Impact Analysis of Terrestrial Resources Associated with the Steepbank Mine

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A INTRODUCTION

A1.0 PURPOSE OF THE IMPACT ANALYSIS REPORT

This terrestrial impact analysis report was prepared to identify and analyze the potential impacts which could occur as a result of the proposed Steepbank Mine project. The objective of the report is to provide a detailed analysis and classification of terrestrial resource impacts, with the incorporation of mitigation measures to eliminate or minimize those impacts.

This report is one of a series of impact analysis reports which were used to prepare the Environmental Impact Assessment (Figure A1.0-1). Similarly, this impact analysis is based on information provided in a series of more detailed reports that describe the existing conditions (i.e., the Terrestrial Baseline Report, (Golder Associates 1996a), the Baseline Soil Survey Report, (CAN-AG Enterprises Ltd. 1996), the Baseline Forestry Report, (EnviResource Ltd. 1996) and the Visual Impact Assessment Report (Dr. Richard Levy 1996). In addition, quantitative data reporting vegetation changes over the course of mine development and reclamation is provided in the Mine Advance Plan and Cumulative Effects Assessment (Golder Associates 1996b).

A2.0 APPROACH

To understand the effects of the Steepbank Mine development on terrestrial resources (i.e., landforms, soils and vegetation) the resources were first mapped and described at various scales. An integrated, ecological land classification (ELC) approach was used. This involved identifying the types and locations of landforms, soils and vegetation conditions (and their inter-relationships) within a local (detailed) and regional (general) study area.

Remote sensing satellite technology (LANDSAT TM), complimented by aerial photography and field data collected by scientists on the ground, was used with computer-based Geographic Information System (GIS) to develop a terrestrial resource database. This database was used in the assessment of potential impacts to Valued Ecosystem Components (VECs), which included river valley habitat, wetlands, mature forests and jack pine forests. This approach was also used to examine other key issues such as future land use options for the site after reclamation activities are finished, impacts on the visual resource of the Athabasca River valley, impacts to riparian wetlands and peatlands and changes to vegetation conditions and biodiversity.

The impacts from the proposed Steepbank Mine were considered within the context of Suncor's existing mining operations on Leases 86/17 to provide the basis for an integrated, environmental impact assessment for the project. This allowed comparison to be made between proposed habitat losses (new development) and existing and future habitat gains (reclamation).

The environmental impact assessment was structured according to key questions or hypotheses regarding the effects which the Steepbank Mine project could have on the environment. These are shown for each discipline or area of assessment in Table A2.0-1. Key terrestrial issues were identified through Suncor's Environmental Management Program, the Fort McMurray Athabasca Oil Sands Subregional Integrated Resource Plan (Alberta Environmental Protection 1995) and from public input (Table A2.0-3 and Table A2.0-3). These issues were then compiled into six principal hypotheses or key questions for detailed assessment and subsequent incorporation into the EIA. The process is shown in Figure A2.0-1. The hypotheses are summarized as follows:

Hypothesis 12 Valued ecosystem components in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

Hypothesis 13 Existing and future use of the area's landscapes could be limited by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

Hypothesis 14 Visual integrity of the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

Hypothesis 15 Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

TABLE A2.0-1
STEEPBANK MINE EIA IMPACT HYPOTHESES SUMMARY LIST

SOCIO-ECONOMIC	
1	The Steepbank Mine Project will contribute additional local, provincial and national benefits through additional employment, the procurement of goods and services required for the project and the payment of local, provincial and national taxes and royalties.
2	Construction-related activities and employment and the associated temporary increase in population will result in increased demands on services and infrastructure within the Regional Municipality of Wood Buffalo.
3	Operations-related employment and the associated increase in population will result in increased demands on services and infrastructure within communities in the Regional Municipality of Wood Buffalo.
4	The social stability and quality of life of communities within Regional Municipality of Wood Buffalo will be maintained as a result of the continued operation of the Suncor project, through development of the Steepbank Mine.
5	The Steepbank Mine project will contribute to a loss in the traditional resource base of the Fort MacKay community and displace some traditional activities.
6	The cumulative demands from the Suncor, Solv-Ex and Syncrude projects combined with the expected demands from existing populations within the Regional Municipality of Wood Buffalo will result in increased demands on local communities and affect the quality of life of those communities.
HUMAN HEALTH	
7	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by changes to Athabasca and Steepbank River water quality caused by water releases resulting from extraction, processing and reclamation of oil sands from Suncor's existing and proposed mines.
8	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by air emissions resulting from extraction, processing and reclamation of oils sands from Suncor's existing or proposed mines.
9	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by cumulative exposure to chemicals associated with water and air emissions from Suncor's activities and other developments within the Regional Study Area.
10	The health of people who in the future may occupy and/or use the land reclaimed from Suncor's Lease 86/17 and Steepbank Mine may be affected by release of chemicals from the reclaimed landscapes.
11	The health and safety of on-site workers may be affected by development and operations of the Steepbank Mine and related facilities.
TERRESTRIAL	
12	Valued Ecosystem Components in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.
13	Existing and future use of the area's landscapes could be limited by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.
14	Visual integrity of the Athabasca River Valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

15	Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.
16	Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage, and reclamation release water.
17	Air emissions from the Suncor operation could have an impact on vegetation and soils, as well as aquatic environments.
WILDLIFE	
18	Mine development will result in changes in the availability and quality of wildlife habitat which will bring about a reduction in wildlife populations
19	Disturbance associated with mechanical noise and human activity may result in reduced abundance of wildlife.
20	Direct mortality of wildlife caused by mine development could result in reduced abundance of wildlife.
21	Mine development will disrupt the movement patterns of wildlife in the vicinity of the Steepbank Mine, thereby reducing access to important habitat or interfering with population mechanisms, resulting in decreased abundance of wildlife.
22	Mine development could cause a reduction in wildlife resource use (hunting, trapping, non-consumption recreational use).
23	Development of the Steepbank Mine could contribute to a loss of natural biodiversity.
SURFACE AND GROUNDWATER RESOURCES	
24	Flows in the Athabasca and Steepbank Rivers could be significantly changed by mine development withdrawals for extraction, upgrading and/or reclamation.
25	Ice jams, floods or other hydrological events could cause structure damage and flooding of facilities that will result in subsequent impacts to hydrological/aquatic systems and downstream uses.
26	Navigation along the Athabasca River could be affected by bridge construction.
27	Groundwater quality could be affected by contaminant migration from processing and extraction activities.
AQUATIC RESOURCES	
28	Construction, operational or reclamation activities might adversely affect aquatic habitat in the Steepbank River.
29	Construction, operational or reclamation activities might adversely affect aquatic habitat in the Athabasca River.
30	Water releases associated with construction, operational or reclamation activities might adversely affect aquatic ecosystem health in the Athabasca or Steepbank Rivers.
31	Water releases associated with construction, operational or reclamation activities might adversely affect the quality of fish flesh.
32	Construction, operational or reclamation activities might lead to changes in aquatic habitat and/or aquatic health which might result in a decline in fish abundance in the Athabasca or Steepbank Rivers.

33	Construction, operational or reclamation activities might lead to changes in fish abundance or quality of fish flesh which might result in a decreased use of the fish resource.
34	Construction, operational or reclamation activities might cause changes in Athabasca River water quality which limit downstream use of the water.
AIR QUALITY	
35	Global climate change could be affectd by increased release of greenhouse gases associated with production expansion related to the Steepbank Mine.
HISTORICAL RESOURCES	
36	Significant archaeological, paleontological or historical resources could be affected by the development and operation of the Steepbank Mine.

TABLE A2.0-2
STAKEHOLDER ISSUES REGARDING TERRESTRIAL AND AESTHETIC ISSUES

ISSUE	IMPACT HYPOTHESIS
Shipyard Lake may be affected by changes to surface and groundwater recharge, and overburden dump; loss of vegetation habitat due to direct loss, degradation, contamination, erosion into wetlands.	12, 13, 16
Proximity to rivers is a major environmental issue.	12-16
Consider low productivity wetlands displacement, dewatering of non-mined areas, changes to run-off patterns after reclamation, disturbance to creeks and catchments and impacts to vegetation and wildlife habitats.	12, 13, 14, 16
Promote speedy recolonization of reclaimed areas to pre-disturbance levels of biodiversity.	13, 15
Is erosion a concern for dry landscape units? There is limited availability of reclamation soils. Dykes: will they be resistant to erosion? Will they be recontoured to duplicate natural conditions, side slope habitat requirements?	13
Will there be contaminant uptake by plants in treatment wetlands?	16
Are berry picking plants and medicinal plants part of the survey? Are they a VEC?	12
Ecosystem just west of Poplar Creek has unique plants; rare and endangered species may be present.	12, 15
We should consult with elders to help determine what should be planned for reclamation.	13
If we identify special plants and ecosystems, would we have to save it?	12, 15
How does the EIA relate to the IRP?	EIA Introduction
Will there be impacts from greater sulphur stockpiling?	13
What will be the visual impacts of utility corridor, especially tributary stream crossings and shop/maintenance facility?	14
Mining of the Athabasca River escarpment will affect the aesthetic profile of the east bank of the river.	14

TABLE A2.0-3

SUBREGIONAL INTEGRATED RESOURCE PLANNING ISSUES REGARDING TERRESTRIAL AND AESTHETIC COMPONENTS IN THE ATHABASCA RIVER VALLEY[1]

ISSUE	IMPACT HYPOTHESIS
Wildlife	
• valley vegetation (wind shelter, ungulated wintering areas, travel corridors)	12
• riparian habitat	12, 16
• habitat diversity	13, 15
Erosion	
• sensitive soils and drainage patterns from erosion or disturbance	13
• downstream users from sedimentation	13
Floodplain	
• setback to at least 1:100 year flood level	12, 13
• accommodate for natural evolution in the path of the river	12, 13, 14
Water Quality	
• water quality for downstream users including human, fish, and other biota	See Aquatics Impact Assessment Report
• natural surface water and groundwater regimes	See Surface Water and Groundwater Impact Analysis Report
Recreation and Tourism	
• visual and acoustic aesthetics; minimize impacts of developments upon river users and recreationists using the river as a travel corridor.	13
• characteristic valley horizon - maintain or restore.	14
Ecological	
• unique physical river valley characteristics (e.g., springs)	12, 15
• rare flora and fauna	12, 15
• critical ecological functions and processes	12, 15

[1] Source: Page 44 of the Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan.

ISSUE	IMPACT HYPOTHESIS
Traditional Uses • important traditional areas for First Nation Peoples	See Socio-Economic Impact Assessment
Historic Sites • historic resources for scientific, educational and interpretive purposes.	See Historical Resources Impact Assessment

Hypothesis 16 Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage, and reclamation release water.

Hypothesis 17 Air emissions from the Suncor operation could have an impact on vegetation and soils, as well as aquatic environments.

The investigation of each hypothesis is described using flow diagrams and summary tables to illustrate the linkages between project activities, terrestrial resource impacts and mitigation measures to reduce impacts. Sub-hypotheses were developed to examine specific areas of concern under the broader main hypotheses. For example, soil erosion/loss is examined under Hypothesis 12, which investigates habitat loss in the Athabasca River valley. Soil erosion losses are also discussed in the context of existing and future use of the reclaimed landscapes under Hypothesis 13. The intent of the hypothesis approach is to focus the assessment on key environmental issues and to examine linkages both within and between hypotheses to fully integrate the analysis.

For each hypothesis, impacts and mitigation measures are presented following an analysis of resource "losses" and "gains" within the local and regional context. Resource losses are primarily the result of land disturbance, while resource gains reflect reclamation and revegetation measures. A classification of impacts is provided for the construction phase (1997-2001), operational phase (2002-2020) and at mine closure (long-term). Impacts are described for the local and Regional Study Area under the criteria of "direction" (a positive or negative impact),"severity" (the degree or magnitude of impact) and "duration" (the time required for impact recovery or vegetation re-establishment). Finally, an overall degree of concern is provided for each hypothesis based on a qualitative synthesis of each of the previous categories of assessment.

A3.0 METHODOLOGY

Ecological land classification (ELC) involves mapping landforms, soils and vegetation resources in an integrated manner and at a variety of scales. Map boundaries are first drawn around clearly recognizable landforms such as river valleys, ridges or wetlands at a broad level of generalization. These map units are typically called "ecosections". Within these map units, the vegetation and soil conditions are described at an overview level. At a more detailed level of description and analysis, subdivisions called "ecosites" focus on specific vegetation associations and soil types within the ecosection. An example in the Local Study Area would be the "wetland shrub ecosite" and the particular soil, drainage and site conditions which support that type.

Within the Local Study Area, delineation of ecosites was made primarily 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. Subsequent description of landform type and position, along with soil and drainage conditions were added to the map unit descriptions using field data and landform or terrain modelling (Digital Elevation Model or 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.

Potential impacts to the terrestrial resources were evaluated for each hypothesis by examining the areas directly impacted by mine development. This was examined both in terms of the total hectares lost at the time of maximum mine development (year 2020), as well as through the incremental losses over time as development proceeds. In addition to hectares lost, the relative percentage of habitat loss was also calculated. Impacts were first evaluated in the context of the Local Study Area and then within the larger context of the Regional Study Area.

The amount and relative percentage of "ecosite or habitat gains" are reported, reflecting the progression of reclamation over time. Tables and figures showing "net vegetation or habitat balance" illustrate the phased approach to development and reclamation of Lease 86/17 and the Steepbank Mine project.

A4.0 STUDY AREA BOUNDARIES

Terrestrial resources for the Steepbank Mine environmental assessment were examined at three levels of detail. This was done to examine possible impacts at a local level (i.e., the mine "footprint" and a larger Local Study Area) and then to look at such impacts within a broader, regional context to provide a perspective of the possible impacts. The Regional Study Area also provided the basis for a cumulative effects assessment. This involved quantifying the impacts from Suncor's operations as well as from other oil sands operators and forestry operations within the region. The cumulative effects assessment was conducted for the present time period, 1995, and for the year 2020.

At the most general level, the Regional Study Area was delineated based on airshed, watershed and ecological criteria (Figure A4.0-1). A description of the criteria used to select the study area boundaries are summarized in Appendix I, as well as within the Terrestrial Baseline Report for the Steepbank Mine (Golder Associates 1996).

A Local Study Area was delineated based on the Lease and Lot boundaries which comprise the Steepbank Mine development project as well as the existing development in Lease 86/17 (Figure A4.0-2). An extended buffer zone was also included around these areas.

The third level of detail investigated primarily those areas that would be impacted by the mine footprint. This was completed for regulatory approval requirements, i.e., Conservation and Reclamation planning (C&R) purposes, and included detailed soil and forestry mapping at scales of 1:20,000 (Figure A4.0-2). The results of these studies are presented in the supporting reports prepared by CAN-AG Enterprises Ltd. (Baseline Soil Survey for the proposed Suncor Steepbank Mine, 1996) and EnviResource (Suncor Inc. Mine Expansion: Baseline Forestry Report, 1996).

B EXISTING ENVIRONMENTAL SUMMARY

B1.0 REGIONAL STUDY AREA SETTING

The Regional Study Area falls within the Mid-Boreal Mixedwood Ecoregion, characterized by generally subdued topography and extensive organic-lacustrine plains (Strong and Leggat 1992). Shaped by glacial and post-glacial activity, the landscape comprises several undulating plains and intervening uplands. The plains support peatlands or muskeg, shrublands and closed aspen or mixed aspen-white spruce forests on better drained lands, while riparian wetlands occur along the river valley bottoms or in shallow depressions and drainages on the uplands. Jack pine stands are found on the well drained till and sand deposits, largely in the higher elevation plains and along the escarpment sleeps.

The Athabasca River is the principal drainage within the Regional Study Area (Figure A4.0-1). It is characterized by a wide U-shaped valley, owing to glacial scouring on the sandstone bedrock of the McMurray formation. The upper slopes of these valleys are often unstable, though not to the degree of those in the more steeply incised V-shaped valleys of tributaries such as the Steepbank River. The geological strata of these valleys include shales and siltstone which contribute to localized slumping. A more complete description of the terrestrial resources of the Regional Study Area is provided in the Terrestrial Baseline Report for the Steepbank Mine (Golder Associates 1996A).

The Local Study Area represents a portion of the broader region and is described briefly in the following sections.

B2.0 LOCAL STUDY AREA SETTING

The Local Study Area covers approximately 400 km^2 (154 square miles) to the south, east and west of the existing Suncor Plant, north of Fort McMurray. This is equivalent to approximately 40,000 ha, inclusive of the existing Suncor operation in Lease 86/17 and the Steepbank Mine leases. Within this area, approximately 3,875 ha is currently developed as Lease 86/17. The maximum area of disturbance resulting from the Steepbank Mine is approximately 3,220 ha (in the year 2020), an area approximately equivalent to the current disturbance in Lease 86/17. Specifically, the study area is located within Townships 91 and 92, Ranges 8, 9, 10, and 11 West of 4th Meridian.

B2.1 BEDROCK GEOLOGY

The Local Study Area is underlain by three Lower Cretaceous Formations and one Upper Devonian Formation (Green 1972). The Grand Rapids Formation, which occurs along the eastern boundary of the study area, is composed of fine-grained quartzose and feldspathic sandstone, laminated siltstone and silty shale, with thin coal beds. This formation is of shoreline complex origin. On the upland plains on both sides of the Athabasca River lies the Clearwater Formation, which is a dark gray, fossiliferous silty shale with laminated siltstone and fine-grained cherty sandstone.

The McMurray Formation consists of sandstone and siltstone and outcrops along the banks of the Athabasca River. This is the formation which contains the Oil Sands deposits on which the Fort McMurray Oil Sands industry is based. In the valley bottom of the Athabasca River, lies the Devonian - Waterways formation, comprised of shale and limestone of marine origin (AOSERP 1982).

B2.2 SURFICIAL DEPOSITS AND LANDFORMS

The Local Study Area is characterized by six principal types of surficial materials, i.e. the types of sediments and deposits which overly the bedrock of the area. The surficial materials identified have been mapped on Figure B2.0-1. Each type of surficial material is associated with a particular landform in the study area, such as a river valley or upland plain. Landforms provide a base for ecological land classification. Within the ecological land classification scheme, these landform types are referred to as ecosections and have been mapped and described as follows:

- Midland Plains
- Midland Drainages
- Upland Organic/Lacustrine plain
- Highland Moraine

- Escarpment Slope
- Floodplain Terrace
- Floodplain

These map units are shown on Figure B2.0-1, while the soils classification is provided in Table B2.0-1.

A summary of the types of surficial materials associated with each landform type is provided as follows:

B2.2.1 Kinosis Till Developed on the Upland Organic/Lacustrine Plains Ecosection

This material covers about 10% of the Local Study Area and occurs mainly on the Upland Plains east of the Athabasca River, towards the eastern end of the mapped area. The till is sandy loam, sandy clay loam to clay loam textured and very stony. The topography is gently undulating across the plain.

B2.2.2 Horse River Till Developed on the Midland Plains Ecosection

This material covers about 9% of the area and occurs mainly on the Midland Plains west of the Athabasca River, primarily towards the western boundary of the Local Study Area. The till is clayey, slightly stony, and includes glacio-lacustrine and lacustro-till deposits. The topography is nearly level to very gently undulating.

B2.2.3 Glacio-Fluvial Deposits Developed Within the Midland Drainage Ecosection

A glacial-meltwater channel occurs on the midland plateau, west of the Athabasca River, southwest of the Suncor Plant. It occupies four percent of the Local Study Area and contains sandy, gravelly and stony materials. Three main water bodies occur within the shallow topography of the remnant channel. In places, appreciably finer material occurs making the deposits till-like. The topography is near level to gently undulating.

TABLE B2.0-1
SOIL CLASSIFICATION WITHIN THE LOCAL STUDY AREA

Map Unit	Symbol	Subgroups	Parent Material	Texture Surface/Subsoil	Drainage Class	Topographic Class	Stoniness	Vegetation
Algar	ALG	pt, RG	O/M OR L	peat/L, CL, C	P	2-3	S0-S2	Wooded
Firebag	FIR	EEB, EDB	F	LS, SL/S, SL, LS	R, W	2-3	S1-S4	Wooded
Horse River	HRR	OGL, GLGL	M					
Kinosis	KNS	OGL, GLGL	M	LS, SL/SCL, CL	W,MW, I	2-4	S1-S3	Wooded
McLelland	MLD	Ty.M, T.M	O, O/M	Of/Om/Mineral	VP, P	2	S0	Fen
McMurray	MMY	CR, GLCR	F	SL, SiL/SL,SiL, SiCL	MW	2-3	S0	Wooded
Muskeg	MUS	Ty.M, T.M.	O,O/mineral	Of/Om	P, VP	2	S0	Bog
Ruth Lake	RUT	EEB	F/gravel	SL/grSL,gravel	R,W	2-3	S3, S4	Wooded
Rough Broken	RBI Complex	Sand/chert	F/Res	SL, grSL/SL,grSL, bedrock	MW,W	2-3	S0	Wooded
	RB2 Complex	Oil Sands	Res	SL/res oil sands	W	5-6	S1, S2	Wooded
	RB3 Complex	Steep variable	C, Res, M	SL, CL/SL, CL	W, I	7-9	S1-S4	Wooded, Bare
Disturbed Land	DL	Nonsoil	F	Gravel	W	2	S4	Barren
Gleysolic McMurray	GLMMY	R.G, R.HG	F	SL, SiL/SL,SiL, SiCL	P	2	S0	Wooded Wetland

B2.2.4 Organic Bog and Fen Deposits Developed on the Upland Organic/Lacustrine Plain Ecosection

Surficial organic deposits, usually 0.5-1.5 m thick, cover about 63% of the study area. These are most extensive in a band, about 6-10 km wide, on the uplands immediately east of the banks of the Athabasca River. There are also extensive tracts west of the river. The topography is nearly level. Water tables are at or near the surface (<1 m) for much of the growing season.

B2.2.5 Colluvial Deposits Developed on the Escarpment Slope Ecosection

These occur on the steep banks of the Athabasca and Steepbank Rivers and other smaller tributaries. A series of large, rotational slump blocks have produced a ridged landform pattern on the upper, steeper slopes, whereas, a more gently-sloping apron occurs along the lower slopes. The escarpment slope is generally delineated at the base of the lower slope and floodplain of the Athabasca River by the 269 m contour, while the upper boundary corresponds to a point just beyond the crest of the slope at approximately the 334 m contour. Textures vary from sandy to clayey, but till-like materials are predominant. These deposits cover about 10% of the Local Study Area.

B2.2.6 Fluvial Deposits Developed Within the Floodplain Ecosection

Recent fluvial deposits occur in the valley bottoms of the Athabasca and Steepbank rivers. These materials are primarily fine sandy to silty, but gravely tracts also occur. Over half of this landform is well drained with water tables deeper than 1 m (Riparian Terrace Ecosection), however, sizeable poorly-drained areas and wetlands occur at lower elevations (Riparian Floodplain Ecosection). The topography is terraced, with meander scars which create a gently undulating terrain. These deposits cover nearly 5% of the area. Further information on these deposits, including an assessment of permeability, is provided in the Hydrology report (Klohn-Crippen 1996).

B2.3 SOILS

The dominant soils of the Local Study Area have been mapped within the major landform types as shown on Figure B2.0-1. The dominant surficial materials in the regional and Local Study Areas are organic deposits, including bogs and fens. These are characterized by peat thickness of 0.5 to 1.5 m. The soils are poorly drained with water tables at or near the surface (<1m) for much of the growing season. Most of the soils are Mesisols, but Humisols and Fibrisols also occur. Table B2.0-2 provides an approximate percentage of the different kinds of surficial material and soil groups occurring in the regional and Local Study Areas.

Morainal (till) deposits cover a significant part of the landscape. Textures vary and include sandy loam, sandy clay loam and clay loam. The materials are moderately to very stony. Well and moderately well drained Orthic Gray Luvisolic soils are widespread on these materials, in upper slope positions. Lesser extents of imperfectly drained Gleyed Gray Luvisols and poorly drained Gleysolic soils occur in lower landscape positions. The topography is undulating. Moderately productive mixedwood forests are prevalent.

Lacustrine parent materials occur throughout the area but are more extensive in the northwest. These are clay to clay loam, non-stony materials on nearly level topography. Soil and drainage relationships are identical to those described for morainal soils. Moderately productive mixedwood forests also occur on these soils.

Coarse-textured glacio-fluvial soils occur in glacial meltwater channels and spillways on the uplands bordering the Athabasca River valley. The materials are sands to sandy loams, with variable gravel and stone content. Soils are predominantly Brunisols and Luvisols that are rapidly to well drained. The topography is very gently undulating. Forest cover ranges from open pine stands on upper, drier sites, to mixedwood forests in lower, moist locations.

There are minor occurrences of fluvial-eolian, non-stony, sandy deposits which occur 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. The topography is primarily undulating. Open jack pine stands are typical on these soil types.

The final complex unit is referred to as "Rough Broken". It includes morainal, colluvial, and other parent materials found on the steep banks of the Athabasca and Steepbank Rivers. Various soil types and drainage categories occur within this unit.

TABLE B2.0-2
PERCENTAGE OF SURFICIAL MATERIALS AND SOILS IN THE STUDY AREAS

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

B2.4 VEGETATION

B2.4.1 Overview

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 are significant components of the landscape, including the Thickwood Hills in the southwest corner of the Regional Study Area.

Vegetation typical of the Mid Boreal Mixedwood Ecoregion include aspen (*Populus tremuloides*) and Balsam poplar (*P. balsamifera*). White Spruce (*Picea glauca*) and balsam fir (*Abies balsamifera*) are the climax species for the region 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)*, and tamarack (*Larix laricina*) whereas poorly drained sites with moving water are often vegetated by willows (*Salix* spp.), green alder (*Alnus crispa*) and sedges (*Carex* spp.). Such sites include stream and lake margins and shallow water bodies that are stream fed and occasionally flooded. Wetlands are common (Strong 1992).

Within the Mid-Boreal Mixedwood ecoregion of Alberta, subdivisions have been made based on broad landscape features and variations in dominant vegetation composition. This was used in combination with watershed and airshed boundaries to delineate a Regional Study Area for the Steepbank Project. The regional study has been described as "an undulating organic and lacustrine plain, dominated by mixedwood forests and wetlands" (Strong and Leggat 1992). Further classification of the vegetation resources was completed through remote sensing, aerial photography and field ground-truthing. A total of 16 vegetation landuse types were identified and mapped within the Regional Study Area as shown on Figure B2.0-2.

The Local Study Area occurs within an undulating organic and lacustrine plain, dominated by wetlands and mixedwood forests. The average moisture regime is rated at sub-hygric to mesic and soils typically range from Organic to Gray Luvisols (Strong 1992). Within the main landforms (ecosections) identified previously, soil associations and vegetation types were mapped separately as well as in an integrated ecological land classification format. Fourteen ecosites, based on vegetation types were identified within each landform type (ecosection) and described according to site conditions, soil type and variations in vegetation composition and structure. The integration of these data sources is shown on Figure B2.0-3.

Ecosites were described within the following categories:

- Wetland open water-emergent vegetation zone
- Wetland shrub complex
- Closed deciduous forest
- Closed jack pine
- Peatland: open tamarack fen
- Peatland: black spruce-tamarack fen
- Peatland: open black spruce bog
- Peatland: closed black spruce bog

- Closed mixed coniferous, black spruce dominant
- Closed mixedwood
- Closed mixedwood, white spruce dominant
- Closed white spruce

These are shown on Figure B2.0-4.

In addition, two disturbed ecosites were also described: Disturbed/Herb-Grass dominant and Industrial/sparsely vegetated (primarily within Lease 86/17). Figure B2.0-3 illustrates in which ecosection these vegetation communities are found. Each ecosite is described in detail within the Baseline Report.

The Steepbank Mine development would be largely restricted to the Floodplain, Riparian Escarpment and Upland Ecosections (Figure B2.0-4). Each of these main landform types supported several predominant vegetation types (ecosites). The Riparian Floodplain and Riparian Terrace ecosections supported a vegetation cover that was dominated by closed deciduous forest (balsam poplar dominant). These stands are typically successional to closed mixedwood, closed mixedwood white spruce dominant and closed white spruce - which were also common ecosites on the Floodplain ecosections. In addition, flooding and backwater ponding had allowed for the development of riparian wetlands, which were classified as the Wetland Shrub Complex (willow dominated) and the Wetland Open Water/Emergent Vegetation zone. Shipyard Lake and the associated wetlands is an example of this.

The Riparian Escarpment of the Athabasca and Steepbank Rivers supported a high cover of the closed deciduous forest, dominated by aspen. The variation in stand age, fire history and succession has resulted in the establishment of other forest cover types including closed white spruce (common in ravines) and closed jack pine (common on well-drained knolls and ravine crests).

The upland ecosection is a broad upland plain which gently directs drainage from east to west. Large scale pooling and slow drainage has resulted in the establishment of bogs and fens, which dominated the vegetation cover in this ecosection.

The other ecosections (Highland, Midland and Midland Drainage) would not be disturbed by the Steepbank Mine, and are described in the Terrestrial Baseline Report (Golder 1996a).

B2.4.2 Rare Plants

A rare plant survey was a component of the vegetation inventories conducted within the study area. 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 in the Mildred Lake study area, and associated habitat types within the region.

Potential rare and uncommon plant species in the local study have been identified in the Baseline Report (Golder 1996) and are considered in more detail in Section C. It is apparent, given the preferred habitat types and those rare/uncommon species found during the field program, that areas of highest potential within the Local Study Area included the Open Water/Emergent Vegetation Zone, Wetland Closed Shrub Complex, Closed and Open Black Spruce Bogs, Fens and Jack Pine Forests (on sandy till). In the VEC selection process, these communities were rated high for rare plant potential.

B3.0 SIGNIFICANT NATURAL RESOURCES

Significant natural features within the Regional Study Area were evaluated using previous information on the Eastern Boreal Forest Region by Westworth (1990). Selection of a significant natural feature was based on seven criteria:

1. Performs a vital environmental function
2. Geological and/or physiographic uniqueness
3. Significance in terms of rare or endangered plant or animal species
4. Diversity of flora and fauna
5. Large areas of pristine state
6. Areas providing a "linkage function" for wildlife as well as plant species

7. Areas of unique or special habitat within the region.

Within the Regional Study Area, regionally significant natural resources identified by Westworth (1990) included:

- Athabasca and Steepbank Rivers;
- MacKay, Muskeg, Dover, Ells, Tar, Horse, Hangingstone and Christina Rivers;
- Thickwood, Bitumont and Fort Hills;
- Saline Lake;
- McClelland Lake and associated fens and sinkholes;
- Dover-McKay moose area;
- Kearl Lake and surrounding lowlands;
- Horseshoe Lake; and
- Calumet Plains and areas of mature (old growth) white spruce forest along the Athabasca River.

These areas are identified within the Terrestrial Baseline Report (Golder 1996).

Some of the regionally significant features occur within the Local Study Area. These include:

- The Athabasca River, rated as a "Nationally Significant" watercourse (including the oil sands reach) (Westworth 1990); and
- the Steepbank River, rated as a "Regionally Significant" watercourse (Westworth 1990).

C VALUED ECOSYSTEM COMPONENTS

The identification and selection of Valued Ecosystem Components (VECs) provides a focus for impact analysis and assessment. Selection criteria for VECs were based firstly on a review of previous work by Noss (1992a, 1992b, 1995) and Noss and Cooperrider (1994) who recognize the following criteria for identifying VECs:

- Pristine areas of significant size;
- 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 rock outcrops etc.;
- Watersheds of high value;
- Sites of inherent sensitivity to development;
- Sites of importance to indigenous peoples; and
- Sites that could be added to adjacent protected areas.

The above criteria were then modified with stakeholder input to address the project more specifically. This resulted in the following criteria being used to select terrestrial VECs:

- Rarity;
- Rare plant potential;
- Sensitivity to physical disturbance;
- Sensitivity to pollutants;
- Recreational importance;
- Diversity;
- Traditional use importance; and
- Economic importance.

TABLE C-1
SCORING CRITERIA FOR TERRESTRIAL VECS

1. **Rarity** (uniqueness of landforms or species 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. **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. **Sensitivity to Pollutants:** 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 or landforms with aesthetic or political importance): 1 = low interest 2 = moderate interest 3 = high interest
6. **Diversity** (landform or terrain diversity as well as the number and extent of vegetation communities in a terrain type or species in a community): 1 = simple 2 = moderately diverse 3 = diverse
7. **Traditional Use Importance** (measures importance to traditional users - food gathering, medicinal plants, utility species, use in general): 1 = low productivity 2 = moderate productivity 3 = high productivity
8. **Economic Importance** (measures importance to resource use such as forestry): 1 = low productivity 2 = moderate productivity 3 = high productivity

These criteria were used in the scoring criteria applied to terrestrial VECs within the Local Study Area, as shown in Table C-1. Sites of importance to indigenous people were included based on available background information, such as the community of Fort McKay traditional uses of the renewable resources of the Suncor Steepbank Mine Site (Fort McKay Environmental Services 1995). However, no specific cultural and spiritual resources study was done as part of this assessment.

The VEC selection process involved a review of the literature as to terrain types, vegetation community types and species which have been recognized as unique and/or of special status within the region. In addition, an analysis of vegetation within the Local Study Area was useful in recognizing communities which were relatively uncommon or of special status. The relationship between vegetation, soils and landform were described in terms of integrated map units or ecosites. In addition, a public scoping process was conducted to identify biophysical resources which were of public/government interest and concern. In view of this, the focus for VEC analysis was the Athabasca River Valley, given that this is considered a "Significant Area" of national importance (Westworth 1990).

The resulting VEC analysis indicates that, based on the criteria, both the river floodplain and escarpment slopes score high, and as terrain or landform types, can be considered to be Valued Ecosystem Components. On a more detailed level, based on vegetation community value, the scoring criteria indicate that the following vegetation types (or ecosites) have a high intrinsic value, due to both ecological and anthropogenic value:

- Mature Forest
- Jack Pine/Blueberry Forests
- Riparian Open Water/Emergent Vegetation Zone
- Riparian Wetland Closed Shrub Complex

Table C-2 shows the scoring process and rating applied to each of the VECs selected. Based on the selection criteria, the terrain types and communities selected as VECs within the Athabasca River Valley scored high, resulting in their selection as VECs. One of the impact hypothesis in the Impact Analysis focused on these resources.

TABLE C-2
CRITERIA AND RATING FOR TERRESTRIAL VEC SELECTION IN THE LOCAL STEEPBANK STUDY AREA

Ecosites	VEC Species Attributes	Rarity	Rare Plant Potential	Sensitivity to Physical Disturbance	Sensitivity to Pollution	Recreational Importance	Diversity	Traditional Use	Economic Importance	Total
Wetland Closed Shrub Complex	alder, cattail, bulrush	3	2	3	3	3	3	3	2	23
Open Water/ Emergent Vegetation	cattail, bulrush pondweed	3	2	3	3	3	3	3	2	21
Mature Deciduous Forest (Balsam Poplar dominant)	balsam poplar	3	2	3	3	3	3	3	1	22
Mature Growth White Spruce	white spruce	3	2	3	2	3	3	2	3	21
Closed Jack Pine Forest	alder blueberry lichen	2	2	3	3	3	1	3	2	19

D IMPACT ANALYSIS RESULTS

D1.0 IMPACT ANALYSIS

D1.1 IMPACT CRITERIA DEFINITIONS

The environmental impact of the Steepbank Mine on biophysical resources (terrain, soils and vegetation) was described according to four main criteria. These include: direction, severity or magnitude, duration and geographic extent. The assessment of the impact was also summarized by an overall "Degree of Concern" rating which synthesizes the previous evaluations in a qualitative manner. The criteria are summarized as follows:

D1.1.1 Direction

This identifies the nature of the impact to the biophysical resource. It can be described as a "positive impact" or as a "negative impact". Where there is no identifiable impact, it can be described as "neutral".

D1.1.2 Severity or Magnitude

The degree of project induced change to the biophysical resource. The severity of impact addresses how much of the biophysical resource will be affected relative to both the local and Regional Study Area. It can be expressed both in hectares and as a percentage of the resources affected (e.g., landform or vegetation type). The percentage values used to distinguish between severity ratings were based on a qualitative assessment of the effect on the ecological balance of the area, coupled with similar values used in EIA's in the Fort McMurray area, for example Solv-Ex and Syncrude. The values provide a means of understanding the degree of change in the biophysical resource. Impacts were classified as:

Negligible:	No measurable affect on the biophysical resource base.
Low (1):	Affects < 5% of the biophysical resource base.
Moderate (2):	Affects 5 to 15 % of the biophysical resource base.

High (3): Affects > 15% of the biophysical resource base.

Impact severity is defined according to a measurable (quantified) change in a landform (ecosection) or vegetation type (ecosite). An accuracy assessment of the ELC classification scheme is provided in Appendix II. These measurements provide a clear and consistent method of assigning severity impacts to high, moderate, low or negligible categories. Our level of confidence in assessing impact severity however must also recognize that natural systems, such as vegetation succession and social values, are complex, and environmental responses to impacts are variable. Such considerations are discussed throughout the report to qualify such assessments of severity.

D1.1.3 Duration

Duration refers to the approximate time period it will take for the biophysical resource to recover from the environmental impact. Recovery here refers to establishing the biophysical conditions (slope, soils, drainage, etc.) necessary for sustaining vegetation growth to an early stage of vegetation succession. Reclaimed landscapes will allow for subsequent vegetation successional development and habitat diversity to approximate pre-disturbance conditions where possible. Impacts were classified as:

Short-term (1): The impact is limited to the period of time of the activity causing the effect. In general, this will be confined to one or two growing seasons during which the ecological recovery process takes place. To simplify the assessment process, it can also be defined in terms of the construction period for the Steepbank Mine which will extend from 1997 to 2001, or a period of 4 years, however, for most short-term impacts, they will be limited to one construction season The selected time period for short-term impacts assessment is < 4 years.

Medium-term (2): The impact extends for greater than 4 years beyond the completion of the activity causing the effect but for less than 18 years. Eighteen years is the time period during which the mine is operational (from 2002 to 2020). This definition recognizes the development and reclamation balance which will take place during this period, as well as the longer time period required for the ecological recovery process to proceed through various stages of soil stabilization and vegetation succession. The selected time period for medium term impact assessment is 4 - 18 years.

Long-term (3): Long-term impacts extend for more than 18 years beyond the completion of the activity causing the effect. This corresponds to the period generally after mine closure, or after 2020, while also recognizing the long-term nature of recovery required for certain habitats and vegetation types. An example of long-term impacts would be the time required to recover mature white spruce stands.

D1.1.4 Geographic Extent

The area affected by the impact. The biophysical assessment of the Steepbank Mine includes the consideration of potential impacts within a local and a Regional Study Area. These are described as follows:

Local (1): Impacts are confined within Suncor's Lease 86/17 and the Steepbank Mine (i.e., the Local Study Area).

Regional (2): Impacts extend beyond the Local Study Area to affect a portion of the larger Regional Study Area.

D1.1.5 Impact Summary - Degree of Concern

An overall qualitative rating that synthesizes the assessment of the previous categories is provided in this section. An impact summary can be:

Low: A combined impact rating that is generally restricted to a small portion of the Local Study Area, is of low to moderate severity or magnitude and is of short-term duration. A low overall rating would be considered as a low overall degree of concern.

Moderate: A combined impact rating of moderate severity or magnitude that affects a moderate to large portion of the Local Study Area and is of moderate to long-term duration. A moderate rating would be considered as a moderate degree of concern.

High: A combined impact of moderate or high severity/magnitude that effects a large portion of the Local Study Area as well as having a large to moderate affect within the Regional Study Area. The impact is also of long-term duration.

D1.2 CUMULATIVE EFFECTS ASSESSMENT

Each of the hypotheses was examined in terms of the impacts resulting from the project as a stand alone development within a local and Regional Study Area. In addition, the assessment also looked at the combined impact of the Steepbank Mine project with other projects in the Regional Study Area. This component of the assessment involved a cumulative effects assessment and was completed for each of the hypothesis and sub-hypothesis components. Cumulative effects are those caused by the Steepbank Mine project when combined with other major existing and reasonably foreseeable projects. It involved looking at the potential effects on a broader spatial and temporal level by considering the following:

- The additional or incremental effect of the Steepbank Mine project on the biophysical resources within the Regional Study Area; and
- The incremental effect of the project and other planned projects in the Regional Study Area.

Cumulative effects assessment provides a means to assess the relative contribution of the project to overall effects on valued ecosystem components (VECs) within the region. The use of the regional ELC map allows quantification of the relative losses of different habitat types, which support various VECs. This provides a means for resource managers and project planners to mitigate potential impacts where possible.

D1.3 IMPACT ANALYSIS FORMAT

Each of the six hypotheses identified in the issue scoping stage of the assessment were described and analysed according to a standard protocol. This involved first of all describing the nature of the hypothesis and any sub-hypothesis or specific areas of concern which could be subdivided within the main hypothesis. The next stage of analysis identified linkages and modes of impact which could occur as a result of the development. This is presented using flow diagrams and summary supporting text.

An analysis of impacts section examines the potential impact using figures and tables to quantify impacts where possible, both within the local and Regional Study Areas. Impacts were then classified using the information presented in the analysis section to summarize and classify the impact according to the criteria of impact direction (positive or negative), impact severity (magnitude or importance) and impact duration (time for recovery). This information is presented for each hypothesis in a summary table, along with supporting text. A cumulative effects section is included to address the combined impacts of Suncor's proposed Steepbank Mine development with other existing and proposed developments in the Regional Study Area. Finally, each analysis is concluded with a summary section on the degree of confidence in the assessment based on the limitations of the data and analysis.

D2.0 HYPOTHESIS 12

Important habitats (or VECs) in the Athabasca River valley could be affected by development, operation and reclamation of the Steepbank Mine and Lease 86/17.

D2.1 HYPOTHESIS DESCRIPTION

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 encompasses not just the proposal to expand mining operations on the East side of the Athabasca River, but also includes the reclamation and possible future land uses of Lease 86/17 on the West side of the river. The environmental impact assessment and Conservation and Reclamation Plan (Suncor 1996) was prepared to address these concerns in an integrated manner.

Impacts to valued ecosystem components (VECs) within the Athabasca River valley can be viewed at the broad landscape level (such as the entire river valley) as well as at the more detailed level of specific vegetation communities or individual plant species. Each level of VEC analysis is discussed under this hypothesis for the Steepbank Mine and Lease 86/17.

An overview of the project lands is shown on Figure D2.0-1. The dominant impact on VECs within the Local Study Area will occur during construction and throughout the operational period of the mine. This will involve activities such as site clearing, grading and excavation, as well as overburden removal and storage. Landscape change will encompass alteration in landform, surface drainage, soil and vegetation conditions as new leases are developed. At the same time, areas where mining is completed, such as the existing mine and tailings storage areas on Lease 86/17, will be reclaimed. Figure D2.0-2 illustrates the project components that will affect the VECs, lists the ways in which the resource will be affected (i.e., linkage), identifies mitigation measures and provides reclamation objectives.

Reclamation initially involves re-establishing landforms and drainage patterns, followed by replacing overburden and previously salvaged topsoil. Subsequently, vegetation types suitable for specific site conditions on particular landform types and under variable soil and drainage conditions are established. The goal in reclamation is to re-establish ecological processes capable of sustaining a diversity of plant and animal life that reflects the natural surrounding environment. Further details regarding reclamation planning are discussed under land use options in Hypothesis 13.

Biophysical impacts are examined under Hypothesis 12 by looking at landforms (ecosections) and vegetation communities (ecosites) in an integrated fashion. The inter-relationship between landform, soil, drainage and vegetation is important in the assessment of impacts to valued ecosystem components (VECs), biodiversity and wildlife habitat. It is of particular importance in our understanding of reclamation and the options which exist for landscape reclamation in both the long- and short-term.

Disturbances which result in the removal or disturbance of landforms (ecosections), or portions of ecosections and ecosites (vegetation and soil types), can be quantified and assessed within the context of both the local and Regional Study Area. In addition, it is possible to compare the predicted and later the actual losses and gains of these map units over the life of the project. Impacts to landforms (ecosections) and vegetation communities or individual species (ecosites) are described under specific sub-hypotheses which address landform, soil and vegetation conditions within the local and Regional Study Area.

D2.2 LANDFORM VEC ANALYSIS

D2.2.1 Sub-hypotheses

At the landscape level of VEC analysis, stakeholders have identified the Athabasca River valley as a key area of concern with respect to the Steepbank Mine development and reclamation of Lease 86/17. Disturbance of the river valley will include impacts on the riparian floodplain, terraces and escarpment slope landforms, each of which can be examined within the context of the local and Regional Study Area. Sub-hypothesis resulting from development within the river valley include impacts to landforms, soil and vegetation resources.

a) <u>Landform Impacts</u>

Landforms here include the terrain and geology of the Athabasca River valley, including the surficial materials made up of glacial, glacio-fluvial, colluvial, alluvial and organic deposits. During construction and mine operation, landforms will be substantially altered by heavy equipment operations, resulting in an overall simplification of the pre-disturbed landscape. Slopes will be modified through the removal and storage of surficial materials such as overburden. Existing drainage patterns will be re-directed to allow dewatering of mine sites and facility infrastructure (Figure D2.0-1).

In summary, landform impacts within the river valley will involve:

- Landform alteration
- Landform coverage by materials

- Slope simplification
- Surface drainage change

b) Soil Impacts

Soil impacts will also occur as a result of mine preparation and facility construction. Along the escarpment slopes, thin, residual soils (Rough Broken map unit) will primarily be affected while at lower elevations, on the floodplain terraces, organic soils (Terric and Typic Mesisols), as well as poorly-drained mineral soils (Gleyed Regosols) will be disturbed (CAN-AG Enterprises Ltd. 1996). Within some gently sloping areas of the upper escarpment, the dominant soils to be affected will be organic muskeg soils (Terric and Typic Mesisols).

The principal soil impacts can be summarized as follows:

- Soil mixing and burial
- Soil organic matter change
- Soil compaction/physical change
- Soil erosion/loss
- Soil contamination/chemical and biological change

c) Vegetation Impacts

Vegetation impacts will occur during mine site preparation and construction activities. This will result in the direct removal of native vegetation as well as through indirect impacts following mine dewatering and natural drainage pattern change. Within the Athabasca River Valley, a variety of vegetation types will be affected on the floodplain and escarpment slope landforms.

The principal vegetation impacts include:

- Loss of native vegetation
- Change in plant community composition, density and structure
- Reduction in plant community diversity
- Introduction of non-native species

D2.2.2 Primary Linkages/Modes of Impact

The primary linkages/modes of impact associated with landscape alteration within the Athabasca River valley are summarized in Figure D2.0-2. These linkages and testable hypotheses include:

1. Mine preparation and facility construction such as roads, utilities, plant facilities and the bridge will result in the loss of important habitats (or VECs) within the Athabasca River Valley.

2. Site clearing, grading, excavation, overburden removal and storage will affect landforms through: landform alteration, slope simplification and surface drainage change.

3. Site clearing, grading, excavation, overburden removal and storage will affect soils through: soil mixing and burial, soil organic matter change, soil compaction/physical change and soil erosion/loss.

4. Site clearing, grading, excavation, overburden removal and storage will affect vegetation through: loss (or removal) of native vegetation, change in plant community composition, density and structure, reduction in plant community diversity and introduction of non-native species.

5. Mine dewatering will result in drainage alterations and local stream diversions, resulting in changes to vegetation composition and structure.

6. Mining operations will further affect landforms through excavation and slope simplification.

7. Emissions from mining operations will affect vegetation composition, density and structure. (See Hypothesis 17 for further details).

Both direct and indirect effects are identified at each stage of project development.

D2.2.3 Impact Analysis

An analysis of the impact which the Steepbank Mine project may have on the Athabasca River valley first involves determining the area of river valley which may be affected. Within the Local Study Area, the river valley is defined as including the Riparian Floodplain, the Floodplain Terraces and the Escarpment Slopes (to the junction of the slope crest with the Upland Organic/Lacustrine Plain ecosection) landforms or ecosections. The Riparian Floodplain occupies 3.7% of the Local Study Area, the Floodplain Terraces, 5.6% and the Escarpment Slopes 10.1% (Table D2.0-1). In total, the Athabasca River valley occupies 19.4% or 7,725 ha of the Local Study Area. By contrast, the majority of the Local Study Area is made up of the Upland, Organic/Lacustrine Plain (42%, Table D2.0-1).

The impact of the Steepbank Mine on the landscape over time is shown on Table D2.0-2. Using 1995 as a baseline, the hectares and relative percent change of the landform with respect to the Local Study Area is summarized for the years 2001, 2010 and 2020. The latter year sees the maximum development of the mine "footprint" on the landscape. In the year 2001, the most development occurs within the riparian river terraces, associated with construction of the ore sizing and pre-processing facilities as well as the hydrotransport system and shop facilities. Some 116 hectares or 5.2% of the riparian river terrace within the Local Study Area will be affected (Table D2.0-2). By the year 2010, development occurs primarily within the Riparian Escarpment (702 ha or 17.5% of this landform within the Local Study Area) and on the Upland Organic/Lacustrine Plain (373 ha or 2.2% of this landform within the Local Study Area). Such development is associated with the mine pits, tailings pond and overburden dykes. By the year 2030, development is focused on the Upland Organic/Lacustrine Plain with 1,284 ha (or 7.6% of this landform in the Local Study Area) being developed. This development is associated with the maximum expansion of the mining activities.

With respect to the Athabasca River valley, the most development occurs within the 2010 time period when 89 ha are developed within the riparian floodplain (6% of the riparian floodplain within Local Study Area), 222 ha are developed on the riparian terraces (10% of the Local Study Area riparian terraces) and 702 ha are developed along the escarpment (17.6% of the escarpment slope within the Local Study Area) (Table D2.0-2). By 2020, the total area affected within the river valley

Table D2.0-1
Landform (Ecosection) Within The Local Study Area (ha And Percentage)

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 Plain	16,792	42.0
Highland Moraine	2,030	5.1
Midland Organic/Lacustrine Plain	5,665	14.1
Midland Drainages	2,700	6.6
Suncor Lease 86/17	3366	8.4
Athabasca River/Water Bodies	1,345	3.0
Total	40,224	100

Shaded Rows: Valued ecosystem components at the landscape level (Athabasca River Valley)

TABLE D2.0-2
LANDFORM DEVELOPMENT WITHIN THE LOCAL STUDY AREA (MINE ADVANCE PLAN)

Landform/Ecosection	1995	2001		2010		2020				
	Incremental Mine Advance (ha)									
	[a]Landform Area in Local Study Area (ha)	ha lost in Landform Type	[a]% of loss of Landform Type	ha lost in Landform Type	[a]% of loss of Landform Type	ha lost in Landform Type	[a]% of loss of Landform Type	Total ha Lost of Landform	Cumulative % loss of Landform Type	Total % loss of Landform Type
Riparian Floodplain	1474	5	0.3	89	6.0	6	0.4	100	6.8	
Riparian River Terraces	2228	110	4.9	222	10.0	35	1.6	367	16.5	River Valley - 21%
Riparian Escarpment	4024	76	1.9	697	17.3	356	8.8	1129	28.1	
SUBTOTAL - River Valley[b]	**7726**	**191**	**2.5**	**1008**	**13.0**	**397**	**5.1**	1596	20.7	
Upland Organic/Lacustrine	16792	25	0.1	373	2.2	1216	7.2	1614	9.6	Upland - 10%
SUBTOTAL - Uplands[b]	**16792**	**25**	**0.1**	**373**	**2.2**	**1216**	**7.2**	**1614**	**9.6**	
Athabasca River/Water bodies	1,345	1	0.0	2	0.1	1	0.1	2	0.2	Athabasca River/ Waterbodies - 0.2%
Total	**25,863**	**216**	**0.8**	**1383**	**5.3**	**1614**	**6.2**	**3213[c]**	**12.4**	**Total % change of landforms Affected = 12%**

[a] Landform area in Local Study Area refers to the total areal extent of the landform (ecosection) within the local study area.

[b] Subtotals include either the entire River Valley, from rivers edge to escarpment crest, or the entire Uplands on the east side of the Athabasca River. The percentage change for subtotals is expressed as a proportion of the River Valley or Upland Total

[c] Value differs from the actual mapped Steepbank Mine extent of 3226 ha by 13 ha due to rounding and interpolation errors.

SHADED ROWS - **Valued Ecosystem Component at the Landscape level (Athabasca River Valley)**

TABLE D2.0-3

LANDFORM (ECOSECTION) DISTURBANCE BY PROJECT FACILITY WITHIN THE LOCAL STUDY AREA, STEEPBANK MINE (2020)

Project Component	Ecosection	Area (ha)	% of Total
Mine Infrastructure		267	8
	Riparian Floodplain	6	0
	Riparian River Terraces	162	5
	Riparian Escarpment	99	3
	Water	0	<0.1
East Overburden		162	5
	Riparian Escarpment	0	0
	Upland Organic/Lacustrine	162	5
Pond 7, Dyke 10		765	24
	Riparian River Terraces	6	0
	Riparian Escarpment	522	16
	Upland Organic/Lacustrine	236	7
	Water	1	<0.1
West Overburden		178	6
	Riparian Floodplain	93	3
	Riparian River Terraces	83	3
	Water	2	<0.1
South Overburden		606	19
	Riparian Escarpment	26	1
	Upland Organic/Lacustrine	580	18
	Water	0	<0.1
North Overburden		145	4
	Riparian River Terraces	39	1
	Riparian Escarpment	106	3
Dyke 11		89	3
	Riparian Floodplain	1	0
	Riparian River Terraces	39	1
	Riparian Escarpment	36	1
	Upland	13	
	Water	0	<0.1
Pond 8 A/B, Dyke 11 A/B, Dyke 12		852	26
	Riparian River Terraces	65	2
	Riparian Escarpment	380	12
	Upland Organic/Lacustrine	407	13
Active Mine		163	5
	Upland Organic/Lacustrine	163	5
	Water	0	
	Total Area	**3226**	**100**

encompasses 101 ha within the floodplain (6.9% of the floodplain within the Local Study Area), 373 ha in the river terraces (16.7% of the Local Study Area) and 1,147 ha along the escarpment (28.5% of the Local Study Area) (Table D2.0-2).

A total area of 1,627 ha will be impacted within the Athabasca River valley, representing some 21.1% of the river valley within the Local Study Area (Table D2.0-2). A total of 1,686 ha will be developed within the Uplands adjacent to the river valley, representing approximately 10% of the Uplands within the Local Study Area (Table D2.0-2). The total area affected by the Steepbank Mine development on all landform types is 3,310 ha, or 12.8% of the Local Study Area.

