Floodplain Ecosections.

Balsam Poplar/ (White Spruce/Balsam Fir)

Closed Deciduous Forest on the Floodplain of the Athabasca River is primarily dominated by balsam poplar, often with less than 10% cover provided by white spruce in the lower canopy and occasionally 5% or less of aspen. These sites are mesic to subhygric with fluvial parent material and soil type classified as MMY - an Orthic Regosol or Gleyed Cumulic Regosol (GLMMY) with a silty loam to sandy texture. Topography is typically level to depressional and supports vigorous balsam poplar growth due to the high nutrient regime, which will eventually succeed to white spruce forests. Balsam poplar forests on the upper to mid floodplain are often late seral stands with an open canopy and very large trees, approaching decadence. The understorey consists of a very dense and multi-structural shrub layer including tall shrubs dominated by Scoulers willow and beaked willow, and a dense mid to low shrub layer consisting of red-osier dogwood, low bush cranberry, prickly rose, snowberry, green alder, bristly black currant, wild red raspberry and wild black currant.

The herb layer is also diverse and of high biomass in these stands, dominated by wild sarsaparilla and common horsetail, with lesser cover provided by dewberry, tall lungwort, baneberry and bishops cap. Patches of shield fern occur throughout these stands. Due to decadent balsam poplar trees, deadfall was abundant, and standing snags are common (Plate 1). This community corresponds well with Beckingham's (1995) e2.1 type - balsam poplar-white spruce/dogwood/fern, which has a mesic to hygric moisture regime and a nutrient regime which is permesotrophic to mesotrophic.

Balsam Poplar/Willow-Alder/Common Horsetail

Early seral stands of balsam poplar are located on the lower floodplain and on some of the larger islands (Plate 2). These forests consist of a relatively open and young balsam poplar canopy with a very high cover of beaked willow, sandbar willow and river alder in the tall shrub strata and red-osier dogwood in the low shrub strata. Frequent inundation and sedimentation is evident throughout these stand types, and soils are predominantly Cumulic Regosols. Other common species include common horsetail and purple-stemmed aster. These stands relate best to Beckingham's (1995) f1.1 community type - balsam poplar- aspen/horsetail, which have a hygric to mesic moisture regime and an eutrophic to mesotrophic nutrient regime.

Balsam Poplar-Aspen/Dogwood-Saskatoon-Low Bush Cranberry

This community type corresponds very closely with Beckingham's (1995) e1.1 type, being dominated by aspen and balsam poplar in the canopy, with a rich and diverse shrub layer, dominated by red-osier dogwood, Saskatoon and low bush cranberry. Other shrubs include common gooseberry, twinning honeysuckle, prickly rose, bristly black currant, wild red raspberry, dewberry, snowberry and chokecherry. The herbaceous layer is less diverse due to the very high shrub cover, and there is a high deadfall and litter component. In addition aspen and balsam poplar snags are common. This community is a younger seral stage to the Balsam poplar/(White Spruce) stand discussed above, but is less developed - with a higher balsam poplar cover (due to the lack of decadence), and low to no establishment of white spruce.

Aspen-Paper Birch/White Spruce-Balsam Fir

Floodplain stands dominated by aspen, often with a high paper birch component, are present on the Riparian Terrace ecosection, where soil conditions are typically coarse and well-drained. This vegetation type is most common on the Steepbank River Floodplain, with a high white spruce and balsam fir cover in the understorey layers, indicating succession to white spruce-balsam fir forest in time. The shrub layer is dominated by moderate cover of dogwood and wild red raspberry, with patches of knight's plume moss under clusters of spruce and fir. Lady fern and shield fern are also present occasionally. There is a high percentage of bare ground, due to frequent soil deposition, associated with flooding. This community type corresponds best with Beckingham's (1995) ecosite phase e1.1 - Balsam poplar-Aspen/dogwood/fern.

With continued age and a reduction in flooding disturbance, this community develops a high shrub layer, due to a eutrophic to mesotrophic nutrient regime, with dominant shrubs including green alder and prickly rose. Where white spruce is less common the herbaceous layer is rich, dominated by bunchberry, blueberry, fireweed, clubmoss, hairy wild rye and occasionally, patches of bearberry, on sandy knolls. Soils in this community are also Cumulic Regosols, due to flooding on an annual basis.

Mixedwood

Mixedwood communities on the Floodplain are variable in composition due to variables such as micro-topography, moisture regime, frequency and duration of flooding, soil texture and seral stage. As a result, numerous different community structure types were observed, the most common of which are described below.

Soils are similar to those mentioned in the Closed Deciduous Forest (Table 6.2), however, there were areas of Muskeg soils dissected by McLelland soils which serve as drainage courses. The Muskeg soils occur in the depressional areas and support non-productive forest cover due to the duration of flooding.

Tamarack - Paper Birch - White Spruce - Aspen

This community type is a transition type between wetter depressional types and higher levees. As a result, site conditions are favourable to a variety of tree species, particularly over time with continued aggradation and a corresponding decrease in flooding frequency and extent. Other shrub species present in this community include willows, prickly rose and blueberry. The herbaceous layer is dominated by feather moss with stairstep and Schreber's moss most common. Other species include dewberry, bishop's cap, bunchberry, woodland horsetail, twinflower and a low cover of various other species typical of mesic forest floors. The litter layer at these sites is high, consisting of needles and leaves, with moderate deadfall cover of 20 to 30 %. Snags are common, with up to 20 within a 10 m^2 plot.

Site conditions are typical of those found in floodplain environments. The terrain is undulating to level, and the moisture level is mesic to subhygric. Factors influencing stand establishment are largely water related.

Balsam Poplar-White Spruce/Dogwood/Horsetail

Another Mixedwood community observed on the Athabasca River Floodplain is a climax balsam poplar forest, transitional to that of white spruce. These stands are located primarily on the Riparian Terrace ecosection, and support a semi-closed canopy of balsam poplar, with white spruce and paper birch in the lower and to a lesser extent upper tree canopy. This community is typically late seral to climax, with balsam poplar present due to canopy openings as decadent trees fall. As with the mature balsam poplar stand, these sites support a very high diversity and cover within the shrub layers with species including chokecherry, red-rosier dogwood, prickly rose, low-bush cranberry, wild red raspberry, common gooseberry and wild black currant (Plate 3). The herb layer is dominated by common horsetail and wild sarsaparilla, with other common species including bluejoint, Canada violet and patches of shield fern. This community type is similar to Beckingham's (1995) f2.1 community of balsam poplar-white spruce/horsetail, and the e2.1 association of balsam poplar-white spruce/dogwood/fern.

Closed Jack Pine

Although not common, there are a few jack pine stands located on the Riparian Terrace ecosection. These landforms are possibly old slumps, since they are situated at the foot of the escarpment slopes near the confluence of the Steepbank and Athabasca Rivers. Vegetation in these communities is dominated by a closed jack pine forest of even age. Aspen is present around the periphery of these stands. The understorey is of low diversity, consisting of a high cover of green alder and common blueberry, with patches of reindeer lichen and bearberry throughout. These sites correspond with Beckingham's (1995) b1.2 community type - jack pine-aspen/blueberry-alder.

The predominant soils within the Closed Jack Pine forest on the Riparian Floodplain ecosection (Table 6.2) are the McLelland (0.3%), McMurray (0.1%), Muskeg (0.8%) and Rough Broken (RB1, RB2 and RB3) soil types. The most dominant soil type is the Rough Broken (RB2) soil type, which is classified as either Orthic Eutric Brunisol or Orthic Gray Luvisol. The surface soil is a sandy loam over shallow fluvial parent material.

<u>**Closed White Spruce**</u>

Closed White Spruce forest, within the floodplain, typically exists in smaller stands, limited to old levees, upper floodplain terraces and older incorporated islands. The moisture regime of these stands is generally mesic to subhygric, with a poor to moderate drainage class. The nutrient regime is generally considered submesotrophic. Inundation due to flooding occurs infrequently. The most common soil type corresponding with closed white spruce forests on the Riparian Floodplain Ecosection is the Muskeg soil type, which is a Typic or Terric Mesisol. This is an organic soil type over mineral parent material, with the organic layer consisting of a less than 1 m layer of feather mosses

These stands are typical of late seral to climax white spruce forests within the region, with mature white spruce in the overstorey, and several strata of younger, shade-tolerant white spruce coming up in the understorey (Plate 4). Dominant understorey components include common horsetail, dwarf scouring rush, and Schreber's moss. Scattered presence of a high diversity of species is common at these sites, with consistent species including green alder, bastard toadflax, dewberry, bishop's cap, marsh marigold, and arrow-leaved coltsfoot.

Many of the closed white spruce stands sampled on the floodplain support a high cover of balsam fir in the understorey, with paper birch also present in low to moderate cover in the tall shrub layer. These are representative of climax white spruce stands, with an open canopy of large white spruce trees, and considerable deadfall due to decadence. Other common species include wild red raspberry, low bush cranberry, red-osier dogwood and prickly rose. The herbaceous layer is dominated by a thick carpet of Schreber's moss, with other species including enchanters nightshade (on rotting deadfall), Canada violet, twinflower, tall lungwort, common horsetail, northern bedstraw, bunchberry and patches of ladys fern. Where the overstorey of coniferous trees is more dense, the shrub layer decreases considerably and dominant understorey species are herbaceous, and include northern bedstraw, bunchberry and common clubmoss. In addition, the feathermoss layer is of higher cover. Deadfall in these stands is often high.

These mature white spruce stands correspond with Beckingham's (1995) d3.5 community - with an ecosite indicator of low bush cranberry, and dominant species of white spruce and feathermoss.

White Spruce-Jack Pine/Blueberry/Bearberry/Lichen

Drier stands of closed white spruce on the Riparian Terrace ecosection are associated with old incorporated islands. These stands typically support white spruce in all strata, and jack pine is often present in low cover. The dominant understorey shrubs are shrubby cinquefoil and Canada buffaloberry, with a high cover of bearberry and reindeer lichen in the understorey. Feather moss is sparse in these communities. This community corresponds best with Beckingham's (1995) 4.1 type - white spruce-jack pine, with blueberry/lichen in the understorey. This is a subxeric to mesic site with rapid to well drained soil and a mesotrophic nutrient regime.

Closed Mixedwood, White Spruce Dominant

Vegetation community types of this type form a patchwork on the floodplain, occurring in association with mesic to subhygric conditions, and reflecting successional changes within a stand, from deciduous forest to mixedwood, and eventually to closed white spruce. Soil type corresponding to this vegetation is the McMurray soil unit, which is fluvial in origin with a silt loam, loam, sandy loam or sandy texture. This type is typical of depressional meander scars on the lower floodplain, where conditions are moderately to imperfectly drained, terrain is depressional, and flooding occurs annually. Signs of flooding were apparent in July, with a thick fluvial silt covering much of the vegetation.

On the Steepbank River, the lower to middle floodplain areas are subject to inundation and seepage from both flooding and drainage from the escarpment. In response to these conditions, they support a mix of closed white spruce within an open canopy of tamarack, paper birch and some aspen. Fairly even and young ages of these species indicated that these stands are young seral. Other common species include beaked willow, prickly rose, common blueberry, dewberry, bishop's cap and a moderate moss cover of stair-step moss and Schreber's moss.

On the Athabasca River floodplain, Closed Mixedwood White Spruce Dominant stands are very similar to the Closed Mixedwood, although white spruce is more prevalent, providing 40 to 50% of canopy cover, with balsam fir providing 30% cover in both the lower tree canopy and shrub strata. This represents a late seral community. As in the Mixedwood stand, shrub cover is very high, composed predominantly of red-osier dogwood, with some river alder in the upper shrub layer and chokecherry, wild red raspberry, currants and low bush cranberry in the lower shrub layer. The herb layer is also very diverse consisting primarily of common horsetail with baneberry, dewberry, Schreber's moss and knight's plume also common. Being similar to some of the Mixedwood communities, this community also corresponds best with Beckingham's (1995) e2.1 type - Balsam Poplar-White spruce/dogwood/fern and f2.1 type where horsetail is more common.

These sites are associated with the Riparian Terrace ecosection, with moderately drained soil conditions, very high litter and a mesotrophic to permesotrophic nutrient regime. Moisture regime in these communities is typically subhygric to hygric and drainage ranges from moderately well to poor. Due to age, litter accumulation and moisture regime, the nutrient status of these stands is typically high, being permesotrophic to eutrophic.

Wetlands Closed Shrub Complex

This vegetation type occurs most predominantly on the Riparian Floodplain area, where it is the dominant vegetation type, providing a cover of 560 ha (Table 6.3). The Riparian Terrace supports 124 ha of the Wetlands Closed Shrub Complex. Two main categories of the closed shrub vegetation type were sampled on the Athabasca and Steepbank River floodplains. Both types occur in depressional areas, near the water, on substrate just above the mean water table. Common throughout the study area is a closed shrub complex located along the river edge, consisting of river alder, green alder and beaked willow. This narrow community is common along both rivers, on well drained sandy fluvial deposits, at 1 to 2 m above the water level (Plate 5). Other species include scattered white spruce and a high cover of sedges. This community corresponds well with Beckingham's (1995) d3.2 community based on indicator species of low bush cranberry and alder, often within an open white spruce canopy. This community is frequently inundated, with debris and freshly deposited alluvium apparent.

In addition to this river edge shrub community, a Wetlands Closed Shrub ecosite is prevalent around backwater ponds and channels on the broad floodplain of the Athabasca River. These highly diverse communities are transitional between the open water/emergent vegetation and the mature balsam poplar stands to the outside. These sites are depressional, occurring in conjunction with old meander scars or swales, abandoned anabranches and oxbows. The shrubby fringe, occurring on hummocks to the outside of the open water and emergent vegetation fringe, is dominated by willow, with occasional red-osier dogwood, wild red raspberry, prickly rose and common gooseberry on higher hummocks (often 1 m above the surrounding level ground) (Plate 6). This community is highly diverse, with other species on the hummocks and throughout the shrub-dominated wetlands including hairy-fruited sedge, two-seeded sedge, marsh cinquefoil, rumex, tall manna grass, bulb-bearing water hemlock, water hemlock and rough cinquefoil. The shrub species become more predominant with distance from the open water, towards a dense wetlands closed shrub vegetation coverage.

Standing water and predominantly emergent and aquatic vegetation species are often found between the hummocks of shrubby vegetation as described in the open water/emergent vegetation type.

The predominant soil types within the Wetlands shrub (Table 6.2) complex on the Riparian Floodplain area include McLelland (6.3%), McMurray (4.0%) and Gleyed McMurray (6.7%), and Muskeg (0.4%). The predominate soil types corresponding with the wetlands shrub complex on the Floodplain Terraces include McLelland (2.4%), McMurray (0.4%) and Gleyed McMurray (0.3%), and Muskeg (1.2%). The dominant soil type within the Floodplain Terraces is the McLelland soil type, which is Typic Mesisol or Terric Mesisol.

Wetlands Open Water/Emergent Vegetation

The open water/emergent vegetation zone also represents a wetlands transition, from open water with aquatic vegetation to a dense zone of emergent vegetation within the water fluctuation zone (Plate 7). Species within the open water area include yellow pond-lily, which provides very high cover in some areas (Plate 8). In addition, common duckweed is prevalent in shallow waters, together with arrowhead and giant bur-reed. Emergents and water tolerant herbs include common mint, cattail, water sedge, spike-rush and patches of water arum. In some areas, cattail comprise a dense fringe around the open water zone. These sites are representative of the three marsh types classified in Beckingham (1995), including cattail marsh, reed grass marsh and bulrush marsh.

The dominant soil type within the wetlands open water/emergent vegetation on the Riparian Floodplain are the McMurray soils. These soils occur primarily in depressional areas (e.g. meander scars).

Disturbed/Herb-Grass

Within the Riparian Terrace ecosection of the Athabasca River Valley, one large cut-block is present at the south end of the study area. This area is newly vegetated with a variety of herbs, grasses and low shrubs, which provide almost 100% cover.

Non-Vegetated

Non-vegetated areas within the lower floodplain occur on recently formed and frequently inundated sandbars along pointbars and islands. Early vegetation cover largely consists of sandbar willow and patches of sedges and equisitum.

6.2.2 Ecosites Associated with the Escarpment Slopes

The Escarpment Slope terrain class supports the highest number of community types within the Local Study Area, with community representation by 13 of the 14 natural vegetation cover types (Table 6.4). This reflects the hetereogeneity of landforms within this terrain class, with terrain variations ranging between a variety of slopes, slope positions, aspects, surface shapes (convex/concave/level), drainage conditions, erosional conditions, among others. In addition, stands of various successional age are reflected in the cover (Plate 9). The most abundant community type is that of Closed Deciduous Forest - Aspen Dominated, with a distant second of Peatland Open-Tamarack Fen (Table 6.4).

TABLE 6.4 **Vegetation Coverage (ha) within the Local Study Area: Riparian Escarpment**

ELC Terrain Class	ELC Vegetation Class	Coverage Area (ha) 1995
Riparian Escarpment		4024
	Closed Jack Pine	465
	Closed White Spruce	365
	Closed Deciduous Forest	1647
	Closed Mixedwood	63
	Closed Mixed Coniferous, Black Spruce Dominant	241
	Peatland:Closed Black Spruce Bog	283
	Peatland: Open Tamarack Fen	518
	Closed Mixedwood, White Spruce Dominant	91
	Peatland: Open Black Spruce Bog	16
	Peatland: Black Spruce-Tamarack Fen	28
	Wetlands Shrub Complex	192
	Disturbed, Herb-Grass	110
	Industrial/Sparsely-Vegetated (Primarily Lease 86/17)	5
	Wetlands Open Water/Emergent Vegetation Zone	0
	Subtotal Area	**4023**
	Subtotal Cumulative Rounding & Interpolation Error	**0**

The presence of paper birch on escarpment slopes is somewhat unpredictable - often present with aspen on mid to upper slopes, where soils are well drained sandy loams, but where moisture conditions are mesic to subhygric. Although paper birch presence is associated with both seed source and landform/site conditions, its dominance is likely related to the successional phase of the vegetation cover at the time of seed dispersal and seedling establishment - establishment in early seral stages could result in dominance at a site.

The dominant soil types within the Riparian Escarpment include Algar (ALG), Firebag (FIR), Kinosis (KNS), McLelland (MLD), McMurray (MMY), Muskeg (MUS) and Rough Broken (RB3) (Table 6.5). The soils of the Algar group are peaty Gleysols developed on clayey and silty glaciolacustrine and mixed glaciolacustrine deposits (Turchenek and Lindsay 1982). The parent material consists of thin or thick glaciolacustrine materials composed of bedded clay and silt containing pebbles and till-like layers. Due to the glaciolacustrine material being thin, soil development has occurred throughout and has developed into the underlying glacial till.

The Algar soils occur in depressional areas and on level to undulating topography with very gentle slopes (less than 5%). The soils are generally wet, poorly drained with <30 cm of surface litter or peat. They occur as islands within muskegs, in the transition zone from muskeg to uplands and as depressional areas within uplands. The subgroups include Peaty Orthic Gleysols and Orthic Gleysols (Can-Ag 1996).

Soils of the Firebag group are classified as Eluviated Eutric Brunisols and Orthic Eutric Brunisols, however, Dystric Brunisols are also likely to occur within the escarpment. The soils are formed in sandy, moderately to exceedingly stony, glaciofluvial material. The soils occur in areas of large kame moraines. Topography is generally hummocky to rolling. The sandy material that the soil is formed on ranges in color from light brownish yellow to brown.

The surface soil of the Firebag group has a 3 cm thick LFH layer consisting of slightly to moderately decomposed needles and lichens (Turchenek and Lindsay 1982). The LFH layer is somewhat thicker under aspen woodlands. The Ae horizon is from 5 to 20 cm thick and the material is very friable and sandy. The subsoil (Bm) is from 20 to 60 cm thick and uniformly sandy. The horizon has a BC of variable thickness as well.

TABLE 6.5 SOIL AND VEGETATION COVERAGE (%) WITHIN THE SUNCOR LOCAL STUDY AREA: RIPARIAN ESCARPMENT

VEGETATION TYPE	SOIL TYPE											
	FIR %	KNS %	MLD %	MMY %	MUS %	RUT %	RB2 %	RB3 %	ALG %	GLKNS %	RIVER %	VEGETATION TOTAL %
Closed Jack Pine	0.4%	0.9%	0.0%	0.1%	3.2%	0.2%	0.1%	2.6%	0.2%	0.0%	0.0%	7.7%
Closed White Spruce	0.0%	0.7%	0.0%	0.4%	2.2%	0.1%	0.0%	6.0%	0.0%	0.0%	0.2%	9.7%
Closed Deciduous Forest	1.0%	10.8%	0.0%	1.5%	1.0%	4.5%	2.7%	25.0%	0.2%	0.0%	0.1%	46.9%
Closed Mixedwood	0.3%	0.2%	0.0%	0.0%	0.2%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	1.1%
Closed Mixed Coniferous Black Spruce Dominant	0.1%	1.9%	0.1%	0.0%	1.9%	0.2%	0.0%	1.5%	0.1%	0.0%	0.0%	5.8%
Peatland: Closed Black Spruce Bog	0.0%	0.1%	0.0%	0.0%	3.9%	0.1%	0.0%	0.4%	0.0%	0.0%	0.0%	4.6%
Peatland: Black Spruce-Tamarack Fen	0.1%	0.2%	0.2%	0.0%	13.6%	0.0%	0.0%	0.6%	0.1%	0.0%	0.0%	14.8%
Closed Mixedwood White Spruce Dominant	0.0%	0.1%	0.0%	0.1%	0.4%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	1.3%
Peatland: Open Black Spruce Bog	0.0%	0.0%	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Peatland: Open Tamarack Fen	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Wetland Shrub Complex	0.1%	0.3%	0.1%	0.1%	0.4%	0.7%	0.0%	2.5%	0.0%	0.0%	0.0%	4.2%
Wetland Open Water/Emergnt Veg.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Disturbed/Herb, Grass Dominant	0.0%	1.0%	0.0%	0.2%	0.3%	0.3%	0.0%	1.4%	0.0%	0.0%	0.0%	3.2%
Industrial, Sparse Veg.	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Soils Totals	**2.1%**	**16.2%**	**0.5%**	**2.5%**	**27.5%**	**6.1%**	**2.9%**	**41.0%**	**0.6%**	**0.1%**	**0.4%**	**100.0%**

HHR, RB1, DL, GLMMY and WATER soils are not represented in these terrain types

Firebag soils can either be of the subgroup Orthic Eutric Brunisols or Eluviated Eutric Brunisols, however, Dystric Brunisols are also likely to occur. The soils have the general properties specified for soils of the Brunisolic order, the Eutric Brunisol great group and the Dystric Brunisol great group.

The soils in the Kinosis group consist of well to moderately well-drained Orthic Gray Luvisols that are developed on loamy morainal deposits. The soils occur on undulating and hummocky terrain with gentle to moderate slopes. The soils are formed in morainal material, but there are inclusions of lacustrine and fluvial veneers over morainal deposits (Can-Ag 1996).

Soils of the Orthic Gray Luvisol subgroup have well-developed Ae and Bt horizons and have organic surface horizons. The LFH horizon is 5 to 10 cm thick and consists of slightly to moderately decomposed needles, leaves and lichens. The Ae horizon is between 10 to 25 cm thick and has a moderately developed platy structure. Texture of the Ae horizon is sandy loam. The Bt horizon thickness is between 25 to 55 cm and has a weak to moderate subangular blocky structure. The soils often have a BC horizon.