The Steepbank Mine development facilities which will impact each landform type are shown in Figure D2.0-3 and on Table D2.0-3. An analysis of Table D2.0-3 shows that the greatest areal extent of disturbance is associated with Pond 8 (A and B), Dyke 11 (A and B) and Dyke 12, together comprising 1,090 ha, or 33.1% of the development. Of this total, more than half takes place within the Upland Organic/Lacustrine Plain (604 ha). Within the Athabasca River valley, the greatest disturbance is associated with Pond 7 and Dyke 10 where 529 ha are affected within the combined riparian river terraces (7 ha) and the riparian escarpment (522 ha). The next greatest level of disturbance is associated with Pond 8 (A and B), Dyke 11 (A and B) and Dyke 12 with a combined total of 486 ha disturbed within the river valley. Lesser disturbances are associated with the mine infrastructure, north overburden area and Dyke 11.

D2.2.4 Impact Mitigation

The recommended mitigation measures to minimize the impact on the Athabasca River valley are shown on Figure D2.0-1 and are summarized as follows:

1. Loss/disturbance of important habitats (or VECs) in the Athabasca River Valley can be mitigated through facility planning, siting and landscape reclamation.

2. Reclamation will initially include site preparation of the area to be reclaimed, involving: re-grading, re-contouring and re-establishment of surface drainage patterns. Replacement of topsoil will be followed by revegetation.

3. Reclamation objectives will include the re-establishment of river valley function and character, ecological processes and habitat diversity. A specific river valley reclamation plan is currently being developed as part of the Conservation and Reclamation Planning process (Suncor 1996).

4. Specific reclamation activities will involve the stabilization of landforms and the creation of a diversity of landform types appropriate to the river valley location and slope position.

5. Specific reclamation planning will involve terrain stabilization, restoration and re-establishing nutrient cycling and soil capability.

6. Specific reclamation planning will involve re-establishing native plant communities compatible with pre-disturbance conditions and allowing for self-sustainable vegetation growth.

Mitigation begins with mine planning and environmental design. This includes minimizing the impact on the river valley and crest of slopes where possible. Perhaps the most important mitigation measure, however, is the sequential development and phased reclamation of those lands which are no longer required for mining purposes. This balance of development and reclamation ensures that a variety of vegetation types and age classes are established on both Lease 86/17 and the Steepbank Mine.

The flexibility of reclaiming different kinds of land surfaces with muskeg topsoil and various vegetation types is also an advantage in reclaiming habitat types or ecosites. The process begins with re-grading and re-contouring the rebuilt landscape, followed by establishing surface drainage patterns and replacement of topsoil. Revegetation is achieved through natural vegetation growth arising from the muskeg or from seeding and plantings. This process is summarized in Hypothesis 13 and explained in detail in the Conservation and Reclamation Plan (Suncor 1996).

The objectives of reclamation with respect to landforms are to restore landform stability and diversity on the disturbed site. Figure D2.0-3 and Table D2.0-3 show that within the Athabasca River Valley, the Riparian Escarpment will be altered primarily through the construction of dykes and ponds. The dyke surfaces will be graded and contoured to approximate natural slope conditions where feasible; however, slope contouring options are limited given engineering constraints. Greater flexibility exists in the choice of vegetation. Mixedwood forest is the preferred vegetation type for reclamation of dyke surfaces along the escarpment slope. This is generally consistent with the dominant vegetation types which are found at present along the escarpment and also meets aesthetic and wildlife habitat reclamation objectives (see Impact Analysis Suncor Steepbank Mine Environmental Wildlife component, Westworth, Brusnyk and Associates 1996). Reclaimed ponds also provide an opportunity to reclaim a variety of wetland vegetation types, depending on site-specific topographic, drainage and soil conditions.

Overall, the intent of mitigation measures to alleviate impacts on the Athabasca River Valley is to utilize the engineered surfaces of dykes and ponds within the valley to create a diversity of site conditions through grading, contouring and drainage control, and to emulate pre-disturbance conditions as much as possible. Revegetation measures, coupled with natural succession, will result in re-establishment of a variety of vegetation types at different age classes to meet reclamation and mitigation objectives.

D2.2.5 Impact Classification

The classification of impacts to landform VECs in the Athabasca River valley are shown on Figure D2.0-4. Impacts within the river valley are considered of low severity during the construction period with less than 2.6 % of the river valley impacted within the Local Study Area (Table D2.0-3) According to the definition of impact severity, this corresponds to a low impact of local geographic extent, confined within the Local Study Area. The duration of the construction impacts is considered long-term, extending for more than 18 years beyond the completion of construction.

Impact severity increases to high during the mine operational period, primarily as a result of the extent of river valley disturbance within the Local Study Area (21.1%). Within the Local Study Area, this represents some 1,619 ha of river valley landforms which will be affected by the Steepbank Mine operation to the year 2020. This can also be equated to a regional level impact of low severity.

The duration of impacts during the construction period will be long-term, extending beyond 30 years from the completion of mining operations. Impacts during the closure stage are also of long-term duration, given the alteration in river valley landforms from the pre-disturbed landscape condition. The severity of impacts is however reduced to moderate as final landscaping and revegetation efforts provide the basis for long-term reclamation. The overall degree of concern associated with impacts to the Athabasca River Valley at a landform level is described as moderate.

D2.2.6 Cumulative Effects Assessment

To examine the cumulative effects of the proposed development on the Athabasca River Valley, the area to be affected was examined in a regional context. The length of river valley which is currently affected is approximately 8.6 km. Future river valley disturbance will affect 12.7 km, which will increase the total affected area by 4.1 km. Within the Local Study Area, the Athabasca River Valley extends for 25 km, while in the Regional Study Area it is 169 km. Within the entire Mid-Boreal Mixedwood Ecoregion of Alberta, the Athabasca River extends for 872 km from Whitecourt to the Peace-Athabasca Delta (Strong and Leggat 1992). The Mid-Boreal Ecoregion is the largest in Alberta and covers approximately 32% of the province. This illustrates the challenge of assessing impacts at different scales and within meaningful boundaries.

Further Oil Sands developments, including the expansion of Syncrude's Mildred Lake Mine and proposed Aurora Mine, will primarily take place on the uplands beyond the river valley. Only a small area of river valley will be affected by the Mildred Lake expansion.

D2.2.7 Degree of Confidence

The degree of confidence associated with the ratings for river valley impacts is high, given that it is possible to quantify the areas of impact from mine plans superimposed on the biophysical data base for the Local Study Area. The severity or magnitude of impact is therefore determined from the relative percentage of landform or habitat type altered. There is less confidence in the duration of impacts as recovery from impacts at the landscape level is problematic by definition. The disturbed river valley landscapes will not be restored to pre-existing conditions, rather they will be reclaimed to approximate similar slope conditions so that they can support similar vegetation types. In this regard, the duration of impacts is long-term for each stage of the impact assessment.

D2.3 VEGETATION COMMUNITY AND SPECIES VEC ANALYSIS

To provide a focussed assessment of impacts to vegetation resources, Valued Ecosystem Components (VECs) were identified through a process which combined stakeholder input with a criteria scoring process (Section C). In addition to VEC impacts, other vegetation affects within the Athabasca River valley were identified, and involved primarily the loss of Closed Deciduous Aspen forest along the escarpment slopes, along with lesser amounts of Closed White Spruce and Closed Shrub communities at lower elevations and within the floodplain. Along the escarpment crest, small stands of Closed Jack Pine will be lost, while in low-lying, depressional areas along the edge of the escarpment and upland interface, disturbance to Closed and Open Black Spruce Bog communities, Open Tamarack Fen and Black Spruce-Tamarack Fen communities will occur. Vegetation impacts within the Athabasca River Valley were examined in this context.

Vegetation impacts would occur primarily during the construction and operational stages of the project as vegetation is removed during the site preparation, clearing and dewatering process. Plant communities will be lost due to the direct effects of clearing and possibly from indirect effects which could occur as a result of changes in surface drainage patterns, soil moisture, soil capability and air emissions. Indirect impacts are likely to result in a decrease in plant vigour, an increase in plant mortality, community composition changes and an overall loss of species in the affected area. In addition, reclamation and revegetation activities typically result in the introduction of unwanted opportunistic species. The principal impacts on vegetation can be summarized as follows:

- Loss of native vegetation;
- Changes in plant community composition, density and structure; and
- Reduction in plant community diversity.

D2.3.1 Sub-hypothesis

At the vegetation community level of VEC analysis stakeholders identified a number of habitat or vegetation types that are of key concern with respect to the Steepbank Mine development and reclamation of Lease 86/17 in general, and the Athabasca River Valley in particular. VECs were identified based on a number of criteria including: community type, rarity, rare plant potential, sensitivity to physical disturbance, sensitivity to pollutants, recreation potential, biodiversity, traditional use and economic importance (Section C). The community level VECs within the Athabasca River valley which scored highest on most of these criteria were:

- Mature forests;
- Jack Pine/Lichen Communities; and
- Riparian Wetlands (including Open Water/Emergent Vegetation Zone and Closed Shrub wetlands margins).

D2.3.2 Primary Linkages and Modes of Impact

During construction and mine operation, portions of these VEC communities will be cleared by heavy equipment operations, resulting in a loss of community composition, structure and function. In addition, the impact to soil resources and existing drainage patterns will further result in long-term losses to portions of these habitat types within the Athabasca River Valley until they are reclaimed (Figure D2.0-1). During mine construction, impacts to important vegetation communities within the river valley are primarily related to construction of the mine infrastructure, including bridge abutments, roads, storage facilities, hydro-transportation, and loading/unloading zones. During mining operations, impacts to the river valley will occur due to mining of the escarpment and placement of overburden piles on the floodplain.

D2.3.3 Impact Analysis

a) <u>Mature White Spruce and Balsam Poplar Forests</u>

Definitions of mature, old-growth 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 and structural heterogeneity (Franklin et al. 1981, Greene 1988, Old-growth Definition Task Force 1986). 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 to 112 year cycle (Fairbarns 1991), only a small proportion of the stands are likely to be older than this.

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 Region were identified. Of these, seven stands were old growth white spruce associated with river valley terrain. It is likely that a higher incidence of old-growth forests in this region are associated with floodplain areas where harvesting has not occurred. Conditions are moister in such locations, lightning strikes are less frequent, wind patterns vary from the uplands, and the escarpment slopes and rivers may have formed a fire barrier in the past.

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. Mature river valley forests were characterized as such based primarily on age and the following characteristics:

- 160 years for White Spruce and Balsam Poplar (Alberta Forest Service, pers. comm. 1996);
- Highly-structured forest;
- Regeneration of dominant overstorey trees within the understorey; and
- High presence of decadent trees, snags and deadfall.

The mature White Spruce and Balsam Poplar forests on the floodplain and escarpment slopes of the Athabasca River were found to be highly structured and diverse (which is not typical of old growth spruce forests in the Pacific Northwest). Due to a lower maximum age of balsam poplar, these stands showed signs of decadence. As a result, the canopy was quite open, allowing for a very high cover and diversity of the shrubby understorey, with some minor succession to white spruce.

Fairbarns (1991) classified all old growth deciduous-conifer stands in the Boreal Mixedwood Forest as Mixedwood Old Growth, using the following characteristics:

- Large canopy volume with conifer-dominated canopies over 18 m tall;
- Abundant conifer regeneration leading to a deep understory and a high degree of foliage height diversity;
- Canopy gaps created by small-scale mortality characterized by abundant deciduous and evergreen shrubs and saplings;
- A carpet of feather mosses with scattered herbs and shrubs under the intact forest canopy;
- Abundant coarse, woody debris in various size and decay classes on the forest floor;
- A pit-and-mound soil micro-topography created by root-throw as canopy trees fall;
- A thick organic mat on the intact forest floor;
- Live canopy trees with broken tops, cavities and gnarled branches; and
- Abundant standing dead trees (snags) in varying heights and decay classes.

The stands classified as mature in the Steepbank Mine Study Area typically had all of the above characteristics, although the small stands of mature balsam poplar were largely devoid of spruce regeneration and feather moss cover, likely due to the very high shrub and herb cover.

Within the Local Study Area, the Athabasca River Valley occupies 7,726 ha, or 19.2% of the total area. Within this area, 1,207 ha is comprised of white spruce. Alberta Vegetation Inventory (AVI) mapping was conducted for the footprint of the proposed mine and, through this process, 380 ha of mature white spruce forest was identified within the river valley portion of this area (Table D2.0-4). This is almost 30% of the total white spruce cover within the river valley component of the Local Study Area. Mature balsam poplar is also a component of the mature forests, accounting for a portion of the Riparian Floodplain deciduous cover. Approximately 71 ha of mature balsam poplar forest lies within the proposed footprint of the Steepbank Mine (Figure D2.0-5), situated within the Floodplain Ecosections. This accounts for 5.4% of the 1,309 has of deciduous forest on the Athabasca River Floodplain.

Table D2.0-4 indicates the potential impacts to mature white spruce and balsam poplar forests during each phase of mine development, operation and reclamation. The regional cover of mature white spruce was provided by the Forest Service Branch of Alberta (1995), showing a known resource of 628 ha; however, this data was not available for mature balsam poplar stands.

Based on this information, and the potential impacts of the Steepbank Mine to mature forests within the Athabasca River Valley, by the year 2020, 320 ha of mature white spruce forest will be lost. Using the Forest Service Data, this represents a loss of almost one half of the mature white spruce in the region. However, it is important to note that none of the stands identified in the footprint of the Steepbank Mine are included in the Forest Service mature forest database (Westworth 1990). Therefore, it is likely that only large, harvestable stands have been identified in the Phase III forestry maps, which did not map or recognize smaller stands or unharvestable stands (due to terrain and water quality concerns) such as those identified in the Steepbank Mine area.

Due to insufficient data (both regionally and locally) regarding the location and area of mature forest stands, it is not possible to estimate the percent loss of this resource within the river valley. However, the proposed Steepbank Mine would remove 320 ha of mature white spruce, from the total of 380 ha present within the footprint of the Steepbank Mine in the Athabasca River Valley (Table D2.0-4). This represents a decline of 84.2% of mature white spruce forests within the river valley component of the Steepbank Mine footprint. In addition, this loss represents 30% of the total closed white spurce forest in the River Valley component of the Local Study Area.

Mature balsam poplar stands are not included in the Forest Service database. Therefore it is not possible to estimate the percent loss of this resource locally, or regionally. However, it is recognized that the proposed Steepbank Mine would impact about 10 ha out of 130 ha of mature balsam poplar stands (7.7%) within the mine footprint, in the Athabasca River valley (Table D2.0-4). This would be incurred during Mine construction, from 1997 to 2001 (Table 2.0-4), after which no additional impacts to mature balsam poplar stands in the river valley would occur. In addition, this reduction represents a loss of 5.4% of the Deciduous Forest on the Floodplain Ecosections, within the Local Study Area.

TABLE D2.0-4
Suncor Net VEC Balance - Athabasca River Valley

Area: Athabasca River Valley - Local And Regional

		Local Study Area									Regional Study Area - River Valley		
		1995	2001		2010		2020		Longterm		1995	2020	Long Term
		ha	ha lost	% loss	ha lost	% loss	ha lost	% loss	ha lost	%lost	ha	% Lost	%change
Valued Ecosystem Components													
Vegetation Communities	ECOSITES												
Mature White Spruce Forests	Closed White Spruce-Floodplain, Floodplain Terrace and Escarpment Slopes[a]	380	40	11	220	na	60	na	320	na	na	na	na
Mature Balsam Poplar forests	Closed Deciduous - Floodplain[b]	130	10	na	0	na	0	na	10	na	na	na	na
Jackpine-Lichen Forests	Closed Jack Pine	621	46	7	10	2	26	4	70	11	4500	1	-4
	Closed Shrub Complex	684	8	1	39	6	0	0	48	7	12586	0	0
Riparian Wetlands	Open Water/Emergent Vegetation	44	4	9	0	0	0	0	1	2	0	0	0

na - old growth forest data is not available for the Local or Regional River Valley area

[a]These VECs are not mapped at a regional level

[b]Existing 1995 ha for these units is confined to the river valley component of the mine footprint

While impacts to mature forests are calculated in this report, it is also important to recognize that fire, logging and disease also contribute to forest impacts. Impacts which may be incurred as a result of the Steepbank Mine, could also occur in response to these other factors. The age of these mature stands, and the relatively old age of surrounding mixedwood stands suggests that a fire recurrence in this area could easily occur. There is abundant fuel in the form of living forest as well as accumulated deadfall and understory shrubs. However, the steep escarpment slopes and wide river valley with riparian wetlands may have served as a fire break and a rationale for logging restrictions in the past.

Forest harvesting activities of white spruce (clearcuts) have occurred within the south end of the Local Study Area, both on the escarpment crest and on floodplain terraces. It is possible that a portion of the mature forest stands in the river valley area would be harvested in years to come. Under the proposed mining plan, all merchantable timber would be salvaged (EnviResource 1996).

Disease is also a contributing factor to forest mortality. Dwarf mistletoe, pine bark beetle and spruce bud worm are or have been present in the area, and would also take a toll on some of the mature trees. In addition, the mature balsam poplars showed signs of decadence during the 1995 survey.

b) <u>Jack Pine Forests</u>

Potential impacts to Closed Jack Pine Forest within the Athabasca River Valley would primarily be a result of impacts to the escarpment, where jack pine was present in small stands located on rapidly-drained, sandy deposits and along slope crests and ridge tops. These sites are generally too drought-prone to support a significant cover of other tree species (Fairbarn 1991). Older jack pine forests tend to have few snags, but abundant small-diameter coarse woody debris. Their canopies tend to be even, rather than patchy, and structural diversity is low. Most of the jack pine stands within the river valley component of the Local Study Area were fairly small and isolated, and many showed old burn scars, indicating that these stands had escaped past fires. As a result, they were typically older stands. The return period for fire in this area is 80 to 120 years (Fairbarn 1991), such that most jack pine stands are burned over by this age.

Jack Pine Forests provided 621 ha of cover within the river valley area of the Local Study Area (Table D2.0-4). These stands were typically mature and supported a high lichen ground cover and blueberry component, adding to their VEC status.

Within the river valley component of the Local Study Area, a total of 167 ha will be impacted by the Steepbank Mine. This represents 24% of this resource within the local River Valley, and 3 % of this resource within the regional river valley study area (Table D2.0-4). Based on these figures, a high impact to jack pine forests within the river valley component of the Local Study Area is apparent by the year 2010, and in the long-term assessment. Table D2.0-4 does not reflect reclamation of Jack Pine Forests in the long-term, since this is not a component of the reclamation plans at Suncor.

The Steepbank Mine would result in a loss of 7% or 45 ha of jack pine forest within the Local Study Area, due to project construction (Table 2.0-4). Mine Development would result in an additional loss of 101 ha (16%) and Mine Operations from 2010 to 2020 would result in further losses of 21 ha, or 3.4%. In total, local jack pine cover would be reduced by 26% under the long-term planned scenario (Table D2.0-4).

c) <u>Shipyard Lake and Riparian Wetlands</u>

Riparian wetlands occurring within the footprint of the proposed mine, are primarily restricted to the Shipyard Lake wetlands and associated open water/emergent vegetation and wetland closed shrub vegetation. Characteristics of the important riparian marsh community type include a high interspersion of open water with emergent vegetation, a high rare plant potential, an ability to support plant species of traditional importance and use, a high species diversity and relative local rarity.

A preliminary reconnaissance survey of Shipyard Lake has been undertaken (Hamilton 1992). It is a marsh-swamp-shallow open water complex strongly influenced by its location within the Athabasca River floodplain (Figure D2.0-6). It has been subjected to periodic inundation over post-glacial time when the Athabasca overflows its banks. This wetlands system is still in transition from a shallow lake/pond to a marsh/swamp. It has an intermediate to rich nutrient status indicative of a steady flow of mineral-rich water and the periodic influx of river sediments. Water chemistry is similar to nearby creeks (Golder Associates 1996c). Oil and grease concentrations in the waters were below detection limits (1 mg/L). The presence of low but detectable concentrations of phenols and surfactants are likely natural by-products of organic matter decomposition. The sediments had a silty-clay texture and had adequate to abundant amounts of total nutrients.

Plant species in the southern and middle marsh zones include cattail (*Typha latifolia),* horsetail *(Equisetum fluviatile), Acorus calamus* and duckweek (*Lemna minor*). Species in the northern marsh zone include mountain alder (*Alnus tenuifolia),* willows *(Salix spp.),* buckbean *(Menyanthes trifoliata)* and yellow pond lily *(Nuphar variegatum)*. Submergent plants in open water areas included *(Elodea canadensis)*, pondweed *(Potomogeton sps).* and milfoil (*Myriophylum* spp.). The wetlands contain a relatively high species diversity of both phytoplankton (algae) and zooplankton (aquatic invertebrates). Fish populations were not surveyed, but it is assumed that this wetlands is not a rearing area for Athabasca River fish since fish passage between the two water bodies is unlikely (Golder Associates 1996c). Using laboratory testing, the water was observed to be non-toxic to Fathead minnows and bacteria (Microtox TM), but was somewhat toxic to the aquatic invertebrate *Daphnia magna*. Sediments were non-toxic to Chironomids (insect larvae). Mammals present during the 1992 survey included beaver and muskrat.

Pre-mine flows into Shipyard Lake are estimated at 111 L/s (3.5 x 106 m^3/y) (Klohn-Crippen 1996) and the total water volume was estimated at 2.16 x 106 cubic metres (assuming a mean depth of 1.5 m). Therefore, the theoretical hydraulic retention time (HRT) or the average time that water remains in the wetlands, would be 0.6 yr.

Wetlands are an important aspect 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 wildlife from both of these environments, resulting in highly diverse vegetation cover and composition. Shipyard Lake will receive discharge water from the mine (both surface and groundwater) and will be reduced in size due to the siting of an overburden dump within its eastern boundaries.

Riparian wetlands will be impacted by the proposed mine plan, with impacts primarily restricted to those associated with the placement of the overburden pile along the east side of Shipyard Lake (Figure D2.0-7). The areas of wetlands habitat loss in Shipyard Lake associated with the overburden pile are summarized in Table D2.0-5. In total, some 42 hectares (27.9%) of the wetland will be lost, composed of 37.9 ha of closed shrub vegetation and 4.4 ha of open water. Within the local river valley, there is 729 ha of riparian wetland vegetation which is classified as Wetland, Closed Shrub Complex and Wetland Open Water/Emergent Vegetation Zone. Impacts to these communities, associated with Shipyard Lake, account for a decline of 7% of the wetland closed shrub complex and 2% of the wetland open water emergent vegetation within the Athabasca River Valley component of the Local Study Area. This translates to a negligible impact within the Regional river valley area (Table D2.0-4).

TABLE D2.0-5
ESTIMATED WETLANDS HABITAT LOSS IN THE SHIPYARD LAKE AREA AFTER COMPLETION OF THE WEST OVERBURDEN STORAGE DEVELOPMENT

Year	Wetlands Class (hectares)			Total (ha)
	Open Water	Ratio of Open Water to Closed Shrub	Closed Shrub	
1995	23.3	1:5	128.0	151.3
2010	18.9	1:5	90.0	109.0
Total Loss (ha)	4.3	-----	37.9	42.3
Total Loss (%)	18.7	-----	29.6	27.9

Changes in water retention time within the wetlands and subsequent changes in patterns of channelization and/or nutrient inputs, can be expected. Changes in nutrient inputs due to changes in the overall mine drainage pattern are also likely.

Total riparian wetland habitat losses are estimated to be 27.9% for the total area of the wetlands (open water and closed shrub habitat) and a 18.7% decrease in open water area (i.e., waterfowl habitat). Although excess water inflow rates will be kept at pre-mine levels (i.e., atypical flooding will be prevented), the actual HRT (not presently known) will likely change due to changes in routine inflows. Also, the loss of area (i.e., water volume), resulting from the permanent storage of overburden within the eastern portion of this wetlands, will inevitably result in changes to the normal HRT patterns. Changes in both HRT and the present pattern of dispersed water inflows from surface and groundwater seepage will affect a change in the pattern of deposition and scouring of sediments and sediment-associated nutrients and hence change the numbers and/or distribution of various plants and animals (e.g., macrophytes, algae, zooplankton). Any increase in channelization (due to point source inputs) may also result in a consequent loss of substrate for the roots of aquatic plants. During routine flows, sediment deposition patterns would decrease in the predominant non-channelized areas with a consequent loss of sediment-associated nutrient inputs into the wetlands. Finally, since the contribution of groundwater flows to the overall drainage are less than 1% (Klohn-Crippen 1996), any impact of saline water on the wetlands ecology will be negligible.

D2.3.4 Impact Mitigation

The mitigation measures to minimize the impact on the Athabasca River valley are summarized in Section D2.2.4. In terms of mitigative measures to protect important habitat types, avoidance has been applied to reduce the loss/disturbance of important habitats (or VECs in the Athabasca River Valley). This has included avoidance of direct impacts to a portion of the Shipyard Lake wetlands and mature forest to the west, by stepping back the planned overburden pile in that area. Other protective steps will include measures to avoid overburden spillage into the wetlands area.

A series of retention ponds will be constructed along both the interception and mine drainage channels to regulate flows into the collection channels. Further, flooding into the Shipyard Lake wetlands will be controlled through construction of a diversionary channel which will bypass excess water from Shipyard Lake directly to the Athabasca River. However, it will likely not be possible to duplicate the present complex pattern of flows and flood events into this wetlands. Therefore, as discussed in Section D4.6.3.2, some changes in wetlands characteristics are likely. The final mine design would also alter water inputs into this wetlands from a point source discharge to a dispersed system (i.e., many inputs along the length of the adjacent drainage channel). A dispersed input system would increase actual retention times of water within the wetlands and would also decrease channelization. In addition, an area of deeper water would be included as a buffer between the reclamation drainage channel and the wetlands itself, thereby further dispersing water flows into the wetlands. The extent of this deeper area (i.e., over 2 m depth) would be optimized to replace equivalent open water habitat lost during the mine operation phase (estimated at 19 ha).

Specific reclamation plans include the mitigation losses of VEC vegetation communities, landscape reclamation, contouring, soil restoration and re-establishment of nutrient cycling and soil capability. Reclaiming to expedite the process of replacement of VEC community composition will include immediate transfer of salvaged muskeg/soil to areas of similar terrain and drainage conditions as those areas where the soil was salvaged. This has been shown on Lease 86/17 to promote the successful re-establishment of native vegetation. Immediate muskeg/soil transfer will ensure maintenance of roots, stolons, spores and seed sources. The revegetation program also involves the transplanting of shrub and young tree seedlings, raised from seed or cuttings taken from the Suncor Local Study Area. Further details on the Suncor Reclamation Program are provided in the Conservation and Reclamation Plan (C&R) included as Section D3.0 of the Steepbank Mine Application (Suncor 1996).

D2.3.5 Impact Classification

The classification of impacts to Valued Ecosystem Components at the community level, within the Athabasca River valley are shown on Figures D2.0-8 (Jack Pine Forests) and D2.0-9 (Riparian Wetlands). The rating for impacts to mature forests was considered qualitatively since local and regional cover data for this resource with the Athabasca River Valley was not available. Impacts to the local river valley resource of mature forests was considered to be 'High'. This is based on the high loss of known mature forest cover within the mine footprint in the river valley (87%). In addition, this represents a 30% decline of the white spruce (all age classes) in the river valley portion of the Local Study Area. Regionally, the mature forest decline does not include a loss to any of the stands identified in the provincial database (Westworth 1990). Therefore the regional impact is considered to be 'Low'. Duration of impacts at both the local and regional scale is considered to be long-term due to the time required to re-establish mature forests. However, reclamation planning does include a high replacement of mixedwood and mixedwood white spruce dominant forests, which would eventually reach mature status.

Results of the Impact Analysis show a 'High' degree of concern for impacts to jack pine forests, and a moderate degree of concern for impacts to riparian wetlands within the Local Study Area. In addition, the local impact to both mature and jack pine forests is rated as 'High', due to the low percentage of these types within the local river valley area and the proposed mine area, respectively, and the relatively high cover of these stands on the west-facing escarpment and riparian terraces, within the mine development and overburden storage areas. However, jack pine is common outside of the river valley area and in this context losses are not considered significant, regionally.

D2.3.6 Cumulative Effects Assessment

An assessment of Suncor's contribution to cumulative impacts to mature forests, jack pine stands and riparian wetlands within the Regional Study Area indicates that Suncor is a relatively minor contributor (Table D2.0-6). However, the combination of impacts due to the major operators including Alberta Pacific, Northlands, Syncrude, Solv-Ex and Suncor indicates considerable impacts to some of the Valued Ecosystem Components identified in this report (Table D2.0-6). Direct impacts to jack pine stands (not including fire) are estimated at 9% of the present cover in the Regional Study Area, with Suncor accounting for a little over 1%, Syncrude accounting for approximately 2%, and Alpac/Northlands accounting for 6%. Fire is also a recognized source of impact to jack pine stands within the region but has not been accounted for due to unpredictability, both spatially and temporally. However, regeneration of jack pine after being burned over is typically rapid, of high density and highly successful.

The data available as to the area of mature forest stands and predicted impacts from other sources is inadequate to allow for quantitative cumulative effects assessment to this resource. However, it is known that a portion of the white spruce and mixedwood losses will consist of mature forest stands. The contribution of impacts due to Suncor's operations is likely greater than that which would occur from the proposed Syncrude mine, but is well below that which will occur due to logging activities. This is due to the high timber yield which is usually available from mature white spruce and mixedwood stands, and the projected harvest from Northlands to the year 2020 (Table D2.0-6). White spruce stands would be significantly impacted by the combination of impact sources, with 48% of the mapped resource within the region being removed by the year 2020 (Table D2.0-6). Suncor would account for about 1% of this loss, while Alpac and Northlands would account for 48%. However, it is important to recognize that while timber harvesting accounts for a high loss of mature forest stands, reforestation activities are directed at almost immediate tree plantings, with a Forest Management Plan directed at long-term replacement of forest communities.

The cumulative effects to riparian wetlands within the region cannot be quantified, since riparian wetlands are not separated out from other wetland types, in terms of impacts from other sources, such as Syncrude and Solv-Ex. However, it is apparent that cumulative impacts to wetlands as a whole within the Regional Study Area are relatively low, with the Wetland Open Water/Emergent Vegetation Zone being impacted by 0.8% by the year 2020, with Syncrude accounting for 0.6% of this total. The Wetland Closed Shrub Complex would receive losses to 2% of this resource within the Regional Study Area, primarily due to Syncrude's proposed Aurora mine (Table D2.0-6).

D2.3.7 Degree of Confidence

A number of variables reduce the degree of confidence that can be associated with the overall degree of concern rating given these resources. These include: an uncertainty as to the percentage cover of old growth forests within the local and regional river valley study areas; the long-term role of fire both spatially and temporally, and how it would act to naturally impact forest resources; and logging activities in the region. Therefore, only a moderate degree of confidence can be associated with the overall ratings. Due to the nature of the uncertainties, the degree of concerns are considered an over-estimate. The known area of old growth forests within the region, based on Phase III forestry maps is known to restrict its mapping and documentation to mature forest polygons of a minimum size.

For example, none of the mature stands identified within the river valley component of the proposed Steepbank Mine footprint were identified in the Phase III map analysis (Westworth 1990). Therefore, the percent of loss of this resource due to Suncor's Steepbank Mine is likely well below that which would be calculated based on the provincial forest service data. In fact, estimated impacts to mature forests represent no impacts to the known provincial mature forest database. In addition, the estimated loss of mature forest and jack pine stands over time, does not take into consideration losses which could be incurred by natural sources, such as fire and disease.

The ratings applied to the riparian wetlands and to jack pine forests are considered quite accurate given the capability of the satellite imagery to identify these resources. Inaccuracies may be related to less certainty in identifying Mixed Jack Pine-Conifer Stands and Mixed Jack Pine-Aspen Stands, and the generalization of small areas of jack pine and wetlands into surrounding vegetation types during the classification stage of data analysis. However, these inaccuracies are considered minor.

TABLE D2.0-6
CUMULATIVE VEGETATION IMPACT ASSESSMENT OF VEC VEGETATION TYPES, YEAR 2020 RELATIVE TO 1995 BASELINE

AREA: REGIONAL STUDY AREA

ELC Vegetation/Landuse Class	Total Coverage Area (ha)		Suncor	Syncrude Mildred L/Aurora	Solv-Ex	Alpac & Northlands[1]	Cumulative Loss/Gain (ha)	Percentage of 1995 Baseline
	1995 Baseline	2020						
Closed Jack Pine	29119	26551	-224	587	-26	-1731	-2568	-9
Closed White Spruce	43728	23151	-178	349	-3	-20745	-20577	-47
Closed Deciduous Forest	78738	95640	-673	2266	-32	19873	16902	21
Closed Mixedwood	62530	60383	566	-183	-3	-2527	-2147	-3
Closed Mixedwood, White Spruce Dominant	129594	110858	355	-1895	-3	-17193	-18736	-14
Wetland Closed Shrub Complex	214209	209657	-87	465	0	0	-4552	-2
Wetland Open Water - Emergent Vegetation Zone	13502	84	-32	-85	0	0	-117	-1
Total Area	**571419**	**526324**						

[a] Includes industrial areas and tailings ponds.
[1]Areas Harvested by ALPAC and Northlands return rapidly to a forest cover type, due to reforestation activities.
Information provided by Alpac are estimates based on draft timber supply analysis and may be subject to change.

D3.0 HYPOTHESIS 13

Existing and future use of the area's landscape could be limited by the development of the Steepbank Mine and Lease 86/17 reclamation.

D3.1 HYPOTHESIS DESCRIPTION

Land uses within the Local Study Area are guided by the Fort McMurray - Athabasca Oil Sands Subregional Integrated Resource Plan (Alberta Environmental Protection 1995). This document provides a comprehensive, integrated approach to the management of public land and resources in the region. A series of guidelines has been prepared regarding general resource development for the Athabasca - Clearwater area and for the protection of the Athabasca River Valley. Specific issues are addressed for various land use options and guidelines provided with respect to development opportunities and constraints.

Current land use guidelines and considerations in the region have been described under the following headings:

- Mineral and surface material resources
- Forest resources
- Settlement
- Access and infrastructure
- Recreation and tourism
- Water resources
- Fisheries
- Wildlife
- Ecological resources
- Historical resources

In addition, traditional uses, including hunting and trapping, are recognized as an important component of land use activities in the region.

Hypothesis 13 examines whether these land use options could be limited on the reclaimed lands of Lease 86/17 and the Steepbank Mine once mining operations have been completed. The assumption is that land use options are a function of the lanscape, soil, drainage and vegetation conditions on the reclaimed areas. To simplify the analysis, four land use options were examined from the perspective of whether reclamation efforts could provide the physical and biological basis to support subsequent land uses at various stages of mine development and reclamation.

The land uses selected for assessment are:

- Wildlife habitat;
- Recreation and tourism;
- Traditional uses (including hunting and trapping); and
- Forestry.

Development of the Steepbank Mine and the phased reclamation of Lease 86/17 will affect the types of land use that can occur on these areas during the construction, operation and closure (long-term) phases. The limitations to use are displayed graphically in Figure D3.0-1, showing the generalized land surface characteristics and the corresponding capability of that land surface to support each of the selected land use options over the course of mine operation and following long-term reclamation.

The analysis of this hypothesis involves consideration of land use capability, the Conservation and Reclamation Plan (Suncor 1996), vegetation establishment, development and sustainability and the "balance" between vegetation types and disturbed areas over the course of the mine development plan.

D3.2 SUB-HYPOTHESES

The Sub-hypotheses regarding limitations of future land use options are linked directly to the phasing of the mine advance plan and the success of the reclamation plan for Lease 86/17 and the Steepbank Mine. Potential effects on traditional use, wildlife habitat, recreation and tourism and forestry land uses can be assessed in terms of the reclaimed landscapes through consideration of the following:

- Phasing of the mine development will allow landscape reclamation to take place in sequence with development to minimize the extent of disturbed land at any one time.
- Disturbed landscapes will be reclaimed with stable slopes, compatible with the pre-disturbed terrain, to provide the basis for multiple land use such as wildlife habitat, recreational opportunities, traditional use and forestry (where compatible).
- Reclaimed soils will provide for vegetation establishment, and successional development to allow a diversity of vegetation community types to be established, compatible with the surrounding vegetation.
- Existing and future land use could be limited according to the type of reclaimed landform within the study area (e.g., consolidated tailings (CT) landforms, tailings sand dyke slopes, plateaus and overburden dykes).
- Existing and future land use could be limited depending on human and ecological health restrictions placed on certain reclaimed landforms or stages of reclamation. This issue is addressed in detail in the Impact Analysis of Human Health Issues Associated with the Steepbank Mine (Golder, 1996d).

The above issues are addressed in the Conservation and Reclamation Plan of the Steepbank Mine Application (Suncor 1996). A brief summary of the C&R Plan is provided in the analysis section (D3.4), as it relates to future land use options on the reclaimed landscapes.

D3.3 PRIMARY LINKAGES/MODES OF IMPACT

The primary linkages/modes of impact associated with limitations to existing and future use of the Steepbank Mine area and Lease 86/17 are illustrated in Figure D3.0-1 and summarized as follows:

- Existing mining and processing activity on Lease 86/17 will be replaced over time with land uses appropriate for a variety of reclaimed landscapes such as wildlife habitat, recreation and forestry (on suitable sites).
- Existing use of the Steepbank Mine area will be changed as a result of mine development and operation. Mining will alter the landscape (terrain, soil, drainage and vegetation) to the extent that traditional uses, wildlife habitat, and recreation will be affected.

- Land use options will be affected within the Athabasca River Valley as well as on the adjacent uplands.
- Land uses could be affected in areas adjacent to the developed lands, even though they are not themselves directly affected (for example through visual or noise disturbances).
- Access to adjacent land around the development may be affected, in turn affecting land use options during mining and following reclamation.
- Future use of the Steepbank Mine area will be affected by the stage of reclamation including the maturity of the vegetation successional development. This particularly affects use by wildlife.
- In the long-term, the diversity of land use options will be increased as a result of reclamation efforts.

D3.4 ANALYSIS

D3.4.1 Land Use Capability

Analysis of the impacts of land use change and the implications of such change on existing and future land use was conducted firstly by looking at the direct loss of soil resources within the Local Study Area. Soil provides the basis for forestry and agricultural land use options while also influencing the types of habitat which occur within the Local Study Area. The area of each soil type within the Local Study Area and the maximum area of disturbance to the year 2020 is shown in Table D3.0-1. The rating of each soil type for agricultural capability, as well as an initial rating of forestry capability, provides a means of assessing the overall loss of these soil resources.

The majority of the soils in the area are of low to very low capability for agriculture (Class 6 to 7). The best rated soil (Class 3) will not be impacted by the project. Class 4 soils (moderate limitations) are generally only minimally affected by the proposed development. The absence of current agricultural activity in this region makes reclamation for agriculture a very low priority in terms of end land use.

The rating for forestry capability is tentative pending acceptance of the proposed classification system (CAN-AG Enterprises Ltd. 1996b). The rating has five classes: Class 1 - highly productive;

Class 2 - moderately productive; Class 3 - marginally productive; Class 4 - currently non-productive and Class 5 - permanently non-productive. The classes are approximately equivalent to the Canada Land Inventory Forestry Capability Classes 3 to 7. From Table D3.0-1, it can be seen that a large proportion of the Local Study Area is non-productive forest (Class 4 and 5). The largest area of disturbance (1,629 ha) occurs in the Muskeg Soil Map unit which is rated as Class 5 for forestry (permanently non-productive).

A detailed assessment of forestry resources within the Steepbank Mine development area was prepared by EnviResource (1996). This report provides information on forest productivity, merchantability and understorey regeneration. Forest cover maps, updated to Alberta Vegetation Inventory (AVI) standards have been prepared at a scale of 1:10,000. In summary, the productive forest base of the lands to be directly affected to the year 2020 is dominated by aspen and balsam poplar (44%), black spruce (31%) and white spruce (19%). Only 3% each is made up of jack pine and tamarack. Thirty-four stands were identified within the development area as supporting merchantable forest stands, resulting in a total volume estimate (m^3) of the following:

- Aspen Poplar - 177,470m^3
- Balsam Poplar - 32,160m^3
- Black Spruce - 70m^3
- White Spruce - 51,895m^3
- Jack Pine - 5,250m^3

Where these stands would be directly affected by the Steepbank Mine, the timber will be salvaged prior to overburden removal.

As a future land use option, forest productivity may be enhanced through the provision of improved soil depth and drainage, for example, on the overburden storage areas. Forestry options may be improved in some locations compared to pre-development conditions; however, limitations may exist with respect to slope stability requirements to support logging and the desire for multiple land use options such as wildlife habitat, recreation and tourism, and traditional land uses.

While one reclamation goal may be to restore those formerly poorly-drained, organic-dominant soils to moderately productive forest, a more flexible goal, which addresses wildlife habitat and biodiversity requirements, is to produce a mosaic of both treed cover and shrublands, capable of supporting a variety of land uses. By improving local soil drainage conditions on previously poorly-drained organic soils, the opportunity for a greater variety of land uses such as wildlife habitat, recreation or forestry may be increased (Figure D3.0-1).

D3.4.2 Reclamation Plan

The Conservation and Reclamation Plan prepared for the Steepbank Mine application provides the basis to evaluate possible end land uses on the reclaimed mined areas (Suncor 1996). Considerations include: slope stability, erosion and drainage control, revegetation, and the re-establishment of self-sustaining ecosystems. An overview of the C&R Plan's goals and measures to re-establish ecosystems is provided in this section as it relates to the assessment of end land use options.

a) <u>Overview of the Conservation and Reclamation Plan</u>

The C&R Plan includes a discussion of the following:

- Project Goals - Project goals, design criteria and assessment techniques provide the basis for design of the project.
- Project Design Considerations - The project design phase incorporates: determination of reclamation objectives, including end use; assessment of pre-disturbance conditions; and selection of technologies best suited to achieve both operating and reclamation objectives.
- Operation Phase - This phase involves: oil sands mining and bitumen extraction; mine site preparation; physical reconstruction of landforms; surface contouring; subsoil placement; and establishment of major hydrologic systems. Landforms reconstruction will progress towards dry reclamation by applying new Consolidated Tailings (CT) technology, in which coarse and fine tailings are combined to form a stable deposit. Following this, subsoil construction techniques will produce a trafficable surface for the CT deposit, prior to soil reconstruction and revegetation.

TABLE D3.0-1
AREA OF SOIL ASSOCIATIONS DISTURBED IN THE LOCAL STUDY AREA AND THEIR CAPABILITY FOR AGRICULTURE AND FORESTRY LAND USES

Map Unit	Area in Local Study Area (ha)	Area Disturbed in 2020 (ha)	% of Local Area Disturbed	Soil Capability for Agriculture	Limitations	Forestry Capability Classes	Limitation
Algar (ALG)	26	5	19	5	wetness	4	wetness
Firebag (FIR)	156	105	67	4	low moisture retention	4	droughtiness
Horse River (HRR)	2932	0	0	3	climate	2	moisture regime
Kinosis (KNS)	3068	246	8.0	4	stoniness	2	moisture regime
Gleyed Kinosis (GLKNS)	3	3	100	5	stoniness	2	-
McLelland (MLD)	6848	418	6.1	7	organic	5	organic, wetness
McMurray (MMY)	537	15	2.7	4	organic	1	-
Gleyed McMurray (GLMMY)	275	94	34	6	wetness	4,5	wetness
Muskeg (MUS)	13548	1629	12.0	7	organic	5	organic, wetness
Ruth Lake (RUT)	1356	0	0	6	stoniness, moisture	3,4	droughtiness
Rough Broken (RB1 Complex)	382	0	0	5	slopes	3	droughtiness
(RB2 Complex)	623	313	50	5	slopes	3	droughtiness
(RB3 Complex)	2613	394	15	7	slopes	4	steep slopes

- Reclamation Phase - The reclamation phase involves soil reconstruction; revegetation; and establishment of wetlands and watercourses. Soil reconstruction and revegetation will commence as early as is practical following the operation phase. On Lease 86/17, most overburden storage areas and dyke slopes have already been reclaimed to healthy ecosystems inhabited by a number of wildlife species.
- Reclamation Performance Assessment and Monitoring - Performance projections of reclamation success are discussed based on results from pilot-scale testing. Once active reclamation is complete and vegetation has been re-established, Suncor will continue to monitor progress toward maturation of landscapes and ecosystems to provide the basis for its submission for reclamation certification.
- End Uses and Reclamation Certification - The proposed reclamation plan provides considerable flexibility and opportunities to address specific future land uses, including wildlife habitat, traditional land use, recreation and possibilities for commercial forest production.

b) <u>Goals</u>

Suncor's vision for reclamation of Lease 86/17 and the Steepbank Mine includes tasks (construction of secure landforms and re-establishment of productive, self-sustaining ecosystems) which will provide land use capabilities equivalent to those of the pre-mining environment. About 65% of the reclaimed area will be returned to upland forest; the remaining 35% will consist of shallow wetlands with some open-water areas. These tasks will be undertaken with minimal impact on the surrounding environment. The following general operational and reclamation criteria form the basis for the reclamation program design:

- Structures will be geotechnically secure. Catastrophic discharge of earth materials (coarse and fine tailings, overburden storage piles), particularly to the Athabasca River, must be controlled to an extremely low probability.
- Discharge of earth materials through surface erosion processes will be controlled to rates which are acceptable to the environment.
- Discharge of surface and seepage waters will be managed to ensure an acceptable level of impact on the Athabasca River.

- The ecosystems re-established on disturbed lands will be fully self-sustaining and will participate in natural biological evolutionary processes without presenting significant risk to resident or migratory species.
- Various end uses will be possible for the reclaimed landscape, with end use decisions made based on input from the community. Fully reclaimed lands will be maintenance-free, thereby justifying reclamation certification.

c) **<u>Soil Reconstruction, Revegetation and Ecosystem Re-establishment</u>**

The primary objectives of the revegetation program are to:

- Provide an erosion-resistant plant cover on tailings dyke slopes and overburden dump slopes;
- Utilize woody-stemmed reclamation species common to the region;
- Establish a diverse range of plant species, to re-create the level of bio-diversity common to the pre-disturbed site; and
- Establish a permanent, viable plant community, capable of developing into a self-sustaining cover of forest and shrub species suitable for traditional land uses and for wildlife use and with possibilities for recreation and other end uses.

Typically, the revegetation process begins with excavation and hauling of undisturbed muskeg soils to the reclamation area. This method (which is completed in the winter whenever possible) enhances site revegetation because dormant, in situ native seed and root fragments are transferred with the soil. Spreading of the muskeg soil to depths of 15 to 20 cm on the reclamation site is completed in early spring, with the usual result being an emergence of a variety of native, woody-stemmed species, forbs, wildflowers and grasses.

Revegetation objectives are achieved through implementation of a revegetation program, which involves: seeding of reclamation areas with ground covers designed to control erosion; area fertilization; and establishment of appropriate, woody plant species. Suncor currently uses barley as a ground-covering nurse crop on all reclaimed sites. Barley (an annual variety that does not reseed) provided erosion control without hindering development of native vegetation emerging from the muskeg soil, by leaving stubble which traps snow, thus protecting out-planted shrub and tree seedlings during the winter.

Fertilizer is applied during initial years of revegetation; applications are made over two to four years, depending on results obtained from annual monitoring programs. Yearly fertilizer application is then discontinued, so that developing herbaceous cover does not compete too vigorously with planted woody seedlings.

Suncor's revegetation program includes planting of woody-stemmed species, which enhances the return of the area to ecosystems similar to others found in the region and which assists in creation of four primary reclamation starter vegetation types, including:

- *Closed Mixed-Wood Forest - Coniferous Dominant (Pine Forest)* - This vegetation type will be established on the edges of tailings sand plateaus and slopes.
- *Closed Mixed-Wood Forest - Deciduous Dominant (Poplar-White Spruce/Shrub)* - This vegetation type will be established on the moister areas of tailings and plateaus and consolidated tailings deposits. It will also be established on overburden dykes used to re-establish Steepbank Mine escarpment areas within the Athabasca River Valley.
- *Closed Mixed-Wood Forest - Coniferous Dominant (White Spruce-Poplar/Shrub)* - This vegetation type will be established on the overburden dumps, the more mesic sites on tailings dyke slopes (lower portions of the slopes, areas with northerly aspects) and on reclaimed tailings ponds (where consolidated tailings is used to create areas with lower water tables than poplar-dominated sites).
- *Wetlands Closed Shrub Complex* - This vegetation type will be established on poorly-drained areas of tailings sand plateaus and consolidated tailings deposits.

Reclamation activities on CT-reclaimed storage structures will involve several steps, beginning with the dewatering of the CT-filled area and its undergoing of freeze-thaw cycles (to strengthen the surface). After this initial dewatering period, additional lean CT mixtures or tailings sand will be used to fill the upper layers of the area and to create the hummocky surface. Soil amendments will be placed over stabilized surface materials, primarily during the winter. Revegetation of the hummocky, CT-reclaimed storage area will follow, commencing with seeding the hummocks with barley to provide immediate surface stabilization. Shrubs and woody-stemmed species will be planted, with the selection of species based on experiments conducted (starting in 1996) to identify those species which are more tolerant to CT release water chemistry.

Further details on specific reclamation techniques and methods are provided in the C & R section (Suncor 1996). Reclaimed landscapes are expected to have the flexibility to accommodate a number of end uses and will exhibit the following characteristics:

- Reclamation landforms created will meet or exceed stability requirements. Implementation of the consolidated tailings process eliminates the requirement for fluid-retaining structures. Planned landform modifications will both eliminate future maintenance requirements and satisfy long-term stability requirements.
- The effects of erosion on reclaimed landscapes will be controlled through a combination of drainage design and ecosystem re-establishment. Reclaimed areas will experience natural erosive processes; however, the extent of gullying will be limited by natural means with self-healing processes consistent with those of undisturbed areas.
- Drainage systems developed on reclaimed landscape will function effectively in channelling area waters to off-site environments. These waters, which will be treated naturally within the wetlands systems developed as components of the drainage network, will have acceptable impacts on the receiving environments.
- Ecosystems re-established on reclaimed sites will be self-sustaining and will function in a similar manner to ecosystems on undisturbed areas adjacent to the Suncor development. Individual components of re-established ecosystems have been evaluated as follows:
  - Reconstructed soils have been shown to be equivalent to or better than original soils.
  - Results of field monitoring indicate that Suncor's reclamation sites are developing into sustainable ecological units, comparable to nearby natural forest areas. These results, together with those from terrain modelling, show that Suncor's reclamation strategy will achieve long-term, mature communities sustainable under current topographic and climatic trends.
  - Successful development of a viable reclamation area vegetative cover, together with establishment of reclamation drainage system, means that reclamation ecosystems will become viable wildlife habitats.

D3.4.4 Mine Advance Plan, Vegetation Balance

Land use options were also examined by using projected "vegetation balances" for the Local Study Area. Vegetation balance here means the change experienced in the landform from its existing (natural) state through a disturbed state and eventually to a reclaimed state. Losses (disturbance) and gains (reclamation) were predicted for each vegetation type or ecosite identified in the Local Study Area for the periods 1995, 2001, 2010, 2020 and for a long-term scenario. The procedure is summarized as follows:

a) Development of the Ecological Land Classification (ELC) Scheme

An ELC classification for the Local Study Area was developed by incorporating terrain analysis and landscape variables such as elevation, slope angle and aspect from satellite imagery analysis complimented by aerial photograph interpretation (Golder Associates 1996a). The first general level in the ELC hierarchy is represented by a terrain classification which was undertaken using terrain modelling and air-photo interpretation. The following seven broad landform classes (or ecosections) were mapped primarily on the basis of elevation, physiography and surficial materials:

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

The second level of mapping, ecosites, involved the integration of digitized vegetation and soil data within the broader landform units previously described. The soils data was mapped at 1:50,000 and also at 1:10,000 (CAN-AG Enterprises Ltd. 1996). Forestry data was mapped at a detailed scale of 1:10,000 (EnviResource 1996).

The ecosite map was generated using these data sources as well as field data collected in the summer of 1995 (101 field transects). Fourteen ecosite classes were identified primarily on vegetation types recognized from satellite image analysis; however, landform, soil and drainage conditions were incorporated into the classification scheme to provide a more fully integrated database.

1. Wetland Open Water-Emergent Vegetation Zone
2. Wetland Shrub Complex
3. Peatland: Closed Black Spruce Bog
4. Peatland: Open Black Spruce Bog
5. Peatland: Black Spruce - Tamarack Fen
6. Closed Mixed Coniferous, Black Spruce Dominant
7. Closed Deciduous Forest
8. Closed Mixedwood
9. Closed Mixedwood, White Spruce Dominant
10. Closed White Spruce
11. Closed Jack Pine
12. Closed Lodgepole Pine
13. Disturbed/Herb-Grass Dominant
14. Industrial/Sparsely-Vegetated (Primarily Lease 86/17)

Each map unit is described in detail in the Terrestrial Baseline Report for the Steepbank Mine (Golder Associates 1996a).

b) <u>ELC Analysis of the Revegetation Plan</u>

General reclamation prescriptions have been developed for Lease 86/17 and the Steepbank Mine, depending on site characteristics, soil treatments and the intended long-term land use. A "net vegetation balance" for the project was developed using a time-table developed, according to the reclamation plan, to model the successional pathway of reclamation vegetation types from initial establishment through to a mature state. This was developed according to the assumptions outlined in Table D3.0-2. For example, initial reclamation of sites may start as a disturbed herb-grass community, progress through a mixedwood type and eventually reach a closed canopy, white spruce dominant vegetation type. A schematic showing natural and reclaimed successional sequences of vegetation development is shown in Figure D3.0-2.

The elements representing reclaimed vegetation types were evolved though the successional time-table according to the reclamation and revegetation plan at an interval defined by the scenario years of 1995, 2001, 2010, 2020 and long-term. The progression of mine development and reclamation sequences is shown graphically in Figures D3.0-3 to D3.0-7. Tabular data showing the relative change in ELC vegetation classes compliments these figures and is provided in Table D3.0-4. Further detailed analysis of vegetation change according to landform types is provided in the Suncor Mine Advance Plan (D&R) and Cumulative Effects (Golder 1996b).

This assessment shows the sequence of development and reclamation envisaged for Lease 86/17 and the Steepbank Mine in an integrated manner.

The existing area (ha) of ELC vegetation types or land use types is shown for 1995 in Table D3.0-3. As development of the Steepbank Mine occurs, natural vegetation types are replaced by disturbed types. At the same time, on-going reclamation of Lease 86/17 sees the gradual replacement of existing disturbed land by revegetated types. This "balance" is quantified in Table D3.0-3.

For Lease 86/17, the reclamation sequence is seen in the reduction of the Sparcely-Vegetated type from 1,765 ha in 1995; 1,498 ha in 2001; 1,396 ha in 2010; 386 ha in 2020 and eventually to 0 ha under the long-term scenario. This sequence is shown graphically in Figures D3.0-3 to D3.0-7, with replacement of vegetation types occurring on the reclaimed surfaces through an initial establishment of herbs and grasses (Disturbed/Herb-Grasses type). This vegetation type reaches a maximum extent in 2020 of 3,865 ha including both the reclamation of Lease 86/17 and the Steepbank Mine (Table D3.0-3 Figure D3.0-6). At the same time, successional vegetation development is proceeding on the older reclaimed surfaces with the development of Closed Mixedwood, White Spruce Dominant types and Closed Mixedwood types along the northern and southwestern portions of Lease 86/17 (Figure D3.0-6). By 2020, these areas have increased markedly (Table D3.0-3) while the Tar Island Dyke plateau now supports a Wetland Closed Shrub Complex, within a Disturbed Herb-Grass mosaic.

The long-term scenario continues the successional sequence of vegetation development. On Lease 86/17, the Closed Mixedwood, White Spruce Dominant type occurs primarily around the margins of the Lease, while the central portion is dominated by Closed Mixedwood (Figure D3.0-7).

Wetlands, supporting open water emergent vegetation and Wetland Closed Shrub Complex, add diversity to habitat conditions within the low-lying areas of the reclaimed upland plateaus.

In terms of the long-term percentage change as a function of the 1995 baseline conditions, the largest increase in vegetation type is seen in the Closed Mixedwood, White Spruce dominant type which increases from 845 ha in 1995 to 2,804 ha under the long-term reclamation scenario (an increase of 332%). The closed mixedwood type also increases by 200% from 2,622 ha to an expected 5,240 ha (Table D3.0-3). These increases are matched by decreased in the Peatland: Black-Spruce-Larch Fen, Peatland: Closed and Open Black Spruce Bog types, as well as the Disturbed/Herb-Grasses. Within a regional context, such changes in vegetation type are expected to increase the diversity of habitat types.

In the long-term reclamation scenario, the vegetation within Lease 86/17 shows a much greater diversity and interspersion of habitat types (Figure D3.0-7). This incorporates variations in terrain (slope, aspect) and drainage conditions as modelled from the natural landscape within the Local Study Area. It projects a long-term vegetation successional sequence and provides the basis for future reclamation planning. The next step in this planning process is to incorporate soils information (physical, chemical and biological) to further enhance the reclamation database. This will be completed as part of on-going reclamation research at Suncor.

The comparison of relative vegetation type losses (disturbance) and gains (reclamation) provides a comparison of reclamation progress throughout each period of analysis when compared to the 1995 baseline and the long-term scenario. It also provides a rationale to "select" particular vegetation types to be used in the reclamation plan to meet particular end land use objectives. For example Closed Deciduous Forest may be the preferred habitat type or ecosite along the Athabasca River escarpment slopes for wildlife habitat purposes.

D3.4.5 Land Use Summary

During construction and operational phases of the Steepbank Mine, Oil Sands mining and processing will displace other uses from the mine site. There is a dramatic change in habitat diversity, and net habitat loss from the existing (1995) landscape when compared to the 2001 and 2010 time periods

TABLE D3.0-2

PROJECTED RECLAMATION SUCCESSIONAL SEQUENCE FOR VEGETATION TYPES

Desired Reclamation Vegetation Type	ELC Vegetation Type				
	Existing	**2001**	**2010**	**2020**	**LongTerm**
Spruce/Poplar/Pine	Disturbed HG[1]	Disturbed HG	Mixedwood Spruce dominant	Mixedwood Spruce dominant	Mixedwood Spruce dominant
Spruce/Pine/Poplar	Disturbed HG	Disturbed HG	Mixedwood Spruce dominant	Mixedwood Spruce dominant	Mixedwood Spruce dominant
Spruce/Poplar	Disturbed HG	Disturbed HG	Mixedwood Spruce dominant	Mixedwood Spruce dominant	Mixedwood Spruce dominant
Spruce	Disturbed HG	Disturbed HG	Closed White Spruce	Closed White Spruce	Closed White Spruce
Spruce/Grass	Disturbed HG	Disturbed HG	Disturbed HG	Closed White Spruce	Closed White Spruce
Poplar/Pine/Spruce	Disturbed HG	Disturbed HG	Mixedwood	Mixedwood	Mixedwood, Spruce dominant
Poplar/Spruce	Disturbed HG	Disturbed HG	Mixedwood	Mixedwood	Mixedwood Spruce dominant
Poplar/Pine	Disturbed HG	Disturbed HG	Mixedwood	Mixedwood	Mixedwood
Poplar	Disturbed HG	Disturbed HG	Closed Shrub	Closed Deciduous	Closed Deciduous
Pine/Poplar/Spruce	Disturbed HG	Disturbed HG	Disturbed HG	Closed Pine within Mixedwood	Closed Pine within Mixedwood
Pine/Poplar	Disturbed HG	Disturbed HG	Disturbed HG	Closed Pine pockets within Mixedwood	Closed Pine within Mixedwood
Pine	Disturbed HG	Disturbed HG	Disturbed HG	Closed Pine	Closed Pine
Pine/Grass	Disturbed HG	Disturbed HG	Disturbed HG	Closed Pine	Closed Pine
Grass/Parklands	Disturbed HG	Disturbed HG	Disturbed HG	Disturbed HG	Closed Deciduous

[1] Disturbed Herb-Grasses

(Figure D3.0-1). Land use options are reduced for each of the four examples, considered, i.e. traditional uses, wildlife habitat, recreation and tourism, and forestry.

Reclamation however, provides the means and flexibility to re-establish land use options by stabilizing previously disturbed landforms and establishing a self-sustaining vegetation cover on engineered landforms such as tailings sand dykes and plateaus. In the year 2010, for example, some disturbed landscapes and overburden dykes will be in the early stages of reclamation. During these stages of reclamation, habitat diversity will increase as plants become established and vegetation communities develop (Figure D3.0-1). Land use options, while still limited, will allow use by a variety of wildlife species. Following the natural progression of muskeg stabilization, nutrient cycling, vegetation establishment and development over the long-term, habitat diversity is expected to increase and a correspondingly higher level of land use options will be available (Figure D3.0-1).

The characteristics and ecological diversity of reclamation areas provides the flexibility to accommodate a number of end uses.

a) <u>Forestry</u>

Baseline forestry conditions for Suncor lease areas have been shown to fall primarily in the low-productivity or non-productive capability classes (CAN-AG Enterprises Ltd. 1996b). Suncor's assessments of currently-reclaimed areas show an improvement in capability of post-reclamation potential (compared to pre-disturbance potential). This change is primarily due to alterations in topography which improve drainage patterns and establish productive lakes and ponds. Suncor's reclamation program has been successful in establishing a forest-type ecosystem that is evolving in harmony with undisturbed forest ecosystems adjacent to the lease.

b) <u>Wildlife</u>

Habitats developed on reclaimed Lease 86/17 areas include a variety of both drainage systems and ecosystems. These habitats will be well-used by a variety of wildlife species; therefore, as habitats mature, opportunities for trapping and hunting will increase.

TABLE D3.0-3
SUNCOR LOCAL STUDY AREA VEGETATION BALANCE

ELC Vegetation/Landuse Class	Total Coverage Area (ha)					Longterm % of
	1995	2001	2010	2020	Longterm	1995 Baseline
Closed Jack Pine	2760	2701	2581	2536	2532	92
Closed White Spruce	3443	3408	3295	3265	3259	95
Closed Deciduous Forest	5778	5643	5184	5105	6225	108
Closed Mixedwood	2622	2807	2862	3188	5240	200
Closed Mixed Coniferous, Black Spruce Dominant	1440	1420	1355	1329	1328	92
Peatland: Closed Black Spruce Bog	2995	2952	2808	2604	2597	87
Peatland: Black Spruce-Larch Fen	3453	3430	3165	2626	2615	76
Closed Mixedwood, White Spruce Dominant	845	825	1012	1200	2804	332
Peatland: Open Black Spruce Bog	6032	6008	5873	5277	5263	87
Peatland: Open Tamarack Fen	2109	2098	2097	2085	2085	99
Wetland Closed Shrub Complex	2673	2640	2539	2586	2881	108
Wetland Open Water - Emergent Vegetation Zone	1345	1345	1333	1313	1767	131
Disturbed/Herb, Grasses	2071	2325	2745	3865	1342	65
Sparsely-Vegetated: Natural	283	283	283	283	283	100
Sparsely-Vegetated: Lease 86/17	1765	1498	1396	386	0	0
Sparsely-Vegetated: Steepbank Mine	0	232	588	1562	0	0
Industrial Open Water	607	606	1105	1011	0	0
Total Area	**40221**	**40221**	**40221**	**40221**	**40221**	**100**

c) **Recreation and Tourism**

There will be an overall increase in the recreational capability of upland portions of the lease area, due to conversion of muskeg areas to better-drained, forest-type habitats, which are more accessible to recreational users. These areas may sustain extensive recreational activities such as hiking, hunting, snowshoeing, and snowmobiling. In addition, post-mining topography on lease abandonment will provide a source of recreational interest. Areas of the Suncor leases adjacent to the Athabasca River will still retain moderate-high recreation capability by providing access for angling and boating as well as vantage points for nature viewing.

Areas of the reclaimed lease will require restriction of some forms of recreational activities; for example, slopes of reclaimed tailings sand dykes will not sustain activities involving the use of all-terrain vehicles. Such activities will almost certainly disturb the developing ecosystem and lead to increased potential for erosion.

d) **Traditional Use**

As the successional sequence of vegetation establishment and development proceeds over time, a variety of reclaimed landscapes and vegetation types is expected to provide the basis for subsequent traditional use. Further input on the types and distribution of revegetation can contribute to re-establishing traditional use of the disturbed area.

D3.5 IMPACT MITIGATION

The mitigation measures to minimize the impact on existing and future land use are summarized as follows:

- A phased development and reclamation approach to mine planning will limit the areal extent of non-reclaimed land at any one time throughout the life of the project. This will minimize the overall effect on land use options.
- Reclamation phasing will allow a variety of age classes of vegetation, or successional stages to be established, providing a diversity of habitat conditions and in turn, greater opportunities for multiple land use options.

- Disturbed landscape will be reclaimed with stable slopes, compatible with the pre-disturbed terrain, to provide the basis for subsequent establishment and development of wildlife habitat. In turn, this will allow opportunities for traditional use (hunting and trapping), recreational opportunities and forestry (on selected locations).
- Reclaimed soils will provide for vegetation establishment, and successional development to allow a diversity of vegetation community types to be established, compatable with the surrounding vegetation.
- Flexibility exists in the choice of vegetation type to be reclaimed on particular reclaimed surfaces such as overburden areas, tailings sand dykes and CT plateaus. This can be used in the environmental design of the reclamation plan to meet end land use objectives such as providing deciduous forest along the escarpment slopes to meet wildlife habitat needs.

D3.6 IMPACT CLASSIFICATION

The classification of impacts on existing and future land use of the disturbed areas are summarized in Figure D3.0-8. During construction and operational phases of the project, land use options are restricted to oil sands extraction and processing. Such restrictions are long-term in duration, however, reclamation of disturbed landscapes will occur sequentially as the mine plan advances. Opportunities for wildlife habitat reclamation will occur as part of the mine advance plan both within Lease 86/17 and within the Steepbank Mine.

Following mine closure, a sequence of vegetation communities are predicted to develop over time in response to landform, drainage, soil and microclimatic conditions. A diversity of variously-aged vegetation types is expected to afford an overall increased opportunity for end land uses.

D3.7 CUMULATIVE EFFECTS ASSESSMENT

The cumulative effects of the project can be assessed by looking at the regional impacts on vegetation types in the baseline year of 1995 and in the year 2020 (Figure D3.0-9 and D3.0-10, Table D3.0-4). In addition to Suncor, other oil sands operators in the region were included in the assessment. These included Syncrude's existing Mildred Lake Mine and the proposed Aurora Mine, as well as the proposed Solv-Ex operation. Forestry operations were examined through data provided from Alpac's forestry management plans.

The cumulative losses and gains are provided for each vegetation/land use class as a result of the combined effects of Oil Sands operations and forest management practices (Table D3.0-4). The most extensive "losses" compared to the 1995 baseline is to the Closed White Spruce type for which these will be a 47% loss relative to the Regional Study Area. As expected, the majority of this loss is due to forestry operations (Alpac and Northlands 20,745 ha). In comparison, the amount of this vegetation type affected by Suncor is 178 ha.

The largest decrease in vegetation type affected by Suncor is to the Peatland: Black Spruce-Larch Fen type, associated with the Upland Plains Landform. A total of 1,011 ha are affected which is 4% of this vegetation type within the Regional Study Area. As expected, the largest increase in vegetation type is to the Disturbed/Herb-Grass type, with a combined increase of 36,404 ha or a 20% increase (Table D3.0-4). Other combined large increases occur to the Industrial/Sparsely-vegetated type (125%) and to the Closed Deciduous Forest type (21% or 16,902 ha). The largest increase in vegetation type affected solely by Suncor is to the Closed Mixedwood, White Spruce Dominant type with a 566 ha increase in 2020. These projected figures provide a basis for long-term, integrated resource planning, as well as a means to assess the opportunities for mitigation of habitat losses.

D4.0 HYPOTHESIS 14

Visual integrity of the Athabasca River valley will be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

D4.1 HYPOTHESIS DESCRIPTION

D4.1.1 Background

Visual impact assessments begin by defining the study area or view shed affected by a proposed development. Delineation of the view shed considers that portion of the landscape which can be observed from a single point, such as a scenic rest stop, or along a curved line, such as from a portion of a highway or river. The ability to discern objects within the landscape is also greatly affected by the interaction of color and texture of the object within its surroundings. Because of

TABLE D3.0-4
CUMULATIVE VEGETATION IMPACT ASSESSMENT, YEAR 2020 RELATIVE TO 1995 BASELINE

ELC Vegetation/Landuse Class	Total Coverage Area (ha)		Suncor	Syncrude Mildred L/Aurora	Solv-Ex	ALPAC & NORTHLANDS[1]	Cumulative Loss/Gain (ha)	Percentage of 1995 Baseline
	1995 Baseline	2020						
Closed Jack Pine	29119	26551	-224	-587	-26	-1731	-2568	-9
Closed White Spruce	43728	23151	-178	349	-3	-20745	-20577	-47
Closed Deciduous Forest	78738	95640	-673	-2266	-32	19873	16902	21
Closed Mixedwood	62530	60383	566	-183	-3	-2527	-2147	-3
Closed Mixed Coniferous, Black Spruce Dominant	86949	82409	-111	-3750	0	-679	-4540	-5
Peatland: Closed Black Spruce Bog	42494	38513	-391	-2771	-190	-629	-3981	-9
Peatland: Black Spruce-Tamarack Fen	50720	48882	-827	-1011	0	0	-1838	-4
Closed Mixedwood, White Spruce Dominant	129594	110858	355	-1895	-3	-17193	-18736	-14
Peatland: Open Black Spruce Bog	80554	79030	-755	-769	0	0	-1524	-2
Peatland: Open Tamarack Fen	57951	57315	-24	-575	-37	0	-636	-1
Peatland: Shrub Dominated Fen/Patterned Fen	58751	53654	0	-5097	0	0	-5097	-9
Wetland Closed Shrub Complex	214209	209657	-87	-4465	0	0	-4552	-2
Disturbed/Herb, Grass and Crop Tree Regeneration	18073	54477	1794	10684	295	23631	36404	201
Industrial/Sparsely-Vegetated [a]	10387	23394	587	12421	-1	0	13007	125
Wetland Open Water - Emergent Vegetation Zone	13502	13384	-32	-85	0	0	-117	-1
Urban Areas	2109	2109	0	0	0	0	0	0
Net Total Area	**979408**	**979407**	**0**	**0**	**0**	**0**	**0**	**n/a**

[a] Includes industrial areas and tailings ponds.

Notes: 1. Areas Harvested by ALPAC and Northlands return rapidly to a forest cover type, however, to qualify for a forest cover type, crown closure was set at 70%, which takes decades for seedlings to acheive.

these factors, lighting and atmospheric conditions have a significant impact on the ability to see individual objects.

The relative motion of the observer also places constraints on the viewer's perception of a landscape. A sense of tunnel vision is created as we increase our speed along a path. Our stationary peripheral vision of 180 degrees will decrease to 100 degrees if the speed of the observer is increased to about 40 km/hour, or the speed of a small motorboat. At 100 km/hour, the speed of a car on the highway, vision is restricted to a cone of 40 degrees.

All of these factors make visual impact assessments a challenging exercise which must also consider the response of the local community to the potential impact, incorporating demographic, social and cultural values.

D4.1.2 Approach

The approach used to examine the potential visual impacts on the Athabasca River valley as a result of the Steepbank Mine and Lease 86/17 is illustrated in Figure D4.0-1. Project impacts are examined in terms of discrete development components (e.g., dykes) and an assessment made for the construction (1997-2000), operation (2000 to 2020) and closure (long-term) periods. The assessment was made using a series of computer-generated images which superimpose the development onto the existing environment (Levy 1996). Photographs and video footage taken along the river was used as the basis for this assessment. An example of this technique is shown in Figure D4.0-2.

D4.1.3 Visual Resource Assessment Within the Study Boundaries

It has been assumed that the views of greatest concern are those observed by boaters travelling along the Athabasca River. Key views affected by development from the neighbouring highway or scenic stops have not been identified.

A series of images was created from topographic point data to simulate the change in the landscape over the mine development and closure phases. Textures such as vegetation cover were added to these surfaces from photographic and video images of the surroundings. In modelling the construction phase it was assumed that the exposed surface of the dykes are of overburden material. During reclamation, these slopes would be planted with native vegetation including poplar, pine and spruce.

D4.1.4 Visual Resources of the Baseline Condition (1995)

The area under review includes the Athabasca River valley bordered by an escarpment slope to the east. The escarpment rises gradually to about 50 m above the river. The area to the east is largely undeveloped and is covered primarily with aspen and balsam poplar. Pockets of jack pine, white spruce and willow can be seen from the river. Suncor's existing mining facilities are located on the west side of the Athabasca River. This area is occupied by an oil sands processing facility, powerhouse and service roads. The site is marked by smokestacks, some with heights over 100 m. Several large ponds have also been created along the edge of the river to retain tailings from the mining operations.

Tar Island Dyke, an embankment constructed during the early development of Suncor's operations, is located just south of the plant facilities. The sides of the embankment still retain visible remnants of the lifts used to create this earthwork. The slopes are covered largely by shrubs and forbs with patches of trees throughout. The study site view shed along the river is atypical of the Athabasca River within this region, due to the current level of industrial development located in close proximity to the river. Well to the south of the site, the river is spanned by several bridges. The spans of bridges upstream of Suncor have been designed to maintain navigation.

D4.1.5 Visual Resources affected during the Construction Phase (1997-2000), Operational Phase (2000-2020) and Final Closure

Primarily, views from the river will be affected by the impacts of the proposed dykes and other earthworks created during the mining process. Issues include the impact of the:

- Dykes and earthworks
- Roads, barge loading points and mining operations
- Buildings and mining transport equipment
- Bridge and abutements

D4.2 VISUAL IMPACT CLASSIFICATION

For the purposes of this study the following visual impact criteria have been assumed:

D4.2.1 Direction

This identifies the nature of the impacts to the visual resources. It can be described as a "positive impact" or as a "negative impact".

D4.2.2 Severity

The severity of the visual impact caused by changes to the river valley, is assessed by considering the potential impact on views in the foreground, middle ground and background. Development which affects the foreground of a view will generally have considerably more impact than those in the background. If the texture, colour and form of an object differ from those of the surroundings, it will attract the attention of the viewer. The introduction of objects and landform which are not normally found in the landscape will make a greater impression on the observer. The severity of the impact has been ranked as low, medium and high based on expert opinion. These ratings are described as follows:

Low (L): Defined as changes to the environment which will not change the general impression of an area. Changes to the views may either go unnoticed by a local observer or be insignificant. Typically, a low rating will be assigned when there is an affect only on the background of a view. In this case the color, texture and form of landforms and objects introduced into the environment will not vary from those already present in the landscape.

Moderate (M): Defined as changes to the environment which may be noted by an observer but be considered insignificant given existing surrounding conditions. Typically, a moderate rating will be assigned when the affect is either in the middle ground or background. The color, texture and form of landforms and objects introduced into the environment may differ from those already present, contributing to an observer's recognition that the environment has been altered.

High (H): Defined as changes to the environment which an observer may consider as having made a substantial impact on the surroundings. The color, texture, mass and shape of the proposed development differs substantially from the surroundings. Typically, a high rating will be assigned when the effect is either on the foreground or middle ground. The color, texture and shape of landforms and objects introduced into the environment will differ substantially from those already present contributing to an observer's recognition that the environment has been significantly altered.

D4.2.3 Duration

- A short-term impact is an impact which is limited to duration of the action causing the effect.
- A medium-term impact extends for less than 30 years beyond the completion of the activity causing the effect.
- A long-term impact extends more than 30 years beyond the completion of the activity causing the effect.

D4.2.4 Geographic Extent

Local: The impact occurs on the Suncor Lease 86/17 and the Steepbank Mine area. No visual impacts are considered to extend beyond the Local Study Area.

D4.2.5 Degree of Concern

Low: Any impact that is restricted to the local area is either low in extent or is a moderate impact or short duration.

Moderate: Any moderate impact that does not extend beyond the regional area and is not of long-term duration.

High: A moderate or high impact that is of long-term duration.

D4.3 SUB-HYPOTHESIS A - VISUAL IMPACTS FROM DYKES AND OTHER EARTHWORKS

Dykes at a distance of 350 to 1,200m from the water's edge will create a wall-like berm in view from a boat travelling along the river. During the construction and operation phase, this berm will be partially screened by the existing treed buffers. In the late autumn, winter and early spring, the proposed dyke will have a more noticeable presence.

D4.3.1 Impact Mitigation

The following have been proposed as mitigation measures to lessen the impact of the dykes and other earthworks:

- Develop a regeneration scheme which will produce a texture and color to the slopes to blend with the adjacent areas; and
- Avoid a single profile or straight lines for the dykes. If possible, the addition of small hills on top of the dyke could help camouflage its man-made quality by mimicking glacial formations found in the area.

D4.3.2 Hypothesis Impact Classifications - Degree of Impact

The visual impacts of dykes and earthworks are considered to have a moderate negative impact of long-term duration during the construction and operational periods but will be of reduced impact when considered in the long-term scenario and following revegetation efforts.

D4.4 SUB-HYPOTHESIS B - VISUAL IMPACTS FROM ROADS, BARGE LOADING POINTS AND MINING OPERATIONS

Several major roads, building sites and staging areas have been planned for the development. In creating these roads and staging areas, part of the buffer between the river and the dyke will be removed. It is planned that a minimum of 30 m will be used to create the proposed roadways. In areas where the installation of roads will require substantial grading, further removal of trees is inevitable. This will also be the case for areas reserved as a staging area for barges, as well as heavy equipment. Where the roadways are in close proximity to the river, dust may be visible from truck movement during the dry periods of the year.

D4.4.1 Impact Mitigation

The following have been proposed as mitigation measures to lessen the impact of the proposed roads, barge loading points and areas reserved for mining operations.

- Preserve the treed area as buffers around dykes, embankments and building sites.
- Re-plant areas using native trees and plants after the area is no longer an active mine site.
- Maintain dust control measures on roads where truck movement may create visible dust plumes.

D4.4.2 Hypothesis Impact Classifications - Degree of Impact

The visual impacts of the roads, barge loading points and mining operations are considered to have a moderate negative impact during the construction and operational periods. Much of the mining operation on the upland will not be visible from the river. The severity of impact will be reduced to low following mine closure.

D4.5 SUB-HYPOTHESIS C - VISUAL IMPACTS FROM BUILDINGS AND MINING TRANSPORT EQUIPMENT

Several buildings and structures have been planned for the operations of the Steepbank Mine. All of these buildings will be temporary. Several of these sites will be hidden from view by treed buffers. Maintaining buffered areas will reduce the impact of equipment and structures on views from the river. Lower profile structures will have less impact than those several stories high. Buildings with unbroken facades and flat roofs will also be more easily recognizable as industrial structures then those which have articulated facades and pitched roofs. The choice of colours for the buildings and conveyance equipment is also important in terms of how noticeable they will appear from various distances. Lighting intensity will also affect visibility at various distances.

D4.5.1 Impact Mitigation

The following have been proposed as mitigation measures to lessen the impact of proposed buildings and placement of mining transport equipment.

- Avoid locating buildings and structures outside of buffered areas or in areas close to the river.
- Preserve as much as possible of the treed buffers around buildings and other structures.
- Re-plant areas surrounding buildings and other structures with native plants and trees after the area has been decommissioned.
- Use muted colours for buildings and structures. Bright colours, especially those which differ in hue and value from the surroundings will be more noticeable.
- Lighting should be designed to focus only on the work areas.
- If possible maintain low profiles for building forms. Articulated facades and varied roof lines are more easily hidden than buildings with continuous facades.
- Berms may be used to partially screen building and other structures which are prominent in the landscape.

D4.5.2 Hypothesis Impact Classifications - Degree of Impact

The visual impacts from buildings and mining transport equipment will be restricted to the construction and operational phase. Such impacts are considered a moderate negative impact of short-term duration.

D4.6 SUB-HYPOTHESIS D - VISUAL IMPACTS FROM THE BRIDGE AND ABUTMENTS

A concrete and steel girder bridge will be constructed over the Athabasca River in an area near the current fixed plant area. Computer generated images are shown for the bridge area prior to its construction, during the operational phase and following closure (Figure D4.0-3). Given the loading rating required for this bridge, it will be of substantial dimensions. The bridge also requires sufficient clearance for river traffic. Abutments planned for the bridge will be covered with rip-rap and will create an imposing presence.

D4.6.1 Impact Mitigation

The following have been proposed as mitigation measures to lessen the impact of the proposed bridge and abutments.

- Preserve as much of the treed buffers as possible near the river bank next to the bridge abutment.
- Re-plant areas near the bridge using native trees and plants.
- If possible use muted colours for the bridge span. Bright colours, especially those which differ in hue and value from the surroundings will be more easily noticeable.
- Lighting should be designed to focus only on the bridge deck.

D4.6.2 Hypothesis Impact Classifications - Degree of Impact

The visual impacts of the bridge and abutments are consistent throughout the construction, operation and mine closure phases where they are considered moderate, negative and of long-term duration.

D4.7 RESIDUAL IMPACTS AND NET BENEFITS SUMMARY

In summary, during the construction phase (1997-2000), the overall visual impacts of the Steepbank Mine operation is expected to have a moderate negative impact on the Athabasca River valley viewshed. This impact will be restricted to the Local Study Area but will be of long-term duration. The operational phase (2000-2020) will similarly have a moderate negative impact for the duration of the mining activity, however, sequential reclamation of the river valley and escarpment slopes will gradually reduce the visual impacts along the river valley. Following mine closure, the visual impacts will be reduced substantially as reclamation and revegetation efforts approximate the pre-conditions of the river valley.

The proposed development will transform the physical form of the landscape. The introduction of dykes to the area will not go unnoticed given their presence on the horizon as one approaches the site by boat in either direction. However the impacts are exclusively local. The extent of the duration may be long-term depending on the success of the reclamation efforts. If replanting and landscaping of the dykes is successful, the duration of the impact may be considered of moderate duration. Considerable attention should be given to creating forms which can blend in with their surroundings.

Structures and other buildings of lasting duration should be designed to consider local preferences. Duration of these built forms will primarily be moderate. Careful consideration should be given to the design of the only long-term structure, the bridge. Designs should focus on profile of the form, color and texture of the materials, rather than on the addition of architectural detail which will not be seen except at close range. Maintaining treed buffers will substantially soften the views of buildings and roads. Roads which are in view of the river can be partially hidden through the addition of berms planted with native vegetation. During the operational phase of the mine, attention should be given to reducing the effects of light and dust pollution. Lighting should be designed to focus on work activity and shielded to reduce light pollution. The maintenance of dust control measures for roads will alleviate dust pollution.

The construction of a new bridge will provide a link between the existing and future development. A bridge, besides offering a needed transportation connection can heighten the visual experience of a landscape by providing a sense of scale and by offering a landmark for users of the river.

D5.0 HYPOTHESIS 15

Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

D5.1 HYPOTHESIS DESCRIPTION

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 the *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. Such action is required as there has been a world-wide decrease in biodiversity due to human activities. Many provincial organizations also recognize that it is important to manage for biodiversity (e.g., Saskatchewan Environmental Resources Management 1993, Association of B.C. Foresters 1994).

While the suitability of biodiversity is recognized as being a worthwhile subject for study is apparent, 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."

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:

- Landscapes (regional);
- Communities (e.g., stands);
- Species; and
- Genes.

In addition, each scale of biodiversity can be described in terms of its composition, structure and function. Composition can refer to the number and kind of species in an area, the genetic make up of a population and the variety of forest stands within a landscape. Structure can refer to the vertical and horizontal layering of a community, the abundance and distribution of snags and deadfall, or the distribution of community patches across a landscape. Function refers to the climatic, geological, hydrological, ecological and evolutionary processes that occur within each scale of biodiversity. The integration of biotic and physical properties which combine to create the biodiversity inherent in communities and landscapes is illustrated in Figure D5.0-1.

Biodiversity has been defined in many ways and should be thought of as more than just species richness in an area. It can include spatial and temporal diversity of plant and/or animal communities at the landscape level, structural diversity at the community level, and genetic diversity at a specific level. One widely used definition of biodiversity is from Noss and Cooperider (1994):

> The variety of life and its processes; it includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting.

The definition of biodiversity, offered in this report reflects that identified in the Canadian Biodiversity Strategy, and also incorporates the concepts identified in the above definition:

> 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).

D5.2 LINKAGES AND MODES OF IMPACTS

The potential impacts to biodiversity are assessed within the context of this EIA according to landscape, communities and species. Genetic biodiversity, is considered only at a conceptual level, although it is strongly linked with the species level assessment of biodiversity.

Figure D5.0-2 shows the general pathways and linkages by which biodiversity could be impacted by the Steepbank Mine. These are also summarized as follows:

1. Mine development and facility construction will reduce local and regional biodiversity by reducing/altering the areas of each landform type.

2. At the landscape level, mine development and facility construction will result in fragmentation or loss of connectivity between habitats in the study region.

3. Mine development and facility construction will result in the loss of areas of large patch size, at the landscape level of assessment.

4. Mine development and facility construction will result in the loss of areas with a high habitat interspersion.

5. Facility preparation and mine development will result in impacts to unique and/or significant habitat types (VECs).

6. Facility preparation and mine development will result in adverse impacts to rare, threatened or endangered plant species or their habitats.

7. Mine reclamation will result in the introduction of non-native plant species.

D5.2.1 Impact Assessment

The existing biodiversity within the Local Study Area is considered and assessed at the landscape, community and species level. The impact rating to biodiversity includes the cumulative assessment of impacts to each of these levels of biodiversity.

D5.2.2 Landscape Level Biodiversity

Biodiversity at the landscape level refers to the pattern of vegetation and wildlife species communities 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 the need to use a geographical context when describing ecosystems. Perhaps a better term for landscape level biodiversity is 'ecodiversity'. Ecodiversity cannot be maintained without the maintenance of landforms. One must look at the whole ecosystem as ecodiversity does not just refer to the living organisms in an area. Rather, one must look at landforms, soils, air and climate in addition to living organisms. Together, these elements are more important than when considered independently.

One measurement of landscape level biodiversity is the assessment of the variety of communities which are present within an area of the landscape. This can be described as the interspersion of community types within an area and the corresponding area or patch size of these communities.

a) **Landform Types, Habitat Interspersion and Patch Size**

One component of the assessment of potential impacts to biodiversity at the landscape level was based on the impact ratings to landscapes within the local and Regional Study Areas (Hypothesis 12). The results indicate that a relatively high proportion of the Escarpment Slope and

Riparian Terrace ecosections would be impacted by the Steepbank Mine, with lesser percent loss to the Riparian Floodplain and Upland ecosections. This alone may indicate a Moderate to High degree of concern for impacts to biodiversity at the Landscape level.

Incremental loss of the Riparian Floodplain within the Local Study Area would be 6.8% and 16.5% loss of the Riparian Floodplain and Riparian River Terraces, respectively. The Athabasca River Escarpment would undergo a loss of 28.1% within the Local Study Area (Table D2.0-2). In total, 21% of the River Valley in the Local Study Area would be impacted by the Steepbank Mine (Table D2.0-2). These figures indicate considerable landscape alteration within the Local Study Area. However, they do not indicate landscape level impacts which would deplete these terrain types regionally. In addition, escarpment slopes and floodplain features within the local area are also present on the west side of the river, such that a local resource of these terrain types will remain relatively undisturbed by the Steepbank Mine. Reclamation measures and habitat restoration must also be considered in the assessment of biodiversity impacts.

Another level of impact assessment to biodiversity at the landscape level can be conducted by assessing the potential impacts to highly diverse or interspersed areas. By recognizing those areas which have a high interspersion of habitat types and the extent to which those areas of high interspersion would be impacted by the development, impacts to habitat biodiversity can be inferred at the landscape level. The concept of high interspersion recognizes that areas which support a high number of communities, with a concurrent high amount of edge will also support a disproportionately high species assemblage within that given area. These are recognized as biologically rich areas (Noss and Cooperider 1994). Typically, such areas are linked with sites which have a high terrain, drainage and soil variability - which is reflected in the high interspersion of vegetation types.

Areas of high interspersion were identified through satellite image analysis and digital evaluation model (DEM) analysis, whereby a range of vegetation classes were identified through reflectance signature, with each class representing a specific vegetation type. The DEM identified areas of high physical interspersion based on slope and aspect analysis. Computer generated sampling was then conducted to identify the minimum area or "patch size" which encompassed the highest number of vegetation types and terrain types. Variables measured for each patch size of assessment included:

Diversity: The number of different vegetation or terrain categories within a patch.

Interspersion: The percentage of map units containing categories different from the map unit surrounding it.

Variance: The statistical variance of vegetation or terrain categories within a patch.

Interspersion was measured, as well as the variance of types within each area of sampling size, such that a high interspersion of two types would rate considerably lower than a high interspersion of ten types. The objective was to identify the minimum patch size with the highest degree of interspersion and heterogeneity.

The results indicated that in the Local Study Area, a minimum patch size of 275 m^2 allowed for the maximum number of vegetation types, whereby up to 14 vegetation classes or ecosites were incorporated. Natural terrain areas which displayed this high level of interspersion within the smallest area (275 m^2) included: the escarpment edge and slopes of the Steepbank and Athabasca Rivers, ravine complexes and the Athabasca River floodplain (Figure D5.0-3). These areas often coincide with the edge where two terrain types meet, resulting in a high variability of terrain, drainage and soil conditions. This is reflected by a high degree of habitat diversity.

In addition, the Midland Drainage and Midland ecosections on the west side of the Athabasca River, also displayed a high level of interspersion, or vegetation community biodiversity, likely due to the variations in terrain and drainage conditions resulting from complex drainage patterns south of Lease 86/17 (Figure D5.0-3).

An assessment of habitat interspersion, as one indicator of biodiversity at the landscape level, was scored on a ten point scale reflecting low to high habitat diversity. This was reduced to a three-level rating system of high, medium and low interspersion. The landforms evaluated indicated a relatively low component of highly interspersed habitats: within the Riparian floodplain approximately 5.8% of its area was in the high category; the Riparian River Terraces had 3.7% in the high rating; the Riparian Escarpment had 4.6% of its area in the top interspersion class; and the Upland had about 1.2% of its area in the high category (Table D5.0-1). Highly interspersed areas were primarily found along the extended drainages and upper escarpment crests (Figure D5.0-3).

Impacts to areas of high interspersion were calculated, the results indicating that the Riparian Floodplain and River Terrace areas of high interspersion would be minimally impacted (Table D5.0-1). The area which would be most highly affected by the Steepbank Mine is the Riparian Escarpment, where areas of high interspersion, would be impacted by 4.6% (Table D5.0-1, Figure D5.0-2).

However, it is also important to recognize that areas of medium or low interspersion are an integral component of this environment and represent unique qualities. Relatively uniform areas, in terms of vegetation cover, can be important to vegetation and wildlife species, by providing large patches of certain required vegetation cover. Based on the analysis of interspersion, areas in the low category display minimal habitat and terrain variability within the Local Study Area (Table D5.0-1). In the Upland ecosection, approximately 20% of this area is identified as being in the lowest category for interspersion (Table D5.0-1), indicating that much of the Upland area is of relatively uniform vegetation cover and of large patch size.

In addition, the Riparian escarpment shows 10.7% of this area is of low interspersion based on physical and vegetation properties (Table D5.0-1). This is primarily in the form of consistent slope measurements with uniform closed deciduous (aspen) cover. Impacts to areas of large uniformity or large patch size indicate almost 5% of both uniform areas on the Upland and Riparian escarpment would be impacted by the Steepbank Mine.

b) Fragmentation

One ecological principle that should be considered at the landscape level is the effect of fragmentation of ecosystems. In one context, fragmentation refers to the process of dividing a large contiguous community into a number of smaller units (B.C. Environment 1995). This results in an increase of the amount of edge, decrease in the amounts of interior and increase in the distance between patches. Other definitions identify corridor blockage as a key element of fragmentation (Hudson, 1991). Landscape fragmentation impacts resulting from activities associated with the Steepbank Mine are of primary concern within the floodplain.

TABLE D5.0-1
STEEPBANK MINE POTENTIAL HABITAT BIODIVERSITY IMPACT ASSESSMENT

Ecosection Class		2020 Steepbank Mine Total Impact		Local Study Area (1995 Baseline)		
		ha	% Total	ha	% Total	% of Total Impacted
Riparian Floodplain	**Potential Biodiversity Class**	**101**	**3.1**	**1474**	**100.0**	**6.8**
	Low	2	2.3	69	4.7	0.2
	Medium	98	97.7	1320	89.6	6.7
	High	0	0.0	85	5.8	0.0
	Total	**101**	**100.0**	**1474**	**100.0**	**6.8**
Riparian River Terraces	**Potential Biodiversity Class**	**371**	**11.5**	**2219**	**100.0**	**16.7**
	Low	16	4.3	57	2.6	**0.7**
	Medium	350	94.2	2080	93.7	**15.8**
	High	6	1.5	82	3.7	**0.2**
	Total	**371**	**100.0**	**2219**	**100.0**	**16.7**
Riparian Escarpment	**Potential Biodiversity Class**	**1135**	**35.1**	**4023**	**100.0**	**28.2**
	Low	200	17.7	429	10.7	**5.0**
	Medium	892	445.1	3407	84.7	**22.2**
	High	43	4.8	187	4.6	**1.1**
	Total	**1135**	**2663.1**	**4023**	**100.0**	**28.2**
Upland	**Potential Biodiversity Class**	**1629**	**50.4**	**16792**	**100.0**	**9.7**
	Low	763	46.9	3286	19.6	**4.5**
	Medium	858	52.6	13307	79.2	**5.1**
	High	8	0.5	199	1.2	**0.1**
	Total	**1629**	**100.0**	**16792**	**100.0**	**9.7**
	Grand Total	**3235.6[a]**	**100.0**			

[a]Value differs from the actual mapped Steepbank Mine extent of 3226 by 10 ha.

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

The placement of the mine footprint and its role in fragmenting a large area of relatively contiguous open black spruce bog in the Upland, fragmenting large continuous blocks of deciduous forest on the escarpment slopes and interrupting several east-west drainages which connect the Upland to the Floodplain (and form incised ravine complexes) is considered to contribute to habitat fragmentation in this area. In addition, the placement of the bridge, in conjunction with mining activities and other infrastructure will result in some fragmentation on the east side of the Athabasca River Valley. This is further compounded by the blockage created by existing facilities on the west side of the Athabasca River. The location of valley bottom wetlands on either side of the proposed bridge, contribute to the issue of fragmentation. Fragmentation of communities at the landscape level around the Steepbank Mine is considered to be of moderate concern due to the mine extent in the Upland ecosection, the impact to the Riparian Escarpment drainages and aspen forest stands, and the placement of the bridge and mining infrastructure on the floodplain.

The combination of impacts including impacts to landform types as a whole, loss of areas of high habitat diversity, impact to areas of large patch size locally, and corridor blockage due to ravine interruptions and the placement of the Steepbank bridge, result in an overall 'Moderate' rating of impacts to biodiversity at the landscape level.

D5.2.3 Community Level Biodiversity

Biodiversity must also be considered at the community level, which refers to all the organisms, including plants, wildlife, insects and microbes that live and interact together in an area. For example, a forest stand can be considered to be a community. Diversity within a stand can include: structural measures, such as abundance and density of snags or woody debris, or age class diversity; compositional measures, such as species richness; and functional measures, such as the intensity of disturbance events (Noss 1995). Management at the community level means paying attention to ecological processes such as fire, as well as to hydrological and nutrient cycling (Noss and Cooperider 1994).

Impacts to biodiversity at the community level were assessed by identifying those communities considered to be unique within the area and assessing potential impacts to these types. Those communities assessed included mature forests (mature White Spruce and Deciduous Forest found on the floodplain); Riparian Wetland closed shrub and open water/emergent vegetation wetlands;

and Peatland Tamarack Fens. Many of these communities have been addressed previously under the hypothesis considering impacts to river valley VECs (Hypothesis 12). Typically, these vegetation types exhibited both a high degree of species diversity, and often a high degree of structural diversity, or were of limited cover within the Local Study Area, or provide unique conditions which support less common species.

In addition, impacts are a concern to less common community types not selected in the VEC process, or to those with very specific physical requirements. Communities of this type included the Peatland Open Tamarack Fen, Wetland Closed Shrub Complex and Open Water/Emergent Vegetation Zone beyond the River Valley. Table D5.0-2 shows the losses of these diverse/unique community types within the Local Study Area which would result from the direct footprint of the Steepbank Mine and associated infrastructure and waste dumps. Significant communities which would undergo an impact of 15% or more within the Local Study Area by the year 2020 include the mature White Spruce stands. Impacts to other significant communities were not included in the VEC assessment (Hypothesis 4.2) which are considered more unique include the Tamarack Fen, which would be reduced by 0.66%, locally. In addition the Black Spruce - Tamarack Fen would undergo a 24% decline in its local cover (Table D5.0-2).

The change in wetlands within the Local Study Area shows a decline in the Wetland Closed Shrub Complex and Wetland Open Water-Emergent Zone ecosites of 3.2 and 2.4%, respectively by the year 2020. This is largely related to wetland impacts associated with Shipyard Lake during mine operations from 2010 to 2020.

The long-term planned scenario (Table D5.0-2) shows an overall increase in wetlands, with a substantial increase in the Wetland Open Water-Emergent Zone ecosite of 422 ha (31%) and an increase of 8% (208 ha) in the Wetland Closed Shrub ecosite. These increases are a result of reclamation efforts to provide wetlands habitat in and around the reclaimed areas of the Steepank Mine, following mine closure.

TABLE D5.0-2

SUNCOR LOCAL STUDY AREA NET VEGETATION BALANCE AND REGIONAL CHANGE IN UNIQUE/DIVERSE COMMUNITIES WITH MODERATE RARE PLANT POTENTIAL

ELC Vegetation/Landuse Class	Total Coverage Area (ha)					Longterm % of	Longterm % of
	1995	2001	2010	2020	Longterm	1995 Baseline	Change on Regional[e]
Closed Jack Pine[a]	2760	2701	2581	2536	2532	92	-1
Closed White Spruce[b,c]	3443	3408	3295	3265	3259	95	0
Closed Deciduous Forest[c]	5778	5643	5184	5105	6225	108	-1
Closed Mixedwood[c]	2622	2807	2862	3188	5240	200	1
Peatland: Closed Black Spruce Bog[b]	2995	2952	2808	2604	2597	87	-1
Peatland: Black Spruce-Tamarack Fen[a,b]	3453	3430	3165	2626	2615	76	-2
Closed Mixedwood, White Spruce Dominant[c]	845	825	1012	1200	2804	332	0
Peatland: Open Black Spruce Bog[b]	6032	6008	5873	5277	5263	87	-1
Peatland: Open Tamarack Fen[a,b]	2109	2098	2097	2085	2085	99	0
Wetland Closed Shrub Complex[a,b,c]	2673	2640	2539	2586	2881	108	0
Wetland Open Water - Emergent Vegetation Zone[a,b,c]	1345	1345	1333	1313	1767	131	0
Total Area[a]	**34055**	**33857**	**32749**	**31785**	**37268**	**n/a**	**n/a**

[a]This figure does not include Closed Mixed Coniferous-Black Spruce Dominant, Disturbed/Herb, Grasses, Sparsely-Vegetated: Natural, Sparsely Vegetated: Lease96/17, and Sparsely-Vegetated: Steepbank Mine which account for 6166 ha of the 40221 ha Local Study Area

[b]Highly Diverse +/or Unique Communities

[c]Communities of Moderate Rare Plant Potential

[d]Communities of High Species Richness

[e]Shows the potential impacts of Suncor's activity in the context of the Regional Study Area

D5.2.4 Species Level of Biodiversity

Species diversity is what most people think of when they think of biodiversity (Noss and Cooperider 1994). 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 an extent that it may not become re-established. This has major implications for potential impacts to rare plants. Rare plants are important for both practical and intrinsic reasons. The loss of plant species would impoverish the natural history of an area, and could result in losses of future-needed gene resources (Harms et al 1992).

a) Rare Plants

Impacts to biodiversity at the species level were assessed by analyzing impacts to communities which have a high rare plant potential, such that impacts may result in the isolation or complete loss of individual species or species populations. Table D5.0-3 indicates potential rare and uncommon species within the study area, and the habitats with which they are associated. It is apparent that habitats within the Local Study Area with a moderate rare plant potential include Black Spruce Bogs, Tamarack Fens, Jack Pine Forests and Open Water/Emergent Vegetation Wetlands and the riparian marsh edges of Wetland Closed Shrub Complex. Impacts to these communities of moderate rare plant potential are shown in Table D5.0-2. Communities which would be impacted significantly by the Steepbank Mine, within the Local Study Area include Peatland: Closed Black Spruce Bog (13%), Peatland: Black Spruce-Tamarack Fen (24%), Peatland: Open Black Spruce Bog (13%) and Jack Pine Forest (8%).

The rare and uncommon plant survey conducted within the Local Study Area of the Steepbank Mine did not reveal any areas of a high population of rare plant species. While some rare plant species were identified, these were found in small numbers, and with the exception of the regionally uncommon round-leaved sundew, were found outside of the mine footprint.

b) Species Richness

In addition, significant impacts to communities with a high number of species and with a high structural diversity were assessed. The vegetation surveys completed for the Steepbank Mine (Golder Associates 1996a) assessed vascular plant composition and cover and dominant terrestrial bryophyte composition and cover throughout the Local Study Area. This survey indicated that

TABLE D5.0-3
RARE AND ENDANGERED PLANT SPECIES IN THE SUNCOR/SYNCRUDE AREA

Scientific Name	Common Name	Habitat	Category of Importance
Selaginella rupestris	Little Club-Moss	Dry open areas	S1-3
Lycopodium inundatum	Bog Club-Moss	Moist depressions in sand dunes	S1-3
Isoetes echinospora	Braun's Quillwort	Ponds and lakes	S1-3
Cystopteris montana	Mountain Bladder Fern	Springy or damp calcareous places	S1-3
Dryopteris fragans	Fragrant Shield Fern	Siliceous rocks	S1-3
Potomogeton obtusifolius	Blunt-Leaved Pondweed	Lakes and ponds	S1-3
Polypodium virginianun	Licorice Fern	Moist rocky outcrops	S1-3
Woodsia ilvensis	Rusty Woodsia	Rock crevices	S1-3
Carex lenticularis	Lens-Fruited Sedge	Marshes and lake shores	S1-3
Carex pseudo-cyperus	Cyperus-like Sedge	Swamps and marshes	S1-3
Carex supina	Weak Sedge	Dry, gravelly, eroding slopes	S1-3
Scirpus cyperinus	Wool-Grass	Marshy ground	S1-3
Juncus brevicaudatus	Short-tailed Rush	Shores and marshes	S1-3
Juncus filiformis	Thread Rush	Bogs and marshes	S1-3
**Cypripedium acaule*	Stemless Lady's-Slipper	Bogs, wet woods and sand drunes	S1-3
Chenopodium leptophyllum	Narrow-leaved Goose Foot	Dry slopes	S1; N2,2
Sagina nodosa	Pearlwort	Damp rocky, gravelly, or peaty places	S1-3
Silene antirrhina	Sleepy Catchfly	Dry, open areas	S1-3
Spergularia marina	Salt-marsh Sand Spurry	Brackish or saline muds and sands	S1-3
**Nyphaea tetragona*	Small White Water-lily	Ponds and quiet waters	S1-3
Cardamine pratensis	Meadow Bitter Cress	Bogs and swamps	S1-3
Potentilla multifida	Branched Cinquefoil	Open areas and gravel bars	S1-3

Scientific Name	Common Name	Habitat	Category of Importance
Hypericum majus	Large Canada St. John's-Wort	Moist depressions in sand dunes, sandy shores	S1-3
Gentianella detonsa	Northern Fringed Gentian	Wet meadows, saline flats	S1-3
Pinguicula villosa	Small Butterwort	Sphagnum bogs	S1-3
Utricularia cornuta	Horned Bladderwort	Bogs and lake shores	S1-3
Plantago maritima	Seaside Plantain	Saline marshes	S1-3
Lobelia dortmanna	Water Lobelia	Shallow waters and shores of ponds and lakes	S1-3
Aster pauciflorus	Few-flowered Aster	Saline shores and depressions	S1-3
Erigeron hyssopifolius	Wild Daisy	Gravelly shores and meadows	S_, N?, 3
Tanacetum huronense	Indian Tansy	Sand dunes, sandy and gravelly shores	_, N?, 3
Thellungiella salsuginea	Mouse-ear Cress	Saline shores and flats	S1-3
Drosera linearis	Slender-leaved Sundew	Marly bogs and wet calcareous shores	_, N1, 1

N1	National Status	1	Critically imperiled (5 or fewer occurrences)
		2	Imperiled because of rarity (6-20 occurrences)
		3	Rare or uncommon (21-100 occurrences)
S1	Subnational Status		
N?	Status Unknown		

*Species located in Suncor Study Area

communities with a relatively high species diversity (over 60 species) were also often highly structured, adding to their diverse nature. Those communities with the highest diversity included:

Vegetation Community Type	**Ecosection Type**
Closed Deciduous Forest	Riparian Floodplain Ecosection
	Riparian Terraces
	Riparian Escarpment

	Upland, Highland, Midland and Midland Drainage
Closed Mixedwood White Spruce Dominant	Riparian Floodplain Riparian Terrace Riparian Escarpment
Closed Mixedwood	Upland, Highland, Midland and Midland Drainage
Closed White Spruce	Riparian Escarpment Upland, Highland, Midland and Midland Drainage

The most species rich communities consisted of the Closed Deciduous Forest on the Riparian Escarpment, and the Closed Mixedwood Forest in the Upland ecosection. These communities supported over 100 species.

During mine construction (2001), an assessment of potential impacts to these diverse stands show that the Closed Deciduous Forest (on the Riparian Terrace) would be most impacted, with an 8% loss (Table D5.0-2). During mine development (2010), Closed Deciduous Forest on the Riparian Terrace would decline by 17%, with impacts to Closed White Spruce, Closed Deciduous and Closed Mixedwood on the Riparian Escarpment also of significance, with losses of 12%, 16% and 14%respectively. Species rich communities on the Upland and Highland ecosections would not be highly impacted.

Impacts to species rich communities during mining operations (2020) would be less, although the Riparian Escarpment would undergo a decline of 10% of the White Spruce Forests, 6% of the Deciduous Forest and 5% of Closed Mixedwood.

Planned reclamation, would result in an increase in some of these more species rich communities (Table D3.0-3 Hypothesis 13). Reclamation would result in significant increases from 1995 baseline cover for the following communities: Closed Deciduous Forest on the Riparian Floodplain, Terraces and Escarpment slopes. It should be noted that flexibility in revegetation programs allows a variety of vegetation types to be established depending on land use and habitat preferences.

D5.3 IMPACT MITIGATION

Mitigative options to avoid or minimize impacts to biodiversity include:

1. Maintenance of biodiversity can best be achieved by project planning to firstly avoid or minimize disturbance to diverse habitats.

2. Biodiversity can be maintained through reclamation and habitat re-establishment where the objectives are to replace disturbed habitats with those similar to the natural habitats which were lost. This will be accomplished through the development of wetlands habitats in the Upland, during reclamation of the Steepbank Mine.

3. Further reclamation objectives include the maintenance of: landscape diversity, habitat interspersion, species diversity and sustainability, through developing a comprehensive, ecologically integrated reclamation plan. Such efforts include the establishment of forest types on the reclaimed Escarpment and Upland areas, including diverse Mixedwood and Mixedwood, White Spruce Dominant forests. These would also be managed to attain mature forest status, in time.

4. Tools to assist reclamation efforts include: project planning, ecological land classification (ELC) database, reclamation performance assessment and utilization of Suncor's reclamation history at Lease 86/17 (20 years).

Reclamation efforts are designed to eventually replace a natural level of biodiversity at the landscape, community and species levels. The overall objective in reclamation of disturbed landscapes is to minimize long-term or permanent losses to natural biodiversity, by providing the landscape, soil and drainage conditions necessary to eventually replace as much as possible of the originally disturbed habitat types. This objective places a different emphasis on possible end land uses rather than an objective based solely on productivity as measured by merchantable timber stands. As such, reclamation planning has identified the diversity and habitat importance of some vegetation types with long term reclamation goals formulated to return or increase these units. Table D3.0-3 shows a planned increase in some of the more diverse communities including, Closed Mixedwood, Closed White Spruce Dominant, Wetland Open Water and Wetland Closed Shrub ecosites. The reclamation and habitat development will provide marsh-type wetlands in the upland wildlife habitat in this region of the Local Study Area. In addition, the establishment of open water with closed shrub wetland types will assist in mitigating the losses to Fen and Bog habitats in the upland. Fens, in particular support areas of open water interspersed with bog birch and willow stands - habitat components which will be recreated under the existing reclamation plan. In addition, a growing information base will allow for more reclamation flexibility. Mitigation measures have been discussed previously under Hypothesis 13 which looks at the limitations and opportunities to existing and future land use as a result of reclamation.