Soils of the Kinosis Orthic Gray Luvisols are associated with the Gleyed Gray Luvisols. These soils have the properties specified for the Luvisolic order and the Gray Luvisol great group. The Kinosis Gleyed Gray Luvisols differ from the Kinosis Orthic Gray Luvisols by having distinct mottles indicative of gleying. Another subgroup that may occupy the depressional sites is the Brunisolic Gray Luvisols.

The soils in the McMurray soil type occur on the lower east- and west-facing slopes of the Athabasca River and the lower north-, south-, west- and east-facing slopes of the Steepbank River. These soils are developed primarily on silt loam to loam textured deposits. There is limited profile development. The LFH is typically <8 cm thick and C horizons (>100 cm thick) are rated as fair soil quality with limitations of high pH, due to a presence of lime. The subgroup of the McMurray soil type is typically Orthic Regosol. These soils have the properties specified for the Regosolic order and the Regosol great group (Can-Ag 1996).

Soils in the Rough Broken (RB3) soil group occur on the steeper slopes of the escarpment. Rough Broken (RB3) soils belong to two orders: Regosolic and Luvisolic. Two subgroups are included, typically, Orthic Regosol and Orthic Gray Luvisol. The soils have the properties specified for the Regosolic and Luvisolic order. Orthic Regosols are identified by having an A horizon less than 10 cm thick. The Orthic Gray Luvisols have well-developed Ae and Bt horizons and usually have organic surface horizons. The soils are well drained (Can-Ag 1996).

Closed Jack Pine

Closed jack pine forest represents the third most common forest cover type on the Escarpment Slopes within the Local Study Area, occupying 465 ha (Table 6.4). These stands are found on upper slopes, knolls and the escarpment slope crests, where drainage is rapid to moderately-well, and soil conditions range from sandy loam to sand. These stands are typically semi-open, with a jack pine cover of 30 to 50% (Plate 10). Other tree species include low cover of white spruce, aspen, paper birch and/or black spruce. Shrub cover at these sites is dominated by blueberry and/or green alder (particularly in depressions where moisture conditions are higher). Other very common species include bearberry and reindeer lichen (*Cladina mitis* and, less abundant *C. stellaris* and *C. rangiferina*), with consistent but less common species including prickly rose, Canada buffaloberry, Saskatoon, bog cranberry, bastard toadflax, fireweed, northern rice grass and cushion moss (*Dicranum polysetum*). The sparse shrub cover as well as the low vigour of these species reflects the dry conditions and poor nutrient regime.

These sites correspond well with Beckingham's (1995) a1 ecosite phases - all dominated by jack pine, with community type varying depending on dominance by blueberry, bearberry or alder in the shrub layers. These communities represent the driest and most nutrient poor ecosite type in the Mid Boreal Forest, with a subxeric-submesotrophic moisture-nutrient regime class (Beckingham 1995). A high cover of bearberry typically indicates the most xeric and nutrient poor conditions, whereas high presence of alder indicates higher moisture and nutrient availability. Higher alder cover is apparent where the terrain is undulating, allowing for higher moisture conditions in the hollows, where alder is generally restricted in dense clusters. Blueberry is common in all of the jack pine dominated stand types.

Most of the jack pine stands show signs of historical fire, in the form of old fire scars and burnt stumps and deadfall.

The predominant soil types within the closed jack pine forest (Table 6.5) on the Riparian Escarpment include Algar (0.2%), Firebag (0.4%), Kinosis (0.9%), McMurray (0.1%), Muskeg (3.2%), Ruth Lake (0.25)and Rough Broken (RB2 and RB3). Firebag soils occur on the knolls and ridges of escarpment slopes. The soils are classified as either Eluviated Eutric Brunisol or Orthic Eutric Brunisol. Kinosis soils occur on the mid to upper slope positions and are classified as Orthic Gray Luvisols. The texture ranges from sandy loam to loamy sand. The McMurray soils occur on the higher well drained positions of the escarpment and are classified as Orthic Regosols. Ruth Lake soils occur on the upland positions of the escarpment slope. The soils are classified as either Eluviated Eutric Brunisol or Orthic Gray Luvisol. The soil texture ranges from sandy loam, loamy sand to sand. The drainage is rapid to moderately well drained. Soils of the Rough Broken (RB2 and RB3) occur on the mid to upper valley sides and are well to moderately well drained. The soils are classified as Orthic Eutric Brunisol, Orthic Gray Luvisol and Orthic Regosol. The texture is sandy loam.

Closed White Spruce

The Escarpment Slope terrain class supports approximately 365 ha of white spruce forest, particularly in association with small drainages and deeper ravines where there is a higher moisture gradient (Table 6.4). These sites support white spruce in 50 to 80% cover, with some regeneration in the understorey. Balsam poplar is often associated in low cover with these locations (Plate 11). Green alder is often present in moderate cover, with other shrubs largely being absent due to the high canopy cover and high needle component in the litter. The most common understorey species is common horsetail, followed by dwarf scouring rush, and a carpet of feather mosses, with a high diversity of species, dominated by Schreber's moss. Other less common bryophyte species (<10%) include *Tomenthypnum nitens* and *Polytrichum strictum*. Less common herb species include bastard toadflax, dewberry, bishop's cap, wild lily-of-the-valley, marsh marigold (along seeps) bluejoint and dwarf scouring rush. The herbaceous layer is often diverse, although cover is typically low. These sites often have up to 10 snags present in a $10m^2$ plot, often consisting of over-inundated balsam poplar along creek margins. The litter cover is approximately 30% consisting of a mix of needles and leaves. Witches broom is not common.

The more deeply incised ravines varied in composition and cover, with aspect and slope position. The slope of these sites is steep - approximately 20 to 30%, with erosional faces present, particularly on the Steepbank River escarpment (Plate 12). The north-facing slopes of the ravines, and escarpment slopes along the Steepbank River, often support a moderate cover of mature white spruce, with 50 to 70% cover. Other tree species in low cover include balsam poplar, aspen and paper birch, with a moderate to high cover of balsam fir in the shrub layer. Shrub cover is also high, with dominance varying between choke cherry, balsam fir, red-osier dogwood, Canada buffaloberry, Labrador tea and green. Prickly rose, low bush cranberry and currants are also present throughout. The herb layer is also diverse and of high cover, dominated by a near complete feathermoss cover of knight's plume and Schreber's moss, with other herbaceous species including twinflower, bishop's cap, common pink wintergreen, Canada violet, wild sarsaparilla, palmate-leaved coltsfoot, dewberry and horsetail on depressional slump surfaces.

A high diversity of landform within each slope face is apparent due to slumping, erosion, terraced edges, gullies and windthrow areas, as well as variations in seral stage. Typical site conditions of white spruce stands located along the escarpment slopes often follow along drainage courses. Slope position varies from upper to lower slope, and surface shape ranges from convex to concave. Slope varies from 5 to 30%. Upper slope areas of some of these sites have surface water in small pools which is associated with seepages and may account for up to 10% of the surface.

Although highly variable, white spruce dominated escarpment slopes correspond best with Beckingham's (1995) d3.4 community of white spruce/balsam fir/feathermoss, although balsam fir is only present within the late seral or climax white spruce stands. These communities also correspond well with all communities in the e3 ecosite phase of white spruce/dogwood. The e3 ecosite phase is of moderate moisture regime and high nutrient status. Slope position is typically variable ranging from low to upper slope positions. Moisture regime is mesic to subhygric and nutrient status is permesotrophic to mesotrophic. These sites are highly diverse, both at the landscape level of habitat interspersion and at the community level of species richness.

These sites differ from Closed White Spruce communities on the floodplain in that the canopy is often more closed and the tall shrub layer is of less cover - largely due to shade as well as a lower nutrient and moisture regime, which limits the establishment and growth of an extensive shrub layer.

The predominant soil types within the closed white spruce (Table 6.5) on the Riparian Escarpment include Kinosis (0.7%), McMurray (0.4%), Ruth Lake (0.1%) and Rough Broken (RB3 - 6.0%). McMurray soils occur on the lower escarpment slopes along drainage courses. Soils of the Ruth Lake type occur on the upper positions. Rough Broken (RB3) soils occur on mid to upper slopes of the escarpment.

Closed Mixedwood - White Spruce Dominant

Composition within Closed Mixedwood White Spruce Dominant communities is highly variable, but generally represents a seral stage that is successional to closed white spruce, with much of the high white spruce cover existing in the lower tree and shrub canopies. Other tree species include a mix of jack pine, black spruce and aspen. The shrub canopy is typically variable, supporting components from a variety of communities, and includes Canada buffaloberry, Labrador tea, shrubby cinquefoil, prickly rose and willows. The herbaceous layer is also variable, dominated by palmate leaved coltsfoot, bunchberry, twinflower and dwarf scouring rush. The high cover of feathermoss reflects the transition to white spruce. This community type is located along the upper portion of seepages, moving from east to west, where the edge factor along the seepage adds to terrain and moisture variability, leading to a mixed vegetation cover within the plot. This community type corresponds best with Beckingham's (1995) d3.1 type - typified by white spruce and buffaloberry, and is transitional to the d3.5 type of closed white spruce/feathermoss. However, areas around seepages are also indicative of Beckingham's (1995) white spruce/horsetail community (f3.1) which supports a higher diversity of shrubs and forbs due to intermittently high moisture conditions.

The predominant soil types within the closed mixedwood white spruce dominant community on the Riparian Escarpment include Kinosis (0.1%), McMurray (0.1%), Muskeg (0.4%), Ruth Lake and Rough Broken (RB3 - 0.7%).

Closed Deciduous - Aspen Dominant

The westerly and southerly facing escarpment slopes supports 1647 ha of aspen dominated deciduous forest - by far the dominant vegetation type of the Escarpment terrain class (Table 6.4). These stands vary somewhat in cover and composition in response to varying site conditions such as slope, aspect, soil characteristics and moisture regime, as well as fire history and seral stage.

The predominant soil types within the closed deciduous aspen dominant forest (Table 6.5) on the Riparian Escarpment include Firebag, Kinosis, Ruth Lake and Rough Broken (RB2 and RB3). Firebag soil types occur on the lower slope sites of the escarpment slope and are classified as Eluviated Eutric Brunisol or Orthic Eutric Brunisol. Soils of the Kinosis type occur on the upper to middle slopes of the escarpment slope and are classified as Orthic Gray Luvisol. Rough Broken (RB2 and RB3) soil types occur on the middle to upper slopes of the escarpment slope and are classified as Orthic Eutric Brunisol, Orthic Gray Luvisol and Orthic Regosol.

Aspen/green alder

This is one of the more common community types on Escarpment Slopes, consisting of an upper canopy of aspen, to 60 - 70% cover with a high understorey of green alder in the upper and lower shrub layers (40 to 70%). White spruce is typically present but not of high cover in the lower tree canopy and shrub layers. Other common shrub species include low bush cranberry and prickly rose (Plate 13). The herb layer in this forest type is typically rich, in response to good soil conditions and high litter, resulting a relatively thick organic horizon (Ah) and moderate nutrient availability. Common species include wild sarsaparilla, twin flower, palmate-leaved colt's foot, bunchberry, fireweed and wild lily-of-the-valley. Common grasses include bluejoint, hairy wild rye and mountain rice grass - of low to moderate cover in these stand types. Often white spruce, paper birch and balsam fir are present in the understorey. The deadfall cover is moderate to high depending on stand age and vigour (10 to 40%) and typically, snags are not present.

These stand types are typically found on the upper escarpment slopes, with a site surface shape of level and sloping to somewhat convex, facilitating moderate drainage. Slope varies from 6 to 15% and moisture conditions are considered mesic, with a mesotrophic nutrient regime. Factors which influence these stands include fire - which slows the rate of successional change to a climax forest of white spruce, and terrain effects such as slumping, drainage and erosion.

This community type is similar to the aspen/alder community (d1.4) classified by Beckingham (1995). The 'd' or low bush cranberry ecosite tends to have a mesic moisture regime and mesotrophic nutrient status and ecological processes are controlled more by meso-climate than edaphic influences of soil and site.

Aspen - Balsam Poplar

Deciduous forests on the escarpment slopes respond to varying moisture regimes. Areas that are of low slope and collected run-off support a mix of aspen and balsam poplar in the forest canopy, at the young seral stage of succession. In response to increased moisture, the shrub layer is often dense and diverse. Dominant shrub species typically include river alder, tall willow (*Salix serrisima*), red-osier dogwood, prickly rose and low bush cranberry. Less common species are white spruce, wild black currant, bristly black currant, wild red raspberry, twinning honeysuckle and snowberry. The herbaceous layer is dominated by common horsetail, with other common species including palmate-leaved coltsfoot, wild sarsaparilla, dewberry, tall mertensia, cream coloured vetchling, bishop's cap, American vetch, northern bedstraw and hairy wild rye. Moss cover is low, less than 10%.

This community type is located on mid to lower slope sites, where there is a higher moisture regime due to seepage from upslope and slope. Slope varies from 5 to 25%, but can be near level on the terraces.

Closed Mixedwood

Mixedwood stands, consisting of various combinations of aspen, white spruce, black spruce and jack pine are common on the escarpment slopes and upper escarpment crests. These stands vary from being a mix of tree species, to consisting of a mosaic or complex of fairly homogeneous tree stands - in which case the understorey components are similar to a pure stand of that species. Where this occurs, there is a high interspersion of community types. Closed Mixedwood stands provide only 63 ha on the Escarpment Slope terrain class (Table 6.4).

The predominant soil types within the Closed Mixedwood stands (Table 6.5) on the Riparian Escarpment include Firebag (0.3%), Kinosis (0.2%), Muskeg (0.25) and Rough Broken (RB3 - 0.4%).

Mosaic of aspen/low bush cranberry/rose and white spruce/river alder/Canada buffaloberry

Some areas along the Athabasca River escarpment slopes support a mosaic of small but relatively pure stands of deciduous forest and white spruce forest, which are presented as Mixedwood due to the high interspersion and low patch size. These sites are early to mid seral and reflect variations in the terrain, with white spruce dominated stands in depressional areas and shallow ravines, and aspen dominated stands on knolls, ridges and slopes. The spruce dominated stands are relatively closed, with a cover of over 70%, with some aspen. Shrub cover is low but diverse, as was the herb layer, with common species including low bush cranberry, prickly rose, red-osier dogwood, bunchberry and feather moss. The aspen stands are also of high cover, with low white spruce in the canopy. Common species in the understorey include river alder, Canada buffaloberry, prickly rose, red-osier dogwood, twinflower, common horsetail and bunchberry. These sites provide a high mosaic of habitat types.

Terrain features are undulating, and form gentle ridges and swales aligned down-slope. Drainage type ranges from submesic to sub-hydric with position, from knolls to depressions, and the nutrient regime is mesotrophic. Slope varies from approximately 5 to 15%, and aspects are variable.

Aspen/White Spruce

The escarpment slopes of the Athabasca and Steepbank Rivers also support mixedwood stands dominated in the upper tree canopy by mature aspen with abundant white spruce in all strata (Plate 14). These stands are successional to white spruce, in mid seral stages. Paper birch is often present in low numbers in the upper shrub strata. Dominant shrub species include prickly rose, Canada buffaloberry, low bush cranberry, and to a lesser extent, green alder. The herbaceous layer is diverse and of high total cover, being dominated by bunchberry, woodland horsetail, wild strawberry, twinflower, wild lily-of-the-valley, dewberry, palmate-leaved coltsfoot, and tall mertensia. Slender wheatgrass is also present in less than 10% cover. Less mesic sites support a very high cover of wild sarsaparilla. Litter cover is moderate to high and deadfall and snags are not abundant. Where paper birch is present in low numbers, birch snags are present.

These sites typify Beckingham's (1995) d1, d2 and d3 ecosite phases - with indicator species of aspen, white spruce and low bush cranberry, and with dominant shrub species varying between low bush cranberry, Canada buffaloberry and prickly rose.

Where white spruce is more dominant in cover, the understorey is typically of lower biomass and diversity and feathermoss is more abundant.

The site characteristics of the aspen-spruce community type, located on escarpment slopes include a slope of 10 to 20%, resulting in moderately-well drained conditions. The moisture regime is generally mesic with no surface water.

White Spruce - Jack Pine - Aspen

These stands are similar to the aspen-white spruce stands with the exception of having been influenced by fire history and seed dispersal allowing for the establishment of jack pine, now sharing the upper canopy. In addition to aspen, white spruce is also common, and shows high regeneration in the understorey strata. Shrub species are common in these stands consisting of willow, Canada buffaloberry, prickly rose, shrubby cinquefoil, red-osier dogwood and patches of Labrador tea in depressional areas. The herbaceous layer is less diverse than pure aspen-spruce stands, being dominated by dwarf scouring rush, bunchberry, palmate-leaved coltsfoot and twinflower. The moss layer provides up to 80% cover, consisting predominantly of Schreber's moss. Litter cover and deadfall are of low cover, with snags of a few scraggly aspen. Witches broom is more common in these sites, averaging about 5 trees in $10m^2$.

Site conditions are also similar to aspen-white spruce stands, occurring along variable slopes of the escarpments with southerly and westerly aspects. Sites with jack pine as a major component tend to be on well-drained sandy deposits, although white spruce responds to seepage areas associated with topography.

Closed Mixed Coniferous - Black Spruce Dominant

This community type is located along the upper escarpment where seepage from upland fens and bogs provides a higher moisture regime to the mineral soils along the upper escarpment edge along the east side of the Athabasca River and west side of the Steepbank River. It cover 241 ha of the Escarpment Slope terrain class (Table 6.4). The slope at these sites is variable, ranging from imperceptible to steep, with variable aspects. In response to moderate to high moisture conditions, black spruce dominates in the tree canopy (Plate 15). However, conditions at these sites are not so wet as to preclude the successful establishment of white spruce, and to a lesser extent paper birch. These sites are successional to white spruce, which predominates in the shrub strata. The shrub layer is of moderate cover and relatively high diversity, being dominated by red-osier dogwood, low bush cranberry and bristly black currant, with patchy occurrence of Labrador tea and Canada buffaloberry. The understorey is dominated by a near complete cover of feathermoss - dominated by Schreber's moss. Other common herbaceous species include twinflower, bishop's cap, bog cranberry and wild sarsaparilla, although some more mesic sites support a high cover of common horsetail, with low feathermoss cover. This type corresponds best with Beckingham's (1995) d3.5 type - of white spruce/feathermoss or f3.1 - white spruce/horsetail, and is mesic/mesotrophic to hygric/permesotrohic in the moisture - nutrient status.

Soils of the closed mixed coniferous black spruce dominant community (Table 6.5) within the Riparian Escarpment include Algar (0.1%), Kinosis (1.9%), Muskeg (1.9%), Ruth Lake (0.2%) and Rough Broken (RB3 - 1.5%) soil types.

<u>Peatland - Closed Black Spruce Bog</u>

This community type covers 283 ha in the Escarpment Slope unit (Table 6.4), and is located primarily at the top of the escarpment slope, where seepage from the upland saturates surficial deposits and extends the cover of black spruce bog vegetation. Composition is similar to that of the Closed Black Spruce Bog community found more extensively in the Upland Terrain Class. However, most of the Black Spruce communities on the Escarpment Slopes are drier, such that understorey composition does not include sphagnum mosses, but rather feather mosses, particularly Schreber's moss. Given the lack of peat accumulation in these communities, they do not represent a true black spruce bog. These sites often support some jack pine in the canopy layer. Herb composition is also reflective of unsaturated conditions, and is more similar to composition in white spruce forests, consisting of palmate-leaved coltsfoot, twinflower, bog cranberry, and bishop's cap. Labrador tea is present in high cover.

Soils of the peatland closed black spruce community type (Table 6.5) within the Riparian Escarpment include Kinosis (0.1%), Ruth Lake (0.1%) Muskeg (3.9%) and Rough Broken (RB3 - 0.4%) soil types.

<u>Peatland Black Spruce/Tamarack Fen</u>

Within the Escarpment Slopes terrain class, this community type covers 28 ha, primarily restricted to depressional seepages along the top of the escarpment slopes, where drainage is being directed west from the Uplands to the Athabasca River (Table 6.4). This type of community is referred to as a Poor Fen, where conditions are transitional between bog and fen - with some through drainage occurring resulting in higher nutrient conditions and a less acidic pH. Dominant species include black spruce and tamarack, with understorey shrubs dominated by bog birch, Labrador tea and willow. Sedges are also prevalent and the peat layer is a combination of sphagnum and brown mosses. This community type is discussed in more detail under the Upland terrain class.

Peatland: Open Black Spruce Bog

The Open Black Spruce/Bog community occurs extensively throughout the Upland, and extends into the upper edge of the escarpment slope area, occupying only 16 ha of land. This community is discussed in more detail under the Upland terrain class, where it is extensive.

Peatland: Open Tamarack Fen

The Open Tamarack Fen community is termed a Treed Fen peatland type, occurring along the upper escarpment edge, where the slope is level to gentle. This community is of moderate coverage within this terrain class, occurring in 518 ha. Within the Upland class, it is more prevalent, and is discussed in more detail under that heading.

Wetlands Closed Shrub Complex

The Closed Shrub Complex on Escarpment Slopes is largely associated with drainages in upper slope areas and ravine bottoms throughout this landform type and provides 192 ha of cover (Table 6.4). Shrub cover is associated with wetlands conditions where dominant species include river alder, willow, bog birch and a combination of these species (Plate 16). Less incised seepages in upslope areas are associated with shrub fens, dominated by bog birch, with sedges and brown mosses of high cover. These sites are often rimmed by open stands of tamarack. Permanent and ephemeral creeks, somewhat incised and with sandy fluvial deposits support a high cover of river alder along the edges in a narrow band. Beaked willow and red-osier dogwood are often present in low to moderate cover, as is bluejoint, common horsetail, common hemlock and bulrushes along the creek margins.

Soils of the Wetlands Closed Shrub Complex (Table 6.5) within the Riparian Escarpment include the McMurray (0.1%), Ruth Lake (0.7%), McLelland (0.1%) and Muskeg (0.4%)soil types. McMurray soils occur along the river and streams of the escarpment slope. Muskeg soils occur in poorly drained depressions and are classified as Typic Mesisol or Terric Mesisol.

Disturbed, Herb-Grass

Although not of high cover (110 ha), this community type is present on escarpment slopes on recent clear cuts, now dominated by a highly diverse combination of low shrubs and forbs; and, on erosional slumps where some revegetation has taken hold. This is more common along the escarpment slopes of the Steepbank River (Plate 17).

Unvegetated

Similar to some of the Disturbed, Herb-Grass ecosites, unvegetated sites were found on very steep escarpment slopes, particularly along the Steepbank River. Cover within the Local Study Area was 5 ha (Table 6.4). These sites undergo high erosional rates, precluding vegetation development - except at a very slow and frequently interrupted rate (Plate 18).

6.2.3 Ecosites Associated with the Upland Organic/Lacustrine Plain

The Upland terrain class is the most common landform type within the Local Study Area, representing a broad, gently sloping plain extending from the Athabasca River, east to the Steepbank River, and beyond. This landform type supports 13 of the 16 vegetation associations identified within the area, with Peatland Open Black Spruce Bog being the most prevalent, but other forest types also being present in relatively high cover.

The soil types dominating the Upland Organic/Lacustrine Plain Ecosection include Muskeg (MUS), McLelland (MLD), Kinosis (KNS), and Horse River (HRR). Less prevalent soil types within the Upland Organic/Lacustrine Plain Ecosection include Firebag (FIR) and Ruth Lake (RUT) soils.

Closed Jack Pine

Within the Upland area, sandy knolls are present, particularly along the larger fluvial channels. These well drained knolls support small patches of jack pine forest, resulting in an Upland cover of 1180 ha (Table 6.6). Understorey vegetation is similar to that found in jack pine stands on the Escarpment Slopes, being dominated by green alder in depressional patches, blueberry and

TABLE 6.6 Vegetation Coverage (ha) within the Local Study Area: Uplands

ELC Terrain Class	ELC Vegetation Class	Coverage Area (ha) 1995
Uplands		16792
	Closed Jack Pine	1180
	Closed White Spruce	1363
	Closed Deciduous Forest	1206
	Closed Mixedwood	1721
	Closed Mixed Coniferous, Black Spruce Dominant	723
	Peatland:Closed Black Spruce Bog	1490
	Peatland: Black Spruce-Tamarack Fen	1394
	Closed Mixedwood, White Spruce Dominant	26
	Peatland: Open Black Spruce Bog	5886
	Peatland: Open Tamarack Fen	1309
	Wetlands Shrub Complex	399
	Disturbed, Herb-Grass	91
	Industrial/Sparsely-Vegetated (Primarily Lease 86/17)	3
	Wetlands Open Water/Emergent Vegetation Zone	
	Subtotal Area	**16791**
	Subtotal Cumulative Rounding & Interpolation Error	**1**

sparse ubiquitous cover of prickly rose. Reindeer lichen is also present in variable cover, as is bearberry, ranging from 10 to 60%. Surface topography of these stands is typically convex, lending to the well drained conditions. As in the Escarpment Slope jack pine stands, these sites relate well to Beckingham's (1995) a1 ecosite phase - jack pine/lichen. Although aspen is often present around the periphery of these stands, it is not typically common, with a cover of less than 5%. This is likely due to the xeric moisture conditions and a submesotrophic nutrient regime. Hence, these stands are typically not representative of Beckingham's more mesic jack pine-aspen stands, classified as submesic/mesotrophic.

The soil types under the cosed jack pine stands (Table 6.7) within the Upland Organic/Lacustrine Plain include Firebag, Kinosis (1.4%), McLelland (0.5%), Muskeg (3.1%) and Horse River (1.2%) soils. The Firebag soils occur on sandy knolls adjacent to fluvial channels and are classified by either Eluviated Eutric Brunisols or Orthic Eutric Brunisols. The Horse River soils occur on the better drained, mid to upper slope positions of the very gently undulating topography. These soils are classified as Orthic Gray Luvisols and Solonetzic Gray Luvisols.

Closed White Spruce

Closed white spruce forests within the Upland are present over 1363 ha - less than 10% of this area (Table 6.6). Closed white spruce in this area often also supports a mix of black spruce and, under less mesic conditions, jack pine. Canopy cover is typically very high, with a corresponding high cover of feather mosses including Schreber's moss and knight's plume. Labrador tea is often present in the understorey as is Canada buffaloberry - both in low to moderate cover, distinguishing these stands from those typically found on the Escarpment Slopes. These stands are typically located along the edges of drainages and at the escarpment edges, where moisture conditions are high, but soils are moderately drained.

Soil types under the closed white spruce forest include Kinosis (0.5%)and Rough Broken (RB3 - 0.7%) soils. Kinosis soils occur on the escarpment edges and are classified as Orthic Gray Luvisols. Rough Broken (RB3) soils occur along the edges of drainages and are classified as either Orthic Regosols or Orthic Gray Luvisols. Both soil types are well to moderately well drained.

TABLE 6.7 SOIL AND VEGETATION COVERAGE (%) WITHIN THE SUNCOR LOCAL STUDY AREA: UPLANDS

VEGETATION TYPE	SOIL TYPE							
	FIR %	HRR %	KNS %	MLD %	MUS %	RUT %	RB3 %	VEGETATION TOTAL %
Closed Jack Pine	0.0%	1.2%	1.4%	0.5%	3.1%	0.0%	0.4%	6.7%
Closed White Spruce	0.0%	0.2%	0.5%	0.4%	6.0%	0.0%	0.7%	7.8%
Closed Deciduous Forest	0.2%	3.7%	1.9%	0.4%	0.2%	0.2%	0.8%	7.4%
Closed Mixedwood	0.1%	3.2%	3.4%	0.8%	1.9%	0.0%	0.8%	10.2%
Closed Mixed Coniferous Black Spruce Dominant	0.0%	0.3%	0.0%	0.3%	3.5%	0.0%	0.3%	4.5%
Peatland: Closed Black Spruce Bog	0.1%	1.4%	0.7%	1.1%	4.5%	0.1%	0.5%	8.3%
Peatland: Black Spruce-Tamarack Fen	0.0%	0.0%	0.1%	1.9%	5.9%	0.0%	0.0%	8.0%
Closed Mixedwood White Spruce Dominant	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Peatland: Open Black Spruce Bog	0.0%	0.5%	1.0%	15.5%	19.8%	0.0%	0.1%	37.0%
Peatland: Open Tamarack Fen	0.0%	0.0%	0.1%	1.3%	6.1%	0.0%	0.0%	7.6%
Wetland Shrub Complex	0.0%	0.1%	0.1%	1.4%	0.4%	0.0%	0.0%	2.0%
Wetland Open Water/Emergnt Veg.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Disturbed/Herb, Grass Dominant	0.0%	0.2%	0.0%	0.0%	0.1%	0.1%	0.0%	0.5%
Industrial, Sparse Veg.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Soil Totals	**0.5%**	**10.8%**	**9.2%**	**23.6%**	**51.6%**	**0.5%**	**3.7%**	**100.0%**

MMY, RB1, RB2, DL, GLMMY, ALG, GLKNS, WATER and RIVER soils are not represented in these terrain types

Closed Deciduous, Aspen Dominant

Aspen forests in the Upland are of nearly the same coverage as closed white spruce, occupying over 1200 ha of land (Table 6.6). These sites are generally located on raised morainal deposits where the soils are not saturated year round, as in the surrounding bogs and fens. The terrain is level and convex in shape. Aspen cover is high, at 60 to 80%, with a low white spruce component and very low balsam poplar. The shrub layer is dominated by a high cover of prickly rose with some willow - reflecting mesic to subhydric moisture conditions. Other common shrubs include Canada buffaloberry, snowberry, low bush cranberry and shrubby cinquefoil. The herb layer is dominated by dewberry and bunchberry, with a few patches of feather moss and sparse cover of other herbs. Some stands have a higher cover of hairy wild rye.

This forest community is represented by Beckingham's (1995) d1.6 stand of aspen/rose, with communities described as submesic to subhygric moisture regime and mesotrophic to permestrophic nutrient status.

Stands with a higher moisture regime have a higher cover of black spruce, Canada buffaloberry and beaked willow, with additional common species including dwarf scouring rush, common horsetail and wild strawberry. In addition, one-flowered wintergreen was recorded at one site. The herb layer was very diverse. These stands are more representative of Beckingham's (1995) d1.7 community - aspen/beaked willow.

Both Upland aspen communities represent mature aspen stands, which eventually may be successional to a black spruce/feather moss community. The predominance of black spruce at these sites reflects an adequate moisture regime as well as a proximal seed source.

The dominant soil types within the closed deciduous, aspen dominant forest (Table 6.7) on the Upland Organic/Lacustrine Plain include Horse River (3.7%) and Kinosis (1.9%) soils. The two soils have morainal parent material and the soil texture is sandy loam, silt loam to silty clay (HRR) and sandy loam to loamy sand (KNS). The subgroups include Orthic Gray Luvisol (HRR and KNS) and Solonetzic Gray Luvisol (HRR).

Closed Mixedwood

Closed mixedwood stands in the Upland cover approximately 1721 ha of land - just over 10% of the Upland area (Table 6.6). These stands are an older seral stage than the aspen forest stands in the Upland, with a higher degree of black spruce in the lower tree strata, as well as in the shrub layers. Black spruce in each layer is often as high as 60%. Balsam poplar is often present in low to moderate cover and occasionally tamarack is present. Understorey shrubs include green alder, with few to many patches of Canada buffaloberry and low to moderate cover of willow and prickly rose. Labrador tea is often present in very moist stands. The herb layer is dominated by bunchberry and bog cranberry, with a very high feather moss component.

These sites correspond best with Beckingham's (1995) d2.3 community of aspen-white spruce/alder, which has a mean moisture/nutrient status of submesic to subhygric and permesotrophic to submesotrophic with drainage being well to imperfect. However, in the Upland areas, white spruce is typically replaced by black spruce in these communities, with a high cover of Labrador tea in the understorey.

Where white spruce and aspen comprise the mixedwood stand, balsam fir is typically present in moderate to high cover. These stands are mid seral, with white spruce well established in the understorey and approaching the main balsam poplar canopy height. Due to the high canopy cover, shrubs are of low cover, although the herb layer is diverse, dominated by wild sarsaparilla, bunchberry and feather mosses.

Closed Mixedwood - White Spruce Dominant

Mid to late successional stands in drier upland sites support predominantly white spruce dominated stands which have overtopped mature, often decadent aspen This vegetation type accounts for only 26 ha in the Upland terrain class, likely due to the predominance of black spruce in this area (Table 6.6). These sites have a high spruce cover and a low to moderate aspen cover, with the sparse shrub layer being dominated by prickly rose. The herb layer is also sparse, with feather moss dominating the ground cover. Deadfall is high in these stands due to decadent aspen, and snags are common.

This stand best corresponds with Beckingham's (1995) d2.9 community of white spruce-aspen/feather moss, succeeding to d3.5 - white spruce/feather moss. Moisture and nutrient conditions are described by Beckingham (1995) as submesic to subhygric/submesotrophic to permesotrophic. Terrain at these sites is raised somewhat above surrounding bogs, and is generally level.

Closed Mixed Coniferous, Black Spruce Dominant

Black spruce stands on raised terrain, with better drained conditions, often support a low to moderate jack pine component in the upper tree strata. These stands are dominated by Labrador tea in the understorey, and have a high feathermoss (Schreber's moss) cover, with moderate reindeer lichen cover. This community type occupies 723 ha of the Upland - under 5% (Table 6.6).

Peatland: Closed Black Spruce Bog

The Upland black spruce bog communities are dominated by black spruce, thriving in an area with an annual high standing water and hydric moisture conditions, promoting peat development. The overstorey consists of black spruce, regenerating well in the understorey, resulting in stands of high structural diversity, but relatively low species diversity. Labrador tea is very common (>30 %) in the shrub layer at all sites, and tamarack is often scattered throughout the area (Plates 19, 20). Other species common to the black spruce bogs include common horsetail, bog cranberry, small bog cranberry, cloudberry, arrow-leaved coltsfoot, alpine bearberry, round-leaved sundew, crowberry and sedges (*Carex disperma*, *C. vaginata*, *C. lasiocarpa*). Willows and bog birch are also occasionally present. Where moisture conditions have allowed peat accumulation, the ground cover is dominated by sphagnum moss species, particularly Midway peatmoss (*Sphagnum magelanicum*) and common brown sphagnum (*S. fuscum*).

Where lower moisture conditions have precluded high peatmoss growth, feather mosses predominate, common species including Schreber's moss, stair-step moss and knight's plume.

Other species more common at less hydric black spruce communities include twinflower, palmate-leaved coltsfoot, bunchberry, dewberry, bishop's cap, bastard toadflax, common horsetail and bog cranberry. These stands sometimes support a low cover of jack pine in the upper tree strata, which is often accompanied with a moderate to high cover of reindeer lichen (most commonly *Cladina mitis*). The drier black spruce stands also support species more typical of jack pine stands including shrubby cinquefoil, Lindley's aster, wood lily, yarrow, blueberry (*Vaccinium myrtiloides*) and common pink wintergreen. In addition, the mature black spruce at these sites is often of higher vigour, as indicated by growth rate and stature, likely in response to higher nutrient status, higher pH and better soil aeration. The presence of arboreal lichens in black spruce bogs is variable, from virtually none to a high cover.

Site conditions at black spruce bogs are fairly consistent, with terrain being level to concave, and with a very high soil moisture level due to seepage. Beckingham (1995) classified this type of community as a treed bog.

Soils of the Upland black spruce bog community (Table 6.7) include the McLelland (1.1%) and Muskeg (4.5%) soil types. Both soils cover an extensive area of the Upland black spruce bog and are classified as Typic Mesisol and Terric Mesisol. The drainage is very poorly to poorly drained.

Peatland: Closed Black Spruce-Open Tamarack Fen

Within the Upland terrain class, this ecosite comprises 1394 ha of area (Table 6.6). This community type is called a poor fen and is transitional between a bog and a fen, supporting both black spruce and tamarack in various covers. Some flow-through of water occurs periodically, bringing in a higher nutrient status with fluvial water, and increasing the pH. The understorey vegetation reflects an environment that is conducive to both fen and bog species, including high cover of Labrador tea, moderate cover of bog birch, and a combination of both sphagnum and golden mosses. In addition, sedges are also present. Less common species included sweet gale, arrow-leaved coltsfoot, cloudberry and arctic bearberry.

The dominant soil types within the Upland Ecosection of Peatland Closed Black Spruce/Open Tamarack Fen ecosite (Table 6.7) include Muskeg (5.9%) and McLelland (1.9%). Extensive areas of Muskeg soils occur within the Upland ecosection. In addition, Muskeg soils are dissected by McLelland soils which serve as drainage courses. The soil types are classified as Typic Mesisol or Terric Mesisol.

Peatland: Open Black Spruce/Bog

Open black spruce bog is the most predominant vegetation type in the Upland terrain class, with 5886 ha, almost one third of the Upland area (Table 6.6). This vegetation type is similar to the closed black spruce bog ecosite, although black spruce is considerably more open, and typically of lower stature, usually a maximum of 5 m. Beckingham (1995) classified this community as a shrub bog (i2.1), with low and open black spruce. The understorey consists of dense Labrador tea and complete sphagnum moss cover (Plate 21). Additional species common to this community include three-leaved Solomon's seal, common horsetail, bog cranberry, small bog cranberry, sphagnum moss species, and occasional round-leaved sundew and dwarf scouring rush. This community type represents a blanket bog type, which is present in large expanses, broken up by linear fens and drainages running east to west (Figure 6.1).

The dominant soil types within the open black spruce community type (Table 6.7) in the Upland Ecosection include Muskeg (19.8%) and McLelland (15.5%) soils. The soils are classified as Typic Mesisols and Terric Mesisols.

Peatland: Open Tamarack Fen

Tamarack Fens are dominated by a low tree to tall shrub strata of tamarack, often with scattered black spruce in low cover (Plate 22). This community accounts for 1309 ha of the Upland terrain class (Table 6.6). The dominant shrub species at these sites is bog birch, usually in greater than 50% cover. Willows are scattered and of low cover. Water sedge is common throughout, in about 10% cover. Other common species include arrow-leaved coltsfoot, three-leaved Solomon's seal, dewberry, few-flowered sedge, bog cranberry, small bog cranberry, bog orchid, alpine bearberry, three-flowered sedge, river horsetail and a high cover of golden moss. Open patches of standing water with sedge meadow vegetation occur throughout.

Tamarack fens situated on sites with better drainage (at least periodically) support a more diverse understorey. Common shrub species include willow, green alder, black spruce, Labrador tea and wild black currant. Abundant herbaceous species are often present including three-leaved Solomon's seal, common horsetail, sedges, two flowered sedge, dewberry, bishop's cap, small bog cranberry and arrow-leaved coltsfoot. Ground cover is dominated by golden fuzzy fen moss, sphagnum moss and reindeer lichen. Litter provides 5 to 10% ground cover and snags are present in low to moderate numbers. These sites often have areas of open water nearby, with a surrounding vegetation of sedge meadow.

Site conditions at tamarack fens are depressional, with a very minor slope, allowing for slow seepage throughout. This creates a very high nutrient regime and relatively neutral pH, thus promoting tamarack, bog birch and sedge dominance instead of bog vegetation. The moisture regime is hydric.

Soils of the tamarack fens within the Upland terrain class include Muskeg and McLelland soil types. The soils are classified as Typic Mesisols and Terric Mesisols.

Wetlands Closed Shrub Complex

A variety of closed shrub community types are present in the Upland terrain class, being associated with shrub dominated fens, or found as narrow communities along creeks and drainages. This community is present in 399 ha of the Upland terrain class (Table 6.6).

Soils of the closed shrub ecosite (Table 6.7) within the Upland terrain class include the McLelland (1.4%), Muskeg (0.4%), Kinosis (0.1%) and Horse River (0.1%) soil type. McLelland soils are dominated by moderately to well decomposed fen peat deposits that are associated with drainage courses. The drainage class is very poorly to poorly drained and moisture regimes are subhydric to hydric. The soils are classified as Typic Mesisol and Terric Mesisol (Can-Ag. 1996).

Bog Birch/Sedge Fen

Some fen communities are more open, with tamarack trees along the periphery. In addition to a high bog birch cover, these sites also support beaked willow, sparse cover of sweet gale, water sedge and golden moss.

This community is typically small in area, but often frequent within treed fen vegetation (Plate 23). Surface shape is depressional, allowing seepage waters to pool. Beckingham (1995) classified this community type as a shrub fen, dominated by dwarf birch (k2.2). This is the most common Wetlands Closed Shrub community in the Upland terrain class.

Willow-Alder along Drainages (m1.2)

A myriad of small drainages are located in the Upland terrain of the Steepbank Mine project area. These vary from tiny streams, to larger streams with associated wetlands fringes and beaver dam affected communities. Beaver pond edges are variable in cover but consistently support patches of willow and bog birch on the upper edges. Herbaceous species are of high cover and variability along the pond margin, with bluejoint, cattail, wild mint, patches of rush species (e.g., *Scirpus cyperinus*), common horsetail and water sedge being common (Plate 24). Other species include Baltic rush, *Eleocharis palustris*, *Eriophorum polystachion* and patches of aquatics including duckweed and milfoil. These areas typically support numerous community types in small cover, in response to variations in site and drainage conditions.

Beckingham (1995) classified communities of this type as Shrub fens dominated by willows (k2.2, k2.3), graminoid fens (k3.1, k3.2), and marshes (m1).

The creek bed of such sites is often of a cobble and sand substrate, somewhat incised, with edges dominated by river alder, willows, bluejoint and water sedge. The surrounding forest along these streams and ponds varies with topography, ranging from black spruce bog to mixedwood.

6.2.4 Ecosites Associated with the Highland Plain

The Highland terrain class is located in the southeast corner of the Local Study Area, and is an area of low hills of morainal till, providing better drainage conditions than in the surrounding peatlands. This area supports a high cover of mixedwood forest on till deposits, broken-up by large treed fens in the depressions and drainages (Figure 6.1). Major community types in this terrain class are discussed below.

Soil types associated with the Highland Plain include Kinosis (KNS), McLelland (MLD) and Muskeg (MUS). The Kinosis map unit is comprised of two main series, KNS and glKNS. Kinosis occurs on better drained, mid to upper slope positions, whereas glKNS occurs in the lower lying imperfectly drained positions. The parent material is dominantly morainal, however, there are inclusions of lacustrine and fluvial veneers over morainal deposits. The soils are classified as Orthic Gray Luvisol (KNS) and Gleyed Gray Luvisol (glKNS) (Can-Ag 1996).

The McLelland soil type is dominated by moderately to well decomposed fen peat deposits. The soils are classified as Typic Mesisol and Terric Mesisol. The soils of both subgroups have the general properties specified for the Organic order and Mesisol great group. The soils are very poorly to poorly drained.

The Muskeg soil type are developed on bog peat deposits, from 50 - 150 cm thick. The soils belong to the subgroups Typic Mesisol and Terric Mesisol. The Muskeg soil group has the general properties specified for the Organic order and Mesisol great group. The land use is non-productive stunted black spruce.

<u>Closed Jack Pine</u>

Jack pine forests cover 287 ha within this terrain class, occurring in small stands on well drained ridges and knolls (Table 6.8). As in the Escarpment Slope class, this forest type is typically submesic and submesotrophic, supporting a semi-open canopy with an open understorey. The range of vegetation cover is discussed in more detail under the Escarpment Slope terrain class.

TABLE 6.8 Vegetation Coverage (ha) within the Local Study Area: Highlands

ELC Terrain Class	ELC Vegetation Class	Coverage Area (ha) 1995
Highlands		2030
	Closed Jack Pine	287
	Closed White Spruce	334
	Closed Deciduous Forest	51
	Closed Mixedwood	657
	Closed Mixed Coniferous, Black Spruce Dominant	48
	Peatland:Closed Black Spruce Bog	
	Peatland: Open Tamarack Fen	
	Closed Mixedwood, White Spruce Dominant	
	Peatland: Open Black Spruce Bog	
	Peatland: Black Spruce-Tamarack Fen	612
	Wetlands Shrub Complex	43
	Disturbed, Herb-Grass	
	Industrial/Sparsely-Vegetated (Primarily Lease 86/17)	
	Wetlands Open Water - Emergent Vegetation Zone	
	Subtotal Area	**2030**
	Subtotal Cumulative Rounding & Interpolation Error	**0**

The dominant soil within the Closed Jack Pine Forest (Table 6.9) on the Highland Plain is the Kinosis (5.6%) soil type. The soils are well to moderately well drained. The texture of the soils ranges from sandy loam to loamy sand.

Closed White Spruce

Closed white spruce communities within the Highland terrain class cover approximately 334 ha of land (Table 6.8). This community type varies in composition and structure with seral stage and with moisture conditions associated with drainage, aspect, slope class and slope position. Several community types observed are discussed below.

The predominante soils within the closed white spruce (Table 6.9) include Kinosis (5.7%), McLelland (0.8%) and Muskeg (9.7%). The Muskeg soil is the dominant soil type within the closed white spruce on the Highland Ecosection.

White Spruce/Balsam Fir/Labrador Tea/Feathermoss

The closed white spruce community within this terrain class is a mature and vigorous climax white spruce forest, with a high percent cover in the upper canopy of white spruce, growing to 50 m in height (Plate 25). Balsam fir and regenerating white spruce are also present in the understorey, with 10 to 15 % cover. Understorey shrubs are dominated by a high cover of Labrador tea, reflecting high moisture conditions and acidic soil conditions. The ground bryophyte layer is diverse and of high cover, dominated by a complete feather moss cover of knight's plume and Schreber's moss, with herbaceous species including dewberry, bog cranberry, twin flower, dwarf scouring rush, bunchberry and numerous other species of low cover. This community corresponds to Beckingham's (1995) d3.4 community of white spruce/balsam fir/feather moss, although the high Labrador tea cover indicates a similarity to the more mesic h1.1 class of white spruce-black spruce/Labrador tea/feather moss. Beckingham (1995) describes the ecosite phase of these communities as being hygric to mesic/ permesotrophic to submesotrophic, with imperfect to well drained soils.