D5.4 IMPACT RATING

An assessment and rating of potential impacts to biodiversity of the proposed Steepbank Mine was conducted at the landscape, community and species level. The landscape level assessment was based on impacts to landscapes in general, as well as landscape level changes to habitat interspersion and patch size. Community level impacts focussed on the loss of unique or significant communities, while a species level of assessment looked at rare plant species and species-rich communities.

D5.4.1 Landscape Level Impacts

An assessment of landscape level impacts looked at impacts to areas of very rich habitat interspersion and areas of large ptach size. This assessment is summarized in Figure D5.0-4, indicating a low level of concern at the Construction Phase, a Moderate level of concern at the Operation Phase, and Moderate level of concern at the Closure or Long-Term phase. Moderate levels of concerns resulted from combining a High level of concern for the Riparian Escarpment, with Low Levels of concern for the Floodplain and Upland Terrain Types. Moderate and low levels of concern were given to the loss of areas of high habitat diversity and impacts to areas of large patch size.

Landscape level impacts due to fragmentation are considered moderate. This is related to the loss of some contiguous vegetation cover of large patch size on the Riparian escarpment and Upland ecosections. In addition, impact to the Riparian escarpment landform is significant locally. The placement of the bridge also would have an impact due to corridor blockage and habitat fragmentation on the Athabasca River floodplain.

D5.4.2 Vegetation Community Level Impacts

Impacts to biodiversity at the Community Level are primarily concerned with potential loss to significant community types within the Local Study Area, particularly to those communities of limited cover and/or of significance due to important ecological characteristics. Communities assessed included mature white spruce and balsam poplar forests (Hypothesis 12), Open Water and Closed Shrub Wetlands, and Tamarack fens. Impacts to these communities were assessed with an overall moderate rating of concern, which combined High levels of concern for mature forest loss, with Low levels of concern for the Open Water and Closed Shrub Wetlands and for the Tamarack Fens (Figure D5.0-5). Reclamation efforts under the long-term planned scenario show a replacement of Mixedwood Forest types as well as a replacement of Wetland Open Water and Wetland Closed Shrub ecosites. This will assist in replacing some components of biodiversity in the long-term time frame.

D5.4.3 Species Level Impacts

An assessment of impacts to vegetation at the species level is focused on impacts to communities with a high diversity of species and structure, and on those communities with a higher potential for rare or uncommon plants. This focus reflects the species level concern such that project impacts may remove a resource of species diversity or individual species presence (locally or regionally), resulting in a decline in biodiversity at the species level. Communities assessed for this purpose within the Local Study Area included Open Water/Emergent Vegetation, Mature White Spruce forests and Balsam Poplar forests, Jack Pine forests, Peatland: Open and Closed Black Spruce Bogs and Peatland: Tamarack Fens. The loss of these vegetation types within the Local Study Area can be reviewed in Hypothesis 12 and 13. An overall rating of Moderate at the community level results, combining High concerns related to mature forest and Open Black Spruce Bog impacts, and low to moderate concerns for Jack Pine Forests, Closed Black Spruce and Tamarack Fens

(Figure D5.0-6). Long-term reclamation plans to replace Wetland Open Water and Closed Shrub habitats, as well as the eventual return of mature forests (Mixedwood ecosites) help to reduce the long-term impact to the plant species level of biodiversity.

Of further relevance to biodiversity at the species level is the possibility of the introduction of non-native, weedy species. Many of these species thrive on disturbed landscapes, out-compete native pioneer species and act to stall succession and reduce biodiversity within an area.

The overall rating for the level of concern for potential impacts to biodiversity includes a synthesis of ratings for impacts to landforms, interspersion and patch size at the landform level, significant community impacts and potential impacts to rare and uncommon plant species. Overall, the potential impact to biodiversity is considered Moderate, but at least partially mitigated by reclamation efforts in the long-term reclamation scenario.

D5.5 CUMULATIVE EFFECTS

Cumulative effects assessment to biodiversity within the region has been assessed in this report by addressing proposed impacts to the year 2020 on the vegetation associations mapped within the Regional Study Area. However, it is important to note that, in terms of biodiversity, there are numerous other impact sources which combine to increase the cumulative regional impacts. Some of these include linear developments such as roads, pipelines, seismic lines and cut lines. The cumulative impacts to areas of high biodiversity cannot be assessed at the landscape level. However, it is possible to identify those vegetation types which are significantly impacted and assume that some level of biodiversity will be affected. The cumulative impacts to the closed white spruce community, which would be reduced by 47% under the proposed plans, is highly significant within the large Regional Study Area (Table D5.0-4). While these stands do not appear to have a high rare plant potential, they do provide an important component of mature forests within the region, and may be associated with specific landform features such as floodplains, escarpment slopes and morainal uplands. They can also be species rich communities -- particularly in floodplain and ravine settings. This is also true of the Closed Mixedwood, White Spruce Dominant association, which would be impacted by 14% (Table D5.0-4). This association is a younger seral stage to the Closed White Spruce Forest, and would succeed to mature White Spruce Forests in time.

Of further significance to biodiversity is the high increase in the Industrial/Sparsely Vegetated type and the Disturbed/Herb-Grass type (Table D5.0-4). The increase in these associations is largely related to the clearing of areas for mining, with Syncrude and Alpac being the major contributors. The implications of these increases are related to the encroachment of introduced species during reclamation, and to the combined loss of the native vegetation type during logging or mining activities.

D5.6 LEVEL OF CONFIDENCE

The level of confidence associated with a moderate rating of impacts to biodiversity is considered moderate. Areas of uncertainty are due to limitations in the identification of unusual or difficult to distinguish vegetation communities, and to the limitations inherent in any field sampling program to identify the occurrence of all rare species. However, by looking at all those communities with a moderate to high rare plant potential, with the understanding that rare plants may be present at some time, a qualified assessment can be made. In addition, the existing covers of mature stands of white spruce and balsam poplar has been coarsely defined such that the relevance of the loss of smaller stands is difficult to define. However, impacts to highly interspersed habitats, areas of relatively large patch size, species rich communities and landform types have been more clearly defined.

A focus of the field program was to use the results of the satellite mapping with that of air photo interpretation, to identify and sample areas which were unique and those community types which were known to potentially support rare plant species, building on existing literature and previous studies in the Fort McMurray area. The satellite imagery allowed the vegetation to be mapped in an unbiased, consistent format for the entire local and Regional Study Area at a level of resolution, or detail of 25 m^2. At this level of detail, differences in vegetation communities can be easily distinguished; however, complex boundaries or transition areas such as between peatland and bog types are more difficult to identify.

TABLE D5.0-4
CUMULATIVE VEGETATION IMPACT ASSESSMENT TO VEGETATION BIODIVERSITY, YEAR 2020 RELATIVE TO 1995 BASELINE

ELC Vegetation/Landuse Class	Total Coverage Area (ha)		Suncor	Syncrude Mildred L/Aurora	Solv-Ex	ALPAC & NORTHLANDS[1]	Cumulative Loss/Gain (ha)	Percentage of 1995 Baseline
	1995 Baseline	2020						
Closed Jack Pine	29119	26551	-224	-587	-26	-1731	-2568	-9
Closed White Spruce	43728	23151	-178	349	-3	-20745	-20577	-47
Closed Deciduous Forest	78738	95640	-673	-2266	-32	19873	16902	21
Closed Mixedwood	62530	60383	566	-183	-3	-2527	-2147	-3
Closed Mixed Coniferous, Black Spruce Dominant	86949	82409	-111	-3750	0	-679	-4540	-5
Peatland: Closed Black Spruce Bog	42494	38513	-391	-2771	-190	-629	-3981	-9
Peatland: Black Spruce-Tamarack Fen	50720	48882	-827	-1011	0	0	-1838	-4
Closed Mixedwood, White Spruce Dominant	129594	110858	355	-1895	-3	-17193	-18736	-14
Peatland: Open Black Spruce Bog	80554	79030	-755	-769	0	0	-1524	-2
Peatland: Open Tamarack Fen	57951	57315	-24	-575	-37	0	-636	-1
Peatland: Shrub Dominated Fen/Patterned Fen	58751	53654	0	-5097	0	0	-5097	-9
Wetland Closed Shrub Complex	214209	209657	-87	-4465	0	0	-4552	-2
Disturbed/Herb, Grass and Crop Tree Regeneration	18073	54477	1794	10684	295	23631	36404	201
Industrial/Sparsely-Vegetated [a]	10387	23394	587	12421	-1	0	13007	125
Wetland Open Water - Emergent Vegetation Zone	13502	13384	-32	-85	0	0	-117	-1
Urban Areas	2109	2109	0	0	0	0	0	0
Net Total Area	**979408**	**979407**	**0**	**0**	**0**	**0**	**0**	**n/a**

[a] Includes industrial areas and tailings ponds.

Notes: 1. Areas Harvested by ALPAC and Northlands return rapidly to a forest cover type, however, to qualify for a forest cover type, crown closure was set at 70%, which takes decades for seedlings to acheive.

D6.0 HYPOTHESIS 16

Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage and reclamation release water.

D6.1 HYPOTHESIS DESCRIPTION

Wetlands within the local and Regional Study Area have been identified as a number of community types which are concentrated within the impact zone in the Upland Ecosection primarily as Bogs and Fens and associated drainage. Wetlands are also present in less cover along the upper edge of the Riparian Escarpment where there is an extension of Bogs and Fens along near level areas of the upper escarpment, and in areas on the Floodplain. In addition, wetlands also occur in the Highland, Midland and Midland Drainage Ecosections. Wetland types assessed include:

- Peatland Closed Black Spruce;
- Peatland Open Black Spruce/Labrador Tea;
- Peatland Black Spruce-Tamarack Fen; and,
- Peatland Open Tamarack Fen;
- Wetland Open Water/Emergent Vegetation Zone
- Wetland Closed Shrub Complex

Interest in the assessment of potential impacts to wetlands is related to the extent and ecological importance of these communities within Canada's Boreal Forests. In addition, wetlands communities are considered sensitive to disturbance (both physical and pollution), have a high to moderate rare plant potential, are of growing economic and ecological importance, are important to local water balances and have provided some historical traditional uses. Peatland classification and mapping within the region is currently being completed by Halsey and Vitt (1995). Under their classification, a very detailed breakdown and mapping of peatlands has been applied, identifying about 12 peatland types. The initial distinction is based on tree covers, where peatlands with less than 10% tree cover are termed 'open'. Forested peatlands are further subdivided according to black spruce dominant versus tamarack dominant or co-dominant. Further subdivisions are based on terrain modifiers, such as gently sloping mid-slopes with drainage limitations often supporting tamarack. This type is called a Division 3 Peatland with a V-modifier, and was widely present in the Upland and Upper Riparian Escarpment Landforms in the Suncor Local Study Area. Another level of breakdown is based on bog or fen pattern, such as the presence of internal lawns (Halsey and Vitt 1995). Most of the bog and fen types in the upland area were considered forested. The Open Black-Spruce Bog and Open Tamarack Fen were often transitional between Open and Closed Peatlands, with 10 to 40% cover. Often thin cover was stunted in the Open Black Spruce Bog ecosite.

Open Peatlands, according to Halsey and Vitt (1995) have less than 10% tree cover. Additional breakdowns are based on patterns and dominance of Black Spruce-Tamarack. Patterned peatlands are not present within the Suncor Local Study Area. However, small lineations of shrub peatlands were present in scattered covers, often associated with sedge-dominated peatlands, along slow drainages running from east to west. The following impact analysis focuses on impacts to wetlands within the local and Regional Study Areas, including mitigation opportunities and long-term implications for reclamation.

The impact hypothesis for wetlands is shown on Figure D6.0-1.

D6.2 PRIMARY LINKAGES AND MODES OF IMPACT

The primary linkages and sources of impact to wetlands within the Local Study Area are summarized below:

Impacts

1. Mine preparation and facility construction such as roads, utilities, plant facilities and the bridge will result in the loss of wetlands within the region.

2. Open water wetlands will be affected primarily within the Athabasca River floodplain; peatland and fen wetlands will primarily be affected in the Uplands.

3. Site clearing, grading, excavation, overburden removal and storage will affect wetlands through infilling and altered drainage inflow and outflow patterns.

4. Air emissions may result in changes in wetlands (flora and fauna) species composition.

Wetlands provide a moderate to high proportion of the Local Study Area, with particularly high covers provided by the Peatland: Open Black Spruce Bog ecosite, followed by the Peatland: Closed Black Spruce Bog and Peatland: Open Tamarack Fen ecosites. In this analysis, impacts to wetlands are measured by the direct footprint of the mine, overburden sites and infrastructure. It is assumed that impacts associated with mine dewatering, and water loss from the surrounding wetlands into the mine pit will also further impact peatlands in a more general "zone of influence" around the direct impact area. This zone is estimated to be approximately 300 m around the direct zone (Klohn-Crippen 1996). More specific reclamation efforts and impacts to Shipyard Lake are discussed in Section D2.2 (VEC Assessment).

D6.3 IMPACT ANALYSIS

The majority of the Local Study Area is comprised of the Upland Organic/Lacustrine Plain, which supports a high cover of wetlands types. In addition, there is an extension of wetlands types into the Escarpment Slope along ravines, drainges and peatland extensions, where the slope is less steep. The Floodplain also supports a moderate cover of wetlands types.

Impacts of the Steepbank Mine to wetlands would be most significant to the Peatland: Closed Black Spruce-Tamarack Fen, where approximately 24 % of this peatland type would be directly impacted under the long-term analysis, with the most significant impacts occurring during 2010 to 2020 (Table D6.0-1). The Peatland: Closed Black Spruce-Bog and Peatland Open Black Spruce Bog would also be significantly impacted - both with a loss of 13% under the long-term analysis.

While not representing peatland types, reclamation and replacement of the Open Water and Closed Shrub Wetlands types will result in an increase of 31% and 8 %, respectively (Table D6.0-1). These increases will provide a mosaic of wetlands, shrub and open water emergent vegetation which will help to off-set some of the habitat losses due to the local peatland impacts. This is particularly pertinent where losses of peatlands included a loss to shrub and areas of open water - such as in the Fen types where small ponds, drainage, birch and willow would be lost. Wetland Reclamation will help to mitigate some of these losses, where the reclamation plan would result in a significant increase in emergent vegetation, open water areas and willow, birch and alder in the wetland shrub fringe.

D6.4 IMPACT MITIGATION

Mitigation measures to minimize the impacts to wetlands are summarized as follows:

Mitigation

1. Avoid or minimize disturbance, where possible, to wetlands within the Athabasca River floodplain.

2. Loss/disturbance of wetlands can be mitigated through reclamation.

3. Reclamation of wetlands will involve site preparation of the area to be reclaimed, involving re-grading and re-contouring to re-establish surface drainage patterns.

4. Reclamation objectives will include re-establishment of wetlands habitat function and process. These efforts will be directed at Wetland Open Water/Emergent Vegetation and Wetland Closed Shrub ecosites, in the Upland ecosection.

5. Reclamation will be phased to re-establish drainage patterns and allow stabilization of reclaimed wetlands in the Athabasca River Valley.

6. Environmental monitoring programs will record reclamation progress of wetlands function and process.

D6.5 IMPACT CLASSIFICATION

Impacts to peatlands within the Local Study Area are of moderate to high concern due to relatively high percentage of impact to these resources, locally (Figure D6.0-2). The Steepbank Mine would result in a decrease of 13% of both the Peatland Closed Black Spruce Bog and the Peatland Open Black Spruce vegetation types, and a decline of 24% of the Peatland Black Spruce Tamarack Fen community (Table D6.0-1). When assessed within the Regional Study Area, impacts are rated as

TABLE D6.0-1

SUNCOR NET WETLAND BALANCE

ELC Vegetation/Landuse Class	Total Coverage Area (ha)									Longterm % of	Longterm %
	1995	2001	% loss	2010	% loss	2020	% loss	Longterm	% change	1995 Baseline	of 1995 region
Peatland: Closed Black Spruce Bog	2995	2952	1	2808	5	2604	-7	2597	-13	87	99
Peatland: Black Spruce-Tamarack Fen	3453	3430	1	3165	8	2626	-16	2615	-24	76	98
Peatland: Open Black Spruce Bog	6032	6008	0	5873	2	5277	-10	5263	-13	87	99
Peatland: Open Tamarack Fen	2109	2098	0	2097	0	2085	-1	2085	-1	99	100
Wetland Closed Shrub Complex	2673	2640	1	2539	4	2586	2	2881	8	108	100
Wetland Open Water - Emergent Vegetation Zone	1345	1345	0	1333	1	1313	-2	1767	31	131	103
Total Area	**17262**	**17128**		**16482**		**15178**		**15441**		**89**	**100**

Low, due to the low percent loss of these ecosites within the relatively extensive regional cover of these communities (Table D6.0-2). Higher scores on the matrix are related to the extent of local disturbance as well as the duration of impacts - which is considered to be long-term. Although reclamation of Lease 86/17 includes wetlands reconstruction, these sites are not planned to replace peatland types. However, as discussed in Section 6.3, wetlands reconstruction will result in providing some of the peatland species and characteristics which will be lost, such as emergent vegetation, shrub species and the interspersion of shrub and open water ecosites.

Impacts to the Wetland Open Water and Wetland Closed Shrub Ecosites are minor to the year 2020 due to some loss to the Wetland Closed Shrub from 2010 to 2020, and to very minor losses to Wetland Open Water during the construction phase . These are primarily associated with impacts to Shipyard Lake. However reclamation efforts to create wetland habitats as tailings ponds are reclaimed will mitigate impacts resulting in a net benefit in the long-term scenario (Table D6.0-1). As a result the Degree of Concern for Wetland Open Water and Closed Shrub Ecosites impacts in the Local Study Area are rated as Low (Figure 6.0-3).

D6.6 CUMULATIVE EFFECTS ASSESSMENT

An assessment of the Cumulative Effects to peatlands within the Regional Study Area considered impacts related to the operations of other major industries in the area including Syncrude, Solv-Ex, Alpac and Northlands (Table D6.0-2). Based on this assessment and operations projections to the year 2020, relatively high impacts are expected for the Peatland Closed Black Spruce Bog community (-9%) and the Peatland Shrub Dominated Fen/Patterned Fen (9%). The latter of these two vegetation types was not identified within the Suncor Local Study Area, and impacts to this community would be attributed to the proposed operations of Syncrude, to the year 2020. Suncor would be responsible for approximately 1% of the 9% loss to Peatland Closed Black Spruce Bog communities. Other Peatland types show a regional decline of 2% and 1% (Table D6.0-2). Regional cumulative impacts to the Open Water and Closed Shrub Wetlands types are minor, with a 1% decline in the Wetland Open water and a 2% decline in the Wetland Closed Shrub, of which Suncor contributes approximately 0.1%. However, reclamation efforts at the Steepbank Mine would replace more than this 0.1% decline, over the long-term.

TABLE D6.0-2

CUMULATIVE VEGETATION IMPACT ASSESSMENT TO WETLANDS, YEAR 2020 RELATIVE TO 1995 BASELINE AREA: REGIONAL STUDY AREA

ELC Vegetation/Landuse Class	Total Coverage Area (ha)		Suncor	Syncrude Mildred L/Aurora	Solv-Ex	Alpac & Northlands[1]	Cumulative Loss/Gain (ha)	Percentage of 1995 Baseline
	1995 Baseline	2020						
Peatland: Closed Black Spruce Bog	42494	38513	-391	-2771	-190	-629	-3981	-9
Peatland: Open Black Spruce Bog	80554	79030	-755	-769	0	0	-1524	-2
Peatland: Open Tamarack Fen	57951	57315	-24	-575	-37	0	-636	-1
Peatland: Shrub Dominated Fen/Patterned Fen	58751	53654	0	-5097	0	0	-5097	-9
Wetland Closed Shrub Complex	214209	209657	-87	-4465	0	0	-4552	-2
Wetland Open Water - Emergent Vegetation Zone	13502	13384	-32	-85	0	0	-117	-1
Total Area	**467460**	**451553**						

[a] Includes industrial areas and tailings ponds.
[1]Areas Harvested by Alpac and Northlands return rapidly to a forest cover type due to reforestation activities.
Information provided by Alpac are estimates based on draft timber supply analysis and may be subject to change.

D6.7 LEVEL OF CONFIDENCE

Factors affecting the level of confidence that can be associated with the impact ratings to wetlands are primarily related to possible impacts associated with mine activities outside of the footprint of the mine. These include additional wetlands impacts due to peatland dewatering, should water drain into the mine pit or drainage channels from the surrounding peatlands; and water quality impacts due to reclamation water release into peatlands around the reclaimed mine area. In addition, reclamation objectives and methods are still evolving for ensuring the replacement of desired wetlands types through careful reclamation of terrain, soil and drainage conditions. Due to these additional factors, a Moderate to High level of confidence is placed on the impact rating to wetlands within the Steepbank Mine Area.

D7.0 HYPOTHESIS 17

D7.1 HYPOTHESIS DESCRIPTION

Air emissions from operation of the Steepbank Mine could have an impact on vegetation, soils and aquatic environments in the study area.

This hypothesis examines the effects of the existing (1995 baseline) and future (2001 scenario) air emissions from the Fixed Plant and the Steepbank Mine on the vegetation and soil resources of the Regional Study Area. The impact on aquatic environments is discussed only briefly in the context of Alberta Environmental Protection's on-going process of assessment.

The comparison considers the substantial decrease in sulphur dioxide (SO_2) emissions (one fifth of their current levels) as a result of the new FGD plant, and the likely effect that this reduction may have in lowering the impacts on terrestrial and aquatic systems within the region. Consideration is also given to the design of an environmental effects, long-term monitoring program.

The hypothesis includes an assessment of:

- The existing effects of both Suncor and Syncrude's air emissions in the Regional Study Area.
- The future effects of both Suncor and Syncrude's air emissions in the Regional Study Area.
- The potential impacts of air emissions on revegetation efforts during operation of the Suncor plant and following plant closure.

The assessment was completed using air quality prediction based upon modelling data and on analysis of changing air emissions on air quality conducted by BOVAR Environmental (1996), background literature sources and on-site vegetation monitoring reports conducted in the region (e.g., Reid and Sherstabetoff 1985, Dabbs Environmental Services 1985, Pauls 1992). Emphasis was placed on the interpretation of air emissions data, including concentrations and durations of exposure with respect to the regional distribution of vegetation and soil types.

D7.2 SUB-HYPOTHESIS

The effects of air emissions were examined by looking at three sub-hypothesis: the effects on

(1) vegetation
(2) soils
(3) aquatic environments

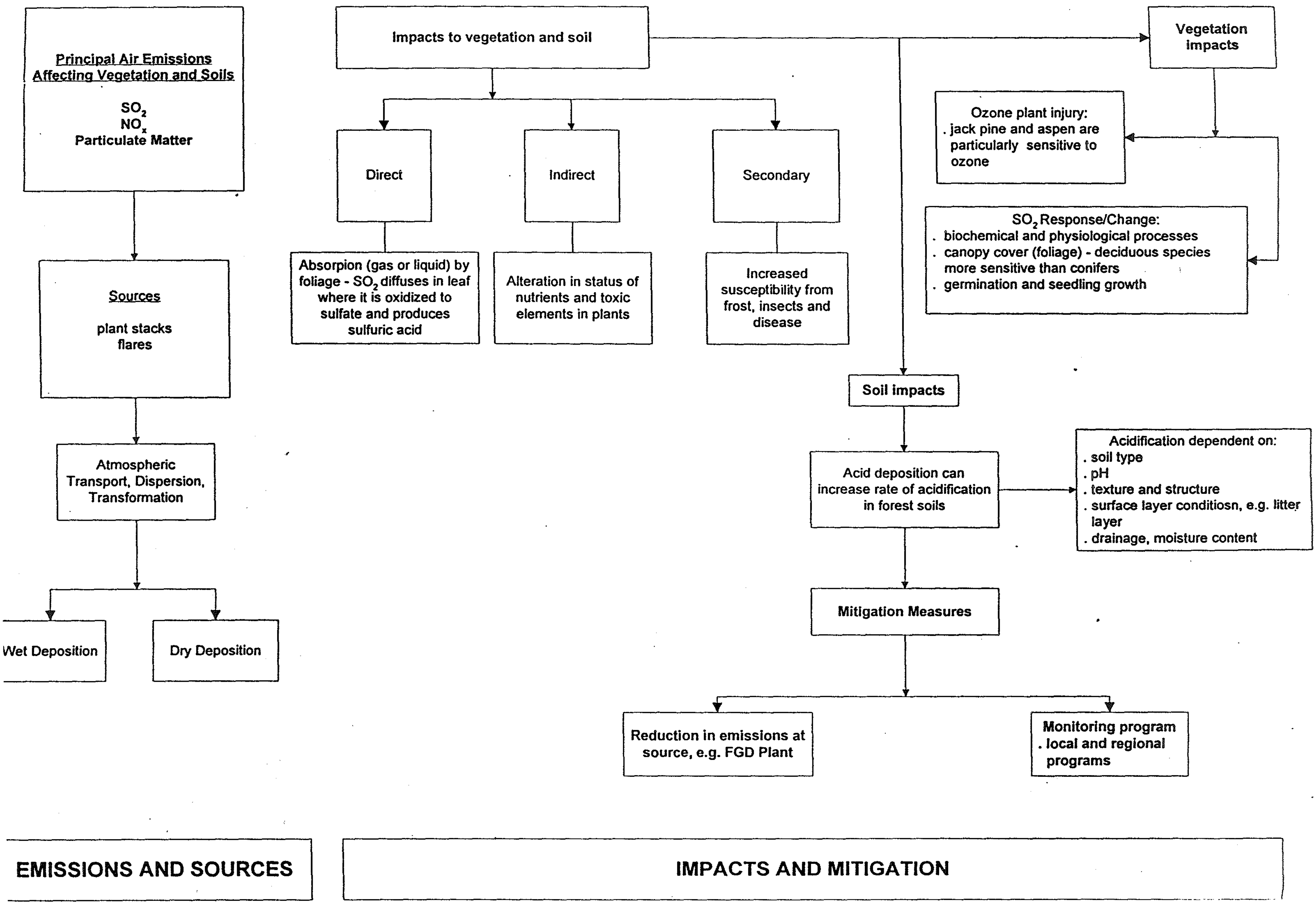
D7.2.1 Effects on Vegetation

a) <u>Types of Effects</u>

Vegetation can be affected by air emissions as a result of direct, indirect or secondary effects:

- **Direct** effects may result when plants absorb gases or liquids containing sulphur and/or other harmful compounds through their leaves. Smith (1990), Malhotra and Blauel (1980), Torn *et al.* (1987), Treshow (1984) and Legge et al (1988) have reviewed the direct effects of SO_2 on vegetation. Injury initially takes place at the biochemical level (interference with photosynthesis, respiration and lipid and protein synthesis). This progresses to the ultra-structural level (disorganization of cellular membrane) and to the cellular level (cell

FIGURE D7.0-1A
AIR EMISSIONS FROM OPERATION OF THE STEEPBANK MINE WILL HAVE AN IMPACT ON VEGETATION, SOILS AND AQUATIC ENVIRONMENTS



wall, mesophyll and nuclear breakdown) and finally, visible symptoms (chlorosis and necrosis of foliar tissue) develop which may result in reduced plant growth and yield.

- Direct effects may result in acute injury from exposure to relatively high concentrations for a short period of time (i.e., less than 24 hours), or chronic injury from exposure to relatively low concentrations over a long period of time (i.e., greater than days, months or years) (Torn *et al.* 1987). In recent years, attention has been paid to the long-term effects of relatively low concentrations of SO_2, as sulphur compounds can accumulate in plant tissues and soils and adversely affect plant growth after a number of years (Legge et al, 1988).

- **Indirect** effects are produced when air emissions such as SO_2 concentrations change the chemistry or biology of soil or water which, in turn, influences the amount and type of nutrients and toxic elements taken up by plants. The most common problem is a reduction in soil pH.

- **Secondary** effects are produced when stress or injury from SO_2 concentrations predisposes plants to another source of stress or injury such as insect infestation, disease, drought or frost (World Health Organization (WHO) 1987).

b) <u>Vegetation Exposure</u>

The extent and nature of vegetation responses to air emission contaminants such as SO_2, NO_x and O_3 are a function of the plant (species, cultivar or variety, stage of development and health), climatic conditions, the characteristics of the exposure (magnitude; duration, frequency and temporal sequence; and the fluctuation) and the plant's history of exposure to such emissions. Plant injury is highest typically during spring when leaves are developing and conditions favor rapid growth (e.g. high light intensity, high relative humidity, adequate soil moisture and moderate temperature). In winter when plants are dormant, the risk of air emission injury is lower although it is still present (Torn *et al.* 1987, WHO 1987).

With respect to the characteristics of the exposure, researchers have found that the magnitude of the exposure has a greater influence on the extent of injury than does the duration of exposure for a given dose (MacDonald and Klemm 1973, Torn *et al.* 1987, WHO 1987). Although vegetation can recover during exposure-free periods, complete recovery will not occur if the exposure duration is too long or the recovery period too short (WHO 1987). Kickert (1990), in assessing the effects of concentrations on vegetation, state that the median, maximum and total concentrations, and numbers of exposures over a given time period should be used, rather than an average SO_2 concentration over the growing season. Further examples are also provided by Dreisenger and McGovern (1970) on studies done in the Sudbury area, Ontario. The response of a plant to SO_2 emissions is also determined by its history of exposure. Plants, particularly perennials, that have been historically exposed to SO_2 show greater decreases in growth and yield when exposed to low concentrations of SO_2 than plants that have not been exposed to emissions (Harvey and Legge 1979, Addison et al 1986).

c) <u>Vegetation Sensitivity</u>

Plants differ in their susceptibility to damage from SO_2 emissions. Lichens and mosses are considered the most sensitive plant groups to air emissions because they absorb all their nutrients from the air and rain water (Malhotra and Blauel 1980 and Treshow 1984). Trees with long life cycles suffer from long-term exposure, because subtle effects can build-up year after year to produce harmful effects (WHO 1987, Smith 1990). Deciduous species generally develop symptoms of stress to air emissions more rapidly than evergreens (Malhotra and Blauel 1980, Addison *et al.* 1986). However, evergreens, because of their long foliar retention time, can accumulate more contaminants than deciduous species, which lose their leaves annually (Addison *et al.* 1986).

d) <u>Concentration Levels</u>

A variety of threshold concentration levels are reported in the literature beyond which vegetation impacts are attributed (Smith 1990). The primary air pollutant considered is SO_2. Jones *et al.* (1979) recommended the threshold dose for foliar injury to sensitive species is 850 $\mu g/m^3$ (0.32 ppm) for 1 hour. The lowest concentrations that caused acute injury to moderately sensitive native species (i.e., aspen and jack pine) was 1,100 $\mu g/m^3$ (0.42 ppm) over 1 hour (Dreisinger and McGovern 1970); and 475 $\mu g/m^3$ (0.18 ppm) over 24 hours (Malhotra and Khan 1978); and that caused chronic injury was 45 $\mu g/m^3$ (0.017 ppm) over the growing season (Linzon 1978).

The lowest daily concentration that causes acute injury to lichens was 265 $\mu g/m^3$ (0.1 ppm) over 1 to 2 days, although results could be reversed under proper conditions (Malhotra and Khan 1978). The concentration causing injury was 50 $\mu g/m^3$ (0.02 ppm) over the growing season (Nriagu 1978) and 25 $\mu g/m^3$ (0.01 ppm) over a year (Anderson and Treshow 1984).

The ambient air quality guidelines of SO_2 in Alberta are 450 $\mu g/m^3$ (hourly); 150 $\mu g/m^3$ (daily) and 30 $\mu g/m^3$ (annually). The FGD plant, to be operational by 2001, will result in a significant reduction in SO_2 emissions for hourly, daily and annual concentrations.

D7.2.2 Effects on Soils

The main cause of acidification of soils is by SO_2 and sulphate SO_2. These emissions may reach the soil directly by either dry or wet deposition. Rates of dry deposition are influenced by soil type and moisture content. An important factor influencing sulphur availability in soil is pH. For example, at a pH below 6.0 sulphate becomes strongly absorbed (Unsworth *et al. 1985*).

The effects of air emissions on the soil resources of the Regional Study Area are determined by the sensitivity of different soil types to acid deposition. Soils naturally vary in pH from the extremes of about 3.0 to 10.0; however, plants are suited to growing only in a portion of that range. For example, pine and spruce can grow in soils with a pH as low as 3.5 yet on forest soils acidified by windblown elemental sulphur, when the soil pH was 5 to 4 the number of vegetative species in the undergrowth was reduced. When the pH was 4 to 3, only a few plant species grew and when it was less than 3, there was no vegetative undergrowth (Nyborg 1978). The growth requirements of a plant community must match the pH, as well as the texture, salinity, nutrient levels and all of the chemical and physical characteristics of the rootzone materials.

A number of studies have been undertaken in the oil sands area to determine the impact of air emissions on soils. No evidence has been found of short-term acidification or metallic element accumulation in soils in a 50 km radius of the Suncor and Syncrude plants (Hollowaychuk and Fessenden 1987, Dabbs Environmental Services 1985). Addison *et al.* (1986) performed an experiment to determine the influence of the five major elements (sulphur, nitrogen, vanadium, aluminum and nickel) in the area on a Brunisolic soil supporting jack pine. Jack pine seedling establishment and growth was not greatly affected by up to 100 times the annual average concentration of pollutants. Root growth, however, was inhibited by pollutants at high concentrations and low pH. Addison *et al.* (1986) reports that root response of the plants appeared to be almost totally controlled by pH.

In another experiment conducted by Addison *et al.* (1986) to determine whether the surface litter layer (LFH horizon) binds pollutants, jack pine seedlings grown in soils with an LFH horizon were larger than those seedlings grown in soil without an LFH horizon. The results from the experiment indicate that surface organic horizons have the capability to bind soluble pollutants, consequently, preventing them from entering the mineral soil and being taken up by plant roots.

D7.2.3 Effects on Aquatic Environments

Emissions of SO_2 and NO_x associated with oil sands operations are the primary sources contributing to acidic deposition in northeastern Alberta. Deposition of acid-forming substances can affect functioning of sensitive aquatic ecosystems. The sensitivity of Alberta surface water bodies to acidic deposition have been described in numerous reports prepared by Alberta Environmental Protection; the most recent report has been updated to include data collected from 1995 (Saffran and Trew 1996). Lakes that are sensitive to acidic deposition are those with low buffering capacity, i.e., total alkalinity less than 10 mg/L. The Birch Mountains are the only "sensitive" regions in northeastern Alberta near the oil sands operations.

One means of assessing potential impacts on surface water bodies is by comparing actual or projected deposition loading rates to critical loading rates. Critical loading rates refer to "the amount of deposition, determined by technical analysis, above which there is a specific deleterious ecological affect to a receptor" (Grigal, 1991). Alberta Environmental Protection (AEP) is in the process of developing an approach for defining critical loading rates to lakes based on "effective acidity". The calculation of effective acidity (EA) can be used to theoretically quantify the impact of atmospheric deposition on a surface water body. Once this approach has been finalized by AEP, it can be used to help assess potential impacts on water bodies associated with Suncor's acid-forming emissions.

BOVAR Environmental (1996) provides a series of maps showing existing and future projections of effective acidity, based on the assumption that all deposited sulphur compounds will be converted into an acid and that the background value is 0.13 $keq(H^+)ha^{-1}yr^{-1}$. In the current situation, the 0.3 $keq(H^+)ha^{-1}yr^{-1}$, which is a rough approximation of the critical loading value for sensitive lakes (Trew 1995), is restricted to a small area immediately around the operating oil sands facilities. In the future, emissions of the Suncor's largest source of acid-forming emissions, SO_2, will drop to approximately 22% of current levels because of the commissioning of the FGD unit; this will result in a reduction of effective acidity by about 35% (BOVAR Environmental 1996) and will reduce the area of potential impacts on surface water bodies.

D7.3 LINKAGES/MODES OF IMPACT

The primary linkages and modes of impact of air emissions on vegetation and soils are shown in Figure D7.0-1A. Principal emissions considered in the effects on vegetation and soils include SO_2, NO_x and particulate matter.

D7.4 ANALYSIS

D7.4.1 Air Quality Modelling Summary

A summary of the air quality modelling analysis (BOVAR Environmental 1996) is provided to form the basis for the assessment, of the effects on vegetation and soils. The model predictions associated with the current emission scenario (1994/1995) and the future (1998/2001) emission scenarios of the combined operation of all sources indicates the following:

a) Hourly Average SO_2 Concentrations

- Hourly maximum SO_2 concentrations are expected to decrease from 1,279 to 1,652 μg/m^3 (0.48 to 0.62 ppm) to 437 to 454 μg/m^3 (~0.17 ppm).

- The maximum number of hourly exceedence values in excess of 450 mg/m^3 is predicted to decrease from 37 to 49 per year to about once per year.

- During periods when the FGD is not operating, the hourly maximum SO_2 concentrations associated with the Powerhouse stack is predicted to be in the 1200 to 1400 μg/m^3 (0.45 to 0.53 ppm) range. This is similar to that associated with the current Powerhouse operation.

The maximum predicted (1998/2001) hourly value of 477 to 498 μg/m^3 (0.18 to 0.19 ppm) compares to that of 1,246 to 1,947 μg/m^3 (0.48 to 0.56 ppm) associated with the current (1994/1995) emission scenario. The maximum values are predicted to decrease by almost a factor of three. Additionally, the number of values that exceed the 450 μg/m^3 guideline are predicted to decrease from about 40 hours per year at the worst location to about twice per year.

b) Daily Average SO_2 Concentrations

- Maximum daily average SO_2 concentrations are expected to decrease from about 246 to 311 μg/m^3 (0.12 ppm) to 125 to 129 μg/m^3 (~0.05 ppm).

- During periods when the FGD is not operating, the daily average maximum SO_2 concentrations associated with the Powerhouse stack is predicted to be in the 235 to 270 μg/m^3 (0.09 to 0.10 ppm) range. This is similar to that associated with the current powerhouse operation.

c) Annual Average SO_2 Concentrations

- Maximum amount average SO_2 concentrations are expected to decrease from 12 to 16 μg/m^3 (0.005 to 0.006 ppm) to about 8 μg/m^3 (0.003 ppm). This compares to the background value that ranges between 1 and 4 mg/m^3.

d) Existing Air Quality

Existing air quality can be defined through ambient monitoring and the application of dispersion modelling. The former is limited to observations collected to date and the benefits of future changes are not accounted for. Air quality modelling can evaluate the potential benefits associated with future reductions in emissions.

- **High SO_2 concentrations** (i.e., in excess of 900 μg/m^3) have been observed on the edge of the Athabasca River valley escarpment (i.e., at the Fina and Mannix air monitoring stations). Dispersion modelling confirms these high occurrences and identifies the Suncor powerhouse as the major contributor. A review of concurrent meteorological conditions indicates that observable SO_2 concentrations are associated with either one of the two oil sands plants being upwind of the monitoring stations and these values are associated with daytime connective and/or limited trapping conditions.

- The SO_2 model predictions support the observations at the air monitoring trailers. In addition, the modelling indicates hourly concentrations in excess of 900 $\mu g/m^3$ and maximum daily concentrations in excess of 150 $\mu g/m^3$ could occur on the elevated terrain towards Muskeg Mountain and Thickwood Hills under the current emission scenario.

- Relatively large (greater than 1,000 $\mu g/m^3$) SO_2 concentrations due to abnormal flaring are predicted to occur within a few kilometres of both the Suncor and Syncrude flare stacks.

- The maximum sulphur deposition of 25.5 kg SO_4 equivalent/ha/a is predicted to occur 26 km to the north-northwest of the powerhouse stack. High values are also predicted to occur 20 km to the south-southwest of the powerhouse stack.

D7.4.2 Effects on Vegetation

a) Direct Observable Effects

The primary source of vegetation impacts from acute, short-term exposure air emissions in the region is attributed to SO_2. The sensitivity of boreal forest species to SO_2 emissions is summarized in Table D7.0-1 as follows:

TABLE D7.0-1
RANKING OF BOREAL FOREST TREE SPECIES BY SENSITIVITY TO SO_2.

HIGHLY SENSITIVE	MODERATELY SENSITIVE	RELATIVELY TOLERANT
Alpine fir	Balsam poplar	Black spruce
Balsam fir	Jack pine	White spruce
Green alder	Lodgepole pine	
Larch	Trembling aspen	
White birch	Willow	

(Source: Malhotra and Blauel 1980).

Dabbs (1985) reports that SO_2 exposures generally produce similar symptoms on all conifer species. Visible symptoms on forest species will depend on the SO_2 exposure and species sensitivity. In mixed forest stands, both black and white spruce which are relatively tolerant of SO_2, will often remain unaffected even though jack pine will show foliar discoloration. Visible symptoms of SO_2 stress in conifers are characterized by:

- discoloration of needles beginning at the tip, progressing toward the base;
- mature needles dropping prematurely;
- some needles having stunted growth due to fumigation events; and
- that portion of the crown exposed to directional fumigation developing more intense injury symptoms than the rest of the crown.

In deciduous species, aspen and balsam poplar are moderately sensitive, whereas white birch is highly sensitive to SO_2 stress. In addition, older mature trees, of both balsam poplar and aspen, are more severely affected than younger trees. Major visible symptoms of SO_2 stress in deciduous species include:

- a wet or water-soaked appearance;
- chlorosis and browning around the edges and between the veins;
- extensive discoloration, leaf curling and shriveling; and
- reduced leaf retention.

Visual effects of SO_2 damage to vegetation in the Regional Study Area have been recorded in localized areas (Reid et al 1990, Reid and Sterstabetoff 1985 and Case 1982). Observations were also made of possible secondary effects such as an increase in the incidence of insect infestation and disease.

These local effects were concentrated within the Athabasca River Valley and adjoining tributaries. Maps showing areas of stressed vegetation are shown to change in areal extent from 1978, 1984 and 1990 (Reid et al 1991); generally increasing in size, however, no direct correlation has been made between actual levels of SO_2 concentration (acute or chronic) and vegetation damage. Further monitoring efforts are required to establish these relationships within the Regional Study Area, and to suggest site-specific mitigation measures.

Secondary Insect and Disease Damage

Reid *et al.* (1991) report that a variety of insects are responsible for the widespread defoliation of aspen and deciduous understory. These include tent caterpillar, leaf beetles, leaf rollers, lace wings, leaf minors and aphids. Leaf beetles have the greatest impact, especially on willow and poplar saplings. Vegetation affected by leaf beetle infestation will generally appear scorched. Aspen attacked by tent caterpillars exhibit partial to complete defoliation and considerable discoloration.

Dwarf mistletoe is a disease that affects jack pine stands. Reid and Sherstabetoff (1985) mention that the disease is found throughout the Regional Study Area. The most noticeable symptom of the disease on jack pine is witch's broom where the deformed branches are often distorted and defoliated.

A summary of the maximum hourly, daily and annual average SO_2 concentration emissions resulting from the combined operation the major regional sources is provided in Table D7.0-2.

TABLE D7.0-2
MAXIMUM HOURLY, DAILY AND AVERAGE SO_2 CONCENTRATIONS ($\mu g/m^3$)

Suncor and Syncrude Emissions	**1 Hour**	**Daily**	**Annual**
1994/95 (modelled)	1279 to 1652	246 to 311	12 to 16
1998 (predicted)	437	125	7.7
2001 (predicted)	454	129	7.9
Guidelines and Thresholds	**1 Hour**	**Daily**	**Annual**
Alberta Guideline	450	150	30
IUFRO Thresholds[1]	132	100	50
Jones *et al.* (1979)	850	-	-
Malhotra and Khan (1984)	-	265	-
LeBlanc *et al.* (1972)	-	-	25
Dreisinger and McGovern (1970)	1,100	-	-
Malhotra and Khan (1984)	-	475	-
Linzon (1978	-	-	45

[1]International Union of Forest Research Organizations (WHO 1987).

The comparison indicates that the maximum predicted values associated with current (1994/95) short-term concentrations (i.e., hourly and daily) are larger than the threshold ranges in the Alberta Guidelines. This reduction in SO_2 emissions and the associated maximum concentrations are consistent with the objective of meeting provincial guidelines. While forest response to exposures is a continuum, the comparison to threshold values does provide an indication of anticipated responses and hence an indication of effects. The maximum daily average SO_2 concentrations resulting from the combined operation of the Suncor and Syncrude facilities is shown for the 1995 and 2001 scenarios in Figures D7.0-1 and D7.0-2, illustrating the marked reduction in areal extent of exposure to elevated SO_2 concentrations.

D7.4.2 Effects on Soils

a) Soil sensitivity to acid deposition

Holowaychuk and Fessenden (1987) developed a system for classifying sensitivity of soils to potential acidification based on soil pH and cation exchange capacity.

b) High overall sensitivity

- Soils with pH less than 4.6
- Soils with cation exchange capacity <6.0 meq/100 g and a pH >4.6 and <6.5

c) Moderate overall sensitivity

- Soils with cation exchange capacity between 6.0 and 15.0 meq/100 g and pH between 4.6 and 6.0
- Soils with cation exchange capacity >15.0 meq/100 g with pH between 4.6 and 5.5

d) Low overall sensitivity

- Soils with pH >6.5 regardless of cation exchange capacity

- Soils with pH >6.0 and cation exchange capacity >6.0 meq/100 g (BOVAR-CONCORD Environmental 1995)

Based on data taken from the Holowaychuk and Fessenden (1987) classification system, soil types in the regional study area have a range of sensitivities to acidification, from low to high (Table D7.0-3).

TABLE D7.0-3
SENSITIVITY OF SOLS TO ACIDIC DEPOSITION

Soil Type	Cation Exchange Capacity (meq/100 g) (a)	pH (a) ($CaCl_2$)	Soil Sensitivity Rating to Acidification (b)	Areal Extent in the Local Study Area (ha)
Algar (ALG)	14.0	5.0-7.1	Low - Moderate	26
Firebag (FIR)	4.1	4.2-5.5	High	156
Horse River (HRR)	20.0	4.7-5.8	Moderate - High	2,932
Kinosis (KNS)	6.3	6.0	High	3,068
McLelland (MLD)	>20.0	6.9	Low	6,848
McMurray (MMY)	>15.0	7.0-7.7	Low	537
Muskeg (MUS)	>15.0	4.5-5.3	Moderate-High	13,548
Ruth Lake (RUT)	2.9	6.2-6.8	Low-Moderate	1,356
Rough Broken (RB1)	n/a	n/a	Moderate	383
Rough Broken (RB2)	4.4	3.6	High	623
Rough Broken (RB3)	n/a	n/a	Moderate-High	2,613

(a) CAN-AG Enterprises Ltd. (1996b)   n/a = not available

(b) Hollowaychuk and Fessenden (1987)

In addition, to the range of sensitivities to acidification, Holowaychuk and Fessenden (1987) developed a rating system for organic soil sensitivity to acidic deposition which is based on pH, exchangeable bases and percent base saturation of the organic material and pH and calcium and magnesium contents of waters contained in the organic deposits (BOVAR-CONCORD Environmental 1995).

Organic soils are grouped into one of three peatland systems:

- **Eutrophic** peatland systems are nutrient rich and are characterized by relatively high pH and base cation contents and high buffering capacities. Eutrophic peatland systems have a low overall sensitivity to acidification.
- **Oligotrophic** peatland systems are low in nutrient status and are characterized by a very low pH and base cation contents. The low sensitivity results in a low overall sensitivity to acid deposition.
- **Mesotrophic** peatland systems are moderate in nutrient status and are characterized by a moderately high to low buffering capacity. Any strong acidic additions will consequently deplete the buffering capacity and reduce the remaining buffering capacity. These peatland systems are highly sensitive to acidification and base loss and moderately sensitive to aluminum solubilization. Mesotrophic peatland systems have a high overall sensitivity to acidification (BOVAR-CONCORD Environmental 1995). Within the Regional Study Area they are associated with the Muskeg soil type.

No evidence of short-term, acute acidification, or metallic element accumulation by soils materials has been reported within a 50 km radius of the Suncor and Syncrude plants (Hollowaychuk and Fessenden 1987, Dabbs Environmental Services 1985). However, chronic effects of air emissions on soils are a concern due to the cumulative effect of the emissions of a number of oil sands plants in the region. In addition, most soils within the regional area are highly sensitive to acidic input due to the predominance of mesotrophic peatlands in the region.

e) **Acidification**

Deposition refers to the removal of emissions from the atmosphere by wet and dry deposition processes. The wet removal involves the action of precipitation through rainout and washout mechanisms. Wet removal of SO_2 results in the direct delivery of the resulting acidic compounds to the receptor. Dry deposition involves the direct uptake of SO_2 by the receptor. Biochemical reactions on and within the receptor result in the formation of acids. The sensitivity of the environment to acidification is dependent on the buffering capacity of the soils and waters.

Deposition can be expressed in terms of sulfur compound equivalent deposition (e.g., kg SO_4^{-2} equivalent/ha/a) or as an effective acidity (EA) (kmol H^+/ha/a). The latter accounts for the presence of other acidifying or neutralizing compounds in the precipitation or the receptor.

Sensitivity to acidification is a measure of the change in pH that a soil would likely experience relative to a given addition of acid. It is related to buffering capacity, which is determined by the cation exchange capacity. Holowaychuk and Fessenden (1987) report that soils with a low buffering capacity and low cation exchange capacity have a high sensitivity to acidification, whereas, soils with a high buffering capacity and high cation exchange capacity have a low sensitivity to acidification. Environmental research on acidic deposition in the oil sands region of Alberta has been summarized in Takyi et al (1987) and by Legge and Davies (1992).

Soils within the study area that have a high sensitivity rating were all those with a pH of 4.6 or lower and soils with a low cation exchange capacity and a pH of 6.5 or lower (e.g., Firebag, Kinosis, Rough Broken). Soils that were assigned a sensitivity rating of low were those soils with a pH in excess of 6.5 and a high cation exchange capacity (e.g., McLelland, McMurray). Organic soils in the oil sands area have been classified as highly sensitive with respect to the impact of acid deposition on the capability of the topsoil to sustain plant growth (Holowaychuk and Fessenden 1987).

Although Alberta Environmental Protection has issued preliminary deposition loading limits, there is a lack of consensus by the technical and regulatory communities on how to calculate EA and what criteria should be used to judge the values by. Although wet, dry and total deposition, as well as EA have been calculated as part of this assessment (BOVAR Environmental 1996), it is recommended that the predictions only be used on a relative basis. It is on this understanding that the effects associated with acidification are addressed.

The maximum deposition associated with the Suncor utilities operations in the Regional Study Area is shown in Table D7.0-4.

TABLE D7.0-4

MAXIMUM DEPOSITION ASSOCIATED WITH SUNCOR UTILITIES OPERATIONS

	Deposition (SO_4^{-2} equivalent/ha/a)		
Year	**Dry**	**Wet**	**Total**
1995	13.6	8.2	19.2
1998	3.5	2.1	5.2
2001	3.8	2.4	5.8

The effect of the FGD system (1998 and 2001) is to reduce the total deposition (wet and dry) by a factor of three. For the combined operation of the other sources in the region, which include the addition of the proposed Solv-Ex facilities, the maximum depositions are shown in Table D7.0-5.

TABLE D7.0-5

MAXIMUM DEPOSITIONS FOR 1995, 1998 AND 2001

Year	Total Deposition (SO_4^{-2} equivalent/ha/a)	Effective Acidity (kmol H^+/ha/a)[a]
1995	25.5	0.66
1998	13.5	0.41
2001	14.4	0.43

[a] Includes a background value of 0.13 kmol H^+ equivalent/ha/a.

Due to the presence of these other sources, the reduction of the maximum deposition associated with the 1998 and 2001 emission scenarios is by about 45%. The reduction of effective acidity is by about 35%.

The EA value estimation conservatively assumes all the deposited sulphur compounds will be converted into an acid and that the background value is 0.13 kmol H^+ equivalent/ha/a. This background value is comprised of 0.05 kmol H^+ equivalent/ha/a as wet deposition and 0.08 kmol H^+

equivalent/ha/a as dry deposition. These values are based on Cree Lake., SK observations (BOVAR Environmental 1996).

f) **Soil Impacts**

Potential soil acidifiction impacts can be examined by looking at the deposition of sulphur compounds and other acidifying or neutralizing compounds. The Effective Acidity (EA) values for the 1995 and 2001 scenarios are summarized in Table D7.0-6 and on Figures D7.0-3 and D7.0-4 (respectively). The modelled information shows a significant reduction in the area of potential effects and in particular, in the areal extent of those areas associated with the 0.3 to 0.1 kmol H^+/ha/a contour (18% reduction in 2001 compared to 1995).

The high sensitivity areas are reduced in area in 2001 to a short section of the Athabasca River Valley, north of the Steepbank River confluence and in another slightly larger area southwest of the plant site (Figure D7.0-3). Within the regional vegetation classification scheme, the river valley area corresponds to a mixture of Closed Deciduous Forest, Closed Mixedwood, White Spruce Dominant and Wetland Closed Shrub Complex (Figure D7.0-4). Soils within the river valley are primarily Cumulic Regosols, Gleyed Cumulic Regosols (McMurray) and eroded (Rough Broken) soils (CAN-AG Enterprises Ltd. 1996a).

The valley bottom McMurray soils are considered to have a Low sensitivity rating to acidification (Table D7.0-3) while the eroded soils, typically found along the Athabasca River escarpment slopes have a Moderate to High sensitivity.

The other high sensitivity rating area includes a mosaic of different vegetation types surrounding Ruth Lake. The three main vegetation types include Closed Deciduous Forest, Closed White Spruce and Peatland: Black Spruce-Tamarack Fen. The dominant soil types includes Organic Mesisols (Muskeg), with a Moderate to High sensitivity rating to acidification, and a Brunisolic Soil (Ruth Lake) with a Low to Moderate rating. The results of this modelling exercise will be used in the design of an environmental effects biomonitoring program.

TABLE D7.0-6

AREAL EXTENT WHERE PREDICTED EA VALUES EXCEED PRELIMINARY DEPOSITION LIMIT RANGES

Sensitivity Class	Range	AREA (km^2)					
		1995		2001		Relative Change	
	(Kmol H^+/ha/a)	(km^2)	(%)	(km^2)	(%)	(km^2)	(%)
Low	Upper range 1.0	0	(0)	0	(0)	0	(0)
	Lower range 0.7	0	(0)	0	(0)	0	(0)
Medium	Upper range 0.4	1,926	(9)	40	(0.2)	1,886	8.2
	Lower range 0.3	6,033	(27)	1,548	(7)	4,485	18
High	Upper range 0.3	6,033	(27)	1,548	(9)	4,485	18
	Lower range 0.1	22,400	(100)	22,400	(100)	22,400	0

Areas are depicted in Figures D7.0-3 and D7.0-4.