TABLE 6.9 SOIL AND VEGETATION COVERAGE (%) WITHIN THE SUNCOR LOCAL STUDY AREA: HIGHLANDS

VEGETATION TYPE	SOIL TYPE				
	KNS %	MLD %	MUS %	RB3 %	VEGETATION TOTAL %
Closed Jack Pine	5.6%	0.4%	7.1%	0.1%	13.2%
Closed White Spruce	5.7%	0.8%	9.7%	0.1%	16.2%
Closed Deciduous Forest	2.2%	0.0%	0.0%	0.1%	2.4%
Closed Mixedwood	22.3%	2.9%	7.0%	0.9%	33.0%
Closed Mixed Coniferous Black Spruce Dominant	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Closed Black Spruce Bog	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Black Spruce-Tamarack Fen	0.0%	0.0%	0.0%	0.0%	0.0%
Closed Mixedwood White Spruce Dominant	0.8%	0.9%	0.5%	0.0%	2.1%
Peatland: Open Black Spruce Bog	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Open Tamarack Fen	6.1%	2.4%	22.5%	0.1%	31.1%
Wetlands Shrub Complex	0.1%	1.4%	0.5%	0.0%	2.0%
Wetlands Open Water/Emergent Veg.	0.0%	0.0%	0.0%	0.0%	0.0%
Disturbed, Herb-Grass Dominant	0.0%	0.0%	0.0%	0.0%	0.0%
Industrial, Sparse Veg.	0.0%	0.0%	0.0%	0.0%	0.0%
Soils Totals	**42.8%**	**8.9%**	**47.2%**	**1.2%**	**100.0%**

FIR, HRR, MMY, RUT, RB1, RB2, DL, GLMMY, ALG, GLKNS, WATER and RIVER soils are not represented in these terrain types

White Spruce/Green Alder/Clubmoss/Feathermoss

White spruce communities situated on better drained materials with a higher nutrient status support a high white spruce cover with moderate cover of green alder in the understorey. Aspen is often present in less than 10% cover in this stand type. These stands also support a high ground cover of common clubmoss and knight's plume feathermoss. These stands are less diverse than the older climax white spruce forest, likely due to a more closed canopy. This community type is most similar to Beckingham's (1995) d3.2 community of white spruce/alder/feathermoss, described as mesic to subhygric, with a nutrient status of mesotrophic to submesotrophic, on well to imperfectly drained soils.

Closed Deciduous, Aspen Dominant

Aspen forest within the Highland terrain class are not extensive, covering 51 ha of land (Table 6.8). These stands are similar to those found on the Escarpment Slopes and are discussed in more detail under that heading.

The dominant soils within the closed deciduous (aspen dominant) ecosite on the Highland Plain is the Kinosis (2.2%) soil type (Table 6.9). The parent material is predominantly morainal and the soils are well to moderately well drained.

Closed Mixedwood

Closed mixedwood forest in the Highland terrain class covers 657 ha of land, and is the most extensive community type in this landform type (Table 6.8). This community is dominated by a moderate to high cover of white spruce in the upper canopy, with low to moderate cover of aspen in the upper and lower tree canopy, being overtopped by white spruce. This represents a mid seral stage, succeeding to white spruce. Other common species within this stand type include balsam fir (in older stands), green alder, prickly rose, low bush cranberry, patches of Canada buffaloberry and a low to moderate herbaceous cover dominated by bunchberry, twinflower, palmate-leaved coltsfoot, hairy wild rye and bluejoint. The ground cover layer supports a low to high cover of feathermoss (knight's plume and Schreber's moss) and extensive patches of common clubmoss. Feathermoss cover is inversely related to a high litter layer - where the deciduous component of the stand is high.

The predominant soils within the closed mixedwood (Table 6.9) on the Highland Plain include Kinosis (22.3%), McLelland (2.9%), Muskeg (7.0%) and Rough Broken (RB3 - 0.9%). The Kinosis soil type is the dominant soil, RB3 is the least common soil type.

Closed Mixed Coniferous, Black Spruce Dominant

Closed mixed coniferous forest within the Highland terrain class covers only 48 ha of land (Table 6.8). This stand type is dominated by black spruce, with a high cover of white spruce in both the upper and lower canopies, indicating eventual successional development to a closed white spruce forest. Understorey components in this community are dominated by Labrador tea, with a high feathermoss layer dominated by Schreber's moss. This community is transitional between low lying black spruce bogs in the Upland class, and white spruce communities in the Highland, and is found on lower slope positions. It is similar in structure, composition and soil characteristics to the closed mixed coniferous forest found in the Upland terrain class and is discussed in more detail under that heading.

Peatland: Black Spruce - Tamarack Fen

The Black Spruce - Tamarack Fen ecosite within the Highland terrain class is located within depressional areas. The slow moving drainage areas provide conditions for treed fen vegetation, where patches of black spruce- tamarack/bog birch/sedge/brown moss are located. This community type is the second most common within the Highland terrain class, covering 612 ha of land (Table 6.8). Functionally and structurally, it is very similar to this community type in the Upland terrain class, and is discussed in more detail under that heading.

Closed Shrub

The closed shrub community type is not common within the Highland terrain class, with a cover of 43 ha (Table 6.8). This community is represented in small copses, associated with drainage ways, where alder and willow provide an edge community. In addition, some areas of bog birch/willow associated with slow seepage and open tamarack fens are also represented in this community.

6.2.5 Midland Organic/Lacustrine Plain

Both the Midland and Midland Drainage terrain classes are located on the west side of the Athabasca river (Figure 6.1), associated with morainal till deposits which are dissected by glacial meltwater channels, classified here as Midland Drainages. Extensive bog areas are associated with depressional areas within this terrain class, and upland areas are dominated by aspen-dominated forests, with some representation by closed white spruce and jack pine communities (Table 6.10). In addition, the Wetlands Shrub Complex is of moderate cover within this terrain class, as is the Disturbed, Herb-Grass ecosite, the latter of which is a result of extensive cutblocks within this area. The more common communities within this terrain class are discussed below.

Soils of the Midland Organic/Lacustrine Plain are dominated by Muskeg (MUS), Horse River (HRR), Ruth Lake (RUT), and McLelland (MLD), with the Muskeg soil type being most common. The Muskeg soil covers approximately 42% of the ecosection within the local study area. Horse River, Ruth Lake and McLelland soil types make up the other soil types that are of less distribution (Table 6.11).

<u>Closed Jack Pine</u>

Closed jack pine communities within the Midland Ecosection cover 332 ha (Table 6.10). This community is similar to those found in the Escarpment Slopes, on ridges and escarpment crests, being dominated by a semi-open jack pine canopy of even age. The understorey shrub strata is of various cover combinations of green alder, blueberry, prickly rose and typically a high reindeer lichen ground cover, with patches of bearberry on very dry sites.

This community is very similar to the Closed Jack Pine ecosite on the Escarpment slopes and Upland terrain types and is described in more detail in those sections.

TABLE 6.10 Vegetation Coverage (ha) within the Local Study Area: Midlands

ELC Terrain Class	ELC Vegetation Class	Coverage Area (ha) 1995
Midlands		5665
	Closed Jack Pine	332
	Closed White Spruce	364
	Closed Deciduous Forest	946
	Closed Mixedwood	141
	Closed Mixed Coniferous, Black Spruce Dominant	395
	Peatland:Closed Black Spruce Bog	905
	Peatland: Open Tamarack Fen	1197
	Closed Mixedwood, White Spruce Dominant	10
	Peatland: Open Black Spruce Bog	131
	Peatland: Black Spruce-Tamarack Fen	94
	Wetlands Shrub Complex	578
	Disturbed, Herb-Grass	479
	Industrial/Sparsely-Vegetated (Primarily Lease 86/17)	93
	Wetlands Open Water - Emergent Vegetation Zone	
	Subtotal Area	**5665**
	Subtotal Cumulative Rounding & Interpolation Error	**0**

TABLE 6.11 SOIL AND VEGETATION COVERAGE (%) WITHIN THE SUNCOR LOCAL STUDY AREA: MIDLANDS

VEGETATION TYPE	SOIL TYPE							
	HRR %	KNS %	MLD %	MUS %	RUT %	RB3 %	DL %	VEGETATION TOTAL%
Closed Jack Pine	1.5%	0.0%	1.3%	1.8%	0.4%	0.0%	0.0%	5.0%
Closed White Spruce	0.1%	0.1%	0.8%	5.3%	0.0%	0.3%	0.0%	6.7%
Closed Deciduous Forest	6.0%	0.0%	2.3%	1.4%	7.2%	1.4%	0.0%	18.3%
Closed Mixedwood	1.2%	0.0%	0.1%	0.3%	0.2%	0.0%	0.0%	1.7%
Closed Mixed Coniferous Black Spruce Dominant	1.6%	0.2%	0.9%	4.4%	0.4%	0.2%	0.0%	7.6%
Peatland: Closed Black Spruce Bog	2.4%	0.0%	1.7%	7.1%	1.1%	0.0%	0.2%	12.5%
Peatland: Black Spruce-Tamarack Fen	0.2%	0.3%	4.2%	17.7%	0.6%	0.0%	0.0%	23.1%
Closed Mixedwood White Spruce Dominant	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Peatland: Open Black Spruce Bog	0.1%	0.0%	1.5%	0.6%	0.1%	0.0%	0.0%	2.2%
Peatland: Open Tamarack Fen	0.0%	0.0%	0.7%	0.3%	0.1%	0.0%	0.0%	1.2%
Wetlands Shrub Complex	2.0%	0.0%	5.4%	1.4%	1.4%	0.1%	0.4%	10.7%
Wetlands Open Water/Emergent Veg.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Disturbed, Herb-Grass Dominant	1.3%	0.1%	0.9%	1.7%	2.7%	0.0%	2.2%	8.9%
Industrial, Sparse Veg.	0.7%	0.0%	0.0%	0.1%	0.0%	0.0%	1.0%	1.9%
Soils Totals	**17.0%**	**0.8%**	**19.8%**	**42.1%**	**14.3%**	**2.2%**	**3.9%**	**100.0%**

FIR, MMY, RB1, RB2, GLMMY, ALG, GLKNS, WATER and RIVER soils are not represented in these terrain types

Closed White Spruce

Closed White Spruce forests are present within the Midland terrain class, with a cover of 364 ha. (Table 6.10). This community type has been extensively logged within this area, resulting in an increase in the Disturbed, Herb-Grass ecosite and in the Deciduous Forest ecosite.

Remaining stands of closed white spruce are patchy in cover. Understorey components reflect a high edge factor - with invading species from the logged areas evident in the more open periphery, including bluejoint, fireweed, northern bedstraw, and shrub species such as snowberry and prickly rose.

The white spruce stands unaffected by logging or edge effect are similar to those found in the Escarpment Slope and Upland terrain classes, and are discussed in more detail under those headings.

Closed Deciduous-Aspen Dominated

Closed deciduous forest in the Midland ecosection are primarily dominated by aspen poplar, with a high shrub component due to relatively moist conditions. Dominant understorey shrubs include green alder, Saskatoon, prickly rose, Canada buffaloberry, and low bush cranberry, with a highly diverse herb layer typical of aspen stands in this region including fireweed, dewberry, bunchberry, palmate-leaved coltsfoot, northern bedstraw, twinflower and hairy wild rye. These sites are typically level to gently sloping, moderately well drained and mesotrophic, with a high litter layer and a poorly to well developed brunisolic soil.

Where selective logging has occurred within what was mixedwood forest and white spruce forests, the remaining community is that of an aspen dominated deciduous forest, often with some white spruce remaining in the canopy. Understorey species in these logged stands are most representative of aspen forests, with dominant species including red-osier dogwood, low bush cranberry, Saskatoon, prickly rose, green alder, common gooseberry, Canada buffaloberry and wild red raspberry - this strata is typically diverse in response to disturbance and to favourable moisture conditions. The herb layer is dominated by bluejoint with few herbs, including northern bedstraw, bunchberry and fireweed.

These stands have been set-back through logging disturbance, to an early to mid seral stage dominated by aspen and successional to white spruce.

Soil types within the closed deciduous (aspen dominated) forest (Table 6.11) on the Midland Organic/Lacustrine Plain are predominately Ruth Lake (7.25), Horse River (6.0%), McLelland (2.3%), Rough Broken (RB3 - 1.4%) and Muskeg (1.4%). The dominante soil types include Ruth Lake and Horse River.

Closed Mixedwood

Some of the closed mixedwood stands in the Midland terrain unit are a combination of aspen and black spruce, often with some white spruce cover in the tree layers. This community is of minor cover in this terrain type, covering 141 ha (Table 6.10). Typically, aspen is dominant in the upper tree canopy with black spruce in the shrub layers - indicating eventual succession to a black spruce forest. As such, this community is early seral to mid-seral. Understorey components are dominated by Labrador tea and black spruce in the shrub layer, with lesser cover of Canada buffaloberry, beaked willow and shrubby cinquefoil. The herb layer is moderately diverse, dominated by wild strawberry, palmate-leaved coltsfoot, bearberry, northern bedstraw, low bush cranberry and bog cranberry. Reindeer lichen is also present in patchy, moderate cover.

Other mixedwood stands are dominated in the tree canopy by a mix of tall aspen (and sometimes balsam poplar) with high white spruce cover in the lower tree canopy. These sites are less moist than those of aspen-black spruce, supporting a shrub cover dominated by prickly rose. Dominant herbs include bunchberry, bog cranberry, hairy wild rye and a low to moderate cover of stair-step feathermoss.

This site is typically quite level to gently undulating, on well-drained morainal till, but with close proximity to the water table - thus providing sufficient available water for black spruce and Labrador tea.

These stands appear to be impacted by drainage interruptions from mining activities to the north and beaver damming/alteration of drainages throughout, causing water to back-up and pool, resulting in increased moisture conditions in aspen communities - leading to the establishment of black spruce and associated vegetation.

The predominant soil types within the closed mixedwood (Table 6.11) on the Midland Organic/Lacustrine Plain include Horse River (1.2%), Muskeg (0.3%), Ruth Lake (0.2%) and McLelland (0.1%).

Closed Mixed Coniferous-Black Spruce Dominated

This community type within the Midland Ecosection is distributed over 395 ha of land, occurring in areas that are transitional between Midland and Midland Drainages (Table 6.10). As a result, conditions are better drained than that found in the black spruce bogs, but wet enough to support a high cover of black spruce, with additional canopy components of jack pine, or white spruce, and often with a very low aspen cover in the lower tree canopy. The understorey is dominated by Labrador tea, with patches of Canada buffaloberry and prickly rose. Ground cover is a thick carpet of feathermosses including Schreber's moss, knight's plume and stair-step moss, with dominant herbs including bunchberry, twinflower, palmate-leaved coltsfoot and fireweed. Often, drier sites of this community type also support a patchy cover of reindeer lichen. This community is similar to those found in the Upland Ecosection, and are described in more detail in that section.

Peatland: Closed Black Spruce Bog

This community is the second most common within the Midland terrain class, with a cover of 905 ha (Table 6.10). Several large blanket bogs are present, dominated by a closed black spruce forest, with high regeneration in the understorey. These communities are typical of black spruce bogs, being of similar cover and composition as those found in the Upland terrain class, with dominant understorey species including Labrador tea, bog cranberry, and less common species including bog birch, willow, scattered tamarack, cloudberry, common horsetail and small bog cranberry.

The dominating soil type within the closed black spruce bog on the Midland Organic/Lacustrine Plain ecosection is the Muskeg (7.1%) soils (Table 6.11).

Peatland: Open Tamarack Fen

This community is the most prevalent in the Midland terrain class, with a cover of 1197 ha - approximately 1/5th of this area (Table 6.10). This community type is discussed in more detail under the Upland heading.

Peatland: Black Spruce-Tamarack Fen

Large bog areas are interrupted by slow moving drainages which support an open treed poor fen vegetation type, dominated by black spruce and tamarack. Shrub and herb species include labrador tea - bog birch, green alder, willow and a high ground cover of sphagnum moss. This community is present in the Midland terrain class in 94 ha of land (Table 6.10). These communities are often transitional between communities in the Midland Drainage terrain class, and to the Wetlands Closed Shrub Complex, in both landform types.

Wetlands: Closed Shrub Complex

Wetlands and waterbodies often support a closed shrub periphery, which is intermediate between the Midland and Midland Drainage Terrain Classes. Within the Midland terrain class, Wetlands Shrub communities constitute 578 ha (Table 6.10). On fluvial deposits which undergo frequent flooding, the dominant cover is beaked willow and green alder, with an understorey dominated by sedges (green sedge), bluejoint and horsetail (Plate 26). This community is transitional between the wetlands edge of emergent species and the upland forest type, and is typically narrow - 5 to 10 m.

Disturbed, Herb-Grass

Disturbed/Herb Grass communities within the midland drainage are largely a result of recent clearing and subsequent early seral regeneration. Clearing is a result of logging activities and cutlines. This community type accounted for 479 ha of the Midland Ecosection. Regeneration at these sites is dependant on the site and moisture conditions of the site. Regenerating sites are dominated by a highly diverse mix of herbs, forbs and low shrubs, with a high cover of opportunistic species. Dominant species include willows (under moist conditions), alfalfa, Kentucky bluegrass, alsike clover, dandelion, Timothy, alfalfa, fireweed, wild strawberry, bluejoint (moist sites), prickly rose and red-osier dogwood. Where spruce has been replanted, a high cover of shrub-sized spruce is evident. Moist areas often support a high deciduous regrowth of balsam poplar, green alder, prickly rose, willow, snowberry, dewberry and some Canada buffaloberry.

6.2.6 Midland Drainage

The Midland Drainage terrain type is largely low-lying drainages which were once glacial spillways, and have since been drainageways for surface flow. In recent times, drainage patterns into and out of these channels have been disturbed, resulting in the pooling of water and infilling and vegetation establishment in some areas. As a result, the Midland Drainage landforms support a variety of vegetation types, the most prevalent types are discussed below.

The dominant soil within the Midland Drainage Ecosection is the McLelland (MLD) soil type. The McLelland soil type is typically associated with drainage courses. The soils are composed largely of organic materials. The McLelland soil type occurs in poorly and very poorly drained areas and as a result, most of the soils are saturated with water for prolonged periods.

In addition to the McLelland soil type, the Midland Drainage Ecosection has other soil types that are not as extensive in distribution, such as Muskeg (MUS), Ruth Lake (RUT), Horse River (HRR), Disturbed Land (DL) and Kinosis (KNS). Disturbed lands are areas of anthropogenic materials or man-made and man-modified materials. For example, areas that have been disturbed by open pit mining and related construction and land clearing activities (Turchenek and Lindsay 1982).

Closed Jack Pine

Jack pine in depressional level areas of the Midland Drainage area account for 328 ha of land, much of this occurring on patchy hills, knolls and fluvial ridges (Table 6.12). Community composition and cover is similar to that of jack pine in the Midland terrain type. However, in this area conditions are often more mesic resulting in some mix of black spruce in the understorey and a high cover of Labrador tea, as well as blueberry, patches of green alder, prickly rose and reindeer lichen.

The dominant soil within the closed jack pine (Table 6.13) on the Midland Drainage is the McLelland (6.9%) soil type.

Closed White Spruce

White spruce forests also occur in the Midland Drainage land area, with a cover of 165 ha (Table 6.12). These are also located on raised land areas and edges of drainages, where moisture conditions are high and drainage is moderate. As with jack pine stands, the depressional and mesic to subhygric nature of these sites is also conducive to some black spruce, with a high component of Labrador tea and willow in the understorey. Groundcover is dominated by feathermosses.

The predominant soil types within the closed white spruce (Table 6.13) on the Midland Drainage include Muskeg (2.7%), Rough Broken (RB3 - 2.2%) and McLelland (0.8%).

Closed Deciduous

Closed deciduous stands are the second most common vegetation type in the Midland Drainage terrain class, occurring in 570 ha (Table 6.12). This vegetation type is located adjacent to open water areas and wetlands, with dominant vegetation consisting of balsam poplar, beaked willow,

TABLE 6.12 Vegetation Coverage (ha) within the Local Study Area: Midland Drainage

ELC Terrain Class	ELC Vegetation Class	Coverage Area (ha) 1995
Midland Drainage		2700
	Closed Jack Pine	328
	Closed White Spruce	165
	Closed Deciduous Forest	570
	Closed Mixedwood	28
	Closed Mixed Coniferous, Black Spruce Dominant	81
	Peatland:Closed Black Spruce Bog	57
	Peatland: Open Tamarack Fen	341
	Closed Mixedwood, White Spruce Dominant	47
	Peatland: Open Black Spruce Bog	
	Peatland: Black Spruce-Tamarack Fen	53
	Wetlands Shrub Complex	603
	Disturbed, Herb-Grass	387
	Industrial/Sparsely-Vegetated (Primarily Lease 86/17)	26
	Wetlands Open Water - Emergent Vegetation Zone	16
	Subtotal Area	**2700**
	Subtotal Cumulative Rounding & Interpolation Error	**0**

TABLE 6.13 SOIL AND VEGETATION COVERAGE (%) WITHIN THE SUNCOR LOCAL STUDY AREA: MIDLAND DRAINAGE

VEGETATION TYPE	SOIL TYPE								
	HRR %	KNS %	MLD %	MUS %	RUT %	RB3 %	DL %	WATER %	VEGETATION TOTAL %
Closed Jack Pine	0.9%	0.5%	6.9%	2.4%	0.6%	0.3%	0.0%	0.1%	11.6%
Closed White Spruce	0.0%	0.1%	0.8%	2.7%	0.3%	2.2%	0.0%	0.0%	6.2%
Closed Deciduous Forest	2.9%	0.3%	10.4%	0.8%	4.8%	2.0%	0.0%	0.3%	21.6%
Closed Mixedwood	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Closed Mixed Coniferous Black Spruce Dominant	0.9%	0.2%	0.6%	0.6%	0.2%	0.1%	0.0%	0.0%	2.7%
Peatland: Closed Black Spruce Bog	0.1%	0.0%	1.0%	0.1%	0.1%	0.0%	0.1%	0.0%	1.5%
Peatland: Black Spruce-Tamarack Fen	0.1%	1.2%	4.2%	7.3%	0.7%	0.0%	0.1%	0.0%	13.6%
Closed Mixedwood White Spruce Dominant	0.0%	0.0%	0.4%	0.0%	0.0%	0.1%	0.0%	0.8%	1.2%
Peatland: Open Black Spruce Bog	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Peatland: Open Tamarack Fen	0.0%	0.1%	1.1%	0.2%	0.0%	0.0%	0.0%	0.0%	1.4%
Wetlands Shrub Complex	1.1%	0.1%	17.0%	0.7%	1.9%	0.2%	0.4%	0.8%	22.3%
Wetlands Open Water/Emergent Veg.	0.0%	0.0%	0.2%	0.0%	0.1%	0.0%	0.0%	0.8%	1.0%
Disturbed,Herb-Grass Dominant	0.3%	0.5%	8.9%	0.5%	1.5%	0.0%	3.9%	0.0%	15.6%
Industrial, Sparse Veg.	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.7%	0.1%	0.9%
Soils Totals	**6.5%**	**2.9%**	**51.8%**	**15.3%**	**10.4%**	**4.9%**	**5.4%**	**2.9%**	**100.0%**

FIR, MMY, RB1, RB2, GLMMY, ALG, GLKNS and RIVER soils are not represented in these terrain types green alder and river alder. Understorey vegetation reflects a high moisture regime, consisting of fowl bluegrass, bluejoint, sedges and horsetail.