D7.5.0 Impact Mitigation

Notwithstanding the positive benefits of SO_2 reduction programs, there are still two issues of concern with respect to SO_2 emissions. These include:

a) Planned and unplanned intermittent flaring

The evaluation undertaken by BOVAR Environmental (1996) indicated relatively high SO_2 concentrations could occur with intermittent flaring. While the evaluation was undertaken on a collective basis, a further evaluation of individual case events may be warranted to provide a better definition of the type of concentrations that actually occurred.

This assessment for the proposed integrated operation has not assumed any reductions in either the SO_2 emissions or the frequency of intermittent flaring. It is understood, however, that Suncor is currently reviewing ways to minimize this type of flaring.

b) <u>FGD downtime</u>

During planned or unplanned downtime of the FGD system, the emissions and associated maximum concentrations will be similar to the 1994/1995 levels.

Suncor plans to participate in a regional receptor monitoring program as part of a coordinated environmental effects monitoring program. This monitoring, which will include assessment of receptor responses to exposure, will help further define responses to the exposure currently occurring.

D7.6 IMPACT CLASSIFICATION

D7.6.1 Impacts on Vegetation

The impact on vegetation as a result of the Steepbank Mine can be summarized as follows:

1. Existing (1995 baseline) air emissions exceed Alberta Guidelines for hourly and daily SO_2 concentrations ($\mu g/m^3$). They also exceed other ambient thresholds of emissions such as the International Union of Forest Research Organizations (IUFRO) (WHO 1987).

2. Observations of vegetation impacts possibly attributed to SO_2 emissions have been made within the Regional Study Area, primarily in the Athabasca River Valley, downwind of the Suncor and Syncrude plants (Reid et al 1991, Reid and Sterstabetoff 1985).

3. The areal extent and location of affected areas change based on the year in which the observations were made. Some areas have increased over the years in which monitoring has occurred.

4. Vegetation disease and insect infestation have also been recorded within the Regional Study Area some areas of which may be a result of previous exposures to SO_2 emissions.

5. No causal relationship has been quantified in terms of the pattern and concentrations of SO_2 emissions from the two oil sands plants and the response by the vegetation in the affected area.

6. The near future (2001 scenario) air emissions will be within the Alberta Guidelines for daily and annual SO_2 concentrations ($\mu g/m^3$).

7. A comparison of the maximum predicted daily average SO_2 concentrations resulting from the combined operation of the Suncor and Syncrude facilities between 1995 and 2001 shows a dramatic decrease in the areal extent of potential impacts. By 2001, there are no areas in the study area which exceed the daily 150 $\mu g/m^3$ Alberta Guideline. Those areas in which the annual 50 $\mu g/m^3$ are exceeded, are limited to narrow bands extending primarily to the southwest and east of the plant sites, as well as one other isolated area in the northeast of the Regional Study Area.

8. Given the predicted SO_2 concentrations in 2001, there should be only minimal impacts to vegetation within the Regional Study Area. Consequently, no impacts on revegetation measures taken after 2001 are anticipated. Current revegetation efforts on Lease 86/17 have not been affected by SO_2 emissions, as part of the annual monitoring program.

9. The environmental effects monitoring program will be designed to address the question of possible residual impacts on vegetation as a result of past emissions, as well as the response of vegetation to the anticipated recovery in those areas where impacts were recorded.

10. The recommended IUFRO thresholds (on uniform growing conditions) for SO_2 include a maximum annual average concentration of 50 mg/m^3. The combined Suncor/Syncrude annual SO_2 concentration in 2001 will be well within this at 8 mg/m^3. The daily average (129 mg/m^3) will be slightly greater than the IUFRO threshold of 100 mg/m^3).

Application of the impact classification scheme of SO_2 emissions on vegetation resources in the Study Area is shown in Table D7.0-7.

TABLE D7.0-7
IMPACT CLASSIFICATION SCHEME FOR VEGETATION AND FOREST HEALTH

Direction	Positive
Severity	Moderate
Duration	Life of Fixed Plant Operation
Geographical extent	Local and regional

The severity or magnitude is a moderate positive imapct since the predicted values are less than provincial guidelines, but in excess of natural background levels. Improvements in SO_2 reduction is expected to result in a substantial lessening of air emissions effects to vegetation resources in the area. This assessment is based on normal emissions and does not include abnormal operating conditions.

D7.6.2 Impacts on Soils

The impacts on soils as a result of air emissions associated with the Steepbank Mine project can be summarized as follows:

1. No short-term, acute acidification or metallic element accumulation effects have been reported in soils within a 50 km radius from the Suncor and Syncrude plant site (Hollowaychuk and Fessenden 1987, Dabbs Environmental Services 1985).

2. The dominant soil type within the Local Study Area (an organic soil) generally has a moderate to high sensitivity to acidification (Hollowaychuk and Fessenden 1987).

3. The reduction in estimated effected acidity (EA) values between 1995 and 2001, reduces the area of potential concern or moderate sensitivity (Alberta Environment) by approximately 23% to two small areas, one immediately north of the plant site, the other a short distance to the southwest.

4. Effective acidity contours, along with other modelled and observed data on possible areas of impacts, will be used to design the environmental effects monitoring program.

Significant acidification at current levels of deposition is likely to take decades or even centuries to detect on a regional scale in soils. As a result, Alberta Environment established a long-term monitoring study designed to monitor regional acidification and at a distance of 30 to 40 km from the Suncor and Syncrude plant sites. The best indicator of acidification expected in the region of an emission source is a monitoring study of local effects near the emission source. This study would monitor local and regional impacts as part of the long-term environmental effects monitoring program.

Soil analysis (e.g. Holowaychuk and Fessenden 1987, Addison *et al.* 1986, and Baker 1980) have been conducted in the general area of the oil sands projects in northern Alberta. The experiments indicate that to date, atmospheric pollution arising directly from the oil sands operations have made little impact on the soils of the study area. Takyi et al (1987) reports that soils of relatively high buffering capacity (e.g. Gleysolic and Regosolic soils) and the trees growing on them, are not likely to be significantly altered by acidifying deposition. In addition, an experiment by Addison *et al.* (1986), involving jack pine germination and their response to various pollutants, reports that poor germination and establishment was related to factors (pH) other that pollutant concentrations. However, in spite of these experiments, it is considered that monitoring of soils could help detect future changes in soils and vegetation.

The application of the impact classification of SO_2 emissions on soil resources within the Regional Study Area is shown in Table D7.0-8.

TABLE D7.0-8
IMPACT CLASSIFICATION SCHEME FOR ACIDIFICATION

Direction	Positive
Severity	Unknown
Duration	Life of fixed plant operations
Geographical extent	Local to Regional

The severity or magnitude of impact was rated as unknown since the relationship between dispersion model predictions, calculations of effective acidity and corresponding SO_2 deposition limits have not been resolved by either the technical or regulatory community. However, the reduction in SO_2 emissions is expected to have an overall positive effect in lowering any potential acidification effects on the soil resources, of the area.

D7.7 CUMULATIVE EFFECTS ASSESSMENT AND RECOMMENDATIONS

Cumulative Effects:

The cumulative effects of the Steepbank Mine project on vegetation and soil resources within the region is to reduce the overall SO_2 air emissions by approximately one fifth of the existing (1995 baseline) conditions. This is expected to reduce any negative impact on vegetation and soils which may have occurred during previous years of operation.

Recommendations

1. Develop an integrated, environmental effects monitoring program to assess and evaluate vegetation and soil response to air emissions exposure. Outputs from air quality modelling can provide estimates of vegetation and soil response to air emission exposure which can be compared to actual field measurements and observations throughout the Local and Regional Study Areas.

2. Continue to observe and monitor vegetation response to air emissions. Continued research may include identifying and quantifying the environmental stress factors and thresholds influencing vegetative response to pollutants. Particular emphasis should be placed on monitoring the revegetation progression throughout the reclaimed areas on Lease 86/17 and the Steepbank Mine.

E RESIDUAL IMPACTS AND NET BENEFITS SUMMARY

E1.0 IMPACT HYPOTHESIS SUMMARY

A summary of the assessment of each of the impact hypotheses is provided as follows:

Hypothesis 12

Issue: Valued Ecosystem Components in the Athabasca River Valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

Assessment: At the broad landscape level of assessment, impacts are considered "moderate" within the context of the Local Study Area and "low" when compared to the Regional Study Area. At the vegetation community level, impacts are also considered "moderate" within the Local Study Area but "low to moderate" within the context of the region. Mitigation measures include reclamation of disturbed land after mining is complete to provide sustainable vegetation growth and a diversity of habitat types.

Hypothesis 13

Issue: Existing and future use of the area's landscapes could be limited by development of the Steepbank Mine and Lease 86/17 reclamation.

Assessment: Within the Local Study Area, land use options will be most affected during the mine operation phase (2000 to 2020). "Moderate" impacts on existing land uses are anticipated during the construction phase, while during the operation phase, impacts are higher given the greater areas involved. At the regional scale, land use restrictions are considered "low". Future land use options will be available through the phased reclamation of disturbed lands to wildlife habitat and forested lands. Overall, this may result in a net increase in land use options within the Local Study Area.

Hypothesis 14

Issue: Visual integrity of the Athabasca River Valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

Assessment: Visual impacts overall, are anticipated to be "moderate" during the construction and operation phases of the project, with "low" impacts expected following area reclamation. The use of visual barriers, revegetation of reclaimed landscapes will further mitigate visual impacts of the project.

Hypothesis 15

Issue: Biodiversity could be affected by the development, operation, and reclamation of the Steepbank Mine and Lease 86/17.

Assessment: At the regional level of assessment, impacts on biodiversity are expected to be "low", while at the Local Study Area level, impacts are considered "moderate". Biodiversity impacts are considered "moderate" at the landscape and vegetation community level, and "low to moderate" at the species level.

Based on the vegetation balance between construction and operation phase losses and reclamation phase gains, the long-term impact on biodiversity is considered moderate to low.

Hypothesis 16

Issue: Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operations, including mine dewatering, changes to subsurface drainage and reclamation release water.

Assessment: The impact on bog and fen wetlands in the Local Study Area is considered "moderate" during the operation phase but "low" in the context of the Regional Study Area. Reclamation activities will result in little overall change in total wetland area in the Suncor Study Area.

Hypothesis 17

Issue: Air emissions from the Suncor operation could have an impact on vegetation and soils, as well as aquatic environments.

Assessment: Observations of vegetation in the Regional Study Area have reported localised impacts to vegetation, primarily in the Athabasca River valley in proximity to the oil sands plants. Although there is no clearly quantified causal relationship between pattern and concentrations of SO_2 emissions and the vegetation condition, SO_2 emissions from the Suncor and Syncrude oil sands plants are implicated. The changing air emission scenario for Suncor will reduce ambient air concentrations of SO_2, and is expected to reduced the potential for further impacts to vegetation.

Impacts to soils from acidification have not been reported in soil monitoring programs in the region.

E2.0 LOCAL IMPACTS AND NET BENEFITS

The analysis of potential impacts to terrestrial resources within the Local Study Area has focused on key or valued ecosystem components, primarily associated with the Athabasca River valley. Mine development within the river valley floodplain and escarpment will have an overall moderate negative impact in the context of river valley disturbance within the Local Study Area. This impact will be of long-term duration (>30 years) and will result in substantial modification to the existing landscape. The impact is considered low within the context of the Regional Study Area.

The residual impacts of the project can be summarized in terms of landforms, soil and vegetation resources:

E2.1 LANDFORMS

The impacts of the Steepbank Mine project on landforms during the construction, operation and closure phases are summarized as follows:

Construction and operation (1997-2020):

- A total disturbance of 3,310 ha of landforms will occur over the 18 years of Steepbank Mine construction and operation, representing approximately 13% of the Local Study Area. In the context of the Regional Study Area, this represents approximately 0.3% of the area. During the operational phase (2002-2020) progressive reclamation on the Steepbank Mine will be initiated on approximately 1,856 ha or over half of the disturbed area.
- A temporary disturbance of approximately 257 ha, or 8% of the total disturbance, will occur during the construction and operation of the Steepbank Mine. This is associated with the mine infrastructure, hydrotransport facilities and ore sizing plant. These areas will be reclaimed following closure and will approximate the pre-disturbed landscape through minor re-grading and slope re-contouring. These temporary landform impacts are considered a low negative impact of long-term duration. Impacts are restricted to the Local Study Area and are reversible following reclamation.
- A permanent alteration of 3,043 ha of landforms will occur during the operation of the Steepbank Mine, representing approximately 92% of the total disturbance. These impacts will result primarily from the tailings ponds, dykes and overburden piles. As a result of the large areas affected, these impacts are considered to be of a high severity within the local context and are of long-term duration. Impacts are, however, restricted to the Local Study Area. They are long-term in duration and irreversible. Landform reclamation efforts will include site-specific contouring and final grading to ensure slope stability and to provide the basis for area reclamation.

Post-operation:

- Under the long-term reclamation planning scenario, a diversity of new landscapes will be created on the previously disturbed tailings ponds, dykes and overburden piles. This will encompass the entire development area (3,310 ha). These impacts will be positive, moderate in magnitude and long-term in duration.
- A net increase will occur in the area of open water wetlands (1,345 ha in 1995 and 1,767 ha in the long-term). Similarly, there will be an increase in the Wetlands Closed Shrub vegetation type surrounding these wetlands from 2,673 ha in 1995 to 2,881 ha in the long-term. Wetlands habitats will increase, along with the types of surficial materials and slope conditions on the reclaimed landscapes. This diversity of landforms in the post operation period is considered to be a moderate positive impact, which is long-term in duration.

E2.2 SOILS

Soil impacts will occur primarily during construction and mine preparation activities, including clearing, grading and muskeg salvage operations. Residual impacts may include soil erosion, soil compaction, soil quality (organic matter, fertility) change, spills, leaks and impacts from SO_2 emissions. A summary of the impacts to the soil resource includes the following:

Construction and Operational Phases:

- A total of 3,310 ha of soils will be disturbed during the mine construction and operational phase, representing approximately 13% of the Local Study Area. The largest area of disturbance (1,629 ha) will affect poorly-drained organic soils (muskeg soil type). Other soil types are of generally low capability for agricultural or forestry use and include poorly drained Luvisols and Brunisols. The residual impacts due to soil disturbance, removal and burial are considered to be of low to moderate severity of long-term duration and restricted to the Local Study Area.
- The Conservation and Reclamation Plan prepared for the Steepbank Mine Application (Suncor 1996) provides details on soil handling practices and procedures to minimize soil impacts such as erosion and degradation of soil quality.

Post Operation:

- Soil reconstruction on previously disturbed landscapes will involve the placement of soil amendments over the final reclaimed surfaces, followed by seeding, fertilizer amendment and revegetation.
- A variety of reclaimed landscape types will be produced, supporting variable soil and vegetation microsites within the Local Study Area. Variations in site conditions will allow a variety of habitat types to develop over time.
- Improvement in soil drainage conditions and therefore soil capability is anticipated on the upland (Muskeg) soils as well as in low-lying, poorly-drained Gleysolic soils.
- Dewatering of existing, poorly-drained soils and use of these soils as reclamation area soil amendments will locally improve the capability of the soil for forestry.
- These residual impacts are expected to be positive, moderate in magnitude and long-term in duration. Impacts will be restricted to the Local Study Area.

E2.3 VEGETATION

The residual impacts of the Steepbank Mine project on vegetation can be summarized as follows:

Construction and Operational Phases:

- A total of 3,310 ha of vegetation will be disturbed during the mine construction and operational phases. The vegetation type most affected is the Peatland: Black Spruce-Tamarack Fen type which incurs a loss of 827 ha, or approximately 25% of the disturbed area. The second largest type affected is the Peatland: Open Black Spruce Bog type with the loss of 755 ha, or approximately 23% of the disturbed area. Additional "peatland" vegetation types account for a further 15% of the disturbed area. In total, some 63% of the disturbed area will affect peatland vegetation types.
- The majority of the deciduous and mixedwood forest types impacted by the project will occur on the Athabasca River Valley escarpment slope and valley bottom. Approximately 673 ha, or approximately 20% of the total disturbed area will affect the closed deciduous forest type. The closed Jack Pine and Closed White Spruce types experience losses equivalent to 7% and 5% of the total disturbed area. The remaining vegetation impacts occur to the Wetland Closed Shrub Complex, along with minor losses to other vegetation types mapped within the area of disturbance.
- The loss of these vegetation types is considered a moderate negative impact of long-term duration. Losses will be confined to the Local Study Area.
- In the regional context, the loss of peatland vegetation types is considered a low negative impact of long-term duration. The loss of the Peatland: Black Spruce-Tamarack Fen type amounts to less than 3% of this type within the Regional Study Area (including the losses due to Syncrude's operations). Similarly, the loss of the Peatland: Open Black Spruce Bog type amounts to less than 1.5% of the Regional Study Area.

Post-Operation:

- Reclamation and revegetation of disturbed lands will result in a net increase in selected vegetation types. The flexibility in choice of vegetation type is determined by end land use objectives.
- The largest increase in vegetation type occurs in the Closed Mixedwood, White Spruce dominant type, with an increase in the long-term of 332% compared to the 1995 baseline.

Similarly, a 200% increase is seen in the Closed Mixedwood type. These vegetation communities will occur throughout the reclaimed surfaces of Lease 86/17 and the Steepbank Mine and will provide a variety of habitat types and interspersion of habitat.

- The revegetated areas will increase specific resource values such as wildlife habitat, recreation and forestry; however there will not be a complete return to pre-disturbance conditions. The impacts will be positive, long-term in duration and restricted to the Local Study Area.

E2.3.1 Summary

Landscape reclamation will mitigate river valley and escarpment disturbance by providing a variety of reclaimed landscape types and a similar variety of vegetation successional types. Future land use options will increase following completion of mining activities and the progression of reclamation efforts. End land uses may include wildlife habitat, recreation, traditional use and forestry (where appropriate). Specifically, the long-term replacement and overall increase in the cover of Mixedwood, Mixedwood White Spruce Dominant, Wetland Closed Shrub and Wetland Open Water/Emergent Vegetation habitats is considered to be a net benefit. These habitat resources are known to be of high habitat importance to many wildlife species. They are diverse community types, both in structure and composition, and in terms of forestry types, have a high economic potential.

Reclamation and monitoring activities, over the long-term planning scenario, are expected to result in net benefits to the Local Study Area in the form of habitat replacement. A high degree of flexibility in habitat selection is also considered a net benefit in the environmental design of the reclaimed landscapes.

E3.0 REGIONAL IMPACTS AND BENEFITS

At a regional level of analysis, terrestrial impacts are generally considered low or negligible for each of the impact hypothesis examined. The activities of other operators within the region provide a perspective which indicates that Suncor's activities would result in relatively minor impacts, with some net benefits to several vegetation types under the long-term reclamation plan.

The database generated for the Regional Study Area can be used in a regional planning context to assist in the integration of multi-resource development and reclamation.

F ENVIRONMENTAL MONITORING

As part of the ongoing environmental management of the Suncor operation at Fort McMurray, monitoring of predicted environmental impacts and mitigation measures will be conducted on both Lease 86/17 and the Steepbank Mine. Suncor will monitor the progress of reclamation throughout the life of the project. Integrated environmental monitoring programs are designed to include data collection and observations on reclaimed areas of the mine site as well as from natural habitats or control sites adjacent to the development area. Data will be collected from sites representative of each stage of reclamation (ecosites), incorporating landscape, soil, drainage and vegetation conditions. Particular attention will focus on the successional stage of vegetation re-establishment to compare actual versus predicted successional patterns.

The intent of the monitoring program is to continue the development and use of an integrated reclamation database to maximize reclamation efforts in meeting a variety of end land use objectives. Through the use of field data, remote-sensing and computer modelling tools, reclamation progress will be documented throughout the mine operations and following eventual closure. Monitoring programs will be designed in accordance with the Conservation and Reclamation Plan (Suncor 1996) and will include observations of representative site conditions for reclaimed surfaces on overburden dykes, tailings sand dykes, CT deposits and other areas of disturbance. Monitoring programs will include, but not be limited to the following:

- Terrain
  - Slope stability
  - Surface drainage conditions

- Soil
  - Soil physical conditions
    - profile depths
    - texture
    - structure
    - consistency
    - moisture

- tilth

- Soil chemical conditions
  - pH, electrical conductivity, saturation percentage
  - soil fertility
  - salinity - sodium adsorption ratio

- Soil suitability for reclamation
  - suitability to support preferred vegetation types
  - suitability to sustain long-term, successional vegetation types

- Vegetation
  - Species composition and abundance
  - Successional stage of development
  - Rate of successional advancement
  - Constraints and limitations to vegetation development.

The terrestrial monitoring program will be designed in conjunction with the assessment of wildlife habitat potential as part of a series of programs Suncor will complete throughout the life of the project. The results of the monitoring program are documented as part of the annual reclamation reporting requirements to Alberta Environmental Protection.

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H GLOSSARY OF TECHNICAL TERMS

Airshed	A term to describe the geographic area requiring unified management for achieving air pollution control.
Alluvium	Sediment deposited in land environments by streams.
Aspect	Compass orientation of a slope as an inclined element of the ground surface.
Biodiversity	A variety of organisms and ecosystems which comprise both the communities of organisms within particular habitats and the physical conditions under which they live.
Bitumen	A highly viscous tarry, black hydrocarbon material having an API gravity of about 9° (specific gravity about 1.0). It is a complex mixture of organic compounds. Carbon accounts for 80 to 85% of the elemental composition of bitumen, hydrogen - 10%, sulphur ~5%, and nitrogen, oxygen and trace elements the remainder.
Climax	The culminating stage in plant succession for a given site where the vegetation has reached a stable condition.
Community	Pertaining to plant or animal species living in close association or interacting as a unit.

Consolidated Tailings (CT)	Consolidated tailings (CT) is a non-segregating mixture of plant tailings which consolidates relatively quickly in tailings deposits. At Suncor, consolidated tailings will be prepared by combining mature fine tails with thickened (cycloned) fresh sand tailings. This mixture is chemically stabilized to prevent segregation of the fine and coarse mineral solids using gypsum ($CaSO_4$).
DEM (Digital Elevation Model)	A three dimensional grid representing the height of a landscape above a given datum.
Diameter at breast height (DBH)	The diameter of a tree 1.5 m above the ground on the uphill side of the tree.
Disturbance	A force that causes significant change in structure and/or composition of a habitat.
Diversity	The variety, distribution and abundance of different plant and animal communities and species within an area.
Drainage Basin	The total area that contributes water to a stream.
Ecological Land Classification	A means of classifying landscapes by integrating landforms, soils and vegetation components in a hierarchical manner.
Ecoregion	Ecological regions that have broad similarities with respect to soil, relief and dominant vegetation.
Ecosection	Clearly recognizable landforms such as river valleys and wetlands at a broad level of generalization.

Ecosite	Subdivisions of the ecosection described and analyzed in greater detail (e.g., subdivisions of the river valley). The focus at this level is on specific vegetation associations (e.g., wetlands shrub) and the particular soil, drainage and site conditions which support it.
Ecosystem	An integrated and stable association of living and nonliving resources functioning within a defined physical location.
Edaphic	Referring to the soil. The influence of the soil upon plant growth is referred to as an edaphic factor.
Edge	Where plant communities meet.
Escarpment	A cliff or steep slope at the edge of an upland area. The steep face of a river valley.
Fines	Silt and clay particles.
Floodplain	Land near rivers and lakes that may be inundated during seasonally high water levels (e.g. floods).
Forb	Broadleaved herb, as distinguished from grasses.
Forest	A collection of stands that occur in similar space and time.
Forest Fragmentation	The change in the forest landscape, from extensive and continuous forests.
Forest Landscape	Land presently forested or formerly forested and not currently developed for non-forest use.

Forest Succession	The orderly process of change in a forest as one plant community or stand condition is replaced by another, evolving toward the climax type of vegetation.
Fragmentation	The process of reducing size and connectivity of stands that compose a forest.
GIS (Geographic Information System):	Pertains to a type of computer software that is designed to develop, manage, analyze and display spatially referenced data.
Grass	Narrowleaved monocots with parallel veination of perennial root system and hollow stem. Flowers are small and now showy.
Habitat	The place where a plant or animal naturally or normally lives and grows for example, a stream habitat or a forest habitat.
Herb	Tender plant, lacking woody stems, usually small or low; it may be annual or perennial, broadleaf (forb), or graminoid (grass).
Heterogeneity	Variation in the environment over space and time.
Integrated resource management	A coordinated approach to land and resource management, which encourages multiple-use practices.
Interspersion	The percentage of map units containing categories different from the map unit surrounding it.

Landform	General term for the configuration of the ground surface as a factor in soil formation; it includes slope steepness and aspect as well as relief. Also, configurations of land surface taking distinctive forms and produced by natural processes (e.g., hill, valley, plateau).
LANDSAT	A specific satellite or series of satellites used for earth resource remote sensing. Satellite data can be converted to visual images for resource analysis and planning.
Landscape diversity	The size, shape and connectivity of different ecosystems across a large area.
Landscape	A heterogeneous land area with interacting ecosystems.
Leaching	The removal, by water, of soluble matter from soil, surficial materials or bedrock.
Mature Stand	A stand of trees for which the annual net rate of growth has peaked.
Mesic	Pertaining to or adapted to an area that has an intermediate supply of water; neither wet nor dry.
Multi-layered Canopy	Forest stands with two or more distinct tree layers in the canopy; also called multi-storied stands.
Overburden	The soil, sand, silt or clay that overlies bedrock. In mining terms, this includes all material which has to be removed to expose the ore.

Overstory	Those trees that form the upper canopy in a multi-layered forest.
Patch	This term is used to recognize that most ecosystems are not homogeneous, but rather exist as a group of patches or ecological islands that are recognizably different from the parts of the ecosystem that surround them but nevertheless interact with them.
Plant Community	An association of plants of various species found growing together.
Population	A collection of individuals of the same species that potentially interbreed.
Reclamation	The restoration of disturbed or waste land to a state of useful capability. At Suncor, reclamation is the initiation of the process that leads to a sustainable landscape (see definition), including the construction of stable landforms, drainage systems, wetlands, soil reconstruction, addition of nutrients and revegetations. This provides the basis for natural succession to mature ecosystems suitable for a variety of end uses.
Regeneration	The natural or artificial process of establishing young trees.
Remote Sensing	Measurement of some property of an object or surface by means other than direct contact; usually refers to the gathering of scientific information about the earth's surface from great heights and over broad areas, using instruments mounted on aircraft or satellites.

Riparian Area	A geographic area containing an aquatic ecosystem and adjacent upland areas that directly affect it.
Scale	Level of spatial resolution.
Silviculture	The science and practice of controlling the establishment, composition and growth of the vegetation of forest stands. It includes the control or production of stand structures such as snags and down logs, in addition to live vegetation.
Snag	Any standing dead, or partially dead tree.
Soil Structure	The combination or arrangement of primary soil particles into secondary particles, units or peds.
Species	A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.
Species Diversity	A description of a biological community that includes both the number of different species and their relative abundances. Provided a measure of the variation in number of species in a region. This variation depends partly on the variety of habitats and the variety of resources within habitats and, in part, on the degree of specialization to particular habitats and resources.
Species Richness	The number of different species occupying a given area.

Stand	An aggregation of trees occupying a specific area and sufficiently uniform in composition, age, arrangement, and condition so that it is distinguishable from trees in adjoining areas.
Stand Age	The number of years since a stand experienced a stand replacing disturbance event (i.e., fire, logging).
Stand Density	The number and size of trees on a forest site.
Strip Mining	Mining method in which overburden is first removed from a seam of coal, or a sedimentary ore such as oil sands, allowing the coal or ore to be removed.
Structure (Stand Structure)	The various horizontal and vertical physical elements of the forest. The physical appearance of canopy and subcanopy trees and snags, shrub and herbaceous strata and downed woody material.
Succession	A series of dynamic changes by which one group of organisms succeeds another through stages leading to a climax community.
Successional Stage	A stage or recognizable condition of a forest community that occurs during its development from bare ground to climax.
Tailings	A by-product of oil sands extraction which are composed of water, sands and clays, with minor amounts of residual bitumen.
Understory	Those trees or other vegetation in a forest stand below the main canopy level.

Valued Ecosystem Component (VEC)	Components of an ecosystem (either plant, animal, or abiotic feature) considered valuable by various sectors of the public.
Vegetation Community	See plant community.
Watershed	The entire surface drainage area that contributes water to a lake or river.
Wetlands	Term for a broad group of wet habitats. Wetlands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands include features that are permanently wet, or intermittently water covered such as swamps, marshes, bogs, fens, muskegs, potholes, swales, glades, slashes and overflow land of river valleys.
Xeric	Referring to habitats in which plant production is limited by availability of water.

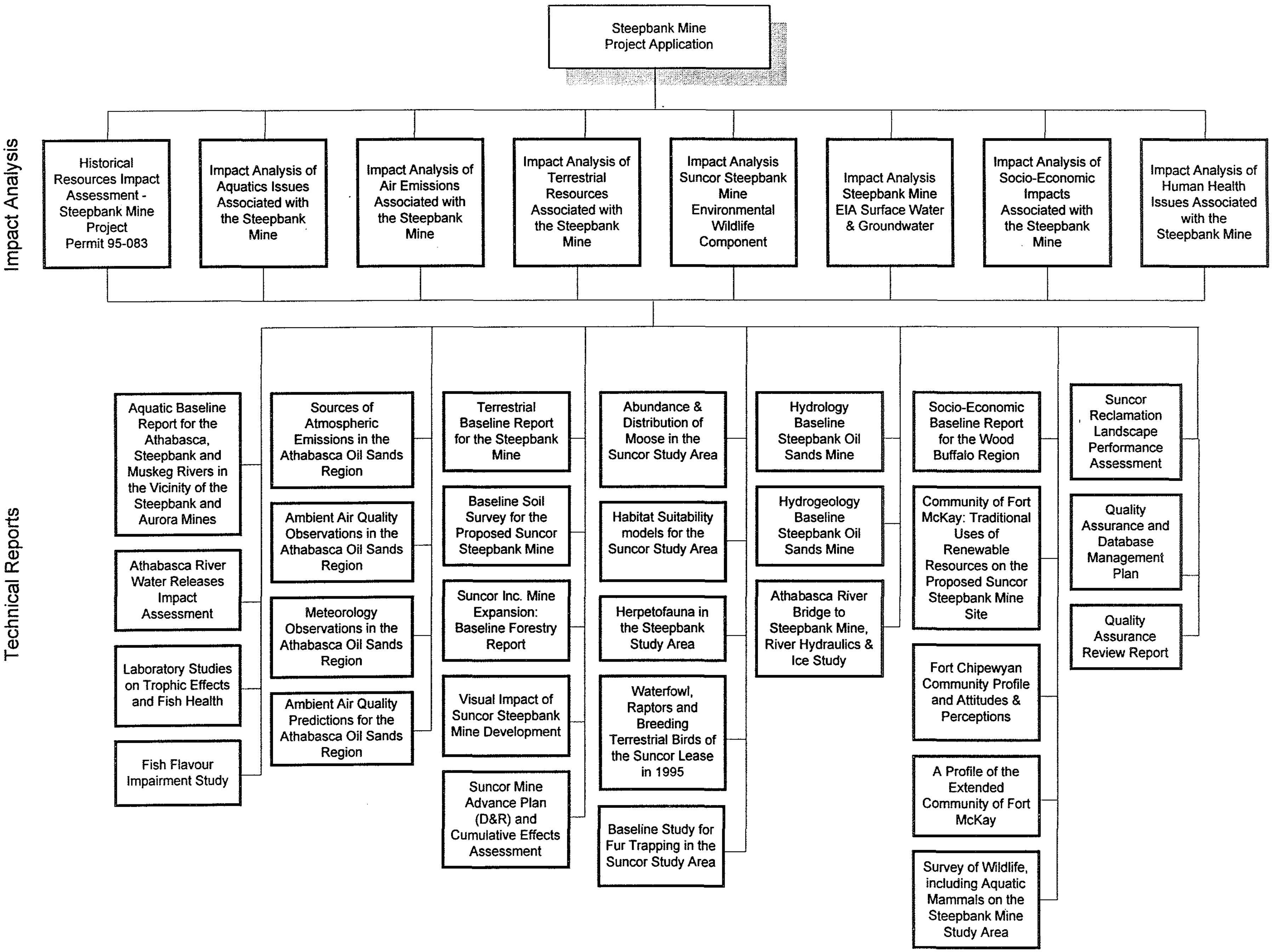

Figure A1.0-1 **Reports Prepared for the Steepbank Mine Environmental Assessment**

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FIGURE A2.0-1

TERRESTRIAL ISSUE IDENTIFICATION AND IMPACT HYPOTHESIS (OR KEY QUESTION) FORMULATION

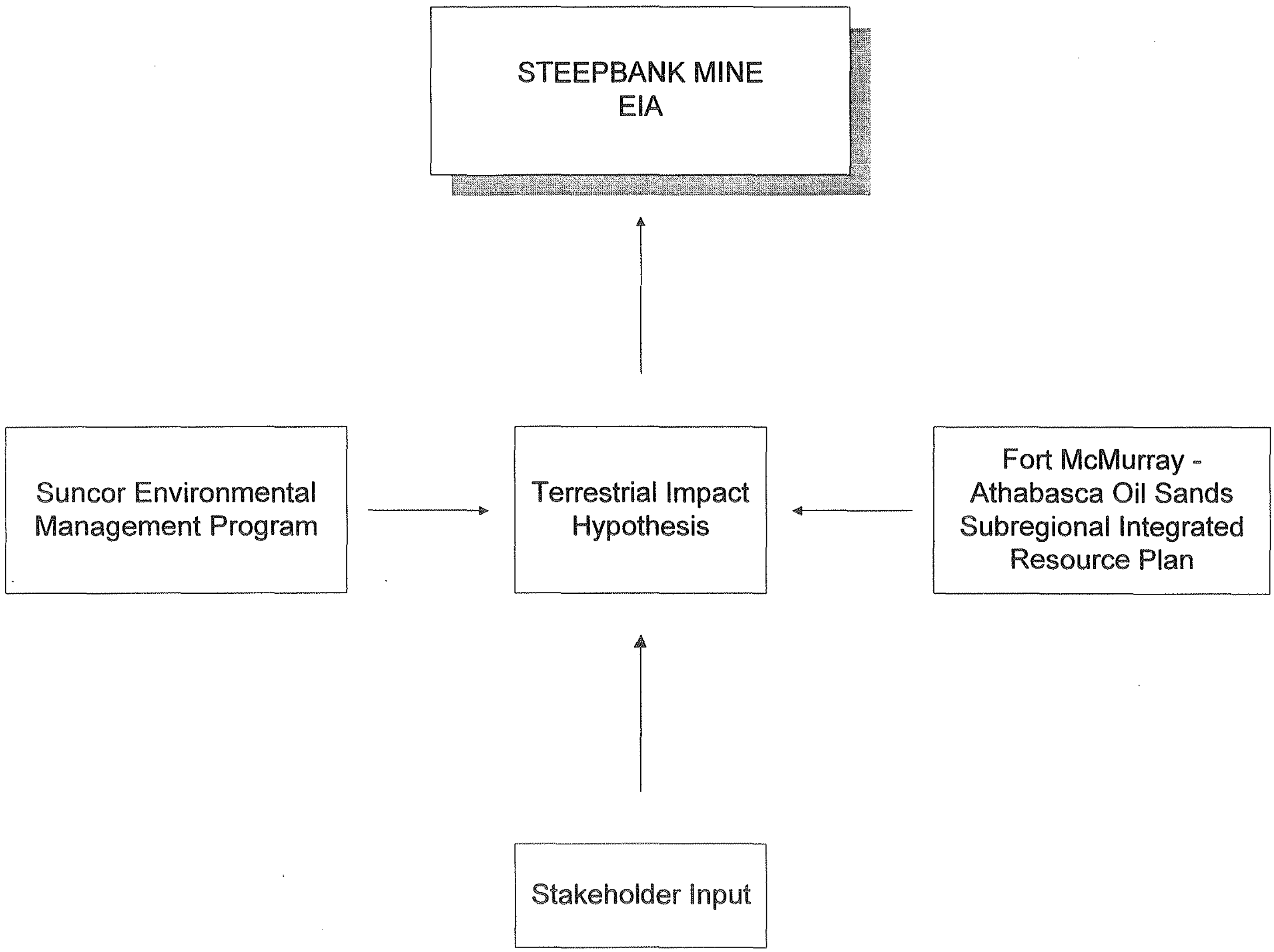

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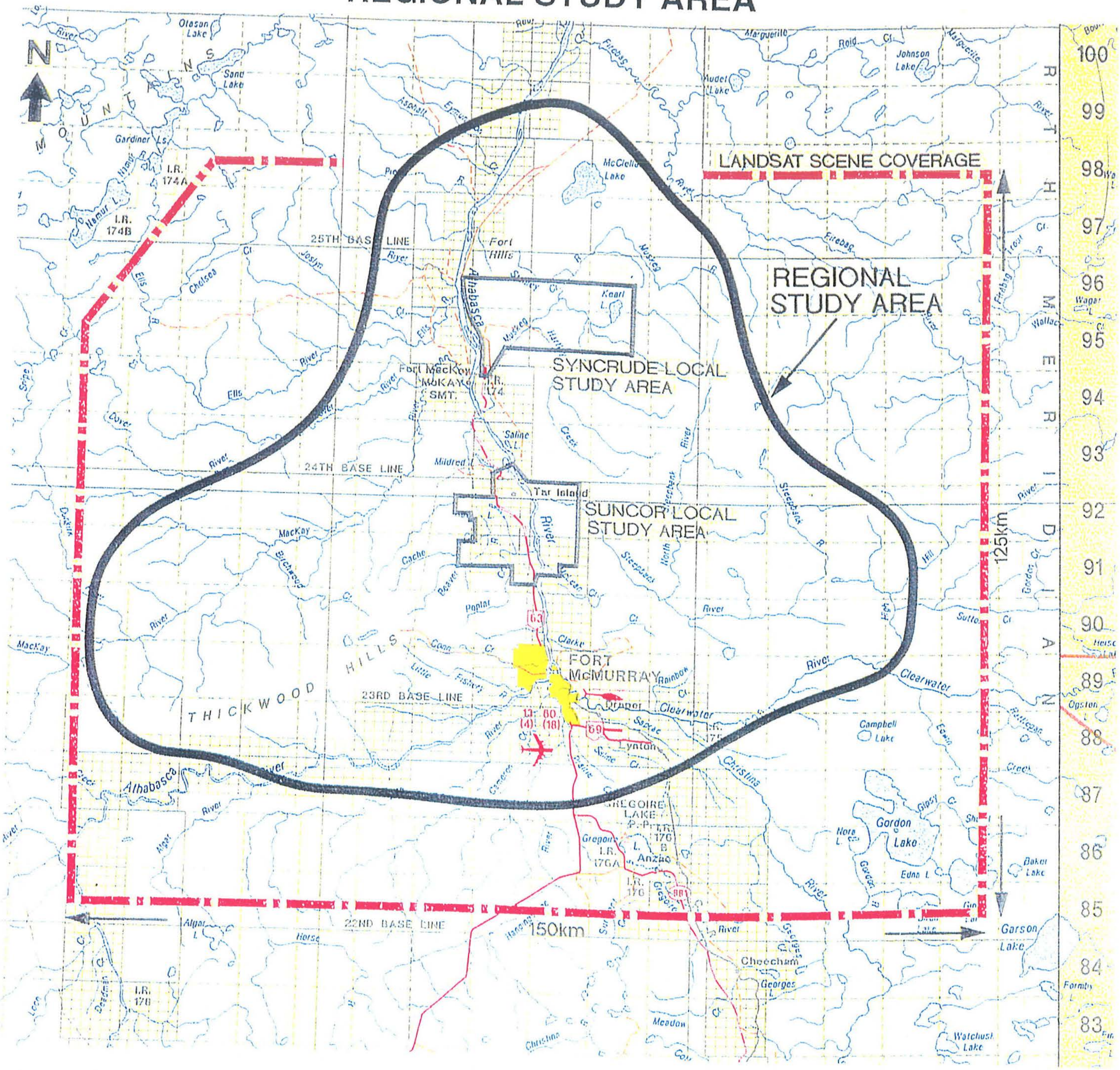
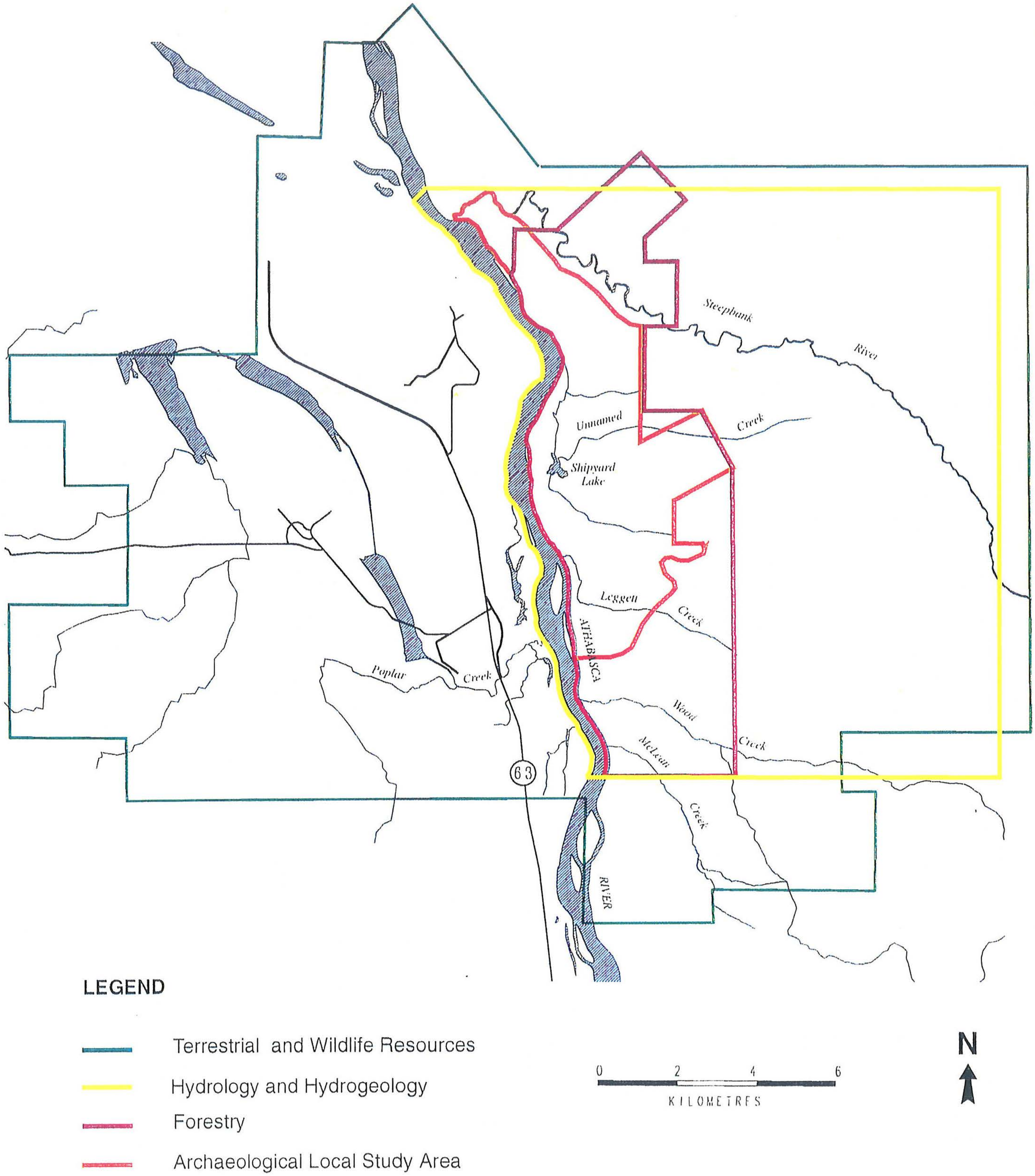
Figure A4.0-1
JOINT SUNCOR/SYNCRUDE REGIONAL STUDY AREA





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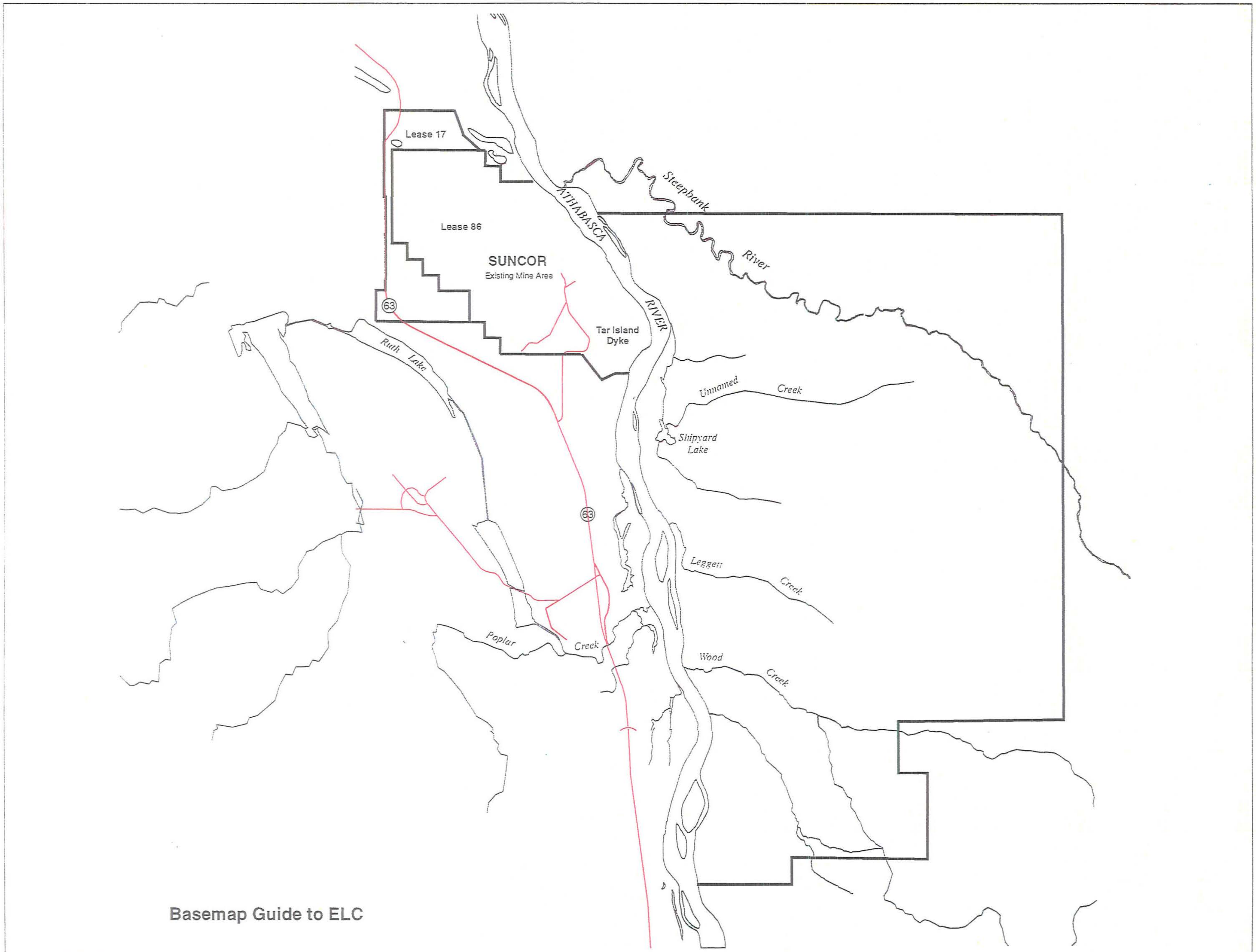
LOCAL STUDY AREA BOUNDARIES
FOR THE STEEPBANK MINE
ENVIRONMENTAL ASSESSMENT PROGRAM

SCALE: AS SHOWN	Steepbank Mine application	REVIEWED BY:
DATE: 18 APR 96		REVISION No.: 1
DRAWN BY: RP		FIGURE No.: A4.0-2



Basemap Guide to ELC

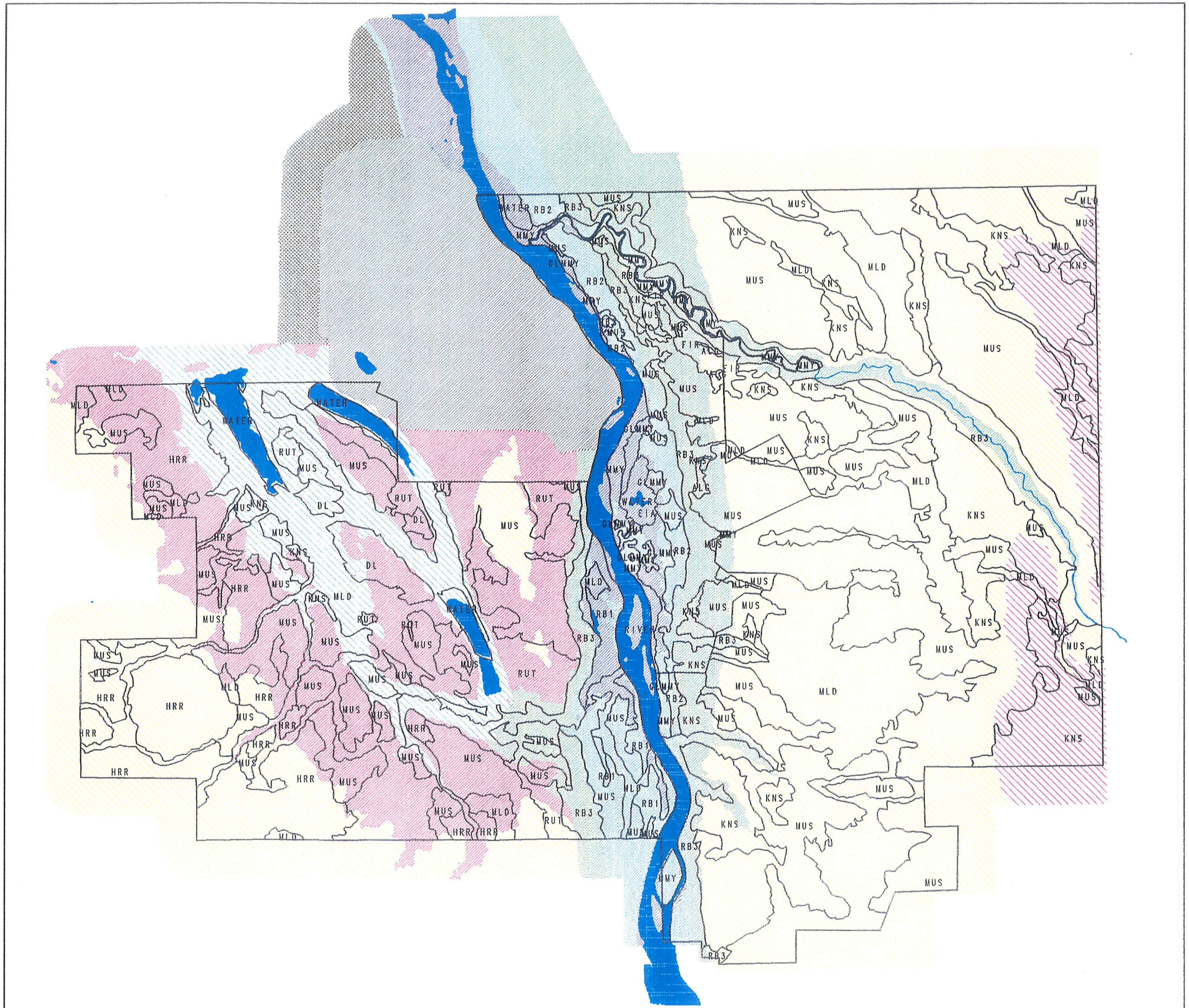


Figure B2.0-1

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

Refer to Table for Soil Map Units

N

Scale = 1:100,000

0 2 4 6

KILOMETRES

Project No. 952-2307.5660 25 March 1996

Golder Associates

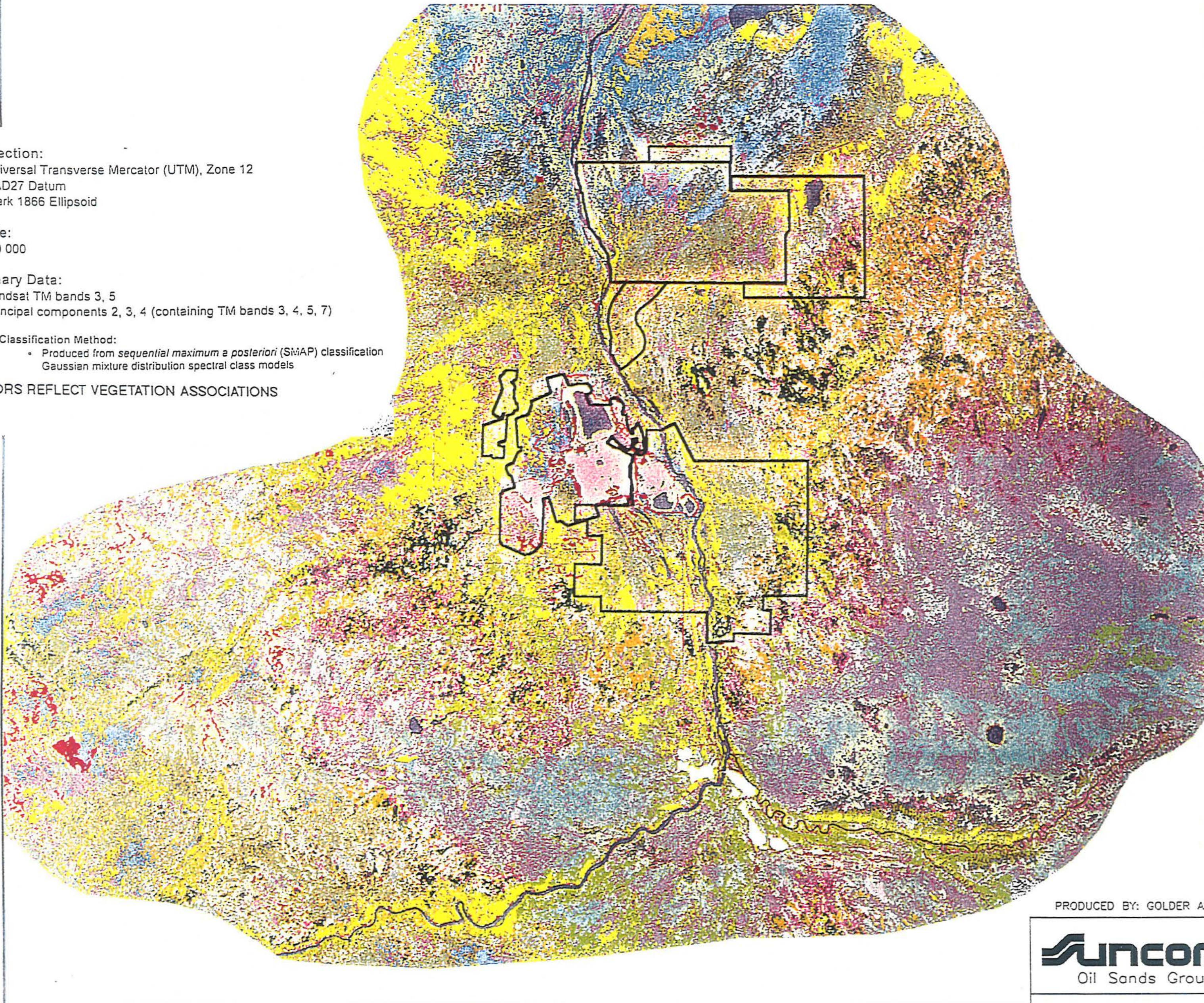
Projection:
- Universal Transverse Mercator (UTM), Zone 12
- NAD27 Datum
- Clark 1866 Ellipsoid

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



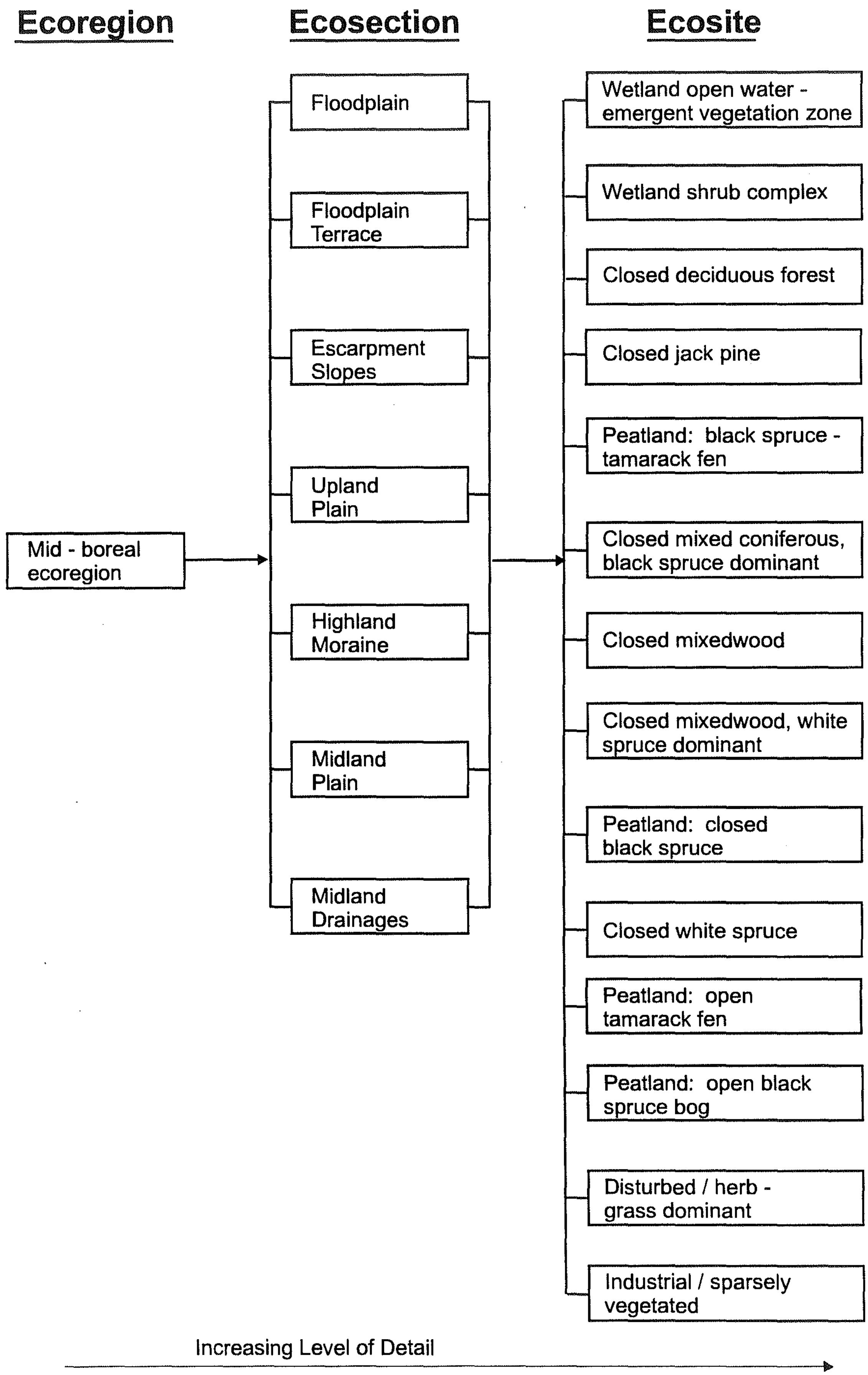
PROJECTION: UTM
PRODUCED BY: GOLDER ASSOCIATES LTD. FOR SUNCOR INC.