The soil types predominating the closed deciduous (Table 6.13) on the Midland Drainage include McLelland (10.4%), Ruth Lake (4.8%), Horse River (2.9%), Rough Broken (RB3 - 2.0%) and Muskeg (0.8%).

Peatland: Open Tamarack Fen

This community type comprises 341 ha of land in the Midland Drainage terrain type, being located in depressional areas within the glacial meltwater channels where water pools and flow through is limited and very slow (Table 6.12). As a result, fen vegetation has developed, dominated by tamarack, bog birch, sedges and golden moss. These stands are open. Understorey vegetation is similar to that of other treed fens, as discussed under the Upland terrain class.

The dominant soil types within the tamarack fen (Table 6.13) include Muskeg (7.3%) and McLelland (4.2%).

Wetlands Closed Shrub Complex

This is the most abundant vegetation type in the Midland Drainage, comprising 603 ha of land (Table 6.12). This vegetation type is associated with wet shorelines, wet meadows and drainages. The edges of sedge fens support a moderate cover of dwarf birch, with a very high cover brown moss (*Hypnum limbergii*) and of hairy-fruited sedge, with less cover of beaked sedge, velvet-fruited willow, pale laurel and scattered tamarack. In addition, one community of this type supports a very high component of pitcher plant (Plate 27).

Soil types within the wetlands closed shrub complex (Table 6.13) on the Midland Drainage include McLelland (17.0%), Ruth Lake (1.9%), Horse River (1.1%), Muskeg (0.7%), Disturbed Land (0.4%), Rough Broken (0.2%) and Kinosis (0.1%). The dominant soil is the McLelland soil type.

<u>Wetlands Open Water/Emergent Vegetation</u>

Open water accounted for 16 ha of area in the Midland Drainage terrain class. These water bodies are associated with Crane Lake. Wetlands emergent vegetation associated with the periphery or shoreline of these waterbodies includes cattail stands, beaked sedge, tall manna grass, common duckweed, slough grass, water hemlock, wild mint, common horsetail, creeping spike rush, marsh cinquefoil, water arum, common great bulrush and spiked water milfoil.

6.3 Forestry Resources

Forestry resources within the footprint of the proposed 2020 mine were assessed, based on detailed field measurements and airphoto interpretation of 1:20 000 airphotos. Based on this analysis and field data collection, forestry resources were mapped to AVI standards and accompanies the EnviResource Forestry Report (1996).

7.0 BIODIVERSITY

The methods and rationale for assessing areas or resources which contribute significantly to the biodiversity of the Local Study Area were described in Section 4.0. This section describes the results of the methods used, identifying and describing those terrain features, communities and species which are considered most important to the biodiversity in this region.

Landform Level Biodiversity

Landform scale components that were considered most important to the biodiversity of the Local Study Area included those terrain types which are unique, support a high level of biodiversity in terms of community types, and/or provide an important ecological component to the area. Important landforms included the terrain and geology of the Athabasca River valley, including surficial materials. In addition, the role of the river valleys as corridors for wildlife and gene flow from one habitat to another is generally recognized as an important component of the biodiversity of an area.

Also at the landscape level, an assessment was done to identify areas that support a high level of habitat interpersion. The results of this analysis are visually displayed in Figure 7.1, which shows that the highest level of habitat interspersion occurs on the escarpment slopes of the Athabasca and Steepbank River, along ravine units, and around open water marshes on the Athabasca River floodplain. Table 7.1 indicates the amount of each terrain type which supports a high, medium or low amount of habitat interspersion. These values support Figure 7.1, showing that for all of the terrain types on the east side of the Athabasca River, the majority of the landform was composed of medium levels of habitat interspersion, with the Riparian Floodplain and Riparian Escarpment supporting the highest amount of 'high' habitat interspersion.

Issues of patch size are also a contributing factor to biodiversity at the landscape level. As areas of large patch size are fragmented, the amount of edge increases with a corresponding decrease in the amount of interior (BC Environment 1995). These changes result in an increase in the distance between patches of larger size, and may contribute to the isolation of some species

TABLE 7.1
STEEPBANK MINE POTENTIAL HABITAT BIODIVERSITY IMPACT ASSESSMENT

Ecosection Class		Local Study Area (1995 Baseline) ha	Local Study Area (1995 Baseline) % Total
Riparian Floodplain	Potential Biodiversity Class	1474	100.0
	Low	69	4.7
	Medium	1320	89.6
	High	85	5.8
	Total	**1474**	**100.0**
Riparian River Terraces	Potential Biodiversity Class	2219	100.0
	Low	57	2.6
	Medium	2080	93.7
	High	82	3.7
	Total	**2219**	**100.0**
Riparian Escarpment	Potential Biodiversity Class	4023	100.0
	Low	429	10.7
	Medium	3407	84.7
	High	187	4.6
	Total	**4023**	**100.0**
Uplands	Potential Biodiversity Class	16792	100.0
	Low	3286	19.6
	Medium	13307	79.2
	High	199	1.2
	Total	**16792**	**100.0**

*Note, hectareage reflects landscape patches resampled at 275 m^2 resolution.

which require a closer juxtaposition of areas of larger patch size. In addition, some species are eliminated or displaced due to habitat changes induced by fragmentation. Areas of larger patch size within the local study area were identified as being those sites with low habitat interspersion (Figure 7.1). The Upland ecosection supported a fairly high homogeneous cover of the Peatland Open Black Spruce ecosite, which likely accounts for the 19% of this area which is of low habitat interspersion (Table 7.1). In addition, the Riparian Escarpment supports about 10% of its area with a relatively homogeneous cover of Closed Deciduous Forest ecosite, which is aspen dominant. Impacts to these areas would contribute to fragmentation, resulting in a decline in one measure of biodiversity in this region.

Community Level Biodiversity

An assessment of biodiversity at the community level was based on an identification of those communities which are particularly unique and/or significant in the Local Study Area. This rationale supports the biodiversity measures recommended by Noss and Cooperider (1994), who list the following communities and/or resources as those which contribute to the biodiversity of an area:

- Pristine sites of significant size - relative to the surrounding state of development;
- Rare species;
- Areas of high species richness, based on high physical habitat heterogeneity of high energy flow (Currie and Paquin 1987; Currie 1991);
- Locations of rare or unusual communities;
- Resource hot spots such as artesian springs, unusual outcrops etc.;
- Watersheds of high value; and
- Sites of inherent sensitivity to development

Communities which were considered to be unique and/or significant within the Local Study Area included mature forests. These were identified during the field program of 1995 and were primarily open and near decadent stands of balsam poplar on the Athabasca River floodplain, and mature stands of white spruce on the floodplain and escarpment slopes of the Athabasca River. Other unique communities included the Riparian Wetlands Closed Shrub Complex ecosites, with a particular focus on Shipyard Lake, since it falls within the impact zone of the Steepbank Mine. In addition, the Peatland Tamarack Fens were also identified as relatively unique within the Local Study Area, due to the drainage conditions required for their sustainability and the potential for these communities to support rare and uncommon plant species. As well as being unique, these communities typically exhibited a high degree of species diversity and often a high degree of structural diversity.

Species Level Biodiversity

At the species level, an assessment of biodiversity focused on communities which have a higher rare plant potential. This approach considered that the potential loss or significant decline of species from an area due to an impact is greater where impacts to rare plants are possible. The vegetation survey and inventory program for the Steepbank Mine project identified several rare and uncommon plant species, which are listed in Table 7.2.

Table 7.2 Rare and Uncommon Plant Species Observed in the Steepbank Mine Study Area

Species	Status	Habitat Type	Location
Pitcher Plant	regionally uncommon	bogs and fens	sedge fen on west side of Athabasca River
round-leaved sundew	regionally uncommon	black spruce bogs	black spruce bogs in Upland
stemless Lady's Slipper	provincial rare	jack pine forests	east-facing escarpment slope of Steepbank River
cyperus-like sedge	provincial rare	open tamarack fen/beaver pond marsh in Upland	along drainage in Upland, near Athabasca River west-facing Escarpment Slope
small white water lily	provincial rare	ponds and quiet waters	floodplain marsh immediately north of Steepbank-Athabasca confluence
sweet gale	uncommon	bogs, fens and marsh edges	on edge of fen in Upland ecosection
buckthorn	uncommon	upland pure and mixed aspen-pine forest	2 locations in drier aspen stands: top of east-facing escarpment of Steepbank River; and, on west-facing escarpment of Athabasca River

Based on findings during the 1995 surveys and on past survey results (Section 3.4), those ecosites included Peatland Black Spruce Bog, Peatland Open Black Spruce Bog, Peatland Tamarack Fen, Peatland Black Spruce Tamarack Fen, Jack Pine Forest, Wetlands Open Water/Emergent Vegetation Zone and Wetlands Closed Shrub Complex. Impacts to these communities would be considered to reduce biodiversity due to the potential for rare plant loss.

Also at the species level, communities which were found to be relatively rich in species were also considered to be an important contributing factor to biodiversity. The vegetation surveys completed for the Steepbank Mine during the summer of 1996 assessed vascular plant composition and cover and dominant bryophyte cover for ecosites within the Local Study Area. The results of this inventory indicated that communities with a relatively high species diversity were also often highly structured, adding to their diverse nature. Those communities with the highest diversity supported 60 to 100 vascular plant species and included:

Vegetation Type	**Ecosection**
Closed Deciduous Forest	Riparian Floodplain, Riparian Terrace, Riparian Escarpment
Closed Mixedwood White Spruce Dominant	Riparian Floodplain, Riparian Terrace, Riparian Escarpment
Closed Mixedwood	Riparian Escarpment, Upland, Highland, Midland and Midland Drainage
Closed White Spruce	Riparian Escarpment, Upland, Highland, Midland and Midland Drainage

The most species rich ecosite was that of the Closed Deciduous Forest on the Riparian Escarpment, typically a mature balsam poplar forest, approaching decadence and supporting a very high diversity and structure in the tall shrub, low shrub and herbaceous layers. In addition, this community type typically had a high abundance of large snags and deadfall. The Closed Mixedwood Forest in the Upland Ecosection was also highly diverse, consisting of a high diversity of tree, shrub and herbaceous species, and with a corresponding high structural diversity.

8.0 VALUED ECOSYSTEM COMPONENTS

A selection of Valued Ecosystem Components (VECs) is typically provided in a baseline study to assist in stream-lining the assessment to focus on those resources considered to be most significant based on a number of criteria. Both the VECs selected and the criteria according to which they are scored often reflect the results of public feedback, indicating areas of importance based on ecological, economic and often intrinsic importance values such as aesthetics.

One of the key terrestrial issues raised by stakeholders and regulators is the potential impact of the Steepbank Mine on the Athabasca River Valley. This resulted in a focus on resources which are contained within, or comprise the river valley. Table 8.1 shows the results of ecosite and ecosection scoring using eight separate criteria. The results of this scoring process indicate that those components which could be considered as Valued Ecosystem Components within the river valley portion of the Local Study Area include mature forests, jack pine forests, and the riparian wetlands including the Wetlands Open Water/Emergent Vegetation Zone and Wetlands Closed Shrub Complex ecosites. In addition, at the landscape level, the entire river valley is considered to qualify as a VEC.

Athabasca and Steepbank River Valley

During stakeholder and regulatory input, the overall importance of the Athabasca and Steepbank River valleys was identified. These terrain features were considered important in their entirety. The criteria scoring reinforces these values, reflecting VEC status based on uniqueness, overall rare plant potential, susceptibility to pollutants and physical disturbance, recreational importance, biodiversity contribution, traditional use and economic importance.

Mature Forests

Mature forests were identified based on the results of AVI mapping which was conducted within the footprint of the Steepbank Mine (Figure 8.1). Definitions of mature forests currently include both the age of the dominant trees as well as structural features such as height, diameter, density and spacing patterns, snag density, cavity characteristics, nutrient cycling, energy flow patterns

TABLE 8.1 VEC Scoring of Ecosites within the Athabasca and Steepbank River Valleys

Selection Criteria	Rarity	Rare Plant Potential	Sens. to Physical Disturb.	Sensitivity to Pollution	Recr. Import.	Diversity	Tradi-tional Use	Econ. Import.	Total
ECOSECTIONS									
Riparian Floodplain and Floodplain Terraces	3	3	3	3	3	3	3	3	24
Riparian Escarpments	3	3	3	3	3	3	2	2	22
Upland	1	2	2	3	1	2	1	1	13
Highland	2	2	1	1	1	2	1	3	13
ECO SECTIONS/ ECOTYPES									
Riparian Floodplain and Floodplain Terraces									
Wetlands Closed Shrub: Complex	3	2	3	3	3	3	3	2	22
Open water/Emergent Vegetation	3	2	3	3	3	3	3	2	22
Deciduous Forest (Balsam Poplar dominant)	2	2	2	3	2	2	2	1	16
Closed White Spruce	2	2	2	2	3	2	2	2	17
Mature Forests (White Spruce and Balsam Poplar)	3	3	3	3	3	3	3	3	24
Closed Mixedwood (White Spruce dominant)	2	2	2	2	2	3	3	3	21
Closed Jackpine	3	3	3	3	3	1	3	3	22

[ ] = shaded areas indicate resource components selected as VECs.

TABLE 8.1(cont'd) VEC Scoring of Ecosites within the Athabasca and Steepbank River Valleys

Athabasca/Steepbank River Escarpments	Rarity	Rare Plant Potential	Sens. to Physical Disturb.	Sensitivity to Pollution	Recr. Import.	Diversity	Traditional Use	Econ. Import.	Total
Closed Deciduous - Aspen dominant	1	1	3	3	2	2	3	2	17
Closed Mixedwood White Spruce dominant	2	2	3	2	2	3	2	3	19
Closed Mixedwood	3	2	3	3	2	3	2	2	20
Mature White Spruce	3	2	3	3	3	3	3	3	24
Closed White Spruce	3	2	3	2	2	3	2	3	20
Closed Jack Pine	3	3	3	3	3	1	3	3	22
Closed Mixed Coniferous Black Spruce dominant	3	2	3	2	1	2	2	1	16
Peatland Closed Black Spruce-Tamarack Fen	2	2	3	2	1	2	1	2	15
Peatland Open Tamarack Fen	1	3	3	3	1	2	1	1	15
Peatland: Open Black Spruce Bog	3	2	3	3	1	1	2	2	16
Peatland: Closed Black Spruce Bog	2	2	3	2	1	1	2	2	15
Wetlands Closed Shrub Complex	3	1	2	2	1	2	2	1	14
Disturbed, Herb-Grass (cut blocks)	1	1	3	2	1	2	1	1	12

= shaded areas indicate resource components selected as VECs.

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and structural heterogeneity (Fairbarns 1991; Greene 1988). However, age is often used as the main indicator of old growth conditions. Fairbarns (1991) used the definition identified through much of North America, i.e., the oldest 10% of the vegetation community within a given natural successional sequence.

The definition of mature or old-growth forests, age and characteristics varies depending on the forest type and geographic location. Most work to date on "old growth" forests has been on coastal forests in western North America (Greene 1988) and little has been done to develop a definition for boreal forests (Westworth 1990). The age of the oldest stands is dependent on the frequency of large -scale disturbance. In the Boreal Mixedwood forests of northern Alberta, where large-scale fire disturbance generally recurs on an 86-112 year cycle (Fairbarns 1991), only a small proportion of the stands are likely to be older than this. Due to the difference between the age and successional sequencing of old growth forests in the Pacific Northwest and old-growth boreal forest stands of much younger age, the term 'mature forests' is used in this document.

Westworth (1990) used Phase III forest cover maps for northern Alberta to identify old growth stands and to record their size, characteristics and age. Twelve sites in the entire Eastern Boreal Forest Ecoregion were identified. Of these, seven stands were old growth white spruce associated with river valley terrain. Mature river valley forests identified within the local study area were considered mature based on the following characteristics:

- over 160 years in age for white spruce and balsam poplar (Alberta Forest Service, pers. comm. 1996);
- highly structured;
- regeneration of dominant overstorey trees within the understorey; and
- high presence of decadent trees, snags and deadfall.

These characteristics, in conjunction with their status and low regional cover contributed to the inclusion of mature forests as a VEC in this study. While other forest cover types are recognized as important, they were not included as VEC components based on higher regional cover, ability for faster recovery or regeneration, and lack of additional attributes such as high snag presence and high deadfall component.

Jack Pine

Jack pine forests were considered a VEC based on the criteria scoring process (Table 8.1). These stands, while limited within the river valley area, are common in small stands on escarpment slopes crests and knolls. Characteristics which were considered important included the common presence of blueberry and green alder - species important to traditional uses including both food gathering and maintenance. Jack pine stands also support a typically high cover of reindeer lichen, which in addition to providing caribou forage, are highly sensitive to airborn pollutants. The terrain and soils of jack pine stands is generally coarse and sandy and prone to erosion, such that these sites are easily impacted by physical disturbance and, due to soil erosion factors, may be difficult to reclaim. In addition, jack pine has value as merchantible timber.

Shipyard Lake Wetlands

With a focus on the river valley for VEC selection and analysis, the Shipyard Lake wetlands was identified as a VEC. Wetlands are recognized as an important component of any ecosystem with such relevant features as the transformation of water quality, provision of flood protection and establishment of a diverse habitat for a wide variety of wildlife. They are often ecotones, that is, transition zones between uplands and deepwater aquatic systems and thus have forms of plant and animal life from both of these environments, resulting in a high diversity.

The areas of the Wetlands Open Water Emergent Vegetation Zone in Shipyard Lake, based on 1995 airphoto analysis, was 23.3 ha. The surrounding area of Wetlands Closed Shrub Complex was 128 ha, with a total wetlands area of 151.3 ha. Changes in water retention time within the wetlands and subsequent changes in patterns of channelization and area of open water are expected.

The selection of Shipyard lake as a VEC was based primarily on the uniqueness of this vegetation association within the Local and Regional Study Areas, with a recognition that it provides important habitat to a variety of species. The scoring process (Table 8.1) reflects the other characteristics of this area including a high diversity of both species and habitat interspersion, susceptibility to both physical and pollution disturbances, important recreation potential, historical importance to traditional land use, and moderate rare plant potential.

9.0 REFERENCES

Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian System of Soil Classification. 2nd ed. Agric. Can. Publ. 1646. 164 pp.

Alberta Environmental Protection. 1990. A review of approaches for setting acidic deposition limits in Alberta. Edmonton, Alberta.

Alberta Environmental Protection. 1995. Draft Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan.

Beckingham, J.D. 1995. Field Guide to the Ecosystems of Northern Alberta. Prepared for Environmental Protection, Land and Forest Services, Edmonton.

Bouman, C., & M. Shapiro. 1992. i.smap Technical Documentation, GRASS4.2 Online Support Manual, U.S Army Corps of Engineers Construction Engineering Research Laboratories (USACERL), Champaign, IL, USA.

BOVAR-Concord Environmental. 1995. Environmental Impact Assessment for the Solv-Ex Oil Sands co-production experimental project. Prepared for Solv-Ex Corporation.

BOVAR Environmental. 1996. Impact analysis of air emissions associated with the Steepbank Mine. Prepared for Suncor Inc. Oil Sands Group and Golder Associates.

British Columbia Environment. 1995a. Biodiversity Guidebook. British Columbia Environment Forest Practices Code.

Campbell, J. 1987. Introduction To Remote Sensing. The Guilford Press, New York,: pp. 334-366 (accuracy assessment)

Can-Ag Enterprises Ltd. 1996. Soil Survey report for the Steepbank Mine.

Carrigy, M.A. and J.W. Kramers (eds.). 1973. Guide to the Athabasca oil sands area. Alberta Research Council Information Series 65.

Concord Environmental Corporation. 1992. Volume III Baseline/Impact Hypotheses Report for Continued Improvement and Development of the Syncrude Mildred Lake Operation. Prepared for Syncrude Canada Ltd.

Cottonwood Consultants Ltd. 1987. The rare vascular flora of Alberta: volume 2. A summary of the taxa occurring in the Canadian Shield, Boreal Forest, Aspen Parkland and Grassland Natural Regions. Prepared by C. Wallis. Edmonton, AB.

Currie, D.J. and V. Paquin. 1987. Large-scale biogeographical patterns of species richness in trees. Nature 329:326-327.

Delta Environmental Management Group Ltd. 1990. Wildlife evaluation, assessment and mapping for the OSLO wildlife study area. Prepared for OSLO Project, Calgary.

Egler, F. 1977. The Nature of Vegetation: Its management and mismanagement. Aton Forest, Norfolk, CT.

Enslin, W. 1992 r.rectify2 Technical Documentation, GRASS4.2 Online Support Manual, US Army Corps of Engineers Construction Engineering Research Laboratories (USACERL), Champaign, IL, USA.

EnviResource Consulting Ltd. 1996. Suncor Inc. Mine Expansion: baseline Forestry Report. Prepared for Golder Associates Ltd.

Environment Canada. 1995. Canadian biodiversity strategy. Biodiversity Convention Office, Environment Canada, Ottawa.

Fairbarns, M. 1991. Old Growth in the Boeal Mixedwood Forest Section. Prepared for: Alberta Forestry, Lands and Wildlife. Natural and Protected Areas Section, Edmonton.

Green, R. 1972. Bedrock Geology Map of Canada. research Council of Alberta. Map No. 35.

Greene, S. 1988. Research Natural Areas and protecting old-growth forests on federal lands in western Oregon and Washington. Natural Areas Journal 8: 25-30.

Hackbarth, D.A. and N. Nastasa 1979. The hydrogeology of the Athabasca Oil Sands area., Alberta. Alberta Research Council, Bulletin 38.

Hardy Associates (1978) Ltd. 1980. Final report on the status of rare species and habitats in the Alsands Project Area. Prepared for Alsands Project Group.

Harris, L.D. 1984. The fragmented forest. Island biogeography and the preservation of genetic diversity. University of Chicago Press. Chicago. 211 pp.

H.A. Simons Ltd. 1995 Steepbank Mine Development Feasibility Study, Ore Processing (Draft), produced for Suncor Inc. by H.A Simons Ltd.

Klein, L. 1962. An Introduction to Econometrics, Englewood, Cliffs, NY.

Knapik, L.T. and D.A. Westworth (eds.) 1982. Ecological resource evaluation of the Calumet Leases. Prepared for Canstar Oil Sands Ltd. by Pedology Consultants and D.A. Westworth Associates Ltd., Edmonton. 385 pp.

Leskiw, L.A., A.D. Laycock, and J.J. Pluty. 1996. Baseline Soil Survey for the Proposed Suncor Steepbank Mine, Suncor Inc. Prepared for Golder Associates Ltd., Calgary, Alberta. Prepared by CAN-AG Enterprises Ltd., Edmonton, Alberta. 72 pp.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons. Toronto. 547 pp.

Noss, R. 1995. Maintaining ecological integrity in representative reserve networks. A World Wildlife Fund Canada/World Wildlife Fund - United States, Discussion Paper. 77 pp.

Noss, R. and A.Y. Cooperrider, 1994. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press, U.S.A. 416 pp.

OSLO 1991. Draft environmental impact assessment issues scoping report. Lease 31 and Redwater Upgrader. OSLO Alberta Ltd. 696 pp.

Packer, J.G. and C.E. Bradley. 1984. A checklist of the rare vascular plants of Alberta with maps. Provincial Museum of Alberta. Natural History Occassional Paper No. 4. 112 pp.

Peterson, E.B. and A.G. Levinsohn 1978. Vegetation types and forest productivity, west part of Syncrude's Lease 17, Alberta. Syncrude Canada Ltd. Environmental Research Monograph 1977-6. 51 pp.

RADARSAT International Inc. 1995 Technical Support Documentation, RADARSAT International Inc. Richmond, BC, Canada.

Rowe, S. 1993. Eco-diversity, the key to biodiversity. Pp 2-9 In: Iacobelli, T.K. Kavanaugh and S. Rowe. A protected areas gap analysis methodology: planning for the conservation of biodiversity. World Wildlife Fund Canada, Toronto.

Smith, J.A., R. Rowell, R. Lauzon, T. Van Egmond and S.J. Michalsky 1992. Wildlife Habitat Evaluation Assessment and mapping for the Syncrude Staged Development Area. Prepared by Concord Environmental Corporation and The Delta Environmental Management Group for Syncrude Canada Ltd.

Stringer, P.W. 1976. A preliminary vegetation survey of the Alberta Oil Sands Environmental Research Program study area. Prepared for the Alberta Oil Sands Environmental Research Program by Intraverda Plant Systems Ltd. AOSERP Report 4 108 pp.

Strong, W.L. and K.R. Leggat. 1992. Ecoregions of Alberta. Prepared for Alberta Forestry, Lands and Wildlife.

Strong. W.L. 1992. Ecoregions and Ecodistricts of Alberta. Alberta Forestry, Lands and Wildlife, Edmonton, Publ. No. T1244.

Thompson, M.D., M.C. Wride and M.E. Kirby 1978. Ecological habitat mapping of the AOSERP study area. Phase I. AOSERP Report 31. 176 pp.

Turchenek, L.W. and J.D. Lindsay. 1982. Soils inventory of the Alberta Oil Sands Environmental Research Program study area. Prep. for the Alberta Oil Sands Environmental Research Program by Alberta Research Council. AOSERP Report 122. 240 pp.

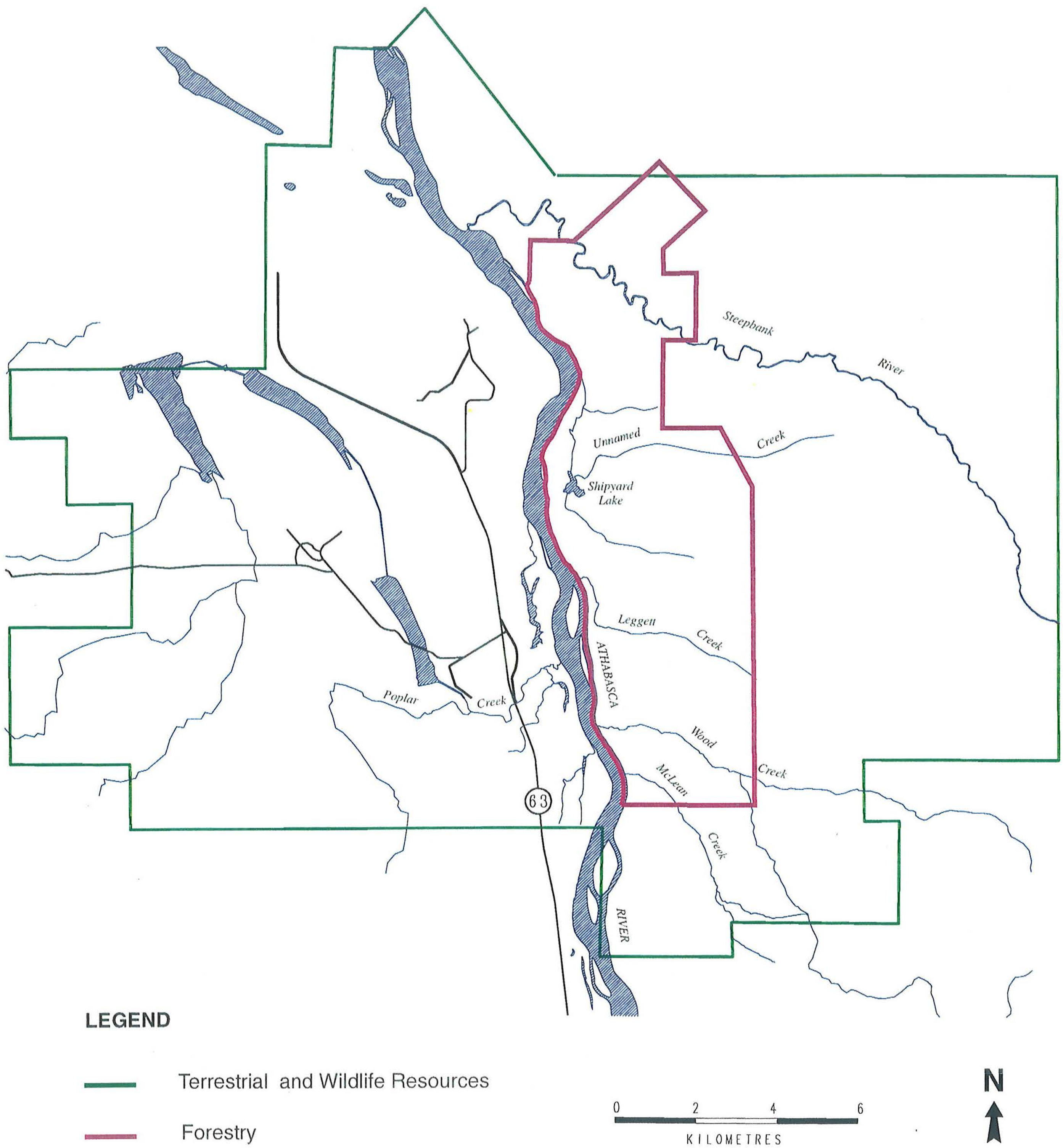
Tuttle, S. 1995. Lease 86/17 Vegetation Reclamation Maps, Suncor Inc. 1995

Westworth and Associates Ltd. 1990. Significant Natural Features of the Eastern Boreal Forest region of Alberta. Prepared for Alberta Forestry Lands and Wildlife, Edmonton, Alberta.

Wilson, E.O. 1989. Biodiversity. National Academy Press, Washington, D.C.

FIGURES

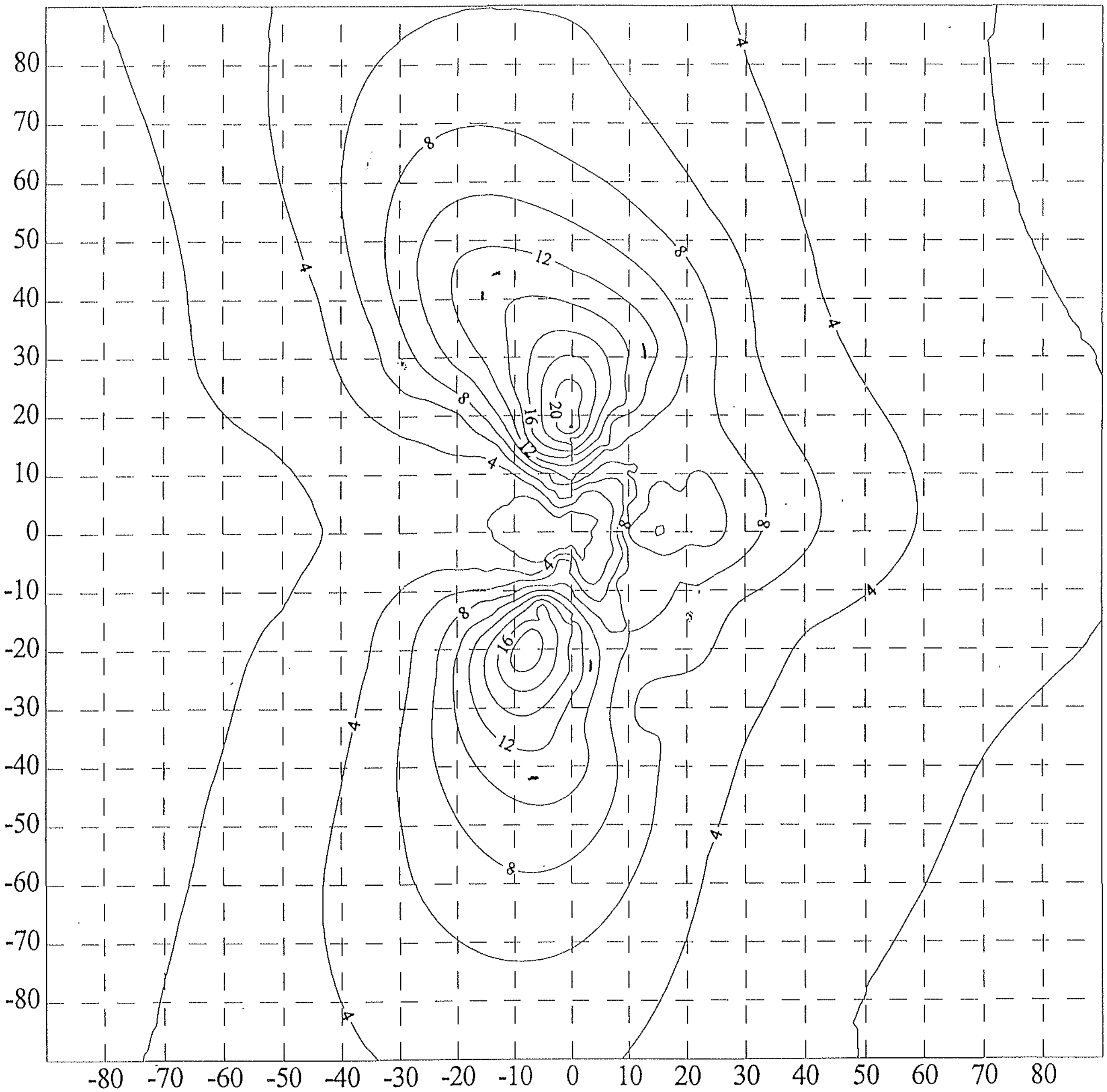
Local Study Area Boundaries for the Steepbank Mine	Figure 4.1



PROJECT 952-2307.5685 DRAWN RP REVIEWED DATE 17 May 1996

Golder Associates

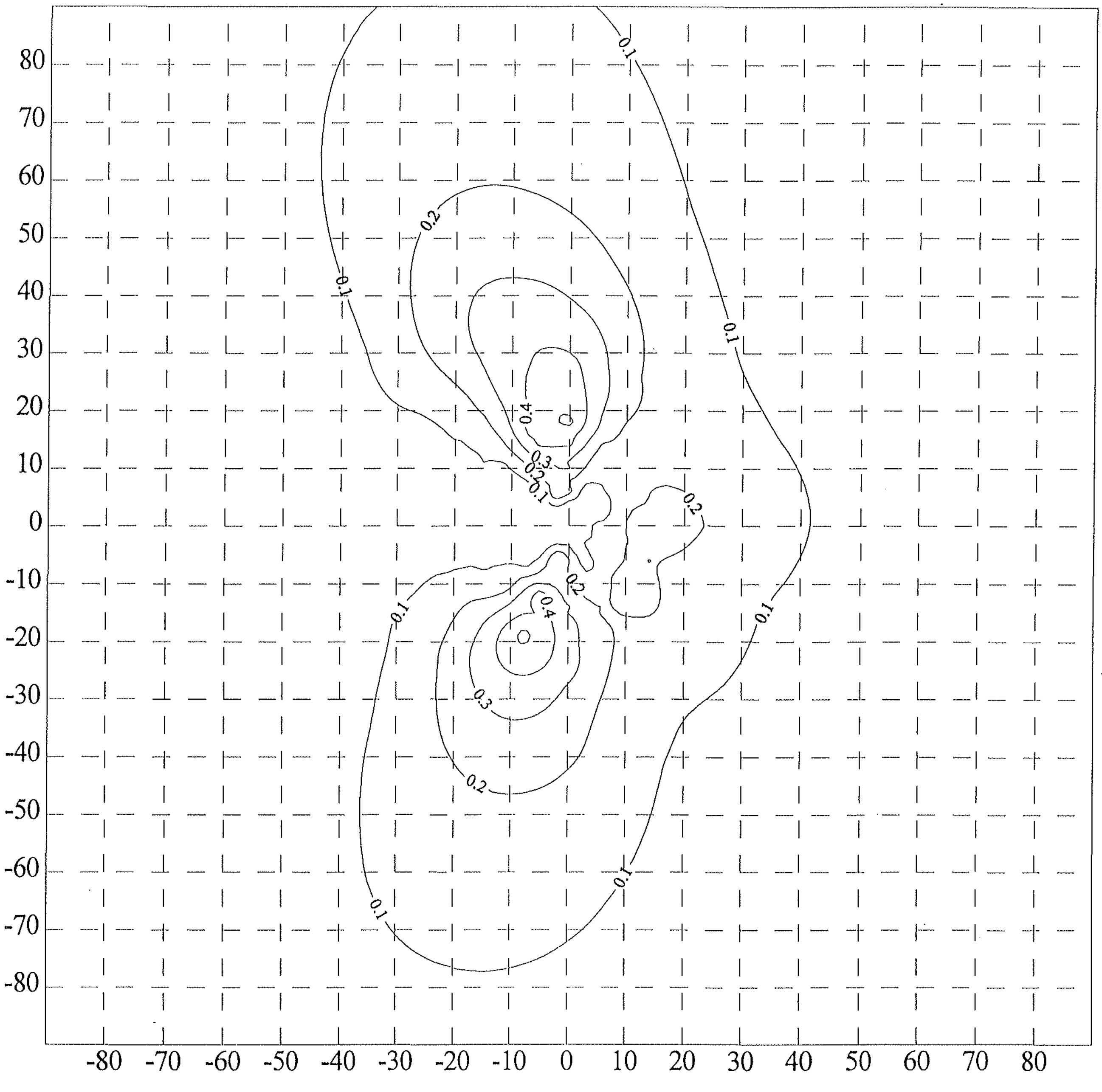
Figure 4.2
REGIONAL STUDY AREA, CRITERIA 1
AIR QUALITY, PREDICTED SO_2 CONCENTRATIONS



USE 13 mg/m^3 CONTOUR FOR BOUNDARY DELINEATION

ADEPT Total Annual SO2 (ug/m3)
Maximum 22 ug/m3
180x180km grid (every 1000m, Kriging)
Concentration contours 20ug/m3 intervals

Figure 4.3
REGIONAL STUDY AREA, CRITERIA 1
AIR QUALITY, PREDICTED EFFECTIVE ACIDITY (EA)



USE 0.2 kmolH+/ha/ha CONTOUR FOR BOUNDARY DELINEATION

ADEPT Effective Acidity (kmol H+/ha/a)
Maximum 0.53kmol H+/ha/a
180x180km grid (every 1000m, Kriging)
Concentration contours 0.1kmol H+/ha/a intervals

Figure 4.4
REGIONAL STUDY AREA
CRITERIA 2 - WATERSHEDS

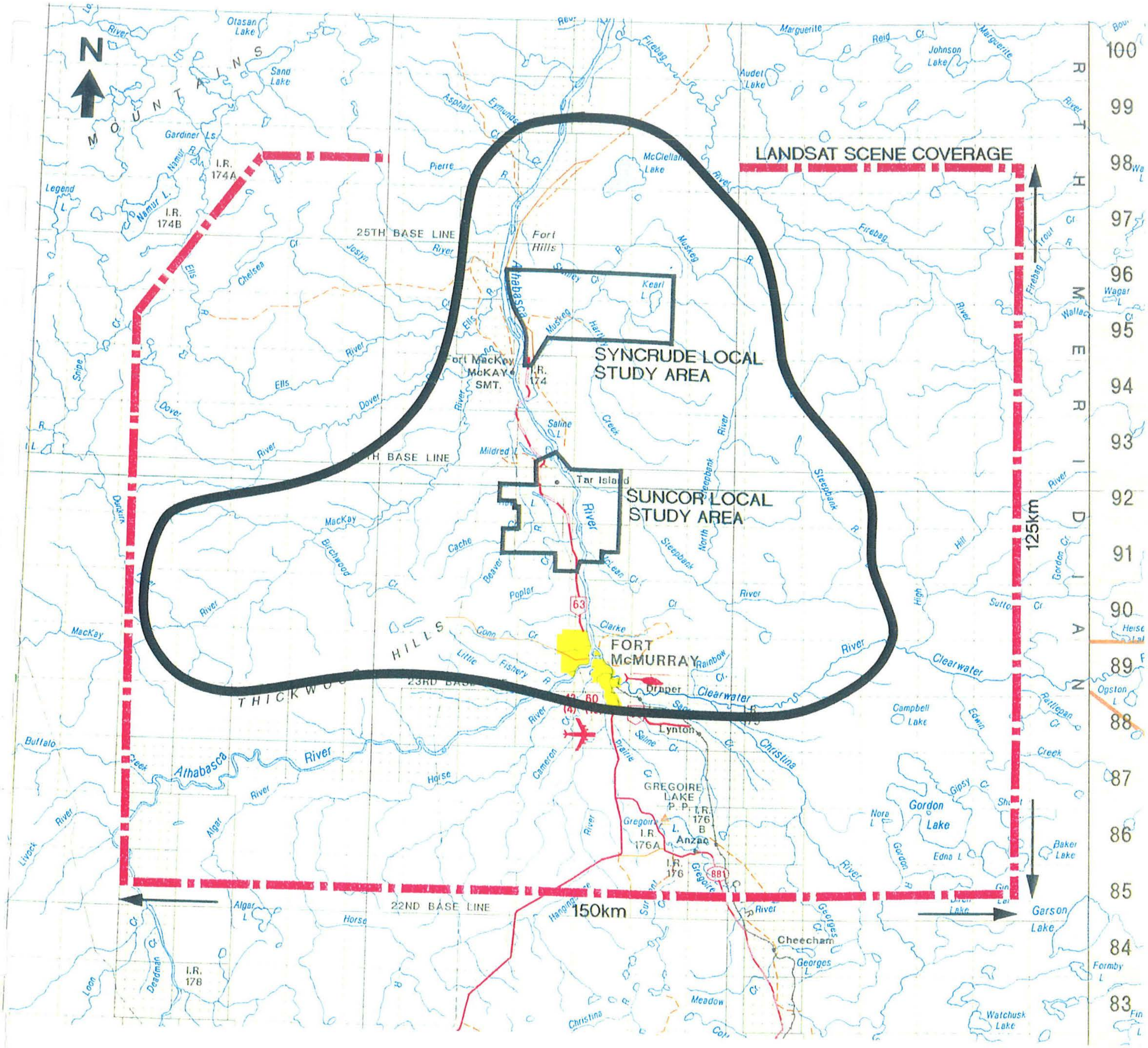


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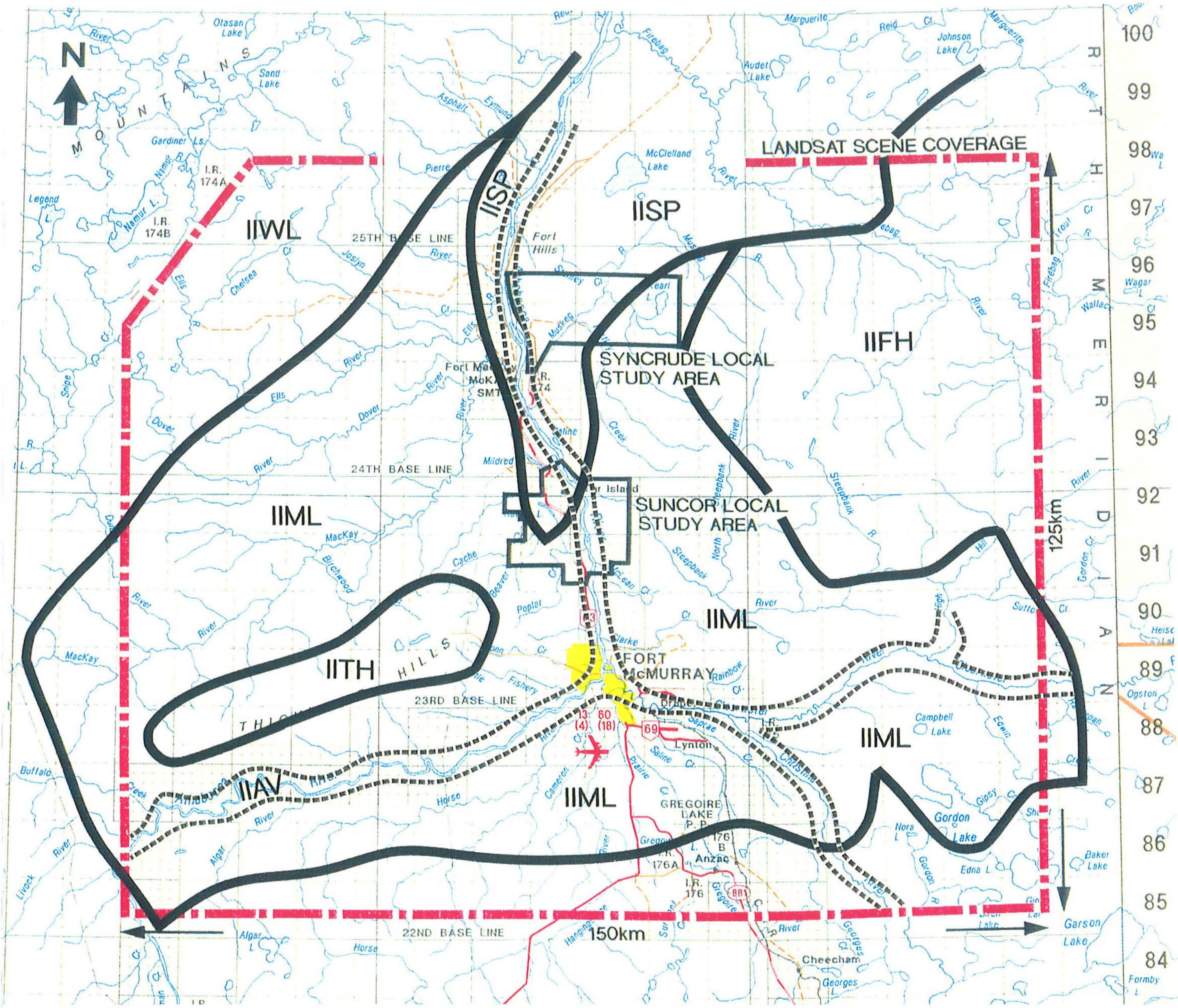
Figure 4.5
REGIONAL STUDY AREA CRITERIA 3
ECOLOGICAL LAND CLASSIFICATION CRITERIA