Suncor Inc.
Oil Sands Group

JOINT SUNCOR/SYNCRUDE REGIONAL ECOLOGICAL LAND (ELC) CLASSIFICATION

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 22 APR 96		REVISION No.: 2
DRAWN BY:		FIGURE No.: B2.0-2

Figure B2.0-3 Hierarchy of ELC Units Within the Local Study Area



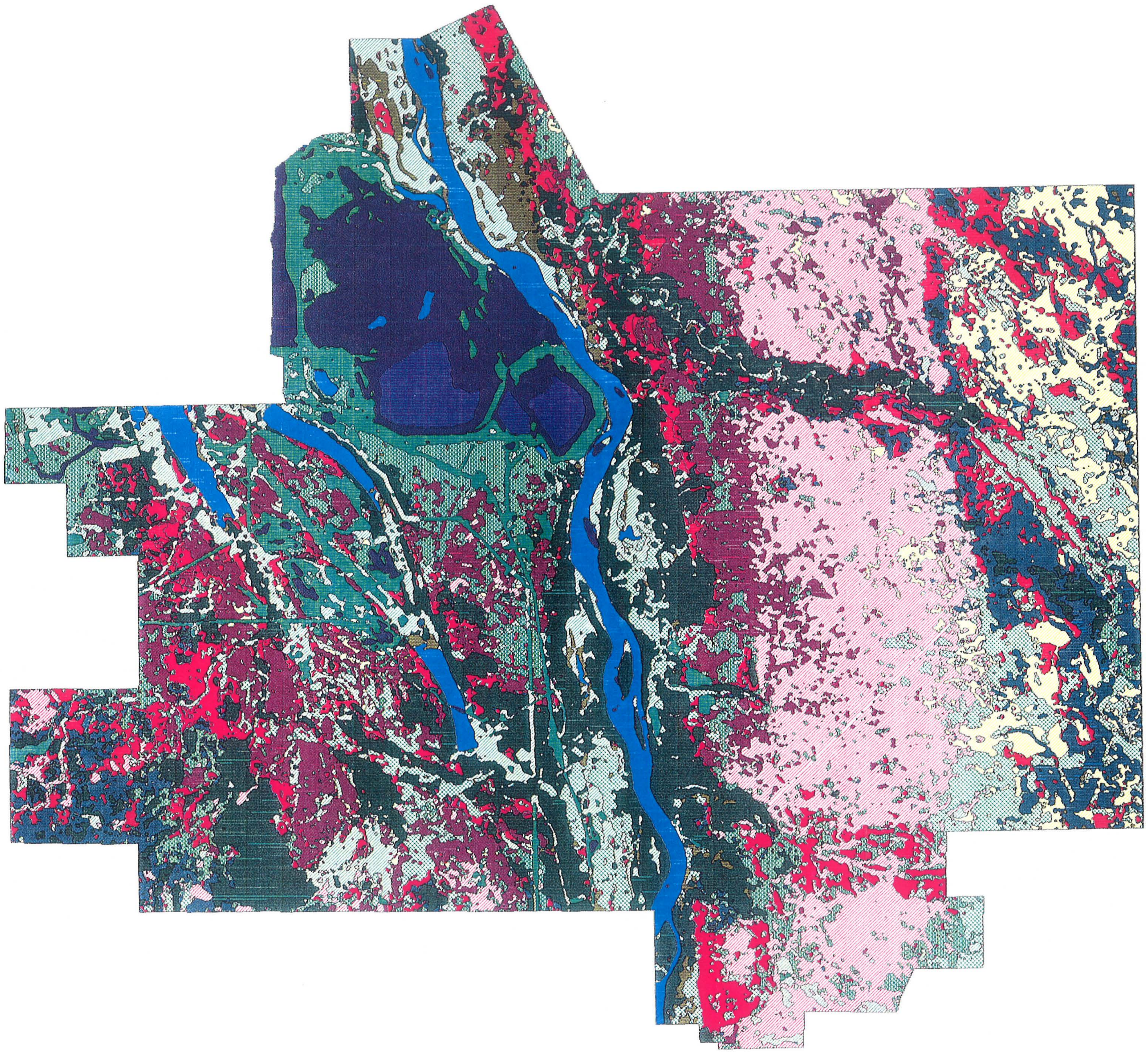


Figure B2.0-4
VEGETATION CLASSIFICATION
(ECOSITES)
WITHIN THE LOCAL STUDY AREA

LEGEND

- Closed Jack Pine
- Closed White Spruce
- Deciduous Forest
- Closed Mixedwood
- Closed Mixed Coniferous, Black Spruce Dominant
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Larch Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Larch Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Industrial Open Water
- Wetland Open Water-Emergent Vegetation Zone

N

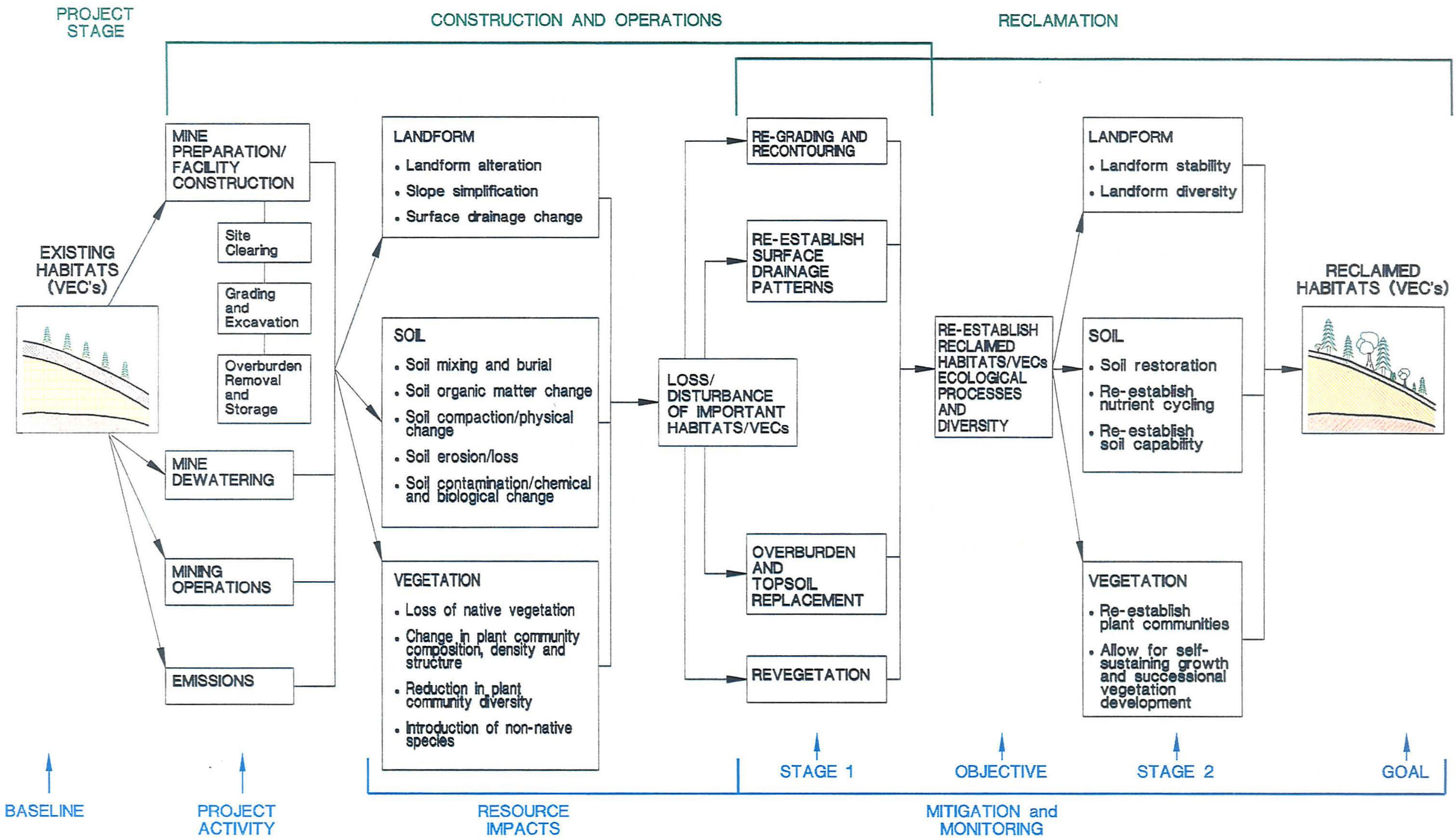
Scale = 1:100,000

0 2 4 6
KILOMETRES

Golder Associates

Figure D2.0-1
AERIAL PHOTOGRAPH OF
STEEPBANK MINE PROJECT LANDS (1995)

Figure D2.0-2
HYPOTHESIS 12: IMPORTANT HABITATS (OR VECs) IN THE ATHABASCA RIVER VALLEY COULD BE AFFECTED BY THE DEVELOPMENT, OPERATION AND RECLAMATION OF THE STEEPBANK MINE AND LEASE 86/17



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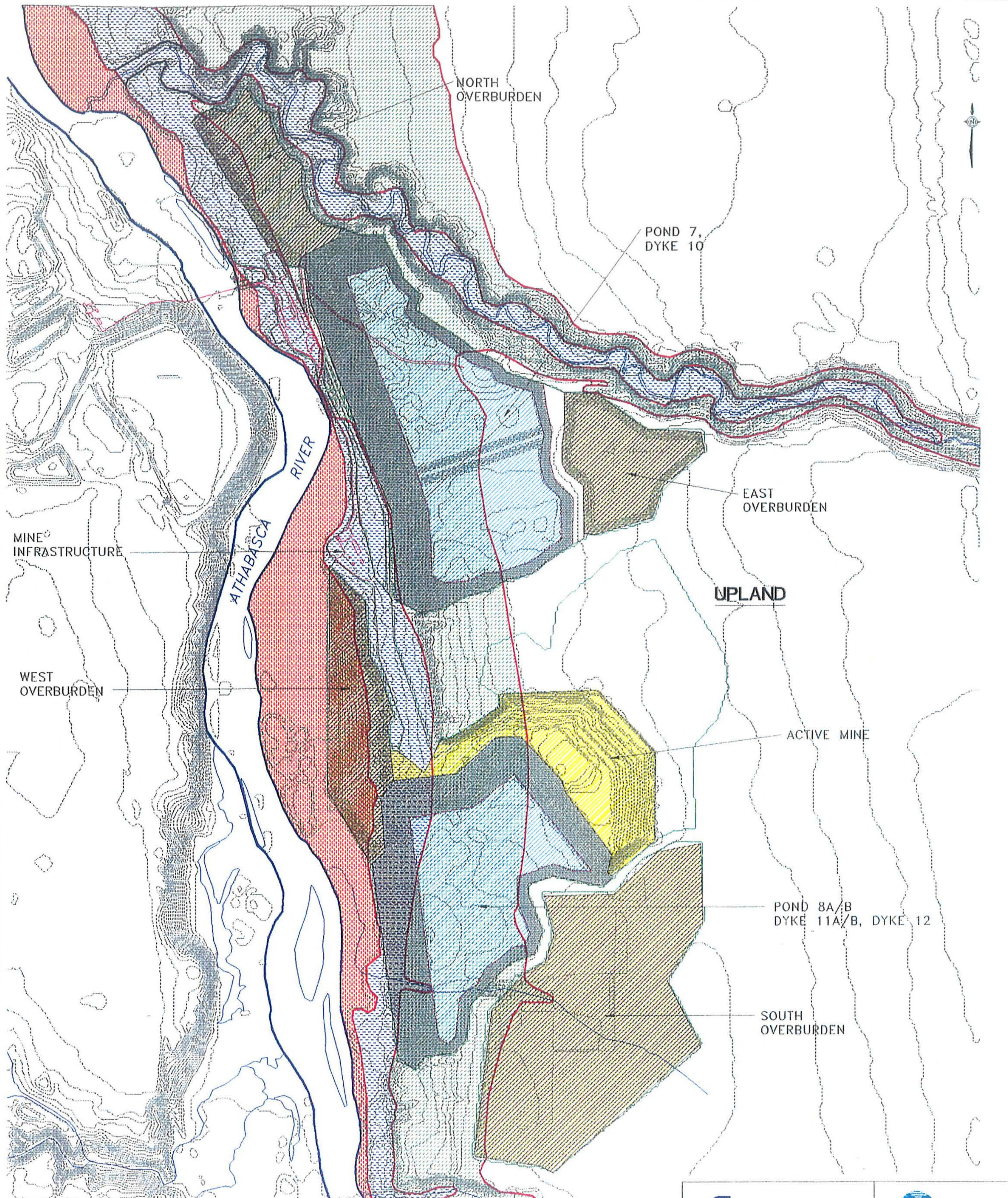
23 APR 96



LEGEND

- FLOODPLAIN
- FLOODPLAIN TERRACE
- ESCARPMENT

0 500 1000m

SCALE

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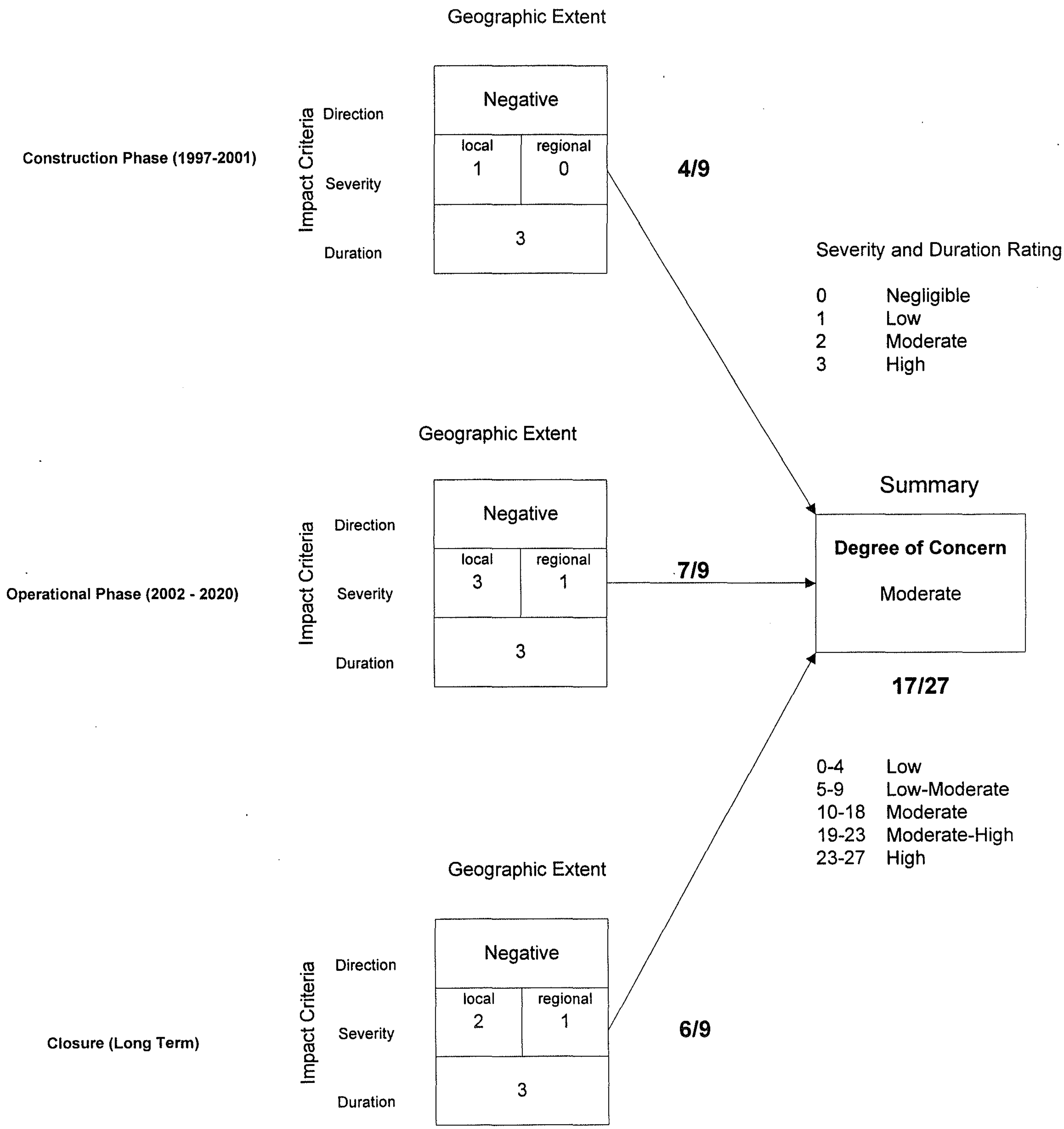
Golder Associates

STEEPBANK MINE DEVELOPMENT TO THE YEAR 2020, SHOWING PROJECT COMPONENTS AND MAJOR LANDFORM DIVISIONS

SCALE: 1:60000 approx	Steepbank Mine Application	AUTOCAD File: RECLAM.dwg
DATE: 22 FEB 96		FIGURE No.: D2.0-3
DRAWN BY: RK		

Figure D2.0-4 Hypothesis 12A: Impact Hypothesis Classification for Landform VECs

Important habitats (or VEC's) at the landform level, in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.



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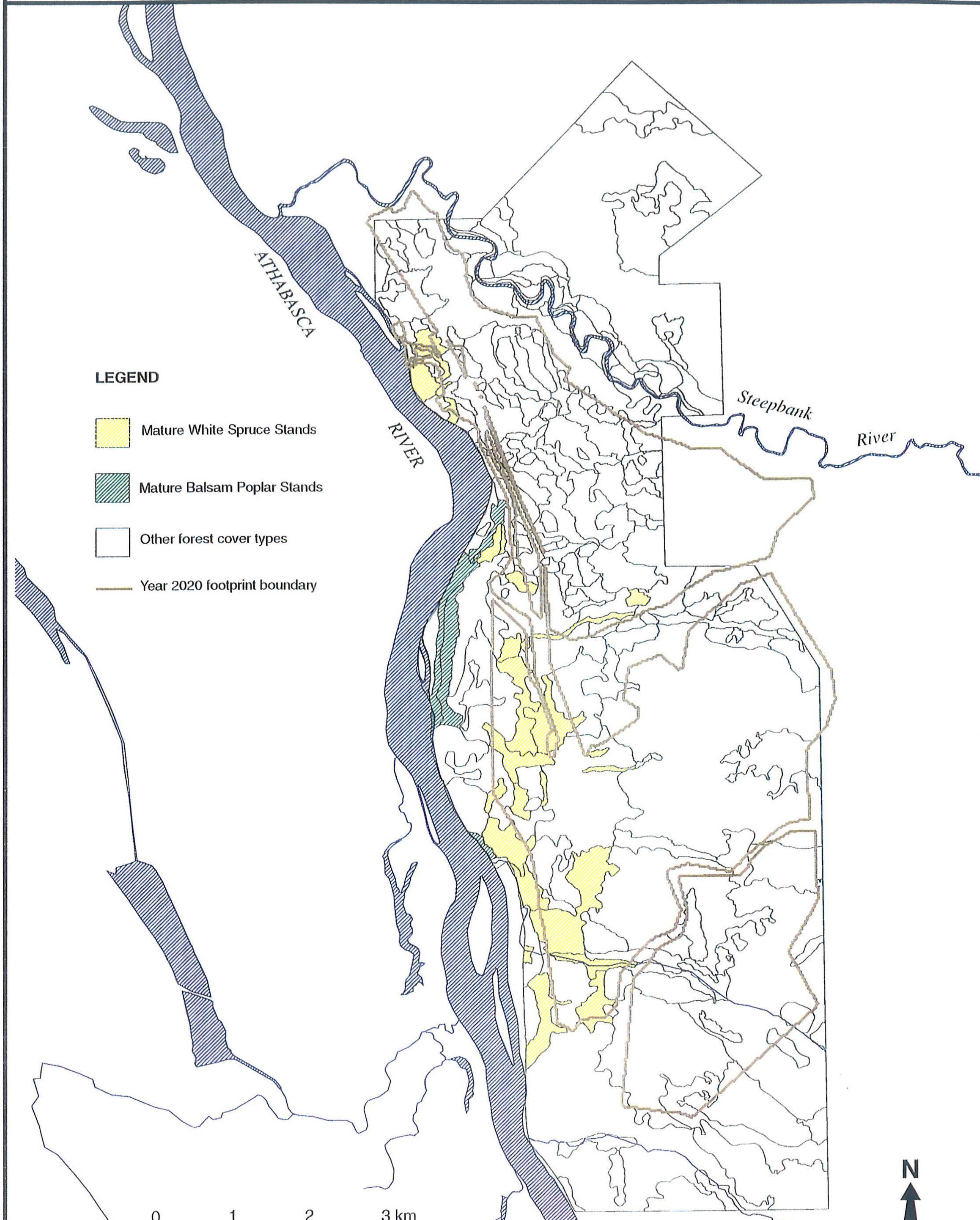
Mature Forest Stands in Steepbank Mine Footprint Athabasca River Valley

Figure D2.0-5

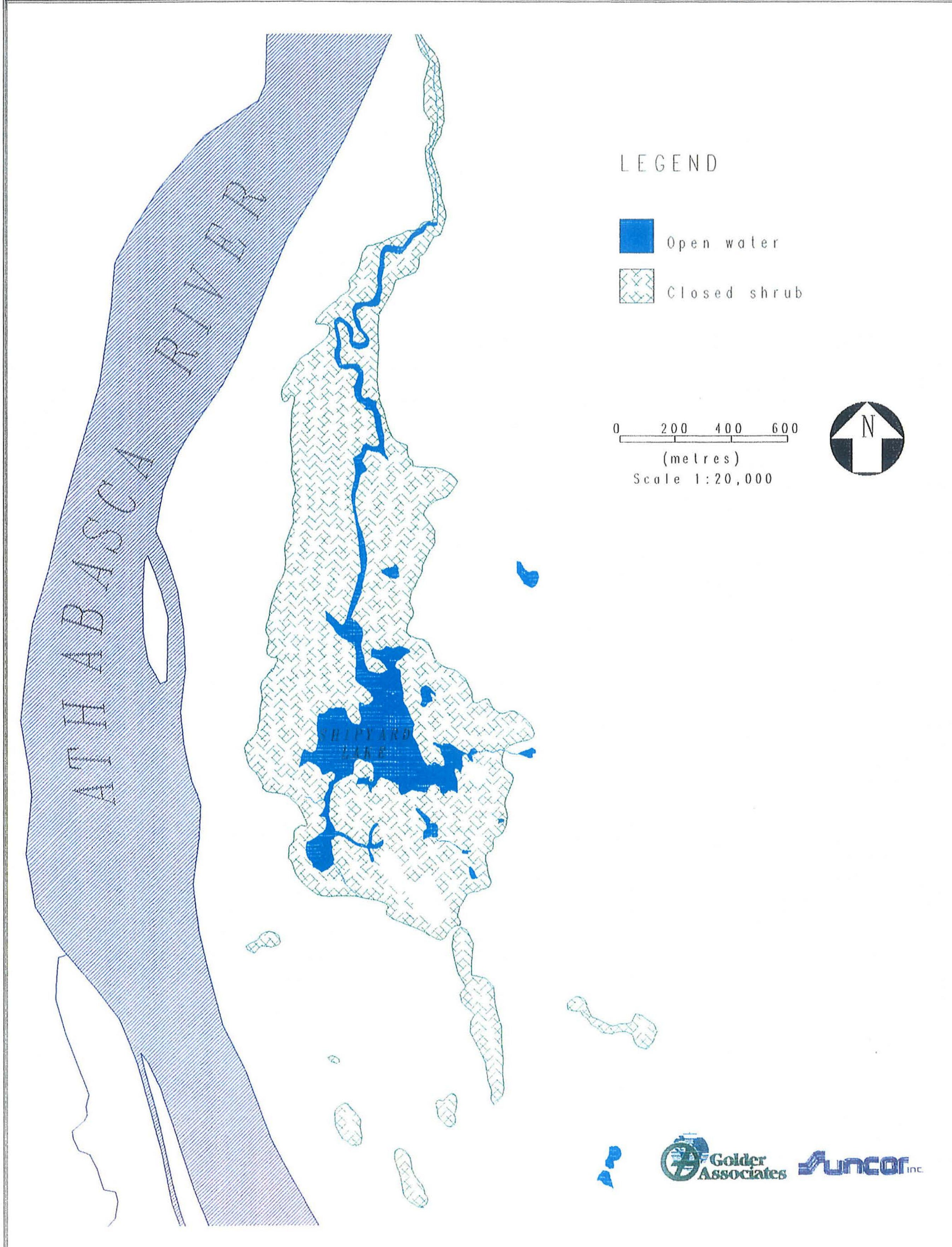


PROJECT 952-2307.5660 DRAWN RP REVIEWED DATE 21 March 1996

Golder Associates

Shipyard Lake Wetlands
Year 1995

Figure D2.0-6



Shipyard Lake Proposed West Overburden Storage - Year 2010

Figure D2.0-7

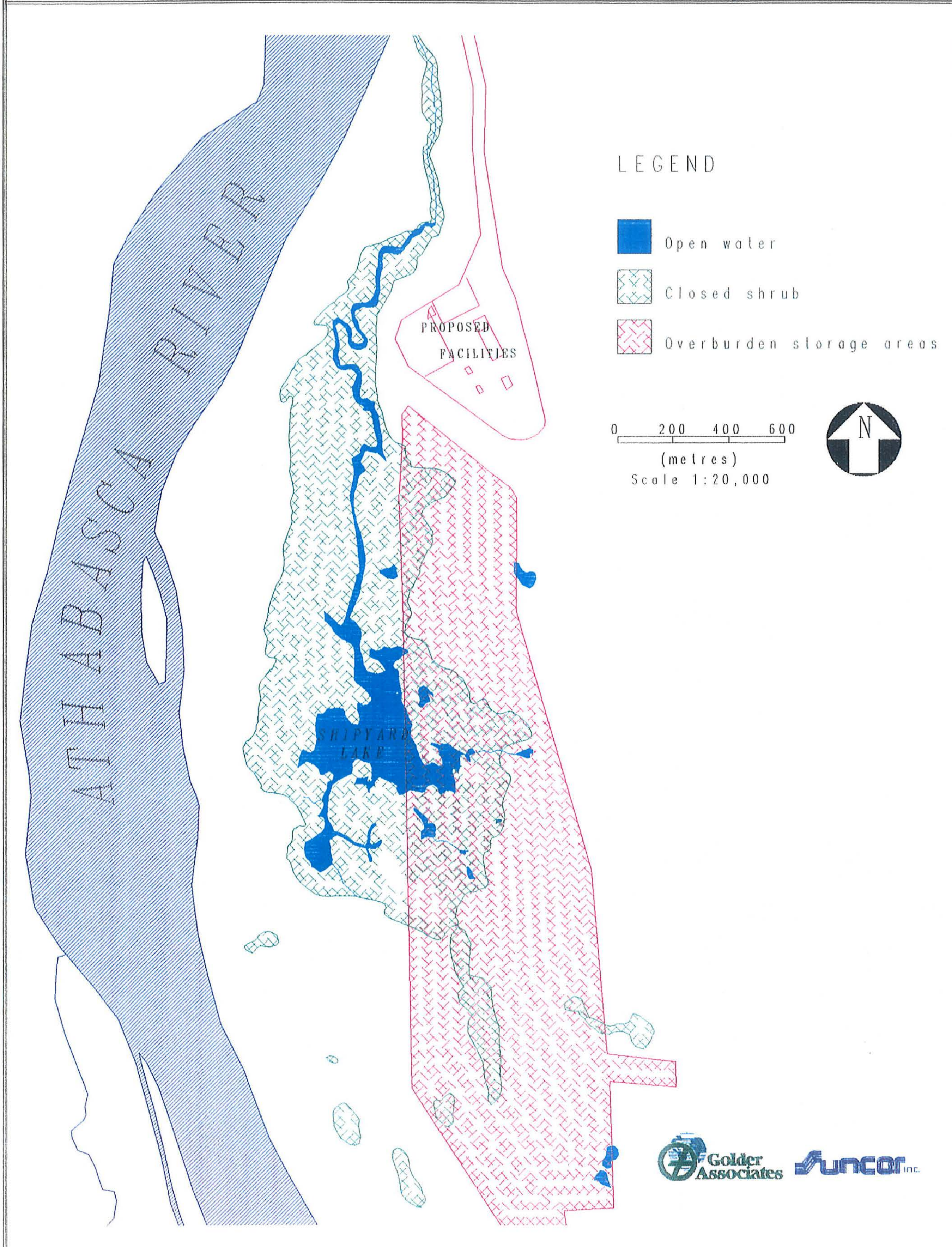


Figure D2.0-8 Hypothesis 12B: Impact Hypothesis Classification for Jack Pine / Blueberrry / Lichen

Important habitats (or VEC's) at the species and community level, in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

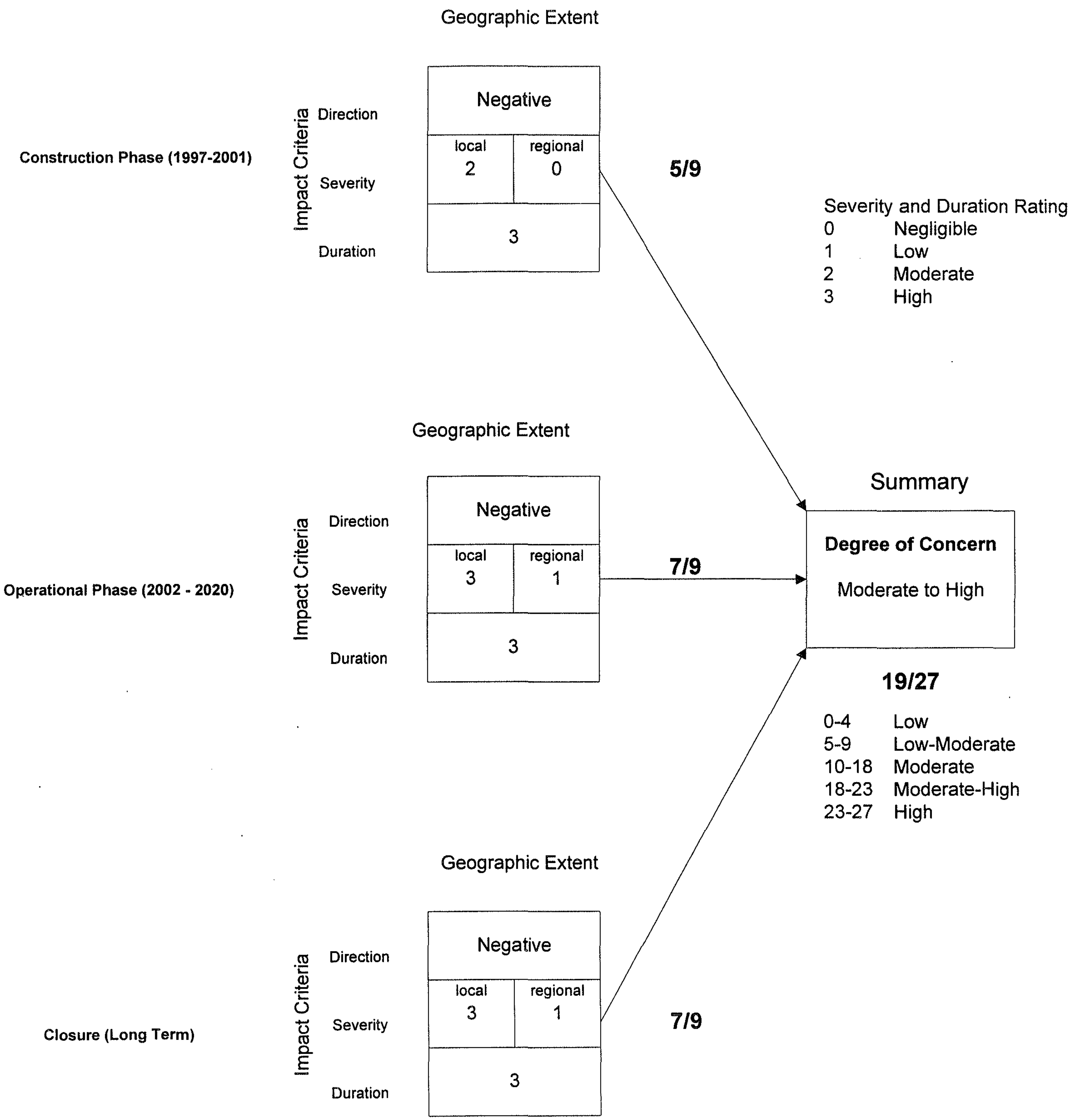


Figure D2.0-9 Hypothesis 12C: Impact Hypothesis Classification for Riparian Wetlands

Important habitats (or VEC's) at the species and community level, in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

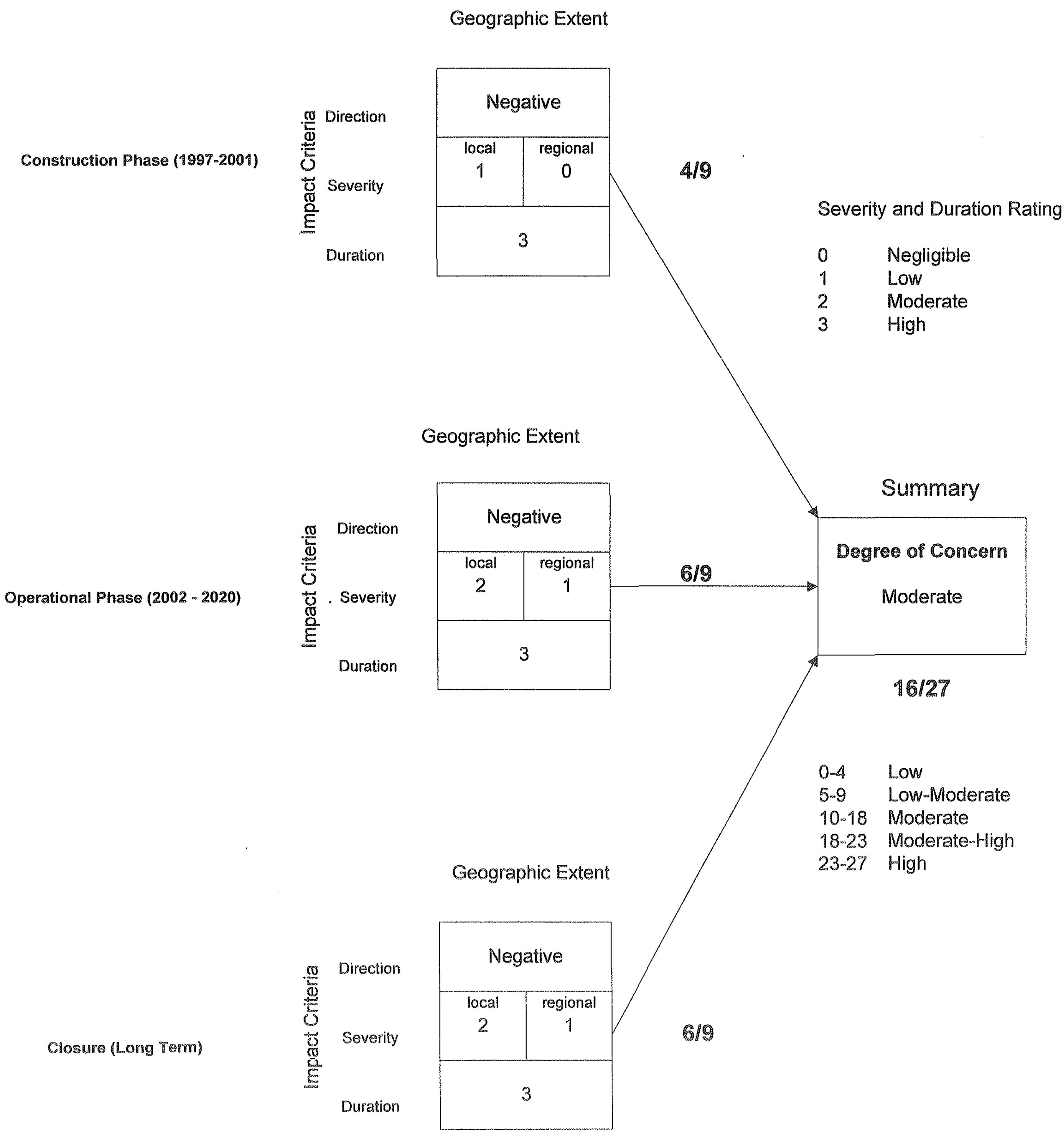


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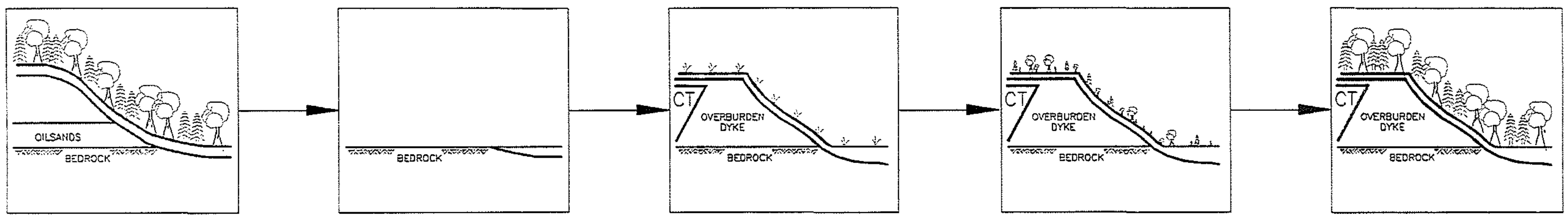
Figure D3.0-1:
HYPOTHESIS 13: EXISTING AND FUTURE USE OF THE AREA'S LANDSCAPES COULD BE LIMITED BY THE DEVELOPMENT OF THE STEEPBANK MINE AND LEASE 86/17 RECLAMATION

1995 | 2001 | 2010 | 2020 | LONGTERM



- Existing Habitat Pre-development
- Mined Surface Development
- Reclamation Surface Post-Development
- Early Successional Stage of Reclamation
- Late Successional Stage of Reclamation

LAND SURFACE CHARACTERSTICS:

	1995	2001	2010	2020	LONGTERM
Landform Stability:	High	Low	Moderate–High	High	High
Soil Development:	High	Low	Low–Moderate	Moderate	High
Vegetation Development:	High	Low	Low–Moderate	Moderate–High	High

LAND USE OPTIONS:

	1995	2001	2010	2020	LONGTERM
Traditional Uses:	High	Low	Low	Low–Moderate	Moderate–High
Wildlife Habitat:	High	Low	Low–Moderate	Moderate–High	High
Recreation and Tourism:	Moderate	Low–Moderate	Low–Moderate	Moderate	Moderate–High
Forestry:	Moderate	Low	Low	Moderate	Moderate–High

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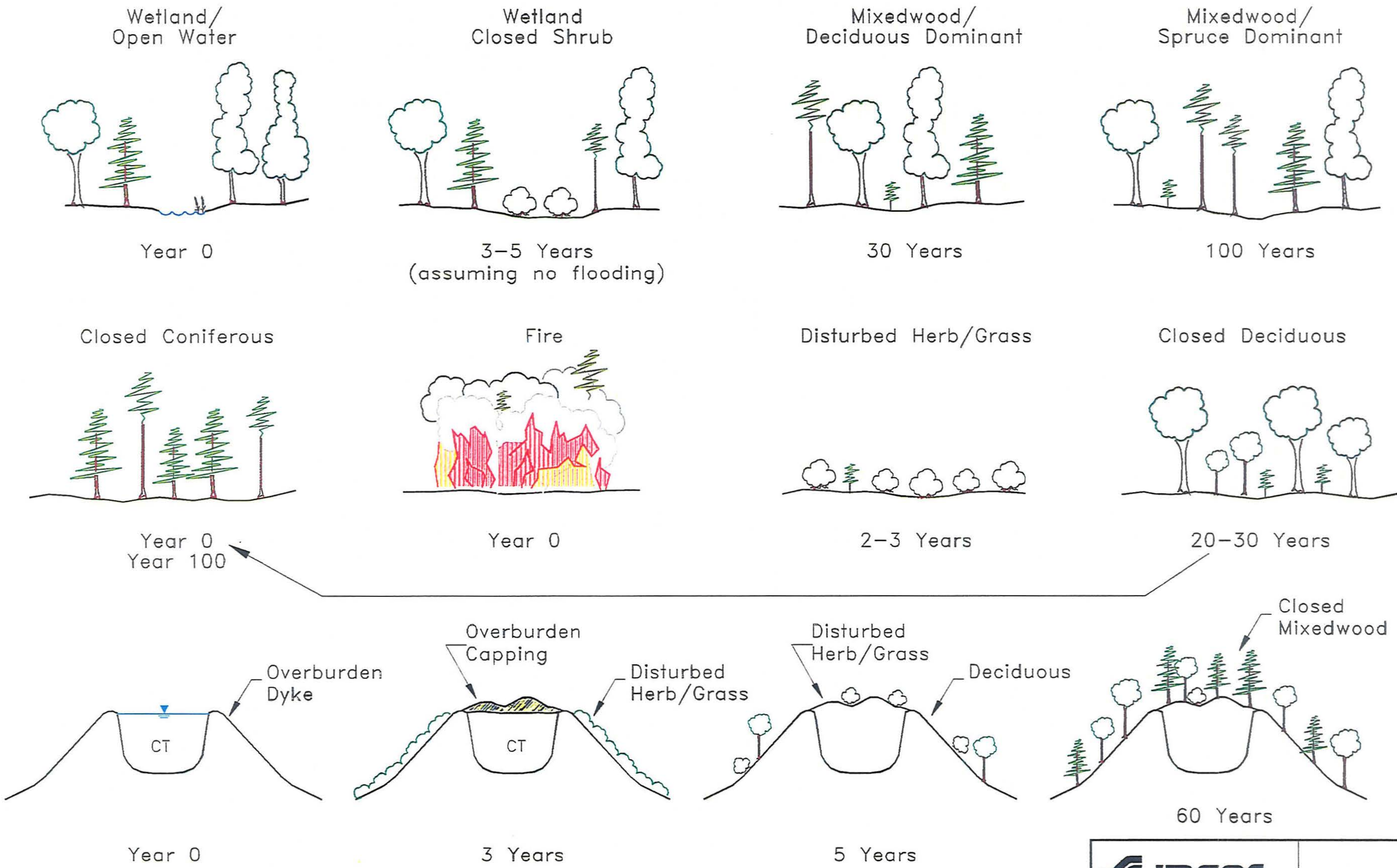
23 APR 96



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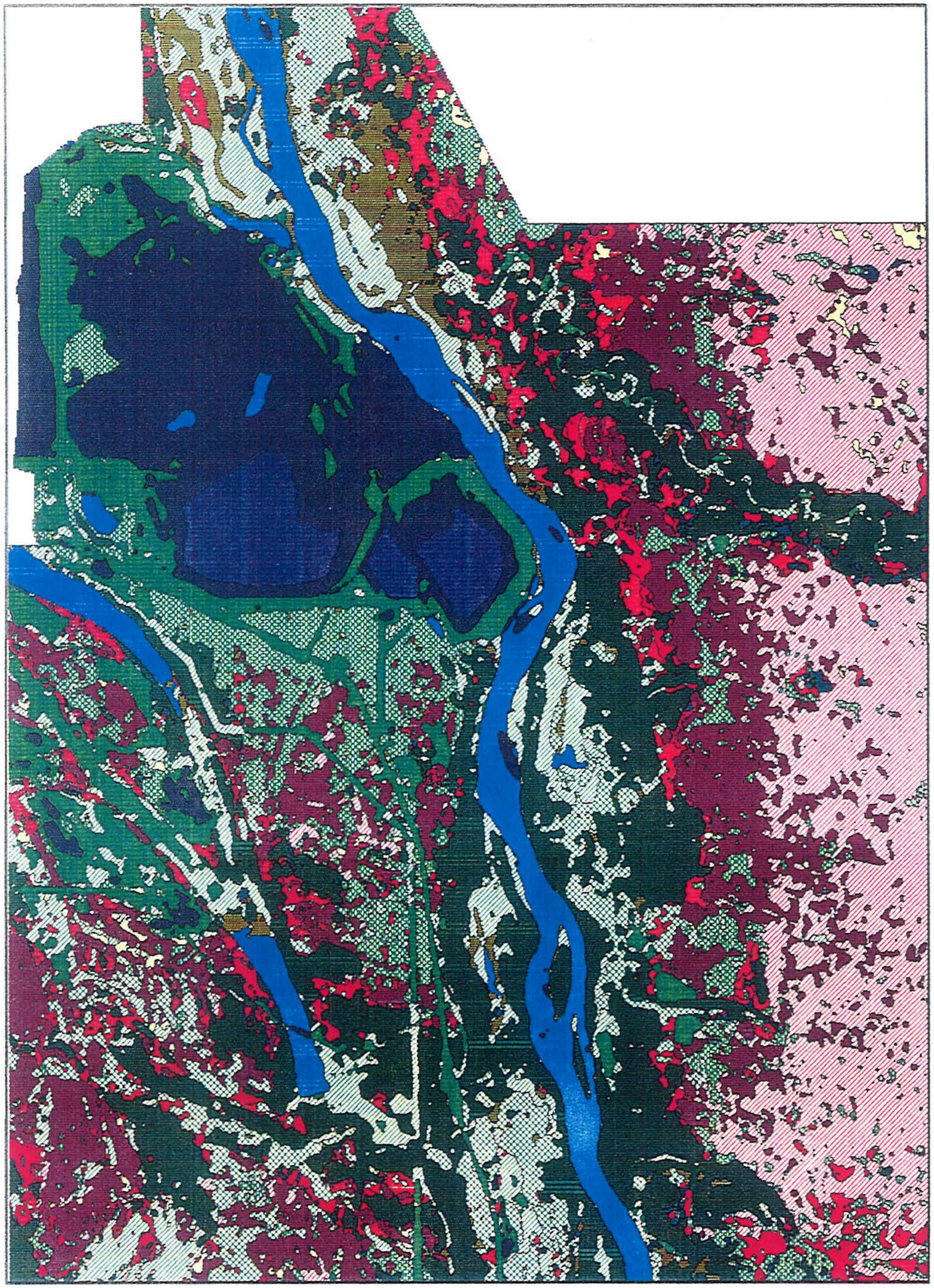
SIMPLE EXAMPLES OF VEGETATION SUCCESSION

SCALE: N/A	Steepbank Mine Application	REVIEWED BY:
DATE: 20 MAR 96		CADFILE: TREES.dwg
DRAWN BY: RK		FIGURE No.: D3.0-2

SUNCOR ELC CLASSIFICATION
LOCAL STUDY AREA, YEAR 1995



LEGEND

- Closed Jack Pine
- Closed White Spruce
- Deciduous forest
- Closed Mixedwood
- Closed Mixed Coniferous, Black Spruce Dominant
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Tamarack Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Tamarack Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Industrial Open Water
- Wetland Open Water-Emergent Vegetation Zone

Scale = 1:100,000

0 2 4 6

KILOMETRES

N

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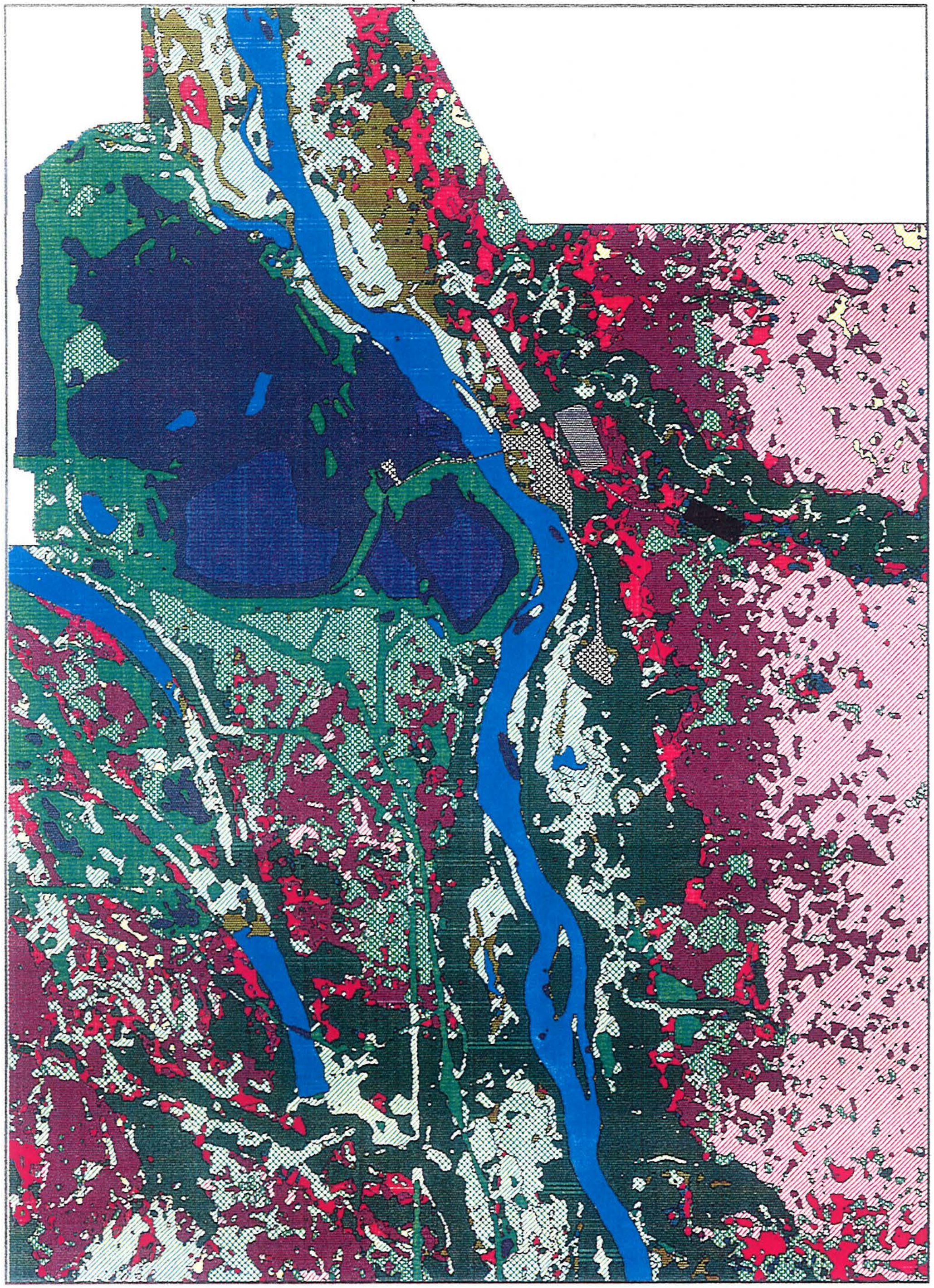
SUNCOR STEEPBANK MINE ADVANCE,
ELC ECOSITE CLASSIFICATION