NOTES: **REFERENCE: 1:1,000,000 - 1992, Provincial Map Series**

II - Mid-boreal mixedwood ecoregion → ECOREGION

IIML - An undulating organic and lacustrine plain: Wetlands / mixedwood forests

IISP - An undulating sandy plain: Mixedwood and jackpine forests

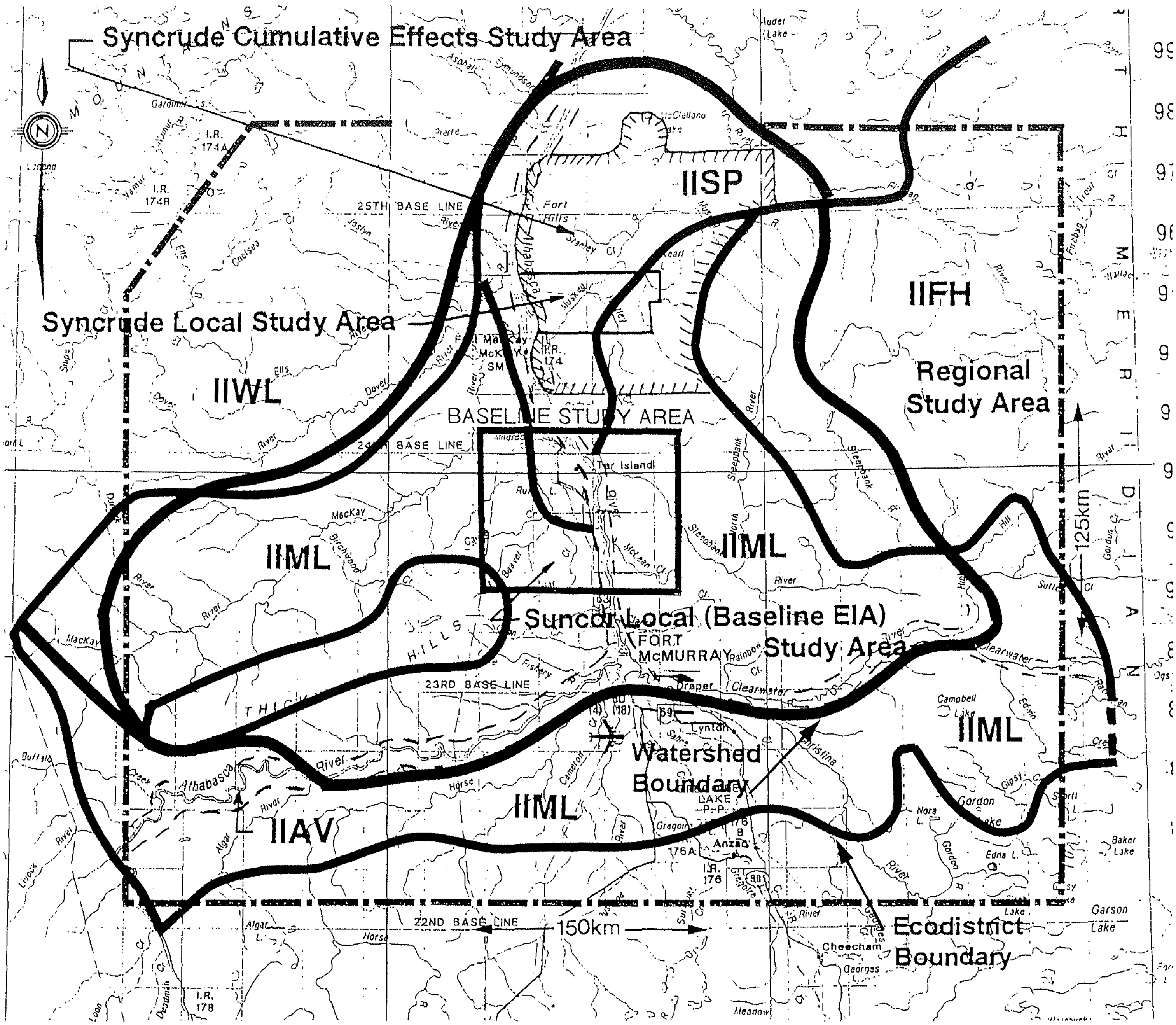
IIFH - Undulating morainal plain: Mixedwood forests

IIAV - River terraces and slopes

(IIML, IISP, IIFH, IIAV) → ECODISTRICTS

952-2307.5660

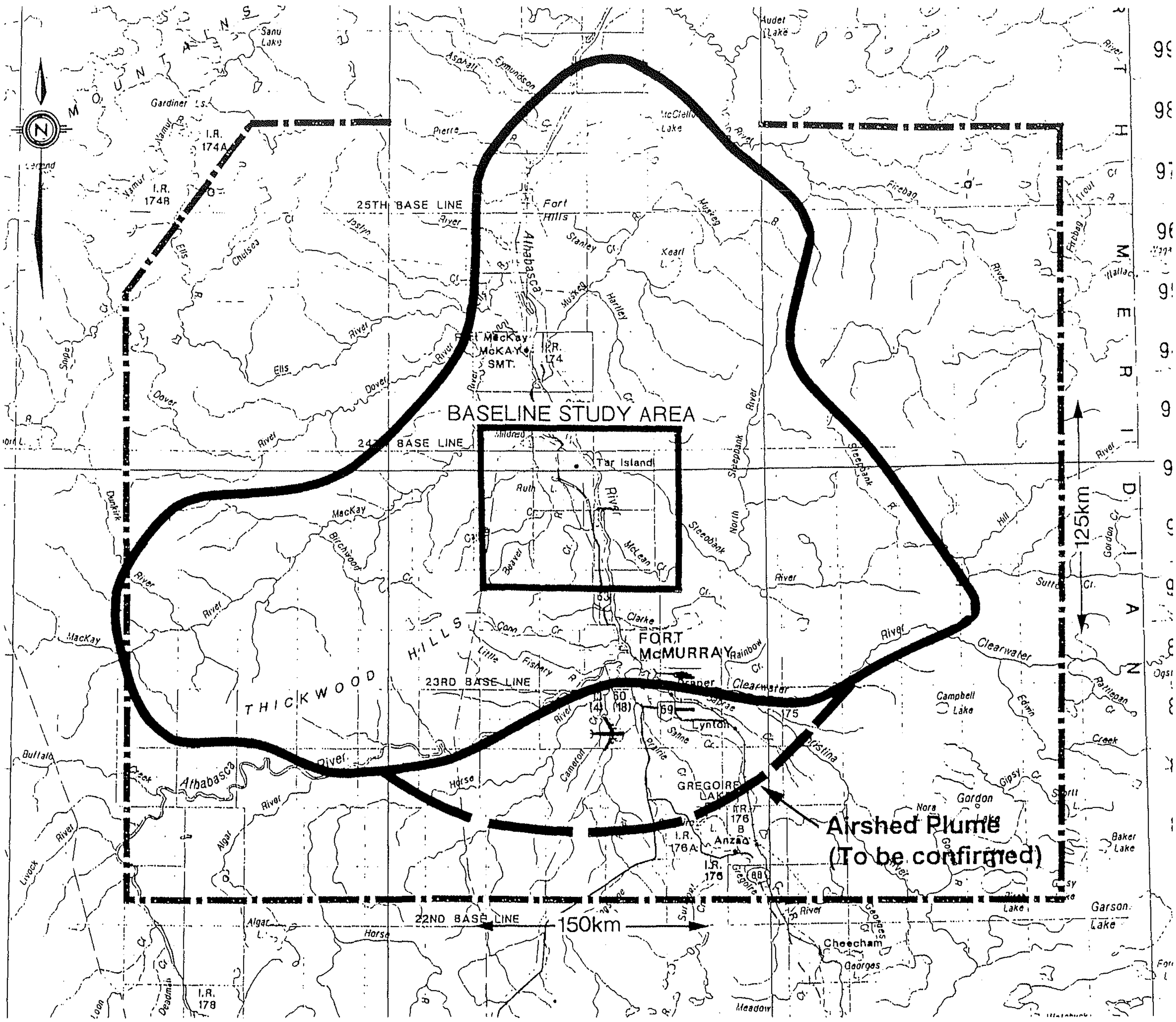
Figure 4.6
REGIONAL STUDY AREA
MODIFIED ECODISTRICTS/WATERSHEDS



Reference: 1:1,000,000 - 1992, Provincial Map Series

952-2307.5660

Figure 4.7
PROPOSED REGIONAL STUDY AREA



952-2307.5660

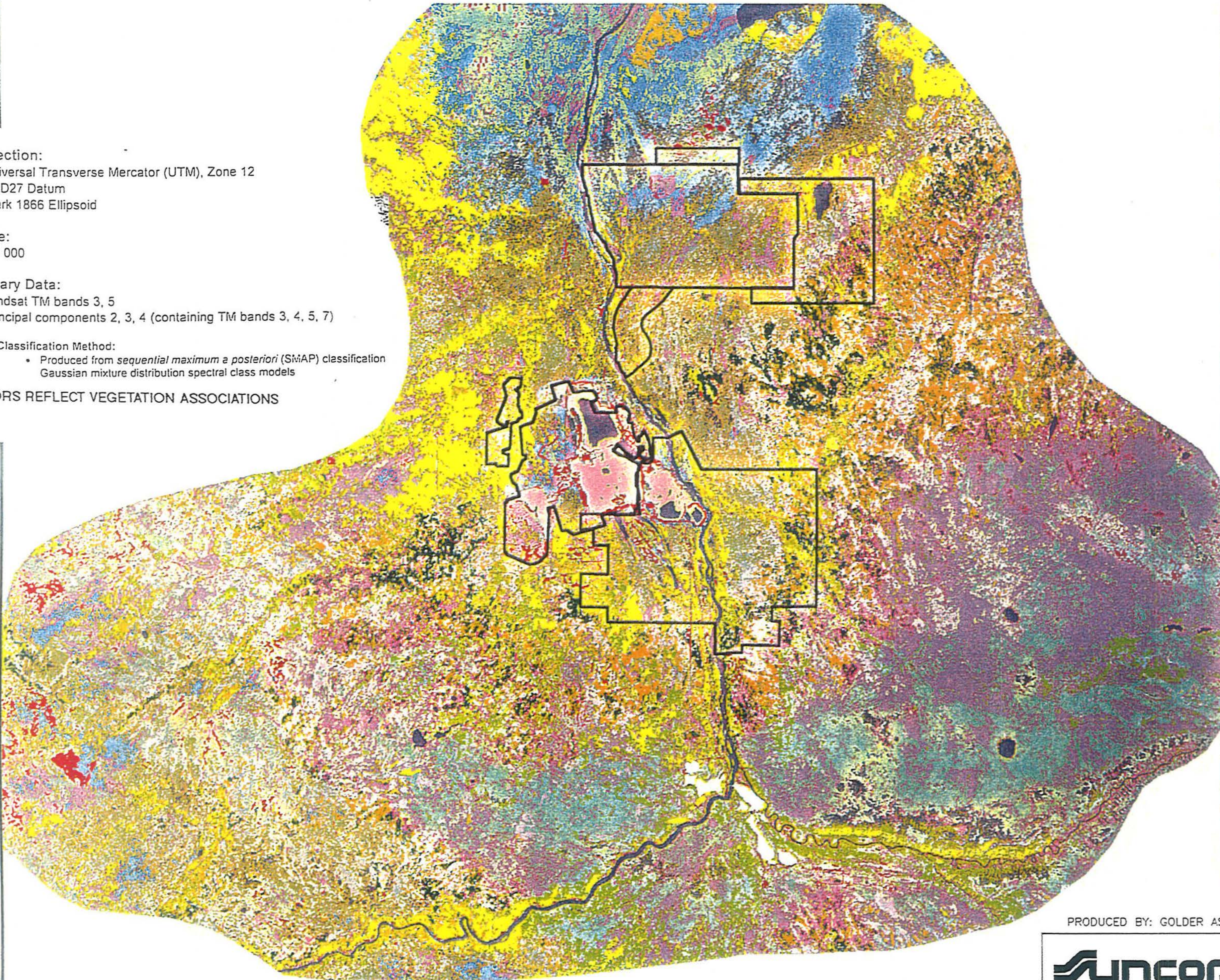
Projection:
- Universal Transverse Mercator (UTM), Zone 12
- NAD27 Datum
- Clark 1866 Ellipsoid

Scale:
1:160 000

Primary Data:
- Landsat TM bands 3, 5
- Principal components 2, 3, 4 (containing TM bands 3, 4, 5, 7)

Classification Method:
- Produced from *sequential maximum a posteriori* (SMAP) classification Gaussian mixture distribution spectral class models

COLORS REFLECT VEGETATION ASSOCIATIONS



PROJECTION: UTM
PRODUCED BY: GOLDER ASSOCIATES LTD. FOR SUNCOR INC.

Suncor Inc.
Oil Sands Group

JOINT SUNCOR/SYNCRUDE REGIONAL
VEGETATION CLASSIFICATION

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 22 APR 96		REVISION No.: 2
DRAWN BY:		FIGURE No.: 5.1

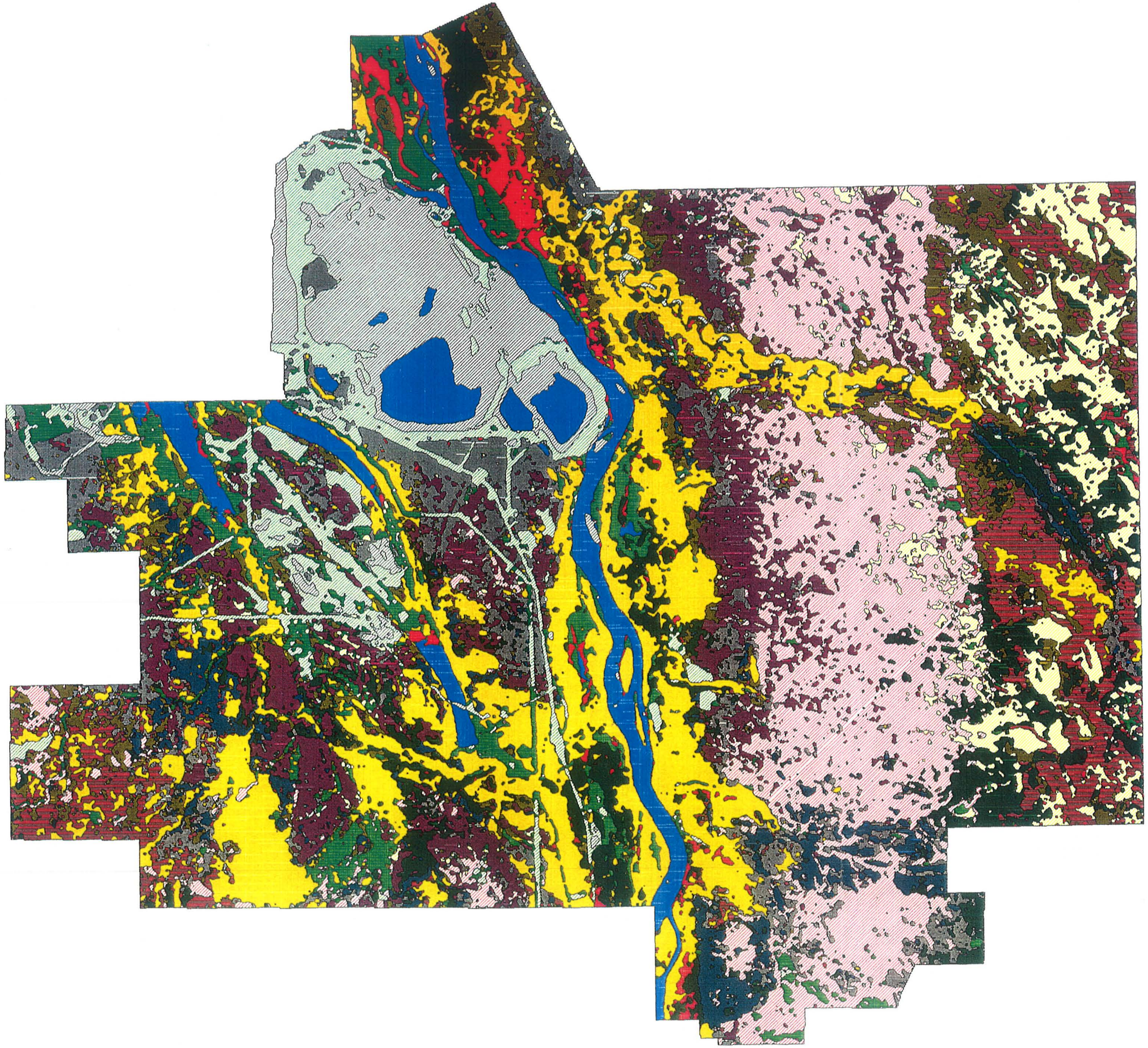


Figure 6.1
VEGETATION CLASSIFICATION
(ECOSITES)
WITHIN THE LOCAL STUDY AREA

LEGEND

- Disturbed/Herb-Grass Dominant
- Industrial/Sparsely Vegetated (Primarily Lease 86/17)
- Wetland Shrub Complex
- Closed Deciduous Forest
- Closed Jack Pine
- Peatland: Black Spruce-Tamarack Fen
- Closed Mixed Coniferous, Black Spruce Dominant
- Closed Mixedwood
- Closed Mixedwood, White Spruce Dominant
- Peatland: Closed Black Spruce Bog
- Closed White Spruce
- Peatland: Open Tamarack Fen
- Peatland: Open Black Spruce Bog
- Wetland Open Water-Emergent Vegetation Zone

N

Scale = 1:100,000

0 2 4 6

KILOMETRES

Golder Associates

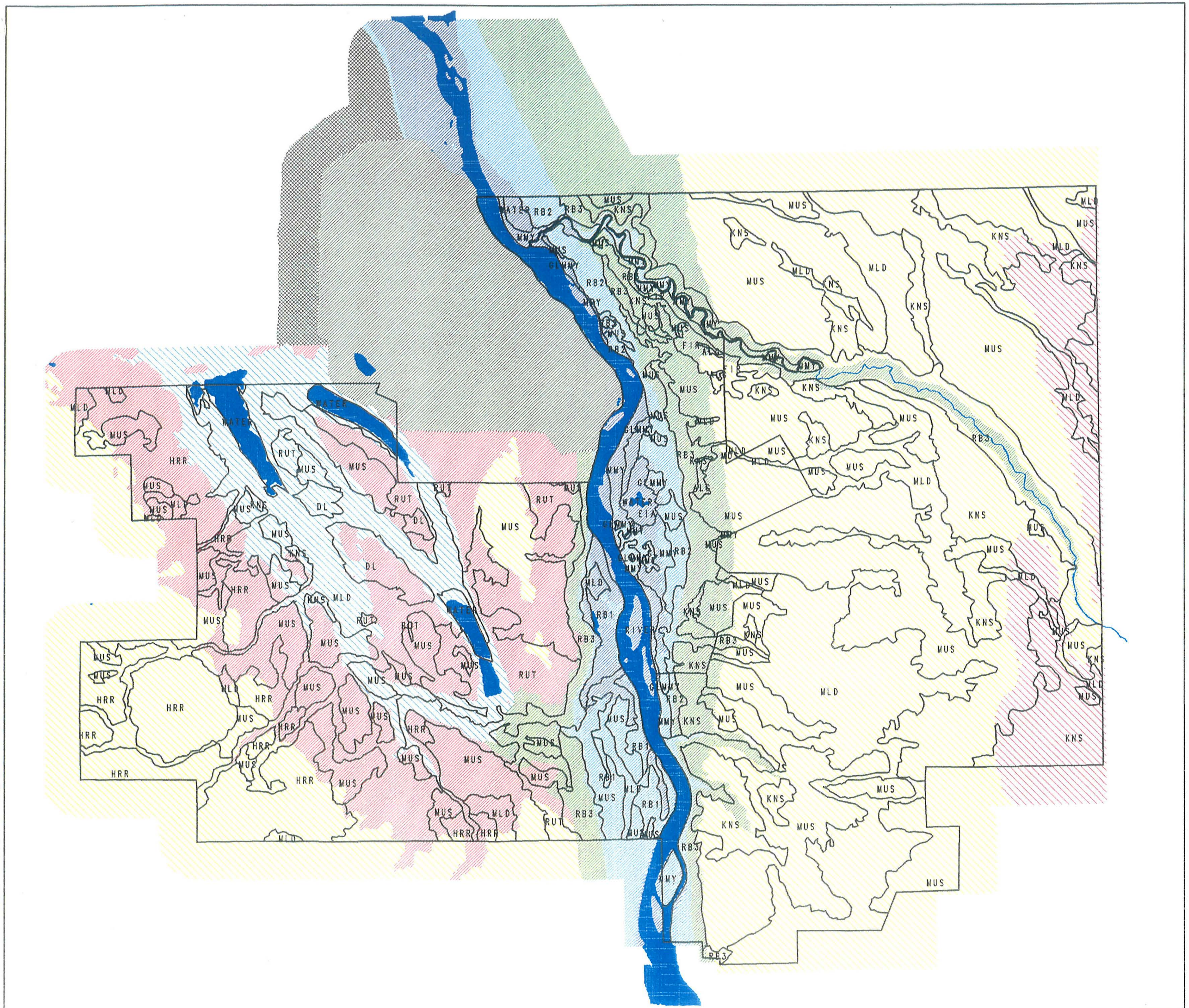


Figure 6.2

LANDFORM AND SOIL CLASSIFICATION WITHIN THE LOCAL STUDY AREA

LEGEND

- Water
- Riparian Floodplain
- Floodplain Terraces
- Escarpment Slope
- Midland Plains
- Midland Drainage
- Upland Organic/Lacustrine Plain
- Highland Moraine
- Suncor
- Syncrude

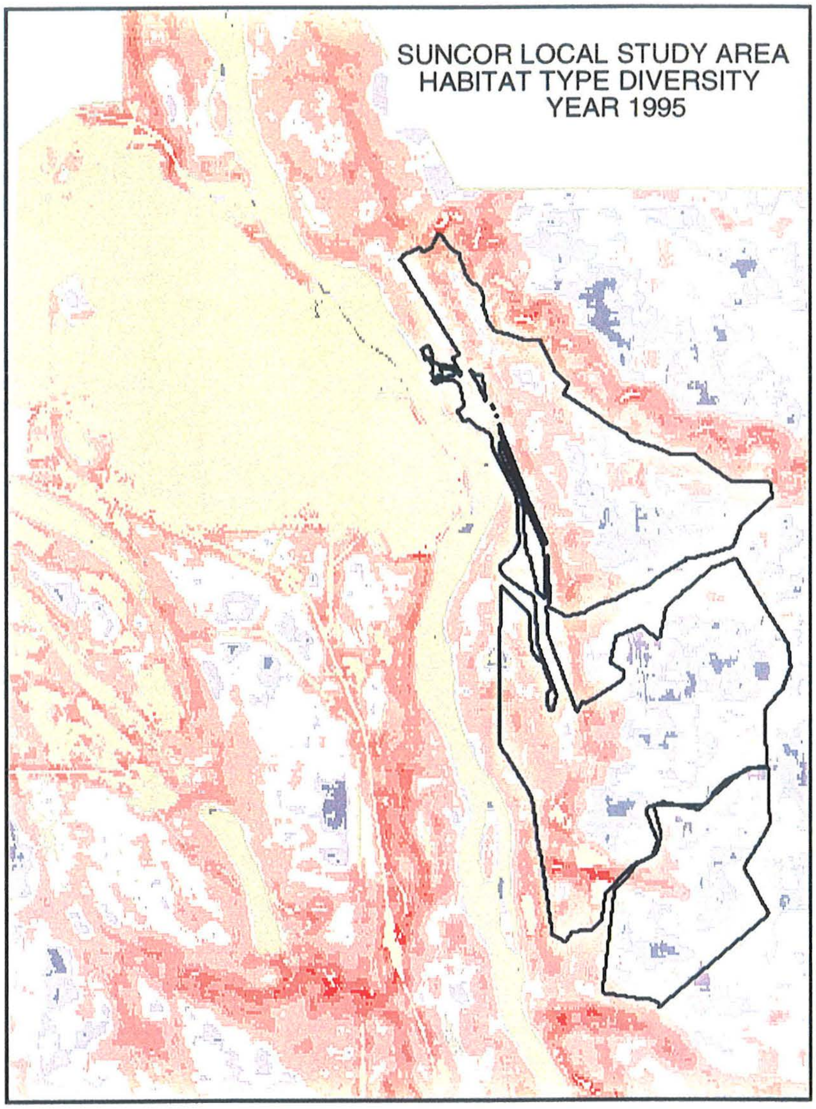
Scale = 1:100,000

0 2 4 6

KILOMETRES

Project No. 952-2307.5660 25 March 1996

Golder Associates



LEGEND
Low Habitat Diversity
High Habitat Diversity
Not Classified

Steepbank Mine, 2020

SCALE: 1 : 125000

REGION: 465450 478675 6323725 6305650

SCALE: 1:125,000
PROJECTION: UTM
PRODUCED BY: GOLDER ASSOCIATES LTD. FOR SUNCOR INC.

Suncor Inc.
Oil Sands Group

AREAS OF HIGH TO LOW HABITAT INTERSPERSION WITHIN THE SUNCOR LOCAL STUDY AREA

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 23 APR 96		REVISION No.: 1
DRAWN BY: KS/RK		FIGURE No.: 7.1

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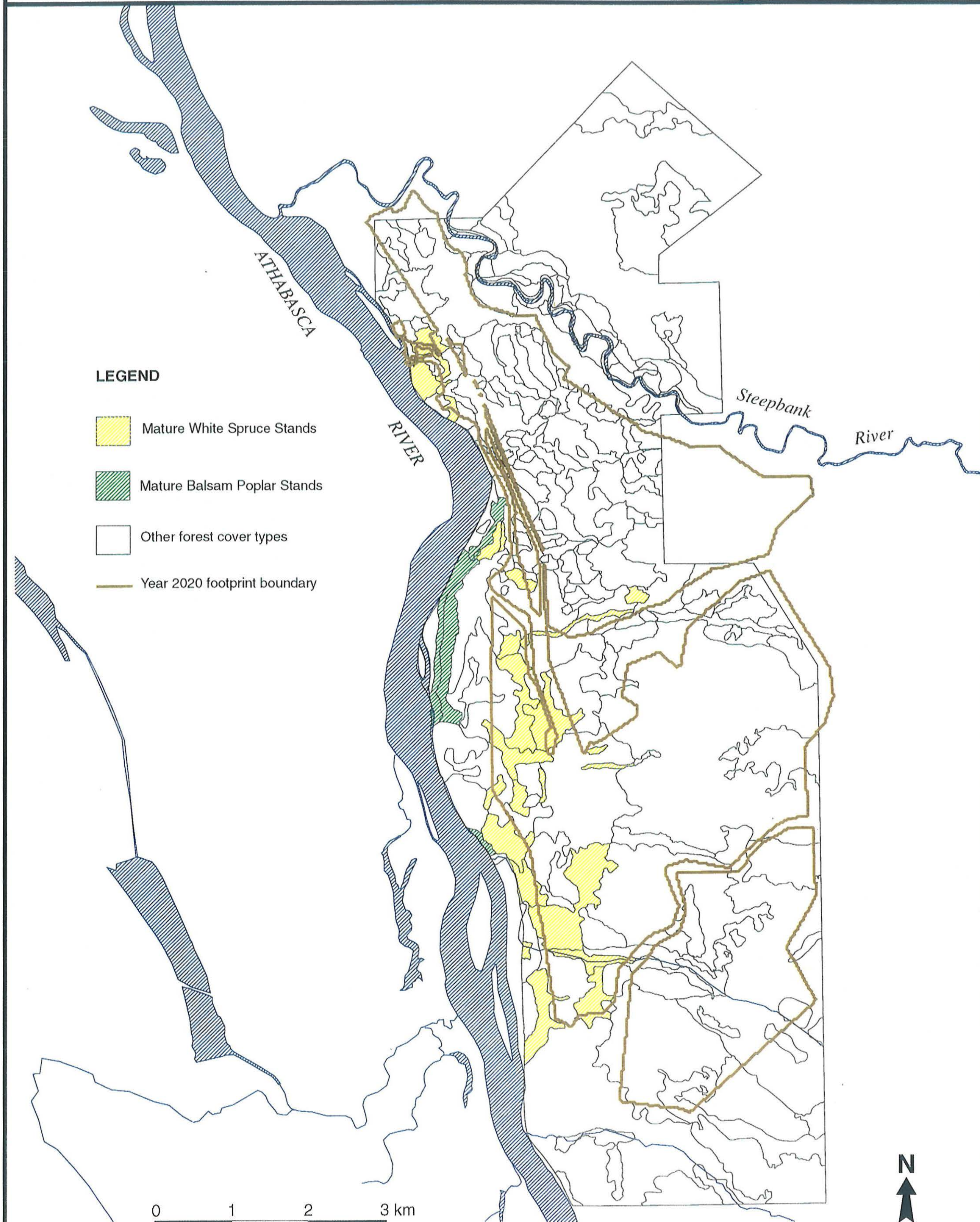
Mature Forest Stands in Steepbank Mine Footprint Athabasca River Valley

Figure 8.1



PROJECT 952-2307.5685 DRAWN RP REVIEWED DATE 17 May 1996

PLATES

Plate 1 Mature deciduous forest on the Athabasca River floodplain. Canopy dominated by large balsam poplar trees, with a high shrub cover of willows, Saskatoon, and red-osier dogwood.

Plate 2 Young deciduous forest of balsam poplar on Athabasca River floodplain, inside a river edge community of willows.

Plate 3 Mature Mixedwood community of balsam poplar/white spruce on the floodplain of the Athabasca River. These sites supported a high diversity and cover.

Plate 4 Climax white spruce forest on the Athabasca River Floodplain. Snags and multi-layer presence of white spruce is typical of these sites.

Plate 5 Common throughout the study area is a closed shrub complex located along the river edge, consisting of river alder, green alder and beaked willow.

Plate 6 The shrubby fringe of wetlands (Wetland Closed Shrub Complex) occurred on hummocks to the outside of the open water and was intermixed with emergent vegetation, creating a highly diverse zone.

Plate 7 The wetland on the east side of the river, across from tar island dyke, as seen from the air, is a complex of open water, emergent vegetation, wetland closed shrub and forest vegetation types.

Plate 8 The open water/emergent vegetation zone also represented a wetland transition, from open water with aquatic vegetation to a dense zone of emergent vegetation within the water fluctuation zone

Plate 9 Escarpment Slopes of the Athabasca River were highly diverse due to terrain variations including a variety of slopes, slope positions, aspects, surface shapes, terraces and ravines.

Plate 10 Jack pine stands on the Escarpment slope knolls were typically open, with a low to moderate shrub component of green alder, blueberry, prickly rose, Canada buffaloberry and a high reindeer lichen and bearberry ground cover.

Plate 11 A Mature closed white spruce stand on a near level terrace of the Escarpment Slope terrain class. Understorey is limited due to shade, with a high horsetail component due to seepage.

Plate 12 Escarpment Slopes of the Steepbank River, with erosional faces and patches of deciduous and white spruce stands in depressional areas, ravines and lower slopes.

Plate 13 An aspen stand on the west-facing slope of the Athabasca River, with a diverse shrubby understorey of green alder, Saskatoon, prickly rose and white spruce.

Plate 14 An aspen-white spruce stand on the escarpment slopes of the Athabasca River, showing a mosaic of stand types and areas of mixedwood.

Plate 15 Mixedwood stand on the upper escarpment slopes of the Athabasca River, dominated by black spruce, with aspen present. Willow and Labrador tea dominate the shrub layer.

Plate 16 Upper portion of an escarpment slope creek, with sandy substrate supporting an edge of river alder, willows, bluejoint, water sedge and common horsetail.

Plate 17 Unvegetated and sparsely vegetated escarpment slopes of the Steepbank River.

Plate 18 Unvegetated patches on the escarpment slopes of the Steepbank River, with adjacent areas showing stabilization and vegetation establishment.

Plate 19 Open and Closed Black Spruce communities within the Upland terrain class. Dominant vegetation includes black spruce, Labrador tea and sphagnum mosses.

Plate 20 A closed black spruce community, with black spruce present in all strata.

Plate 21 An aerial view of extensive open black spruce of shrub-sized stature, with patches of larger closed black spruce, and a shrub-choked drainage in the Upland terrain class.

Plate 22 Peatland class of open tamarack/bog birch fen within the Upland terrain class. Other common species included willows, golden moss and sedges.

Plate 23 A shrub dominated fen of bog birch, willows, Labrador tea, golden mosses and sedges, within the Upland terrain class.

Plate 24 Upland meandering drainage with edge vegetation of sedges, bog birch, Labrador tea and willows. Alder becomes prevalent where substrate is sand, with less organic build-up.

Plate 25 Mature white spruce forest in the Highland terrain class, with a high deadfall component and deep feathermoss layer. Labrador tea is common.

Plate 26 Open Water edge within the Midland/Midland Drainage terrain class, with shrub cover of green alder, river alder, and beaked willow, and a variety of emergent species.

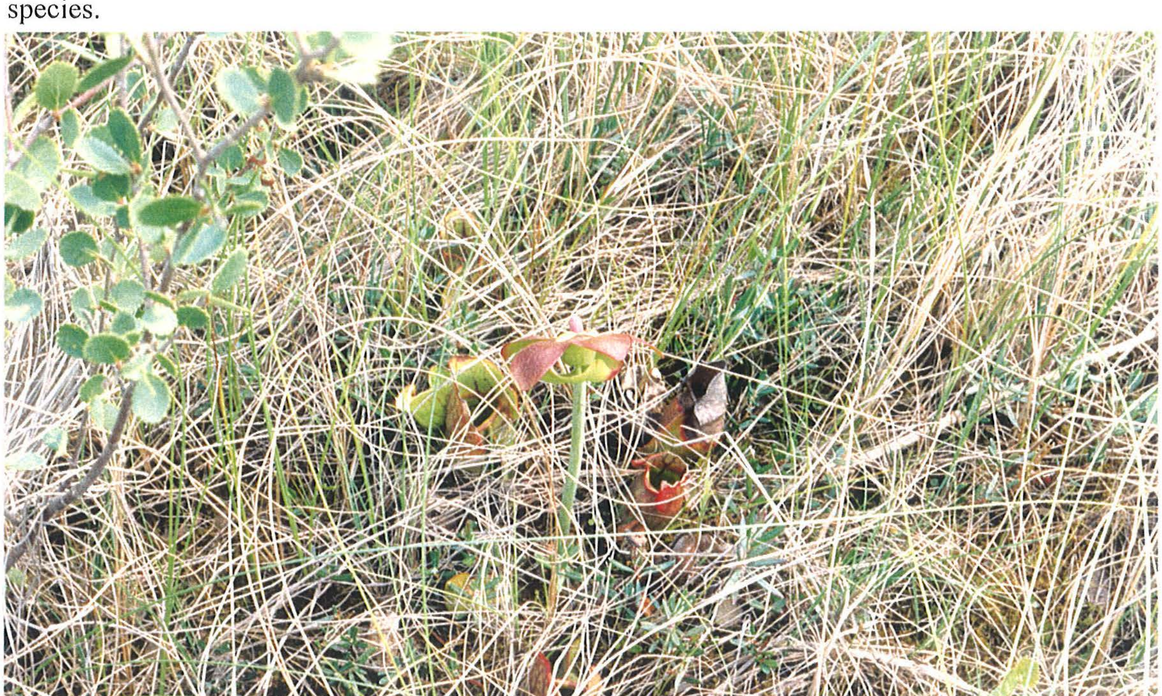


Plate 27 An example of the open tamarack/bog birch community within the Midland Drainage terrain type. The uncommon pitcher plant was found here in high numbers.

APPENDICES

APPENDIX I

SUNCOR STEEPBANK MINE PLANT SPECIES LIST

APPENDIX I SUNCOR STEEPBANK MINE - PLANT SPECIES LIST

Botanical Name	Common Name
Abies balsamea	balsam fir
Achillea millefolium	common yarrow
Achillea sibirica	many-flowered yarrow
Actaea rubra	red and white baneberry
Agropyron spp	wheat grass
Agropyron trachycaulum	slender wheat grass
Alnus crispa	green alder
Alnus tenuifolia	river alder
Amelanchier alnifolia	saskatoon
Andromeda polifolia	bog rosemary
Anemone parviflora	small wood anemone
Apocynum androsaemifolium	spreading dogbane
Arabis Spp	rock cress
Aralia nudicaulis	wild sarsaparilla
Arceuthobium americanum	dwarf mistletoe
Arctostaphylos rubra	alpine bearberry
Arctostaphylos uva-ursi	common bearberry
Arnica cordifolia	heart-leaved arnica
Aster ciliolatus	Lindley's aster
Aster conspicuus	showy aster
Aster modestus	large northern aster
Aster puniceus	purple-stemmed aster
Aster Spp.	aster
Athyrium felix-femina	lady fern
Aulacomnium Spp.	moss
Beckmannia syzigachne	slough grass
Betula glandulosa	water birch
Betula occidentalis	water birch
Betula papyrifera	white birch
Betula pumila	dwarf birch
Bromus inermis	awnless brome
Calamagrostis canadensis	bluejoint
Calla palustris	water arum
Caltha palustris	marsh-marigold
Campanula rotundifolia	harebell
Carex aenea	silvery-flowered sedge
Carex aquatilis	water sedge

Carex atherodes	awned sedge
Carex aurea	golden sedge
Carex concinna	beautiful sedge
Carex deweyana	Dewey's sedge
Carex diandra	two-stamened sedge
Carex disperma	two-seeded sedge
Carex gynocrates	northern bog sedge
Carex interior	inland sedge
Carex lasiocarpa	hairy-fruited sedge
Carex leptalea	bristle-stalked sedge
Carex limosa	mud sedge
Carex paupercula	sedge
Carex pseudo-cyperus	cyperus-like sedge
Carex rostrata	beaked sedge
Carex sartwellii	Sartwell's sedge
Carex siccata	hay sedge
Carex spp.	sedge
Carex tenera	broad-fruited sedge
Castilleja raupii	purple paint brush
Ceratophyllum demersum	hornwort
Cetraria nivalis	
Chamaedaphne calyculata	leatherleaf
Cicuta bulbifera	bulb-bearing water hemlock
Cicuta maculata	water hemlock
Cinna latifolia	drooping wood-reed
Circaea alpina	small enchanter's nightshade
Cirsium arvense	creeping thistle
Cladina mitis	reindeer lichen
Cladina rangiferina	reindeer lichen
Cladina stellaris	reindeer lichen
Cladonia ecmocyna	lichen
Clintonia uniflora	corn lily
Comandra umbellata	bastard toadflax
Coptis trifolia	goldthread
Cornus canadensis	bunchberry
Cornus stolonifera	red-osier dogwood
Corylus cornuta	beaked hazelnut
Cyperas paspasserinum	northern lady's slipper
Cypripedium calceolus	yellow lady's slipper
Deschampsia cespitosa	tufted hair grass
Dicranum pallidisetum	cushion moss
Dicranum undulatum	cushion moss

Disporum trachycarpum	fairybells
Drepanocladus uncinatus	brown moss
Drosera rotundifolia	round-leaved sundew
Dryopteris carthusiana	narrow spinulose shield fern
Eleocharis spp	spike rush
Eleocharis palustris	creeping spike-rush
Elymus canadensis	Canada wild rye
Elymus innovatus	hairy wild rye
Empetrum nigrum	crowberry
Epilobium angustifolium	common fireweed
Epilobium ciliatum	northern willowherb
Epilobium latifolium	broad-leaved fireweed
Epilobium leptocarpum	willowherb
Epilobium palustre	marsh willow-herb
Equisetum arvense	common horsetail
Equisetum brevifolia	
Equisetum fluviatile	swamp horsetail
Equisetum hyemale	scouring rush
Equisetum palustre	marsh horsetail
Equisetum pratense	meadow horsetail
Equisetum scirpoides	dwarf scouring-rush
Equisetum spp.	horsetail
Equisetum sylvaticum	woodland horsetail
Equisetum variegatum	variegated horsetail
Eriogonum androsaceum	cushion umbrella plant
Eriophorum chamissonis	russett cotton grass
Eriophorum polystachion	cotton grass
Eriophorum vaginatum	sheathed cotton grass
Eriophorum viridi-carinatum	thin-leaved cotton grass
Festuca rubra	red fescue
Festuca spp.	fescue
Fragaria virginiana	wild strawberry
Galium boreale	northern bedstraw
Galium labradoricum	Labrador bedstraw
Galium triflorum	sweet-scented bedstraw
Geocaulon lividum	northern bastard toadflax
Glyceria grandis	common tall manna grass
Glyceria striata	fowl manna grass
Glycyrrhiza lepidota	wild licorice
Goodyera repens	lesser rattlesnake plaintain
Habenaria dilatata	tall white orchid
Habenaria hyperborea	northern green orchid

Habenaria obtusata	blunt-leaved orchid
Habenaria orbiculata	round-leaved bog orchic
Habenaria spp.	bog orchid
Hedysarum spp.	hedysarum
Hierochloe odorata	sweet grass
Hippuris vulgaris	common mare's tail
Hylocomium splendens	stair-step moss
Hypnum linbergii	
Juncus balticus	wire rush
Juncus spp	rush
Kalmia microphylla	mountain laurel
Kalmia polifolia	northern laurel
Larix laricina	tamarack
Lathyrus ochroleucus	cream-colored vetchling
Ledum groenlandicum	common Labrador tea
Lemna minor	common duckweed
Lilium philadelphicum	western wood lily
Linnaea borealis	twinflower
Lonicera caerulea	fly honeysuckle
Lonicera dioica	twining honeysuckle
Lonicera involucrata	bracted honeysuckle
Luzula sp.	wood-rush
Lycopodium annotinum	stiff club-moss
Lycopodium clavatum	running club-moss
Lycopodium complanatum	ground-cedar
Lycopodium obscurum	ground-pine
Lycopodium sitchense	sitka club-moss
Lysimachia thyrsiflora	tufted loosestrife
Maianthemum canadense	wild lily-of-the-valley
Medicago sativa	alfalfa
Melampyrum lineare	cow-wheat
Meliotis alba	white sweet clover
Mentha arvensis	wild mint
Menyanthes trifoliata	buck bean
Menziesia ferruginea	false-azalea
Mertensia paniculata	tall lungwort
Mitella nuda	bishop's-cap
Monotropa uniflora	Indian-pipe
Myrica gale	sweet gale
Myriophyllum exalbescens	spiked water-milfoil
Nuphar variegatum	yellow pond lilly
Orthilia secunda	one-sided wintergreen

Oryzopis pungens	northern rice grass
Oryzopsis asperifolia	white-grained mountain rice grass
Oxycoccus microcarpus	small bog cranberry
Oxytropis deflexa	reflexed loco-weed
Parnassia palustris	northern grass-of-parnassus
Peltigera aphthosa	studded leather lichen
Peltigera malacea	leather lichen
Peltigra spp	lichen
Petasites palmatus	palmate-leaved coltsfoot
Petasites sagittatus	arrow-leaved coltsfoot
Phleum pratense	timothy
Picea glauca	white spruce
Picea mariana	black spruce
Pinus banksiana	jack pine
Plagiomnium	mnium moss
Pleurozium schreberi	Schreber's moss
Poa pratensis	Kentucky bluegrass
Polygonum	smartweed
Polygonum ampnibium	water smartweed
Polytrichum	haircap moss
Polytrichum juniperinum	hair cap moss
Populus balsamifera	balsam poplar
Populus tremuloides	aspen
Potentilla	cinquefoil
Potentilla fruticosa	shrubby cinquefoil
Potentilla norvegica	rough cinquefoil
Potentilla palustris	marsh cinquefoil
Potentilla tridentata	three-toothed cinquefoil
Prunus pensylvanica	pin cherry
Prunus virginiana	choke cherry
Ptilium crista-castrensis	knight's plume moss
Pyrola	wintergreen
Pyrola asarifolia	common pink wintergreen
Pyrola chlorantha	greenish-flowered wintergreen
Ranunculus gmelinii	yellow water crowfoot
Ranunculus lapponicus	Lapland buttercup
Rhacomitrium heterostichum	moss
Rhamnus alnifolia	alder-leaved buckthorn
Rhytidiadelphus triquetrus	red-stemmed pipecleaner moss
Rhytidium rugosum	pipecleaner moss
Ribes hudsonianum	wild black currant
Ribes lacustre	bristly black currant

Ribes oxyacanthoides	northern gooseberry
Ribes spp.	currant
Ribes triste	wild red currant
Rosa acicularis	prickly rose
Rubus arcticus	dwarf raspberry
Rubus chamaemorus	cloudberry
Rubus idaeus	wild red raspberry
Rubus pubescens	dewberry
Rumex occidentalis	western dock
Salix arbusculoides	shrubby willow
Salix arctica	Arctic willow
Salix athabascensis	Athabasca willow
Salix bebbiana	beaked willow
Salix exigua	sandbar willow
Salix glauca	smooth willow
Salix maccalliana	velvet-fruited willow
Salix myrtillifolia	myrtle-leaved willow
Salix pedicellaris	bog willow
Salix planifolia	flat-leaved willow
Salix prolixa	Mackenzie's willow
Salix scouleriana	Scouler's willow
Salix serissima	autumn willow
Salix spp.	willow
Sarracenia purpurea	pitcher plant
Schizachne purpurascens	purple oat grass
Scirpus cyperinus	wool grass
Scirpus microcarpus	small-fruited bulrush
Scirpus spp.	bulrush
Scirpus validus	common great bulrush
Scutellaria galericulata	marsh skullcap
Senecio vulgaris	common groundsel
Shepherdia canadensis	Canada buffaloberry
Sium suave	water parsnip
Smilacina racemosa	false Solomon's-seal
Smilacina stellata	star-flowered Solomon's seal
Smilacina trifolia	three-leaved Solomon's-seal
Solidago canadensis	Canada goldenrod
Solidago spp.	goldenrod
Sparganium angustifolium	narrow-leaved ash-reed
Sparganium eurycarpum	giant bur-reed
Sphagnum angustifolium	peat moss
Sphagnum capillifolium	acute-leaved peat moss

Sphagnum fuscum	rusty peat moss
Sphagnum magellanicum	peat moss
Sphagnum spp	peat moss
Sphagnum squarrosum	squarrose peat moss
Spiranthes romanzoffiana	hooded ladies'-tresses
Stellaria crassifolia	fleshy stitchwort
Stellaria longifolia	long-leaved chickweed
Stellaria spp.	chickweed
Symphoricarpos albus	snowberry
Taraxacum officinale	common dandelion
Thalictrum venulosum	veiny meadow rue
Thuidium abietinum	moss
Timmia austriaca	moss
Tofieldia glutinosa	sticky false asphodel
Tomenthypnum nitens	golden moss
Tortula ruralis	hairy screw moss
Trientalis borealis	northern starflower
Triglochin maritima	arrow-grass
Trigonella spp.	trigonella
Typha latifolia	common cattail
Urtica dioica	common nettle
Vaccinium myrtilloides	common blueberry
Vaccinium uliginosum	bog bilberry
Vaccinium vitis-idaea	bog cranberry
Viburnum edule	low-bush cranberry
Viburnum edule	low-bush cranberry
Vicia americana	wild vetch
Viola canadensis	western Canada violet
Viola renifolia	kidney-leaved violet
Viola spp.	violet