4-19-96 RP/KS 952-2307.5685	Steepbank Mine Application	Figure No. D3.0-3



SUNCOR ELC CLASSIFICATION
LOCAL STUDY AREA, YEAR 2001

LEGEND

- Closed Jack Pine
- Closed White Spruce
- Deciduous forest
- Closed Mixedwood
- Closed Mixed Coniferous, Black Spruce Dominant
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Tamarack Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Tamarack Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Industrial Open Water
- Steepbank Mine Infrastructure
- North Overburden Storage
- Active Mine Pit (Pit 7)
- East Steepbank Gravel Pit
- Wetland Open Water-Emergent Vegetation Zone

Scale = 1:100,000

0 2 4 6

KILOMETRES

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SUNCOR STEEPBANK MINE ADVANCE,
ELC ECOSITE CLASSIFICATION

4-19-96 RP/KS 952-2307.5665	Steepbank Mine Application	Figure No. D3.0-4

SUNCOR ELC CLASSIFICATION
LOCAL STUDY AREA, YEAR 2010

LEGEND

- Closed Jack Pine
- Closed White Spruce
- Deciduous forest
- Closed Mixedwood
- Closed Mixed Coniferous, Black Spruce Dominant
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Tamarack Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Tamarack Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Industrial Open Water
- Lease 97 Mine Infrastructure
- Lease 97 Active Mine Area
- Lease 97 Dyke 11
- Lease 97 North Overburden Storage
- Wetland Open Water-Emergent Vegetation Zone

Scale = 1:100,000

0 2 4 6

KILOMETRES

N

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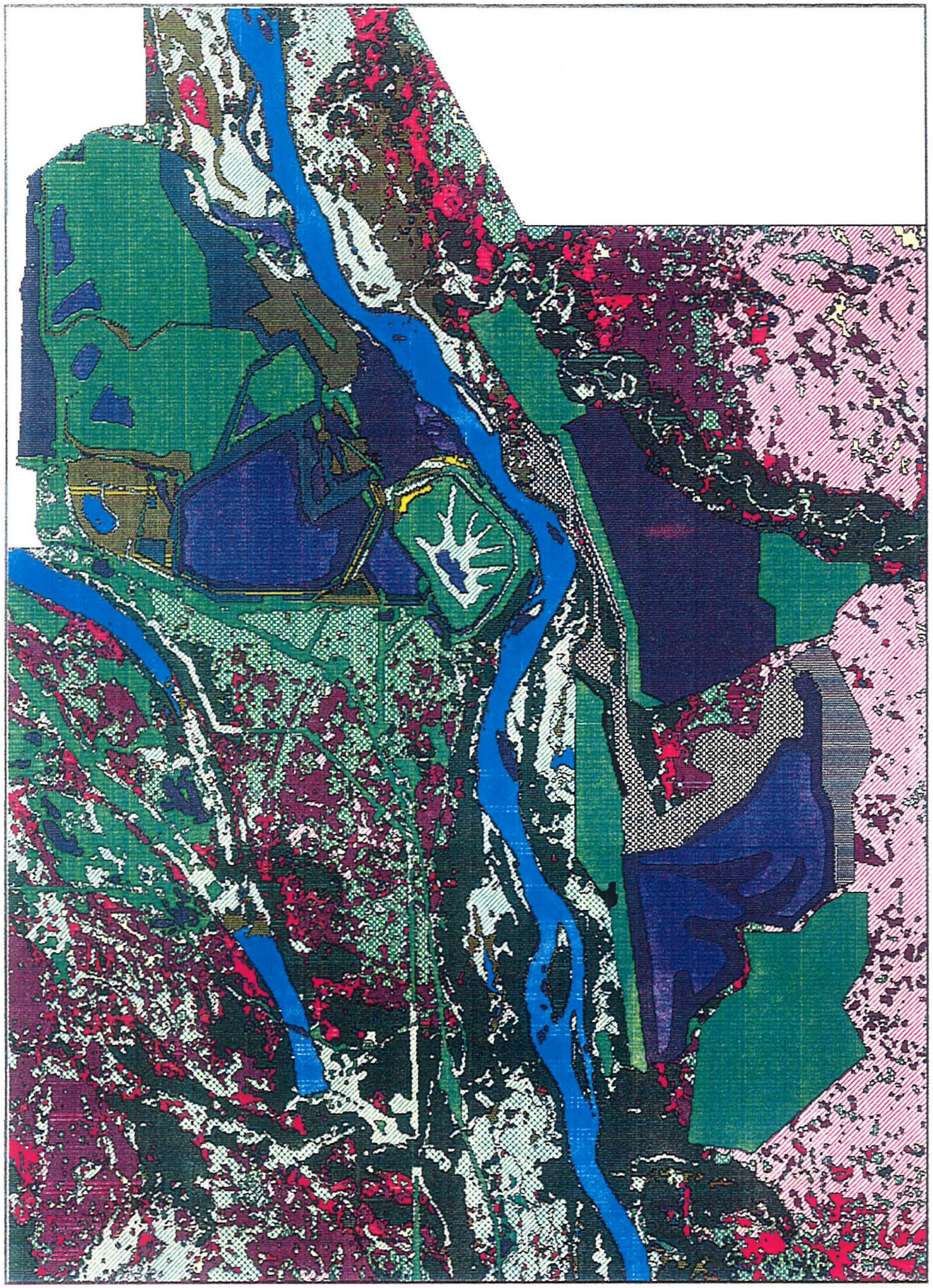
SUNCOR STEEPBANK MINE ADVANCE, ELC ECOSITE CLASSIFICATION

4-19-96 RP/KS 952-2307.5685	Steepbank Mine Application	Figure No. D3.0-5



SUNCOR ELC CLASSIFICATION
LOCAL STUDY AREA, YEAR 2020

LEGEND

- Closed Jack Pine
- Closed White Spruce
- Deciduous forest
- Closed Mixedwood
- Closed Mixed Coniferous, Black Spruce Dominant
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Tamarack Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Tamarack Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Industrial Open Water
- Upland Lodgepole Pine (Reclaimed)
- Lease 97 Mine Infrastructure
- Lease 97 West Overburden Pile
- Lease 97 Active Mine Pit
- Wetland Open Water-Emergent Vegetation Zone

Scale = 1:100,000

0 2 4 6

KILOMETRES

N

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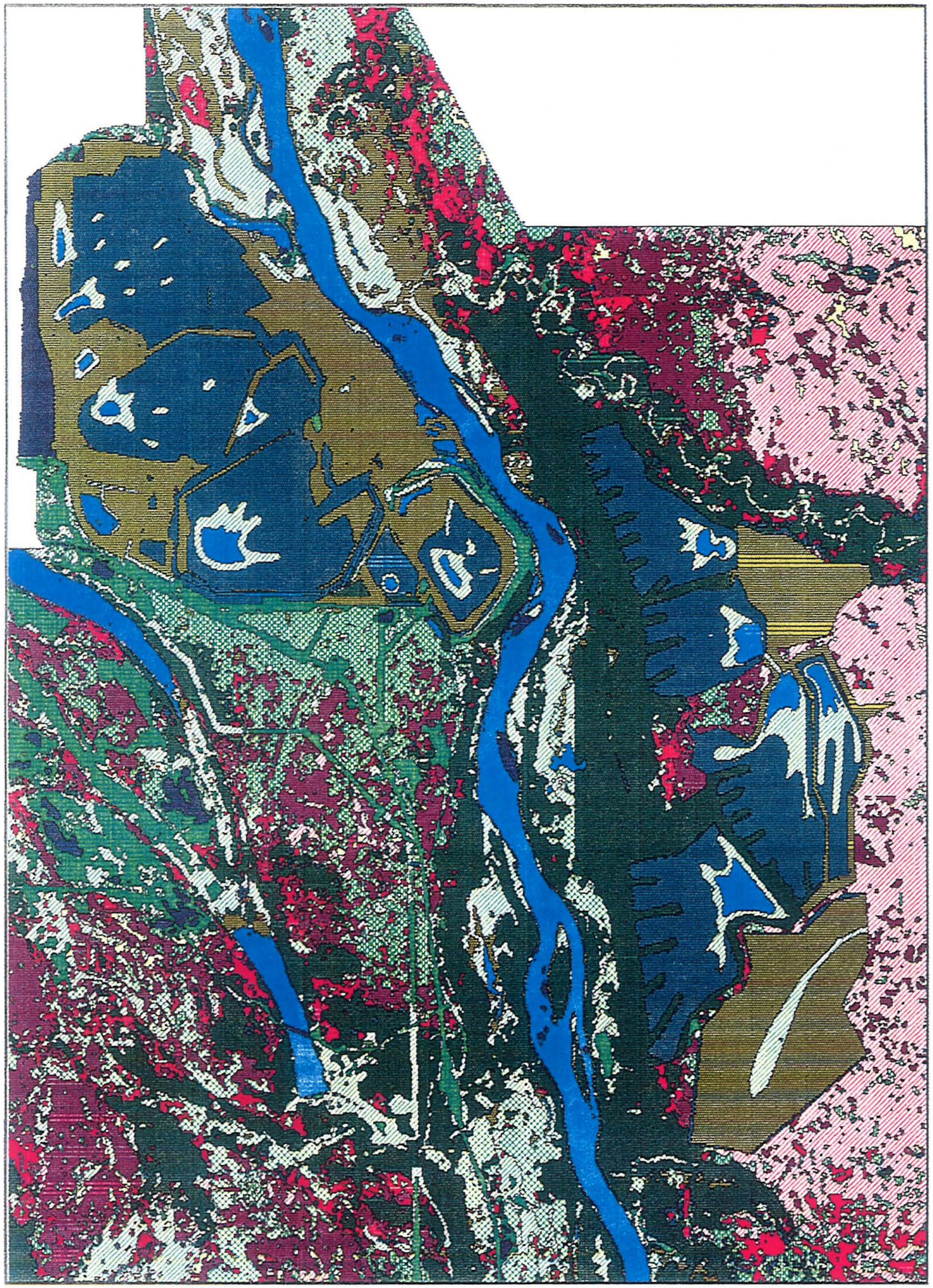
SUNCOR STEEPBANK MINE ADVANCE, ELC ECOSITE CLASSIFICATION

4-19-96 RP/KS 952-2307.5685	Steepbank Mine Application	Figure No. D3.0-6



SUNCOR ELC CLASSIFICATION
LOCAL STUDY AREA, LONGTERM PLANNED

LEGEND

- Closed Jack Pine
- Closed White Spruce
- Deciduous forest
- Closed Mixedwood
- Closed Mixed Coniferous, Black Spruce Dominant
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Tamarack Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Tamarack Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Wetland Open Water-Emergent Vegetation Zone

Scale = 1:100,000

0 2 4 6

KILOMETRES

N

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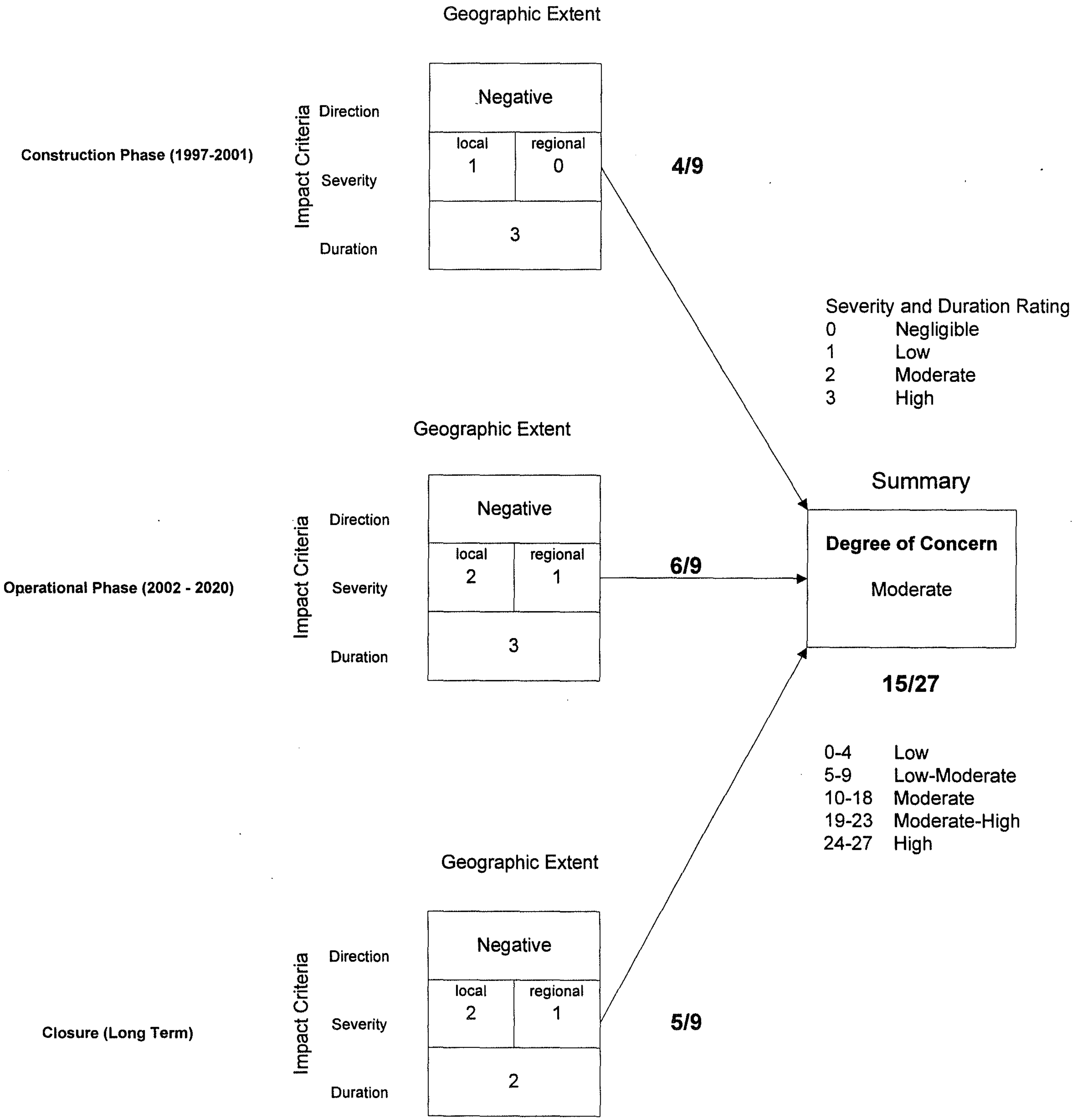
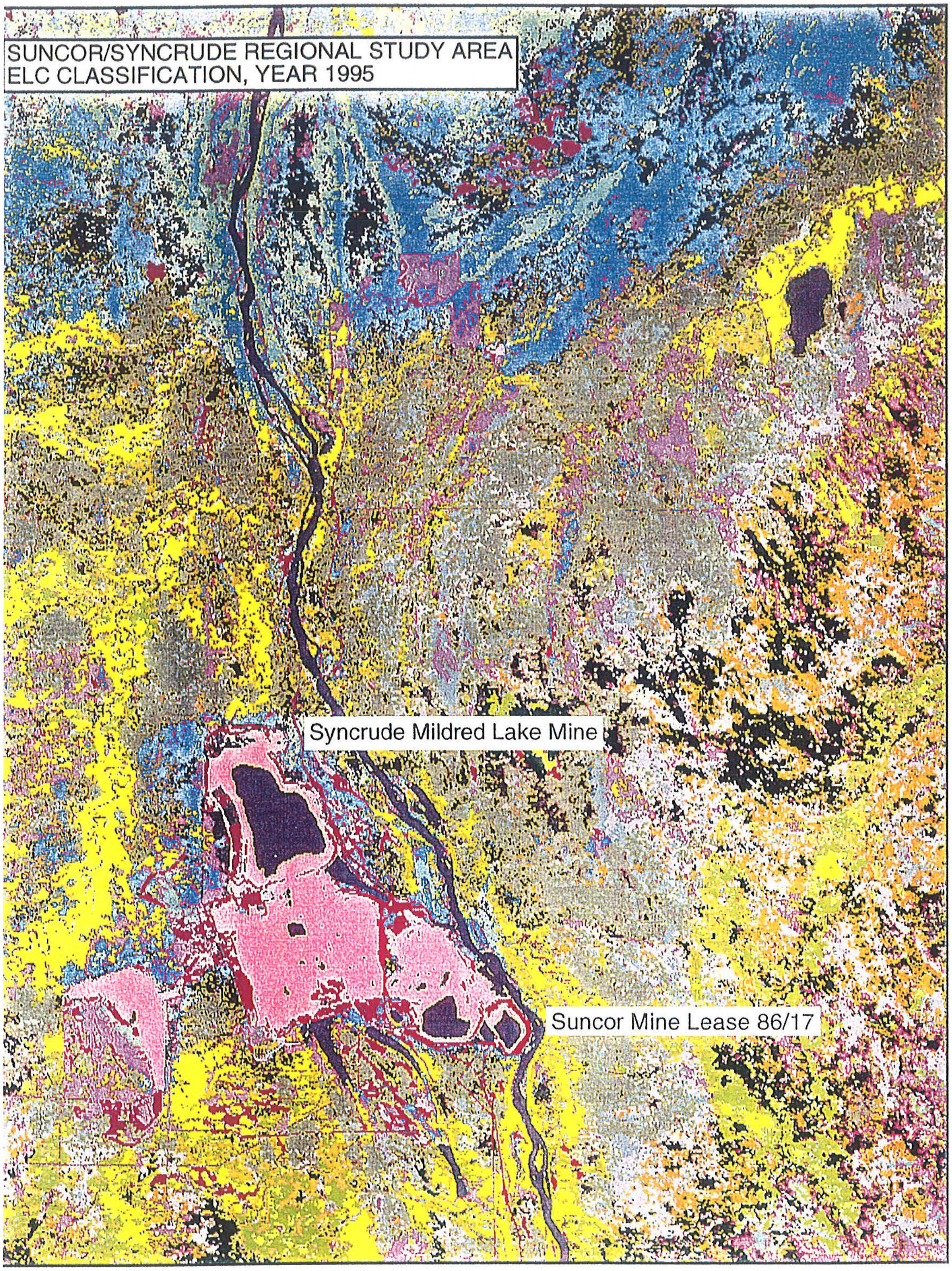
SUNCOR STEEPBANK MINE ADVANCE,
ELC ECOSITE CLASSIFICATION

4-19-96 RP/KS	Steepbank Mine Application	Figure No.
952-2307.5685		D3.0-7

Figure D3.0-8 Hypothesis 13: Impact Hypothesis Classification for Restrictions on Existing and Future Land Use

Existing and future use of the area's landscapes could be limited by development of the Steepbank Mine and Lease 86/17 reclamation.





LEGEND

- Closed Jack Pine
- Closed White Spruce
- Closed Deciduous Forest
- Closed Mixedwood
- Closed Mixed Conif. Black Sp. Dom.
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Larch Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Larch Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Wetland Open Water-Emergent Vegetation
- Peatland: Shrub Dom. Fen/Pat. Fen

SCALE: 1 : 300000

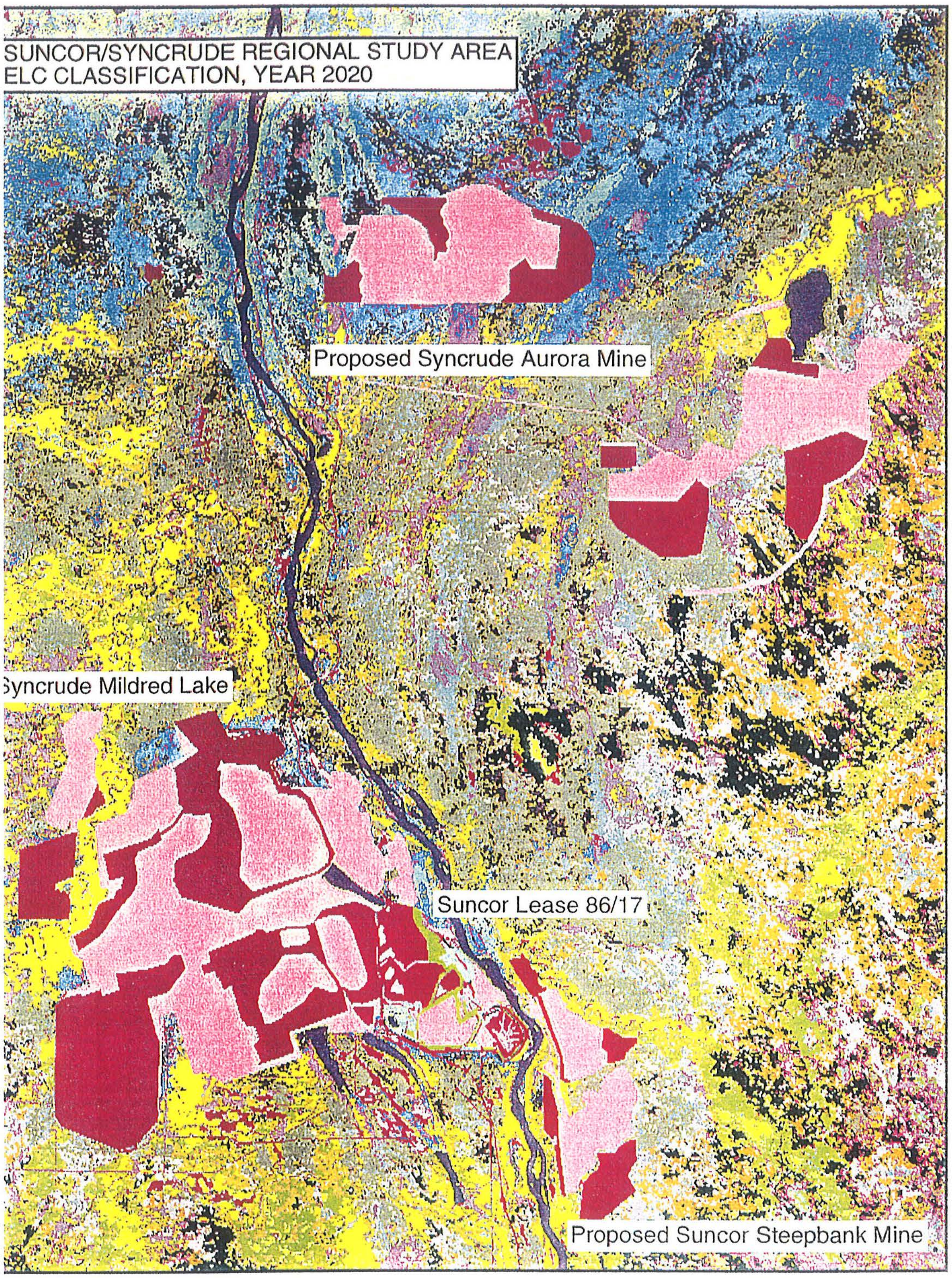
REGION: 6363700 / 447750 492100 / 6305000

SCALE: 1:300,000
PROJECTION: UTM
PRODUCED BY: GOLDER ASSOCIATES LTD. FOR SUNCOR INC.

Suncor Inc.
Oil Sands Group

SUNCOR / SYNCRUDE
REGIONAL STUDY AREA
ELC CLASSIFICATION, 1995

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 23 APR 96		REVISION No.: 1
DRAWN BY: KS/RK		FIGURE No.: D3.0-9



LEGEND
- Closed Jack Pine
- Closed White Spruce
- Deciduous Forest
- Closed Mixedwood
- Closed Mixed Conif. Black Sp. Dominant
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Larch Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Larch Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Wetland Open Water-Emergent Veg.
- Peatland: Shrub Dom. Fen/Pat. Fen

SCALE: 1 : 300000

REGION: 6363700 / 447750 492100 / 6305000

SCALE: 1:300,000
PROJECTION: UTM
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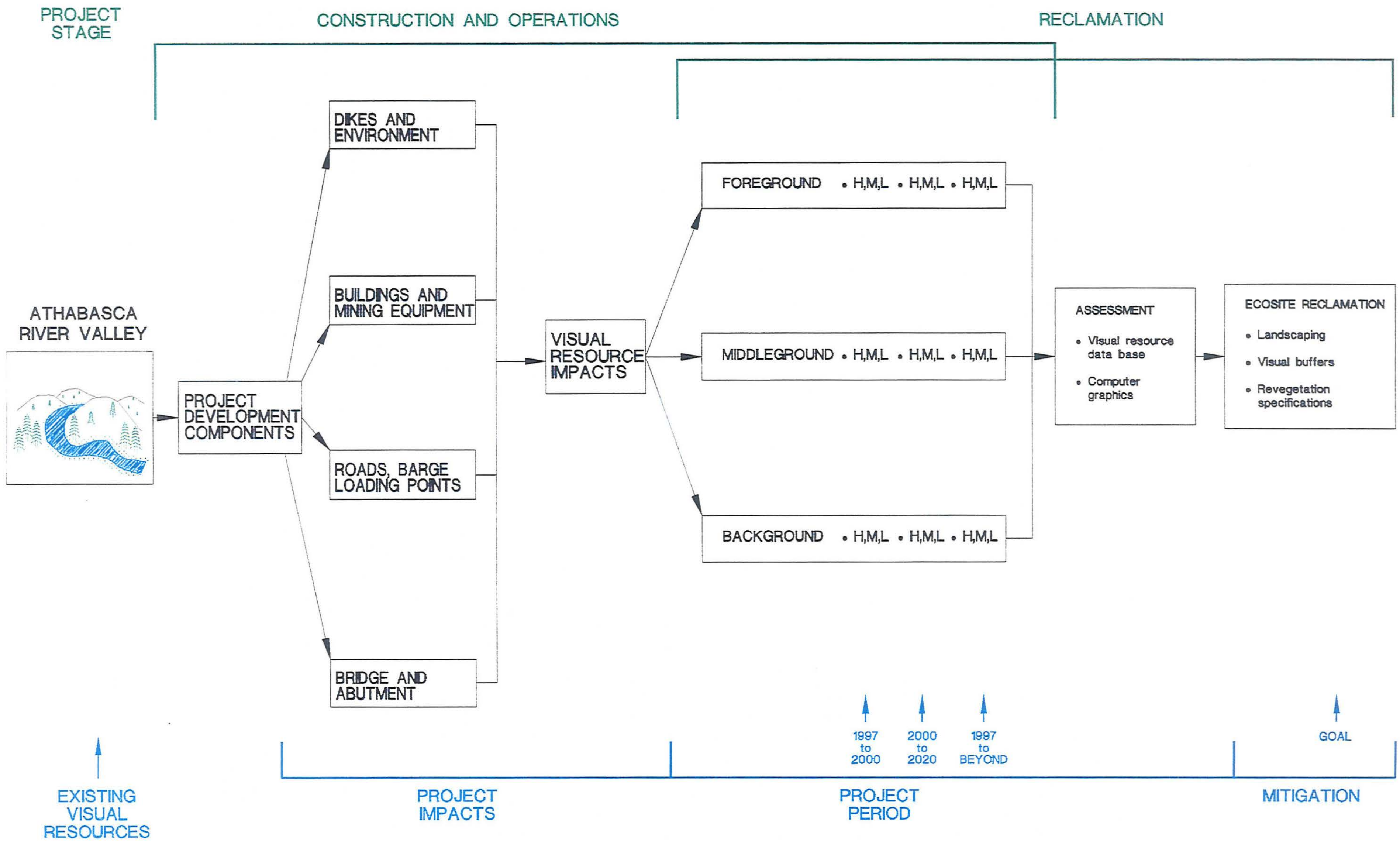
SUNCOR / SYNCRUDE
REGIONAL STUDY AREA
ELC CLASSIFICATION, 2020

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 23 APR 96		REVISION No.: 1
DRAWN BY: KS/RK		FIGURE No.: D3.0-10

Figure D4.0-1
HYPOTHESIS 14: VISUAL INTEGRITY OF THE ATHABASCA RIVER VALLEY COULD BE AFFECTED BY THE DEVELOPMENT, OPERATION AND RECLAMATION OF THE STEEPBANK MINE AND LEASE 86/17



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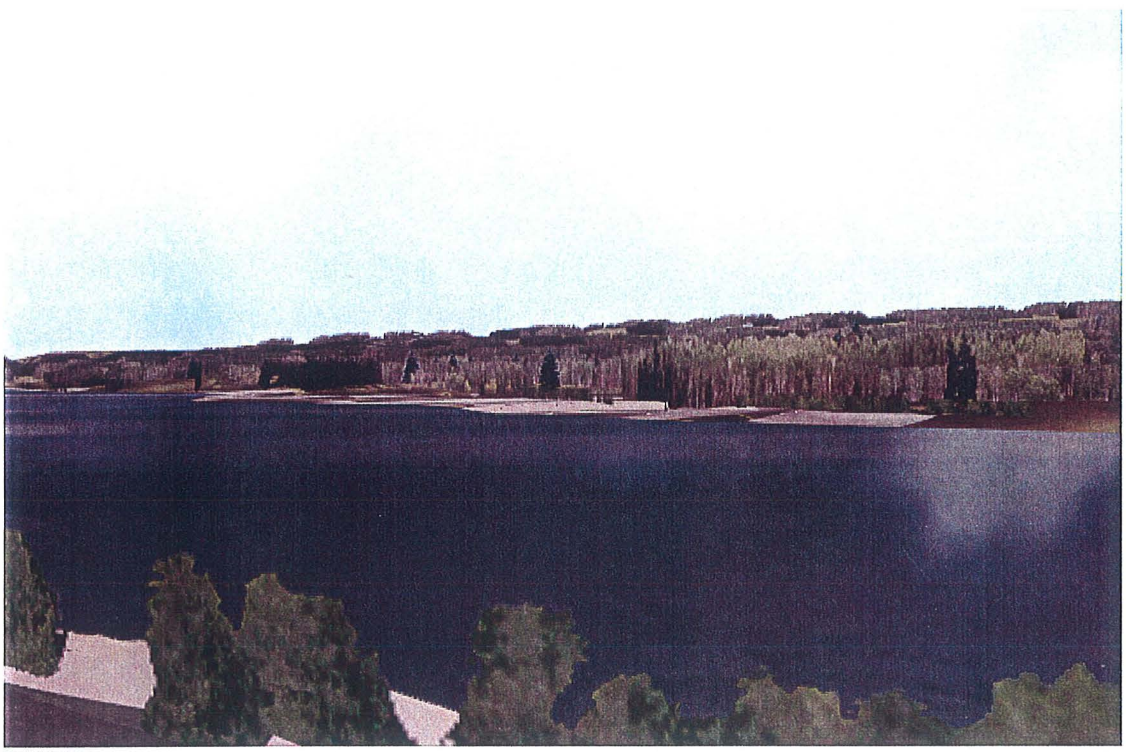
23 APR 96

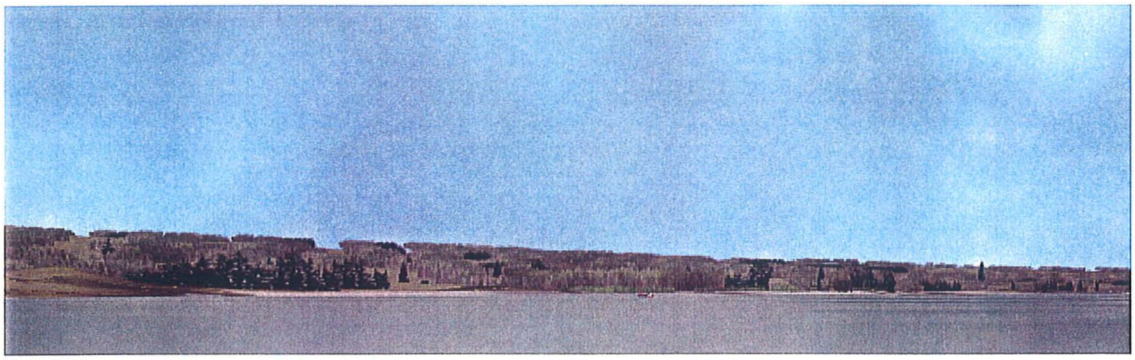
Figure D4.0-2
Comparison of a photographic image
with an image created from the computer model

P88.TIF

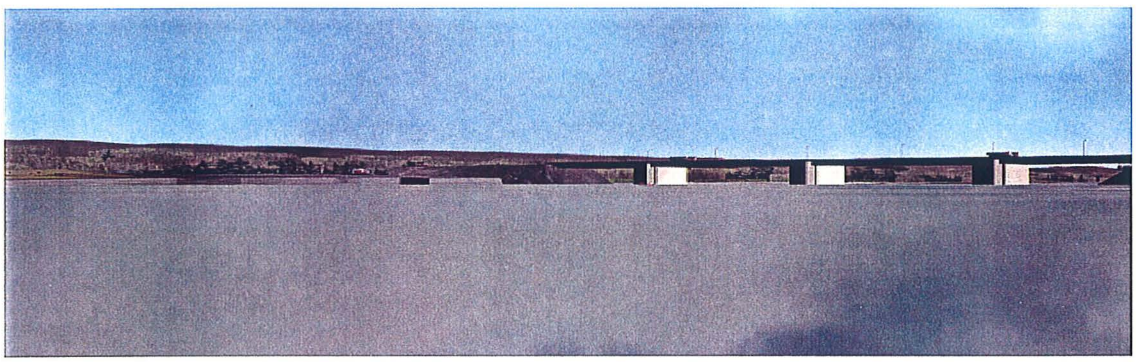


W88.TIFF

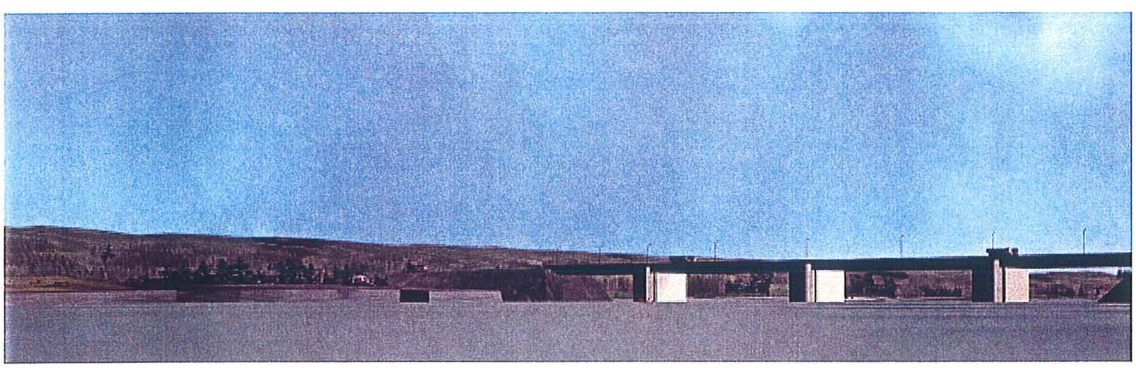
Figure D4.0-3
Computer generated image showing a view of the site prior to construction of the proposed bridge (A), during the operational phase (B) and during reclamation of the dykes (C)



(A) V95A0001



(B) V09A0001



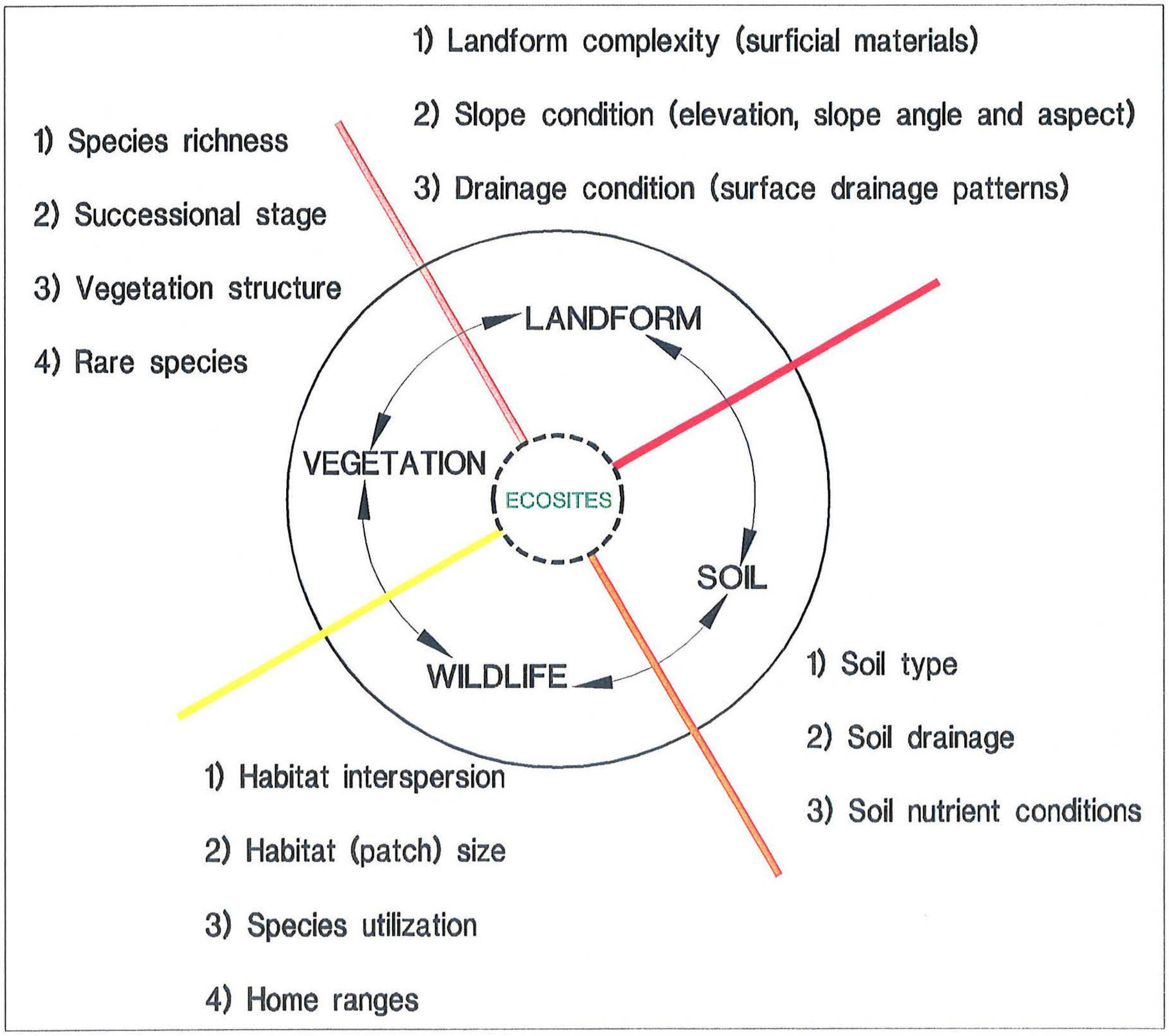
(C) V15A0001

Figure D5.0-1:
HYPOTHESIS 15: BIODIVERSITY COULD BE AFFECTED BY THE DEVELOPMENT, OPERATION AND RECLAMATION OF THE STEEPBANK MINE AND LEASE 86/17: CONCEPT DIAGRAM

DEFINITION: "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)

APPROACH TO BIODIVERSITY ANALYSIS: Ecological Land Classification/Ecosite Analysis

ECOSITE DATA BASE



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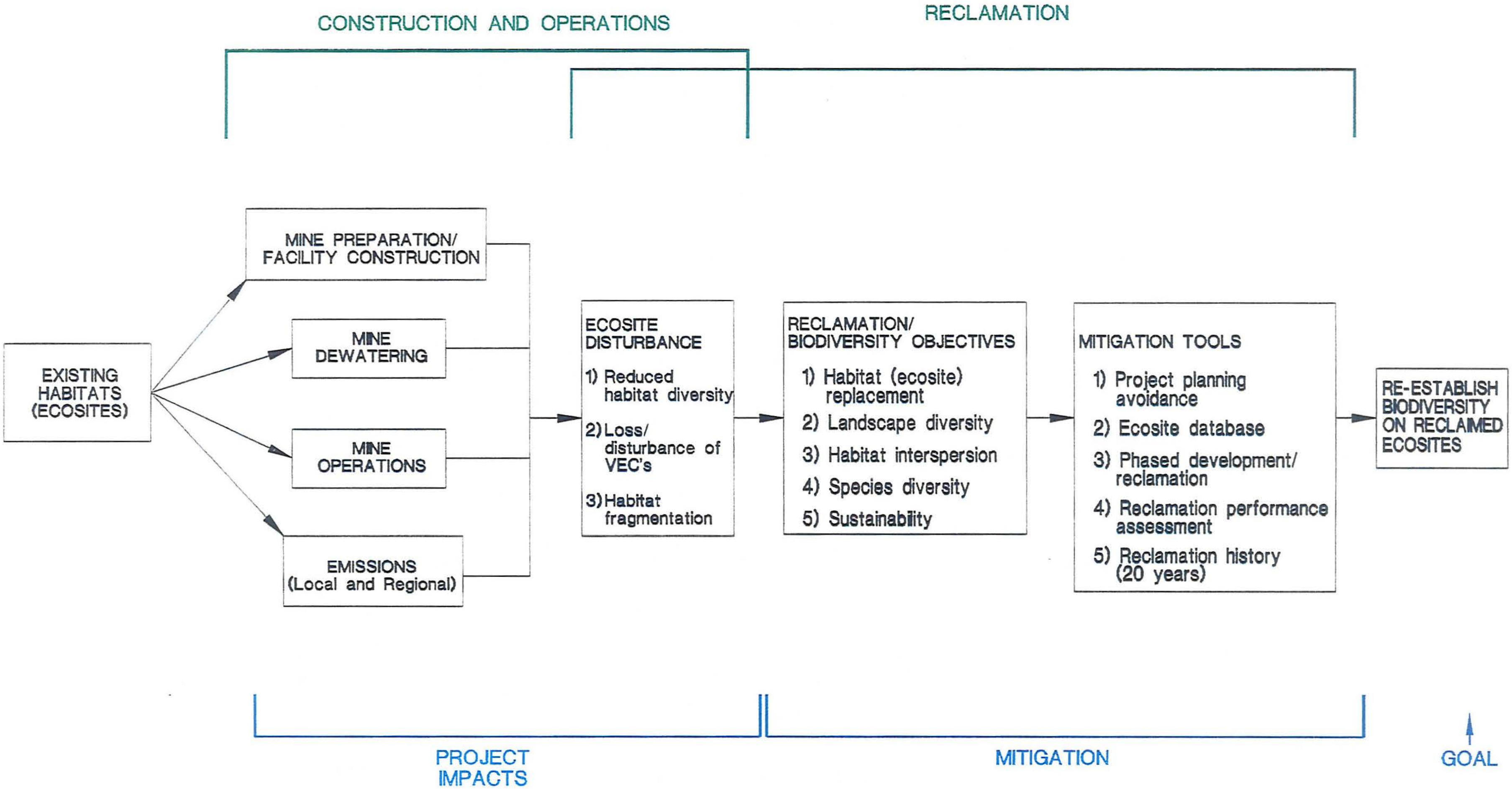
23 APR 96

Figure D5.0-2
HYPOTHESIS 15: BIODIVERSITY COULD BE AFFECTED BY THE DEVELOPMENT, OPERATION AND RECLAMATION OF THE STEEPBANK MINE AND LEASE 86/17: IMPACT/MITIGATION DIAGRAM



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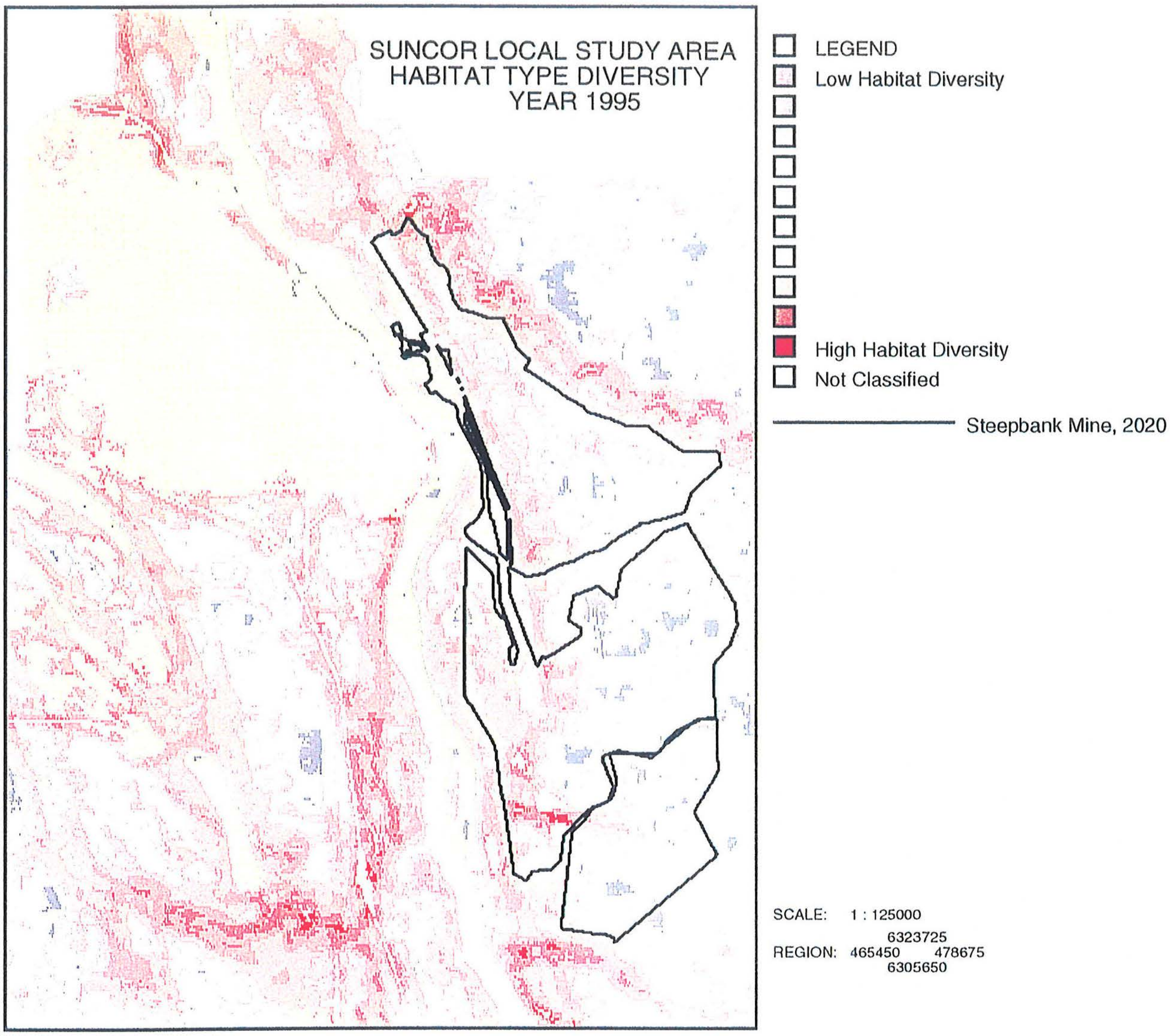
23 APR 96



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

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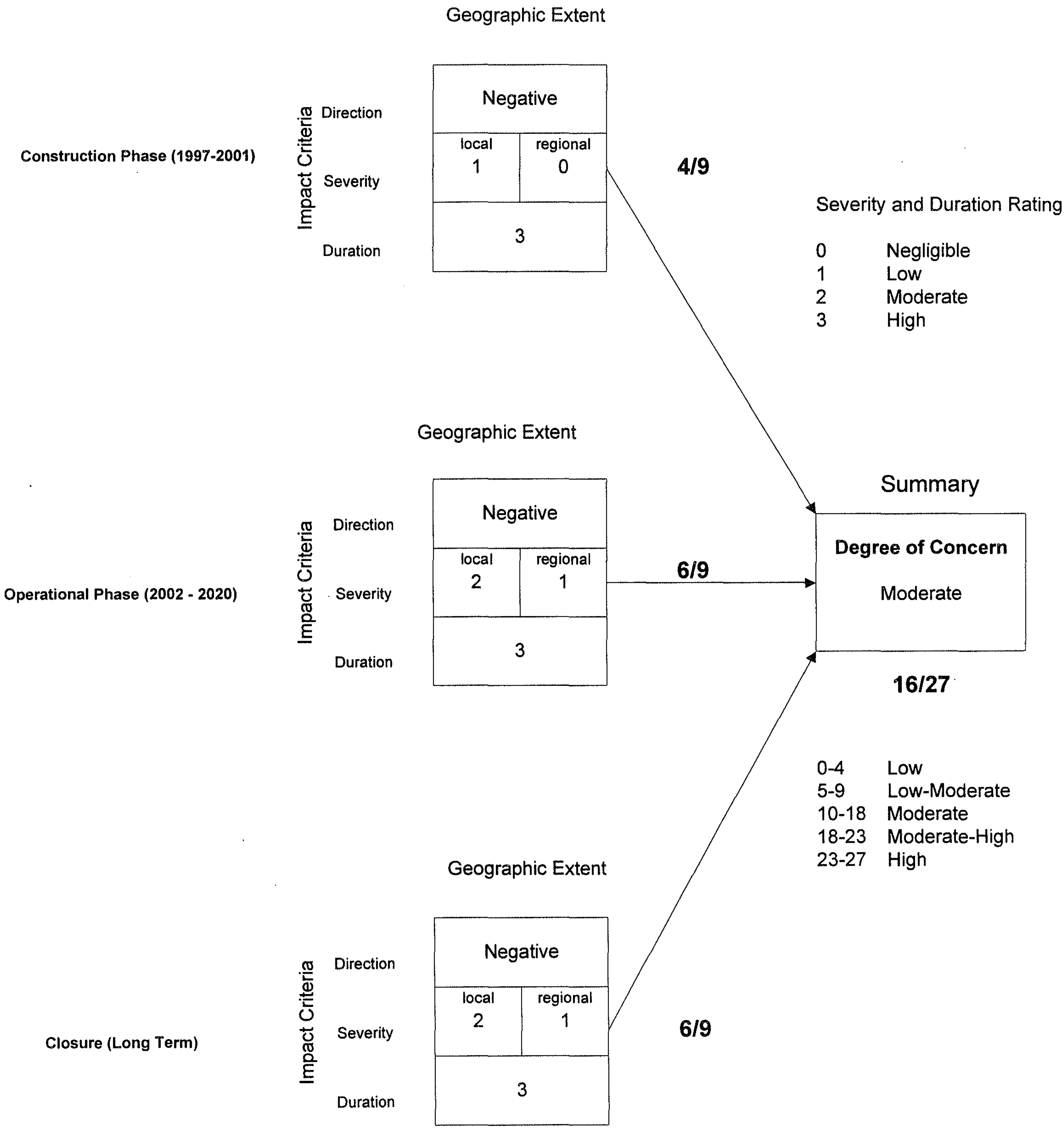
AREAS OF HIGH TO LOW HABITAT INTERSPERSION WITHIN THE SUNCOR REGIONAL STUDY AREA

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 23 APR 96		REVISION No.: 1
DRAWN BY: KS/RK		FIGURE No.: D5.0-3

952-2307.5695\KSTBLK.dwg

Figure D5.0-4 Hypothesis 15A: Impact Hypothesis Classification for Biodiversity at the Landscape Level

Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.



r:\1995\2307\bio\wordperf.rpt\figures\D5.0-4.vsd

Figure D5.0-5 Hypothesis 15B: Impact Hypothesis Classification at the Community Level

Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

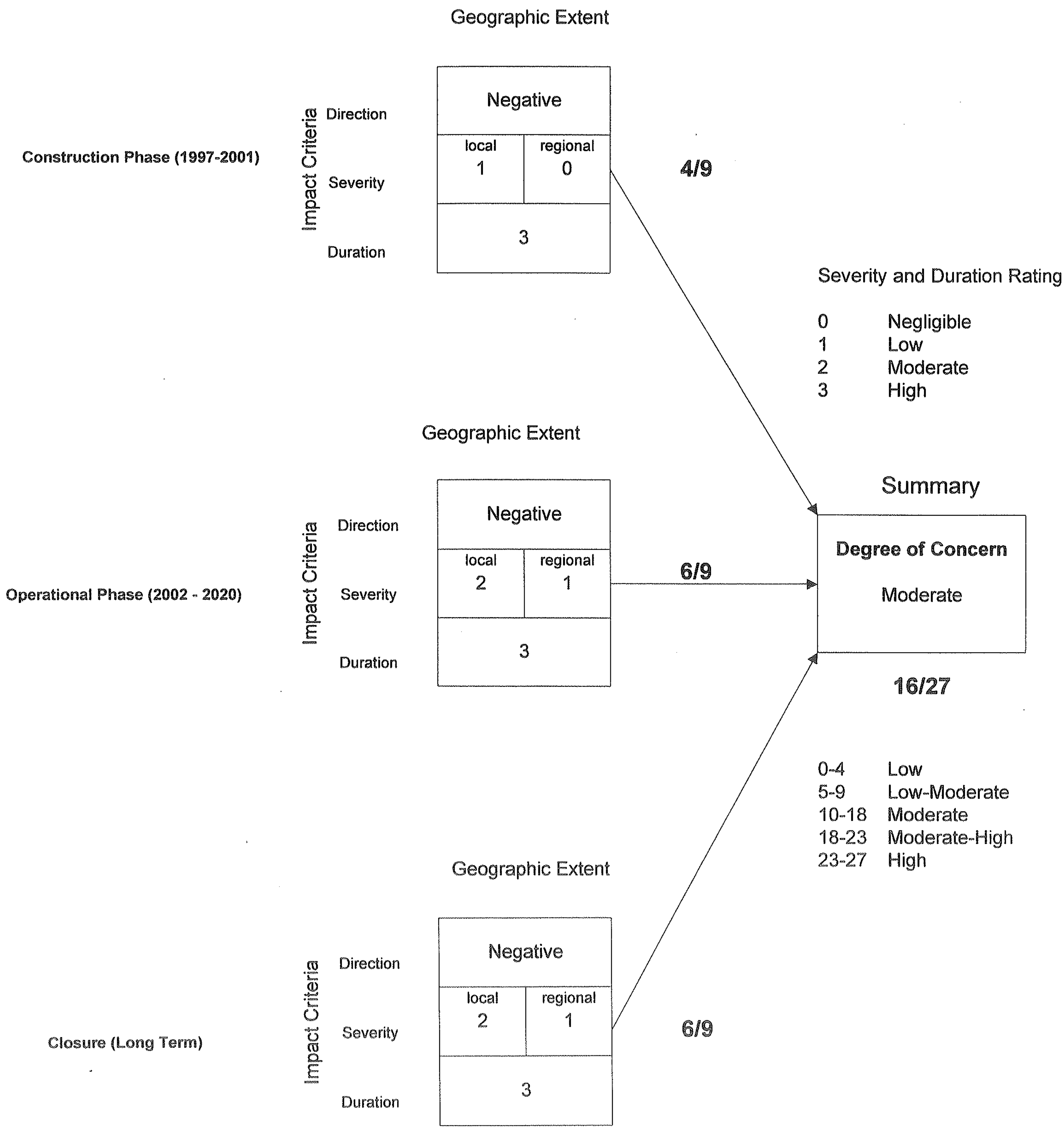


Figure D5.0-6 Hypothesis 15C: Impact Hypothesis Classification at the Species Level

Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

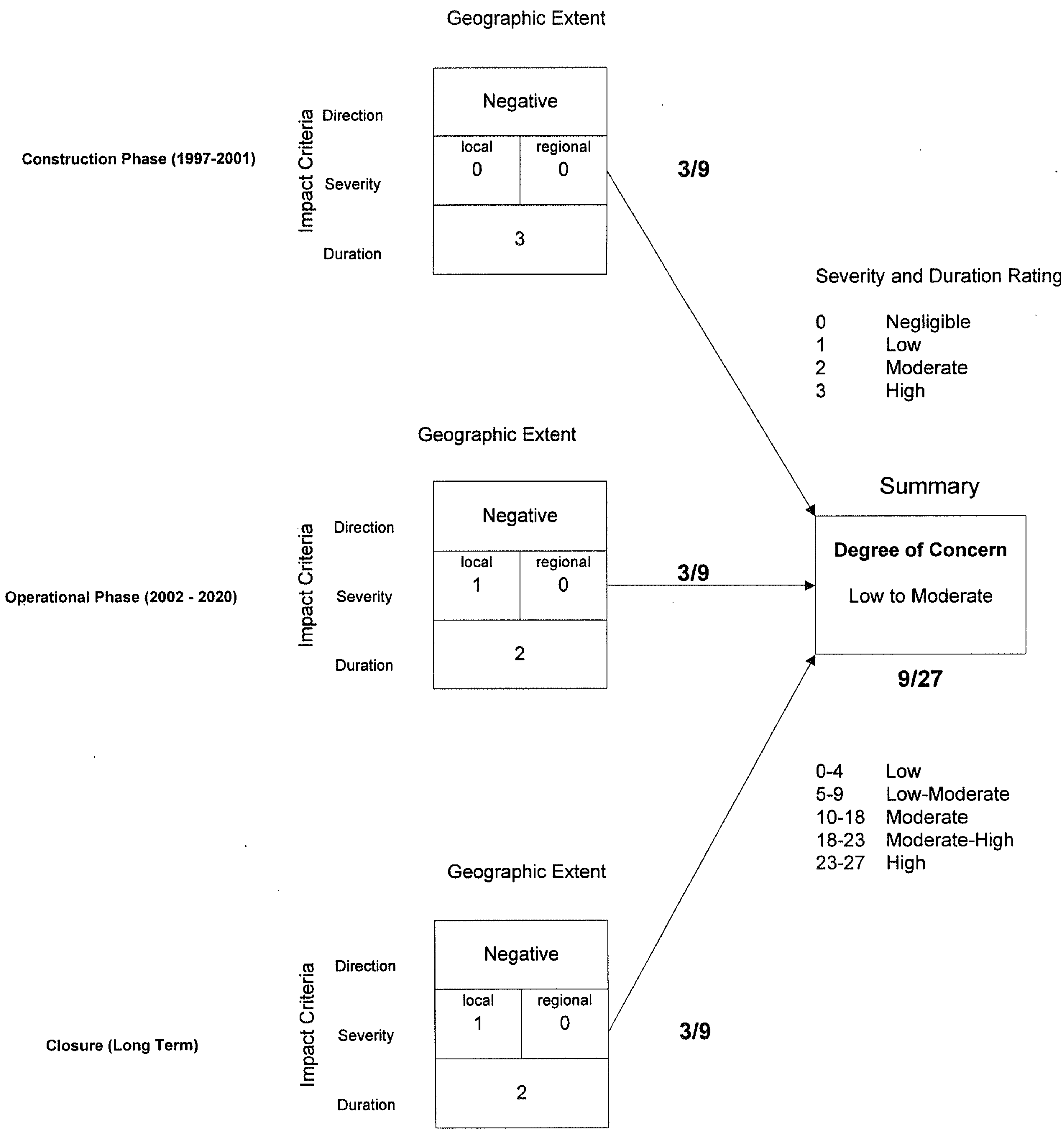
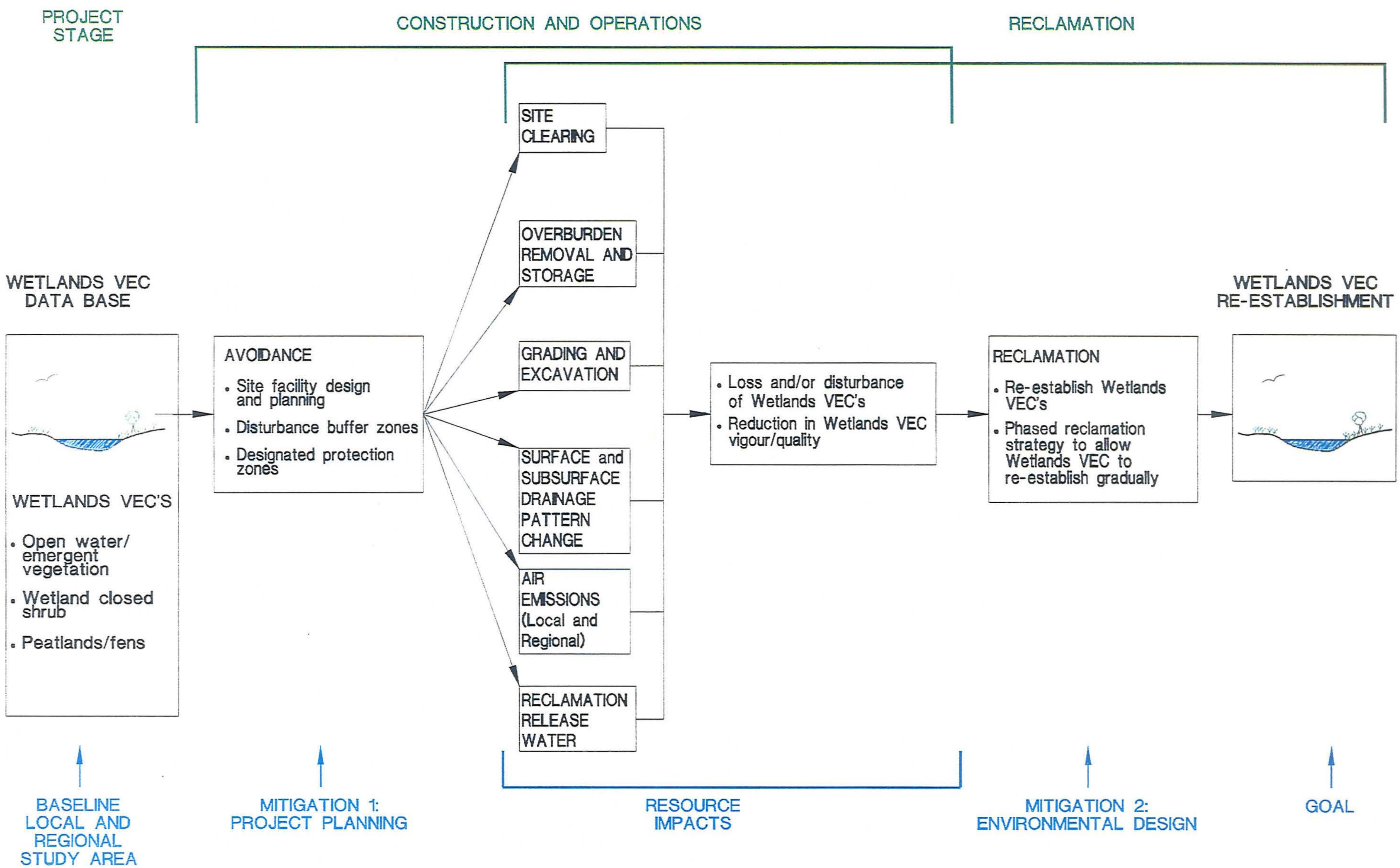


Figure D6.0-1
HYPOTHESIS 16: WETLANDS COULD BE AFFECTED BY LEASE 86/17 AND STEEPBANK MINE DEVELOPMENT AND OPERATION, INCLUDING MINE DEWATERING, CHANGES TO SUBSURFACE DRAINAGE AND RECLAMATION RELEASE WATER



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23 APR 96

Figure D6.0-2 Hypothesis 16A: Impact Hypothesis Classification for Wetlands (Bogs and Fens)

Wetlands (bogs and fens) could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage, and reclamation release water

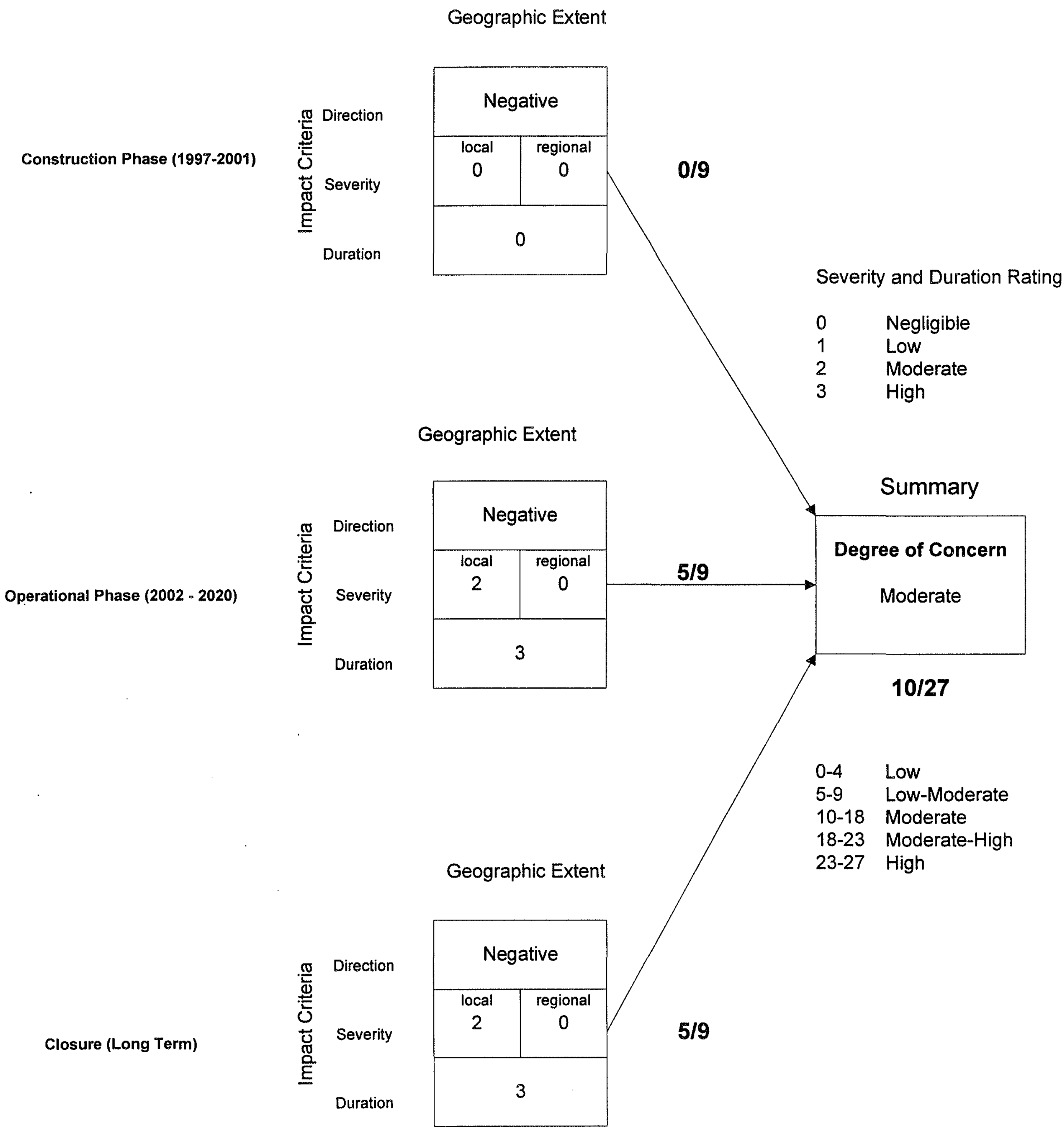

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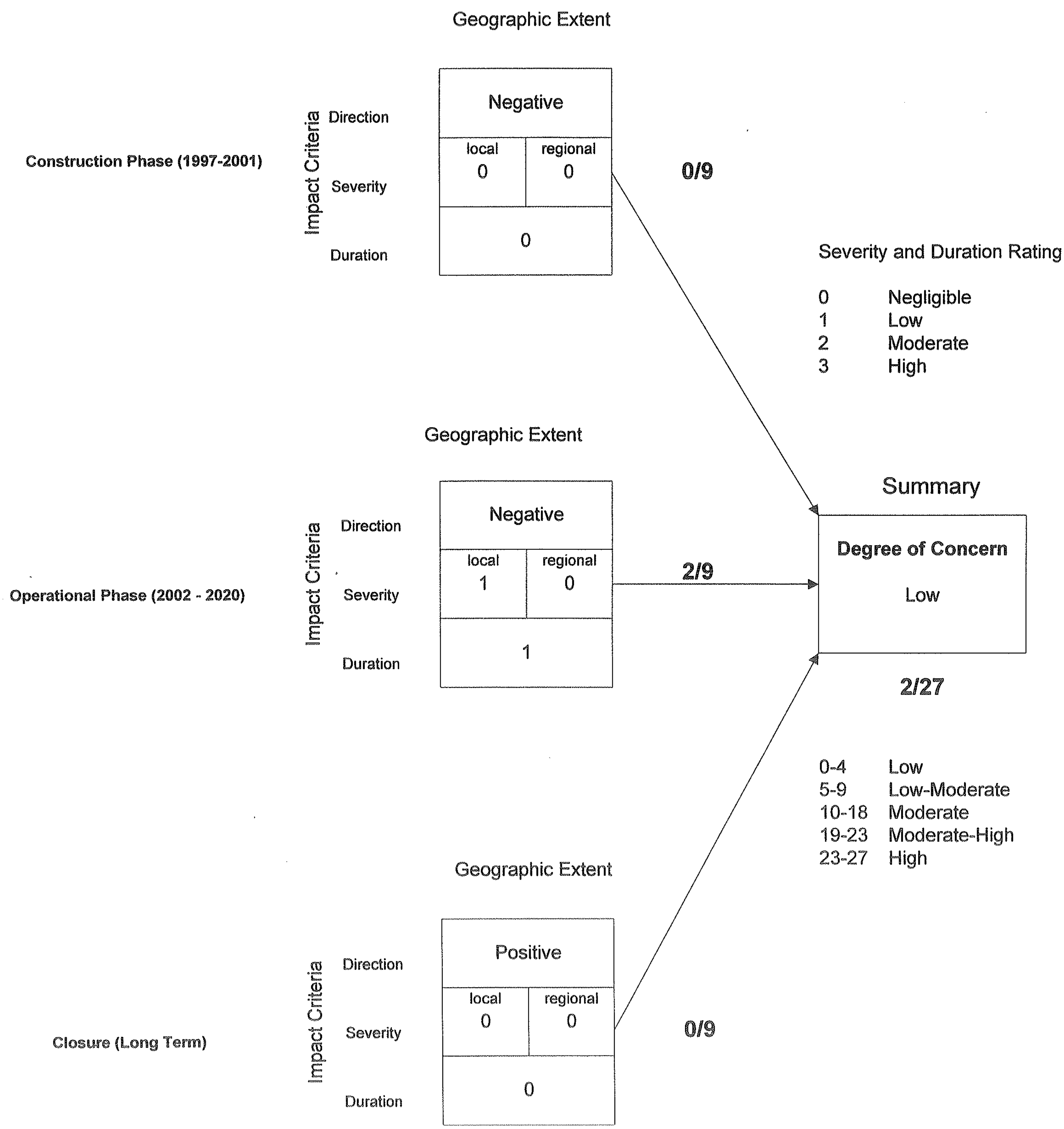
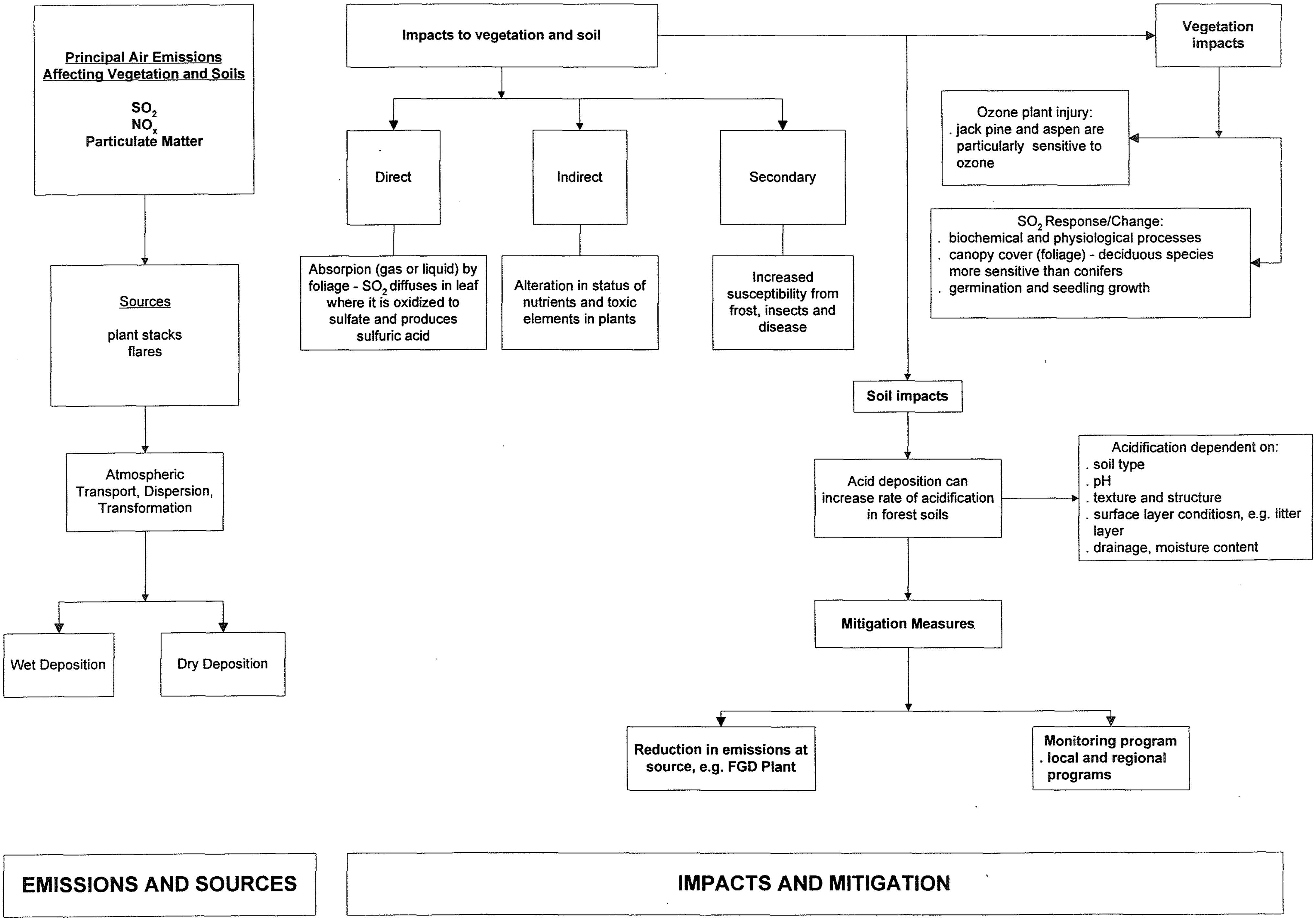
Figure D6.0-3 Hypothesis 16B: Impact Hypothesis for Wetlands (Open Water/Emergent and Closed Shrub)

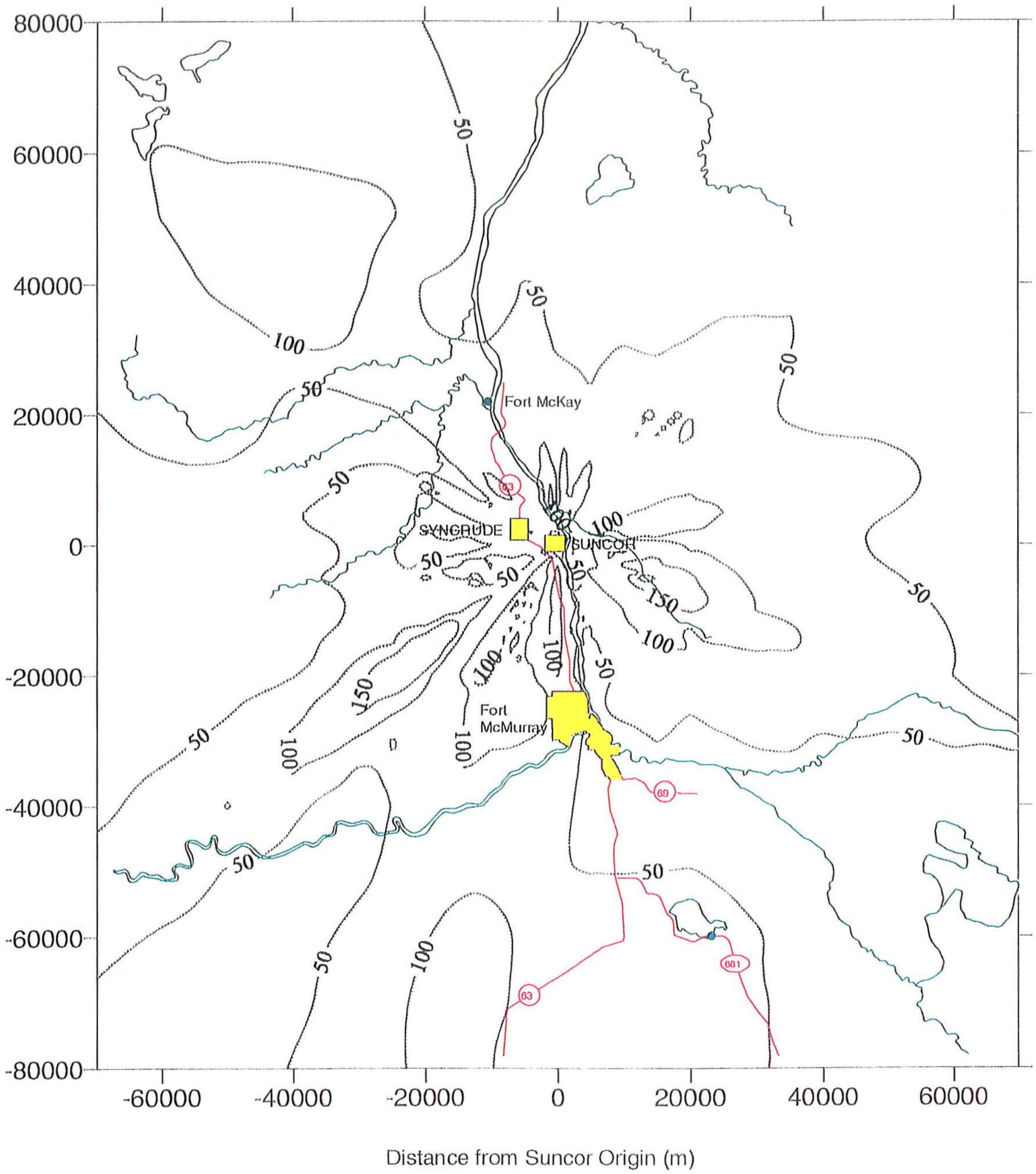
Wetlands could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.



r:\1995\2307\bio\wordperf.rpt\figures\D6.0-3.vsd

FIGURE D7.0-1A
AIR EMISSIONS FROM OPERATION OF THE STEEPBANK MINE WILL HAVE AN IMPACT ON VEGETATION, SOILS AND AQUATIC ENVIRONMENTS





Source: Bovar Environmental (1996)

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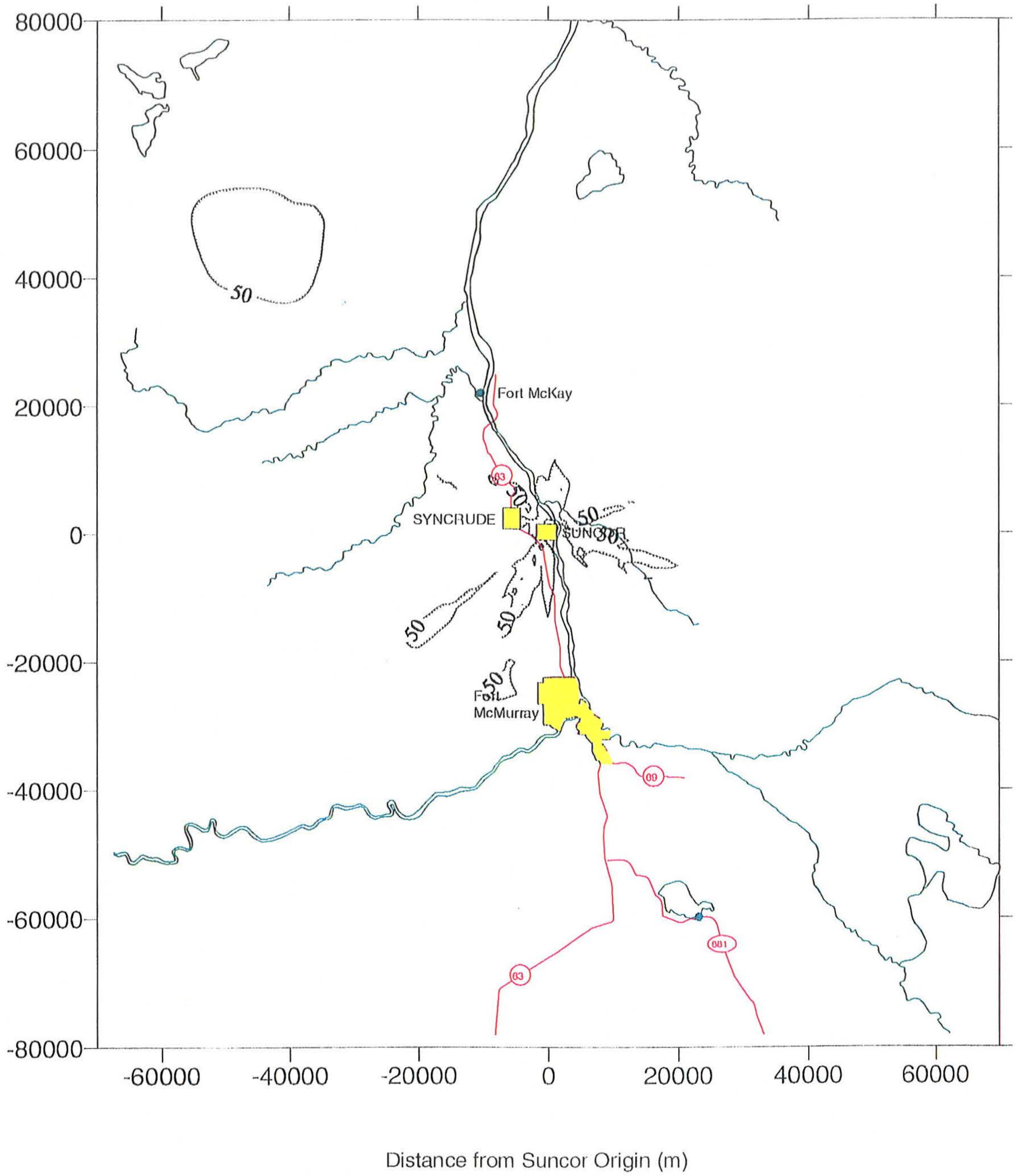
MAXIMUM PREDICTED DAILY AVERAGE S02 CONCENTRATIONS (ug/m^3) RESULTING FROM THE COMBINED OPERATION OF THE SUNCOR AND SYNCRUDE FACILITES (1995 AVERAGE S02 EMISSIONS)

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 24 APR 96		REVISION No.: 1
DRAWN BY: KS/CG		FIGURE No.: D7.0-1



Source: Bovar Environmental (1996)

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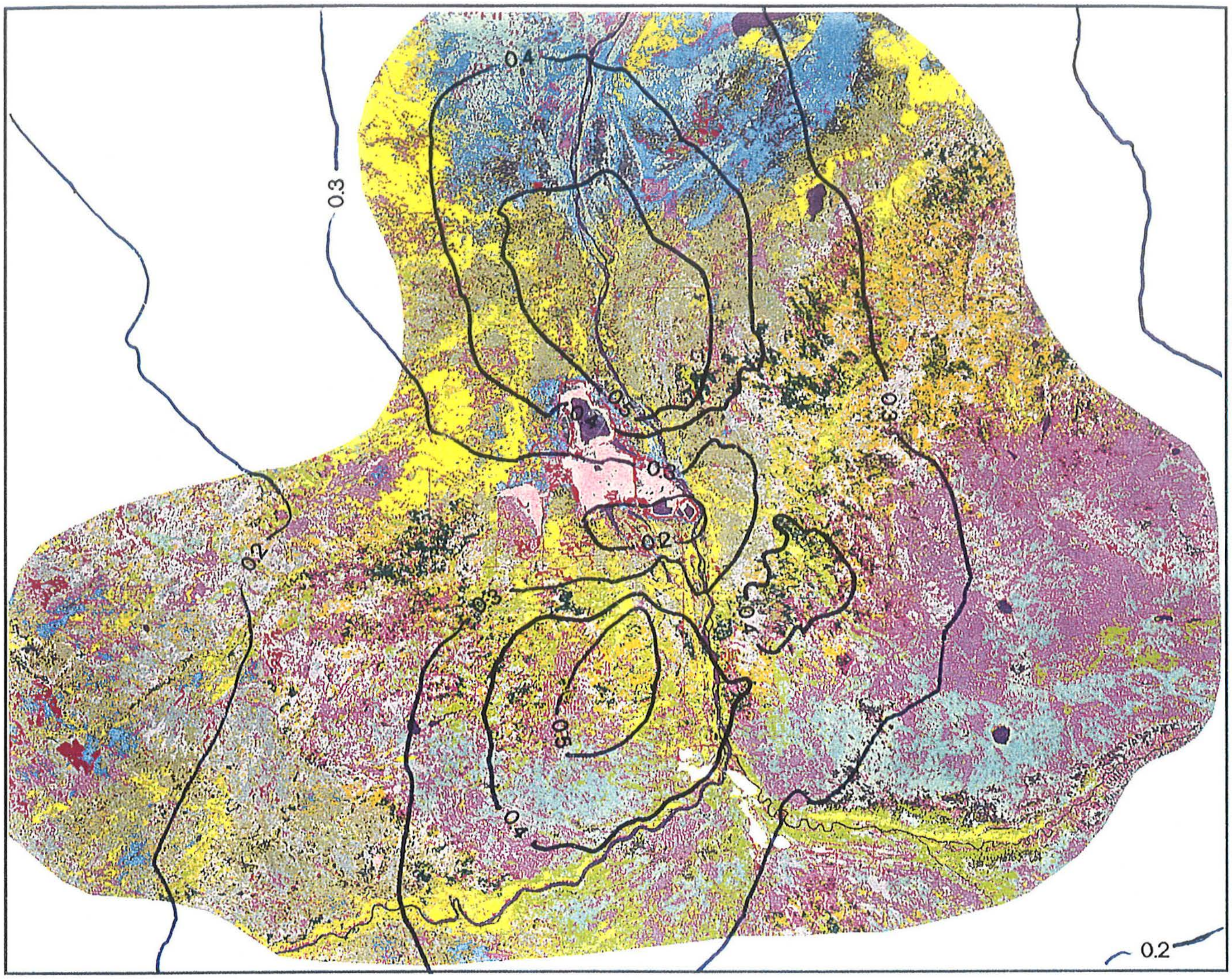
Oil Sands Group

MAXIMUM PREDICTED DAILY AVERAGE SO2 CONCENTRATIONS (ug/m^3) RESULTING FROM THE COMBINED OPERATION OF THE SUNCOR AND SYNCRUDE FACILITES (2001 AVERAGE SO2 EMISSIONS)

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 24 APR 96		REVISION No.: 1
DRAWN BY: KS/CG		FIGURE No.: D7.0-2



- Closed Jack Pine
- Closed White Spruce
- Closed Deciduous Forest
- Closed Mixedwood
- Closed Mixed Conif. Black Sp. Dom.
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Larch Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Larch Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Wetland Open Water-Emergent Vegetation
- Peatland: Shrub Dom. Fen/Pat. Fen
- Urban Areas

NOTES

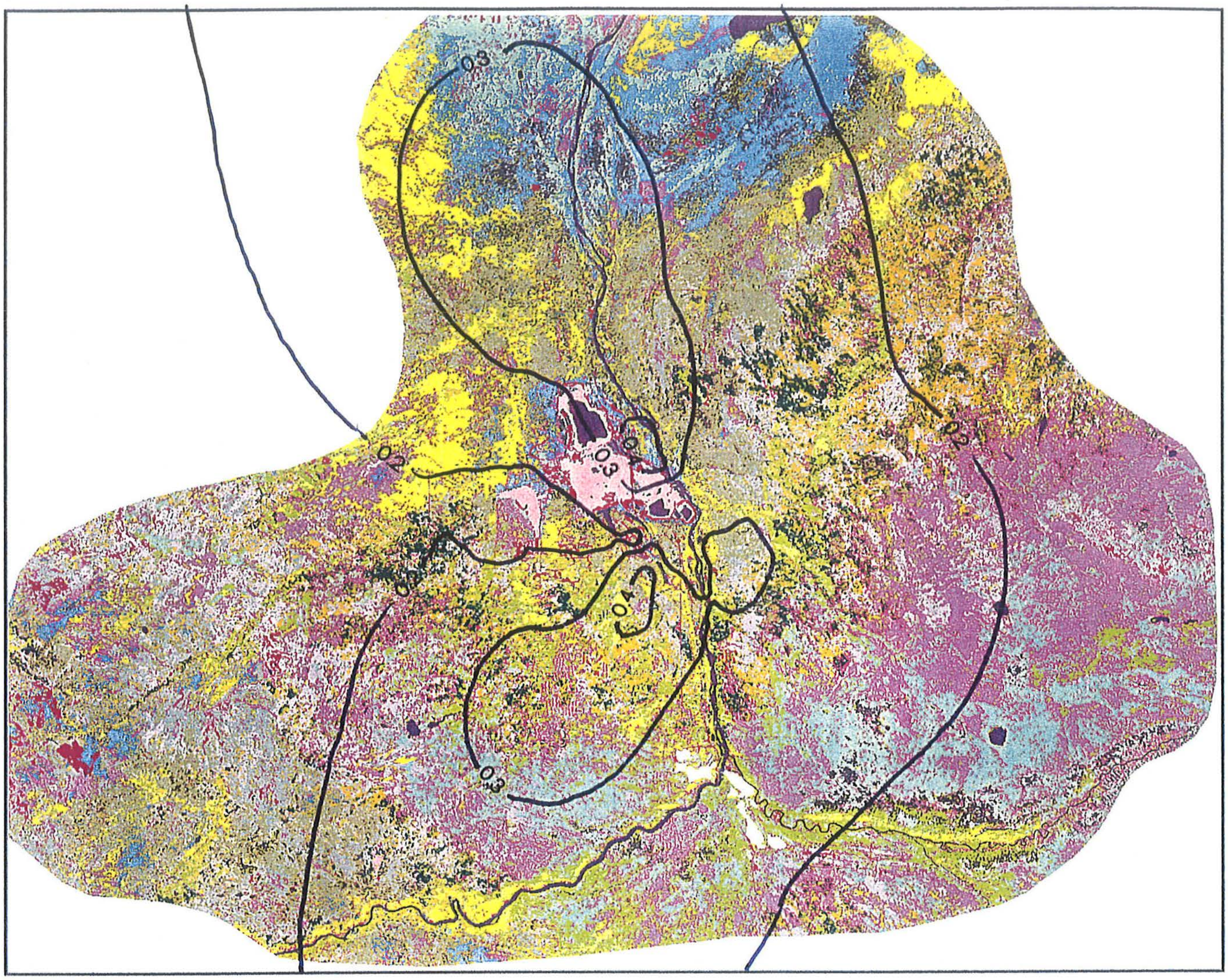
1) CONTOURS ARE IN kmol H^+/ha/a

Source: Bovar Environmental (1996)

Suncor Inc. Oil Sands Group

ESTIMATED EFFECTIVE ACIDITY (EA) WITHIN REGIONAL STUDY AREA FROM THE COMBINED OPERATIONS OF THE MAIN STACKS IN THE REGION (1995 SCENARIO)

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 24 APR 96		REVISION No.: 1
DRAWN BY: KS/CG		FIGURE No.: D7.0-3



- no data
- Closed Jack Pine
- Closed White Spruce
- Closed Deciduous Forest
- Closed Mixedwood
- Closed Mixed Conif. Black Sp. Dom.
- Peatland: Closed Black Spruce Bog
- Peatland: Black Spruce-Larch Fen
- Closed Mixedwood, White Spruce Dominant
- Peatland: Open Black Spruce Bog
- Peatland: Open Larch Fen
- Wetland Closed Shrub Complex
- Disturbed/Herb, Grasses
- Industrial/Sparsely Vegetated
- Wetland Open Water-Emergent Vegetation
- Peatland: Shrub Dom. Fen/Pat. Fen
- Urban Areas

NOTES

1) CONTOURS ARE IN kmol H^{+}/ha/a

Source: Bovar Environmental (1996)

Suncor Inc. Oil Sands Group

ESTIMATED EFFECTIVE ACIDITY (EA) WITHIN THE REGIONAL STUDY AREA FROM THE COMBINED OPERATIONS OF REGIONAL SOURCES (2001 SCENARIO)

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 24 APR 96		REVISION No.: 1
DRAWN BY: KS/CG		FIGURE No.: D7.0-4

APPENDIX I
SELECTION OF THE REGIONAL STUDY AREA

1.0 Introduction

A joint regional study area for Suncor and Syncrude's 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 (RSA) was intended to provide a common basis for both companies to conduct cumulative effects assessment with respect to their proposed mine expansions. Suncor's proposed Steepbank Mine and Syncrude's proposed Aurora Mine were specifically identified as part of the cumulative effects assessment.

Satellite imagery, combined with aerial reconnaissance and field sampling, allowed vegetation resources, waterbodies and land use types to be mapped for the entire regional study area (979,407ha). Impacts to each land cover type were then assessed according to the major types of development or resource use occurring within the region. A comparison of the relative disturbance of land cover types as a proportion of the total cover type within the region provided a basis for assessing the cumulative effects of the existing and proposed development in the area. Comparisons were done for a series of time periods: 1995, 2020 and a long-term scenario. This allowed quantitative analysis to be used in identifying existing and possible future impacts on the land, air and water resource base within the region.

The following text and figures summarizes the rationale and criteria used to establish the joint regional study area boundary.

2.0 Regional Study Area Criteria

The criteria used to establish the regional study area boundary included airsheds, watersheds and landscapes (ecological land classification boundaries). The criteria boundaries are shown on Figures 1 to 3 and are briefly summarized as follows:

1. **Airshed**

A 60 km radius centred 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 an isopleth for effective acidity.

2. **Watersheds**

The entire drainage basins of the Steepbank and Muskeg Rivers;
The majority of the MacKay River basin; and
Portions of the Athabasca and Clearwater Rivers.

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.

3.0 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:

1. **Airshed**

- Criteria review: Based on air quality modelling for 1994 average emissions from the Syncrude and Suncor facilities, two air quality contours 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 concentrations (Figure 1) and Effective Acidity depositions (Figure 2) are attached.

a) **Predicted SO_2 Concentrations**

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

- With background concentrations (assumed to be 8 μg/m3) and predicted concentrations from emissions (13 $\mu g/m^3$), the total SO_2 concentrations will be 21 $\mu g/m^3$.

  Background Concentration + Predicted Concentrations = Total Concentration from emissions 8 $\mu g/m^3$ + 13 $\mu g/m^3$ = 21 $\mu g/m^3$

- Current guidelines and research indicates that vegetation injury does not occur even at 30 $\mu g/m^3$ (e.g., Visible injury does not occur until exposures as high as ~ 200 $\mu g/m^3$; dysfunction of cellular activity, as measured by photosynthetic activity is documented in Alberta to be unaffected at concentrations of 30 $\mu g/m^3$.

  Annual concentrations for SO_2 emissions by IUFRO standards, for good growing conditions, are 29 $\mu g/m^3$. Therefore, two-thirds of 30 $\mu g/m^3$, (i.e., 20 $\mu g/m^3$) 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.

- Geographic area: The boundaries of the $\mu g/m^3$ will extend approximately 45 km north, 42 km south, 12 km east and 15 km west (see Figure 1).

b) Predicted Effective Acidity (EA)

The 0.2 kmol H^+/ha/a (Figure 2) was used to set the RSA boundary.

- Alberta Environment (1990) has set interim critical acid deposition loading for sensitive soils. The Effective Acidity (EA) deposition limits are based on a 10% reduction in base saturation over a 100 year loading period. Based on these 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 are at risk of acidification. Additionally, moderately sensitive soils receiving 0.3 to 0.4 kmol H^+/ha/a are potentially at risk of acidification.

- We have assumed soils lying outside the 0.3 kmol H^+/ha/a contour (background and predicted EA from emissions), will not be at risk of acidification. Assuming a background EA of 0.07 kmol H^+/ha/a, the predicted EA from emissions we should use for the RSA is 0.23 kmol H^+/ha/a.

  Background EA + Predicted EA from Emissions = Total EA
  0.07 kmol H^+/ha/a + 0.23 kmol H^+/ha/a = 0.3 kmol H^+/ha/a

- Geographic area: 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 2).

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.

Advantages:

- 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 models using 2994 average air emissions data from Suncor and Syncrude.

Disadvantages:

- Ignores ecological boundaries such as landform or drainage patterns and therefore does not consider the interactions of air/land/water as a functioning ecosystem.

- Recommendations: Use 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.

2. **Watershedsuse**

- Criteria Review: This criteria includes those tributary watersheds to the mainstem Athabasca River which currently occur thing the existing mining operations of Suncor and Syncrude, as well as those which may be affected by future development activities of the two oilsand 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.

- Geographic Area: The area encompassed using this criteria is shown in Figure 3. 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 portions of the Athabasca River and of the Clearwater River.

Advantages:

- Accounts for the main drainages which could be affected by the existing and the proposed oilsand mine expansions.
- Watersheds can be delineated relatively easily using topographic contours and vegetation conditions.
- Watersheds provide an ecological basis for boundary delineation, which includes vegetation, soil and wildlife habitat utilization.

Disadvantages:

- Large rivers and tributaries encompass extensive watersheds which cannot be included in their entirety. Arbitrary boundaries have been selected.

- Recommendations: Include those watersheds which are directly affected by the existing and proposed oil sand operations for Suncor and Syncrude: the Steepbank

River, the Muskeg River and portions of the MacKay, Athabasca and Clearwater Rivers.

3. **Landscapes (Ecological Land Classification Criteria)**

- Criteria Review: Ecological boundaries can be used as the basis for the delineation of the regional study area, utilizing those already described for this part of the province by Strong (1992, Figure 3) (REF?). 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 ecoregion, represent broadly homogenous areas of the landscape within which their 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 areas. This fits well with a hierarchical approach to landscape inventory, classification and evaluation.

- Geographic Area: 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).

Advantages:

- 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 ELC framework.
- Uses existing (provincial) Ecodistrict boundaries.

Disadvantages:

- Boundaries are not discrete, but rather reflect a 'transition' from one Ecodistrict to the next.

- Recommendations: Use existing landscape, or ecodistrict boundaries, as the basis for cumulative impact assessment within the regional study area. Modify the ELC boundaries to include watershed and airshed boundaries as described previously. Review landscape boundaries in relation to 'traditional use area'.

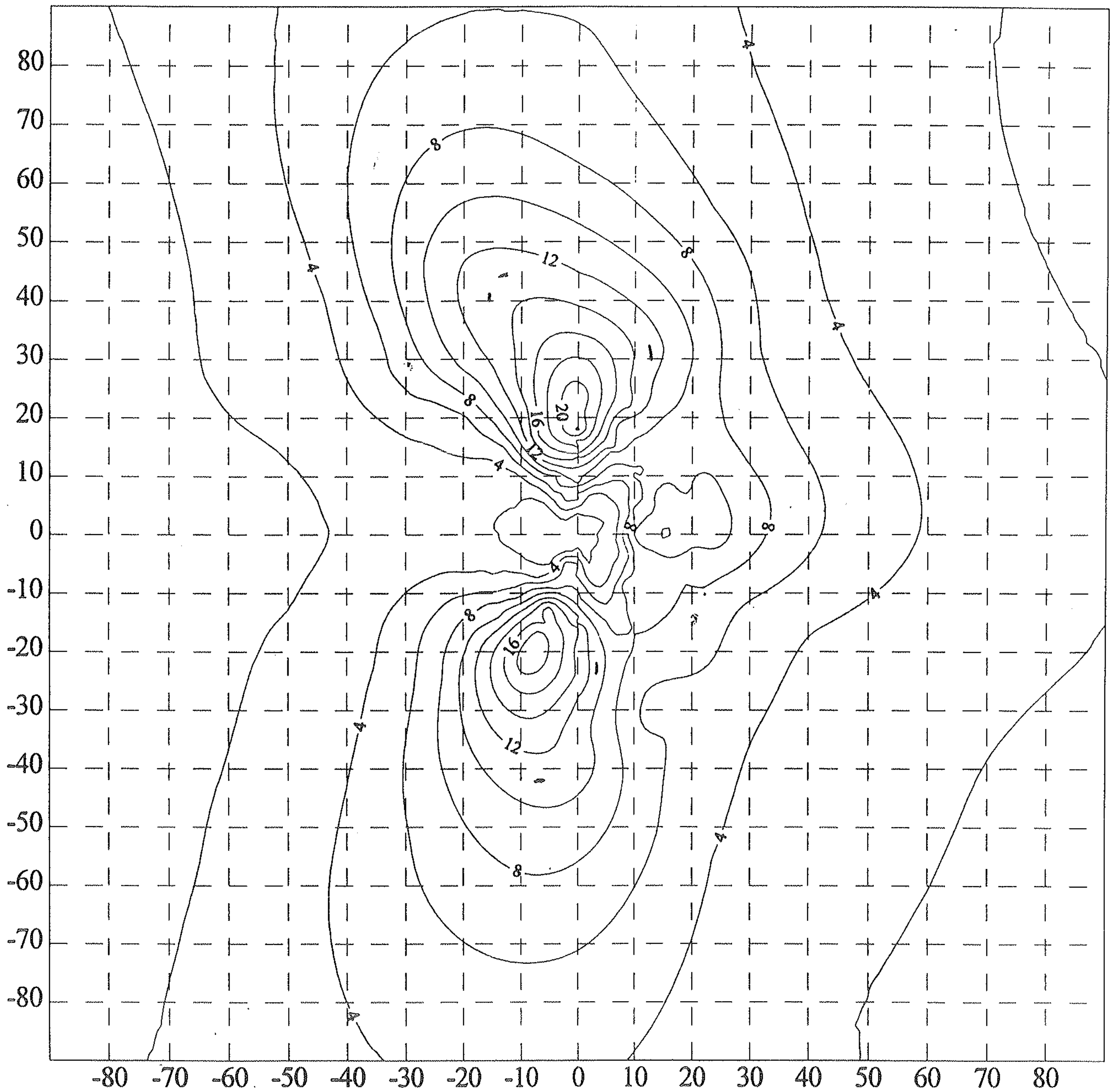
4.0 Regional Study Area Selection

Based on a review of existing information and the requirements to conduct a cumulative impact assessment of oil sand projects in a regional context, the proposed boundary is based primarily on ecological criteria (landscape boundaries), modified to include those watershed which would likely be directly affected by the proposed oil sands projects (Figures 5 and 6).

The boundary for the Regional study Area was delineated by first overlaying the boundaries of the maps outlined for the airshed criteria (0.2 kmol H^+/ha/a), for the watersheds and for the ecodistricts and secondly, connecting the outermost of the three overlaid boundaries.

The boundary to the west encompasses the MacKay River drainage system within the limit of the satellite image, while the boundary to the south follows the Athabasca and Clearwater River valleys, but extends south to include the maximum airshed boundary based on a 60 km radius from the plant. The eastern boundary includes the Steepbank and the Muskeg River drainages within the upland plain landscape type. The northern boundary extends to include McLelland Lake to the northern ranges of the existing satellite coverage.

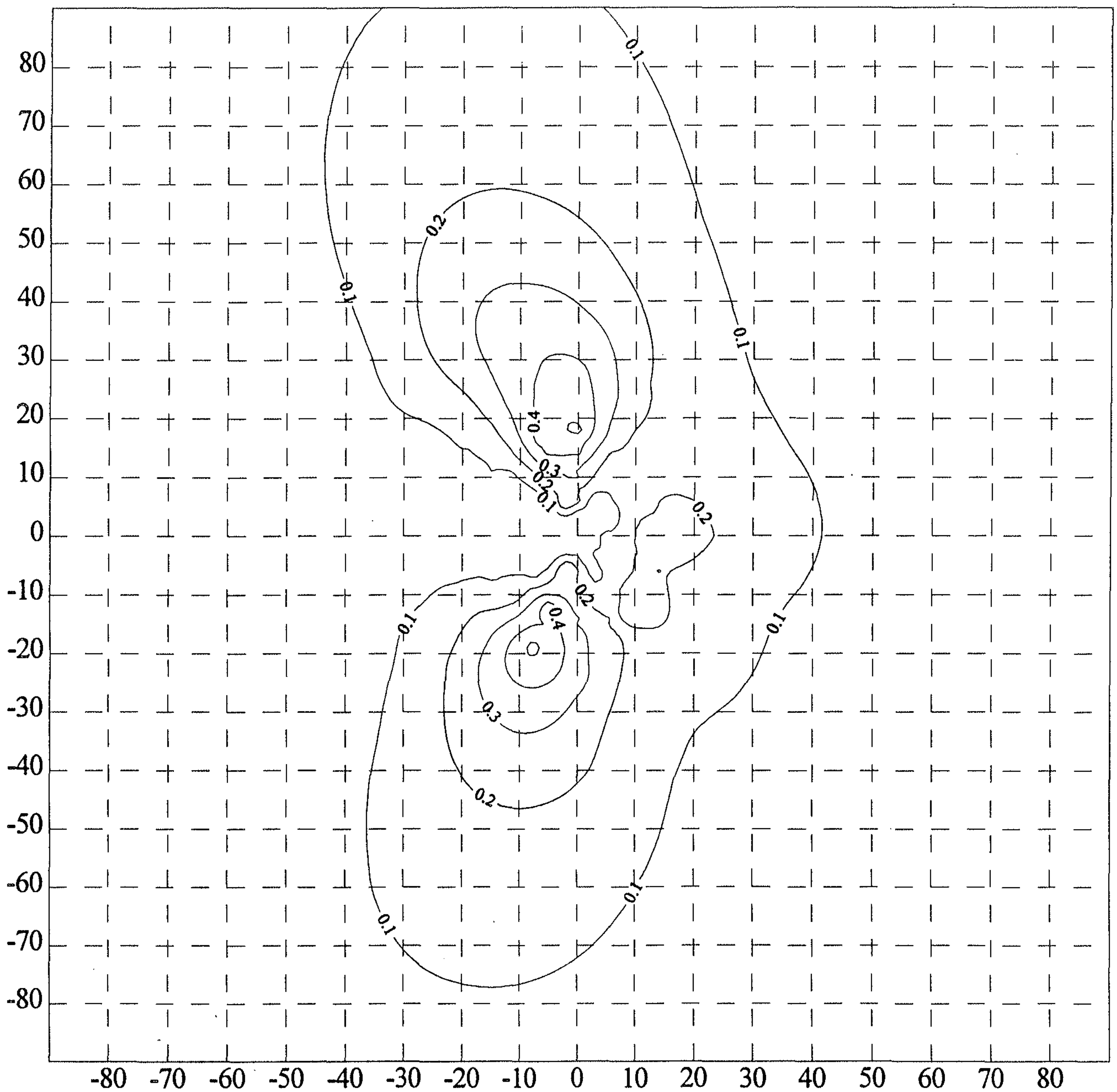
Figure 1
REGIONAL STUDY AREA, CRITERIA 1
AIR QUALITY, PREDICTED SO_2 CONCENTRATIONS



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 2
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 3
REGIONAL STUDY AREA
CRITERIA 2 - WATERSHEDS

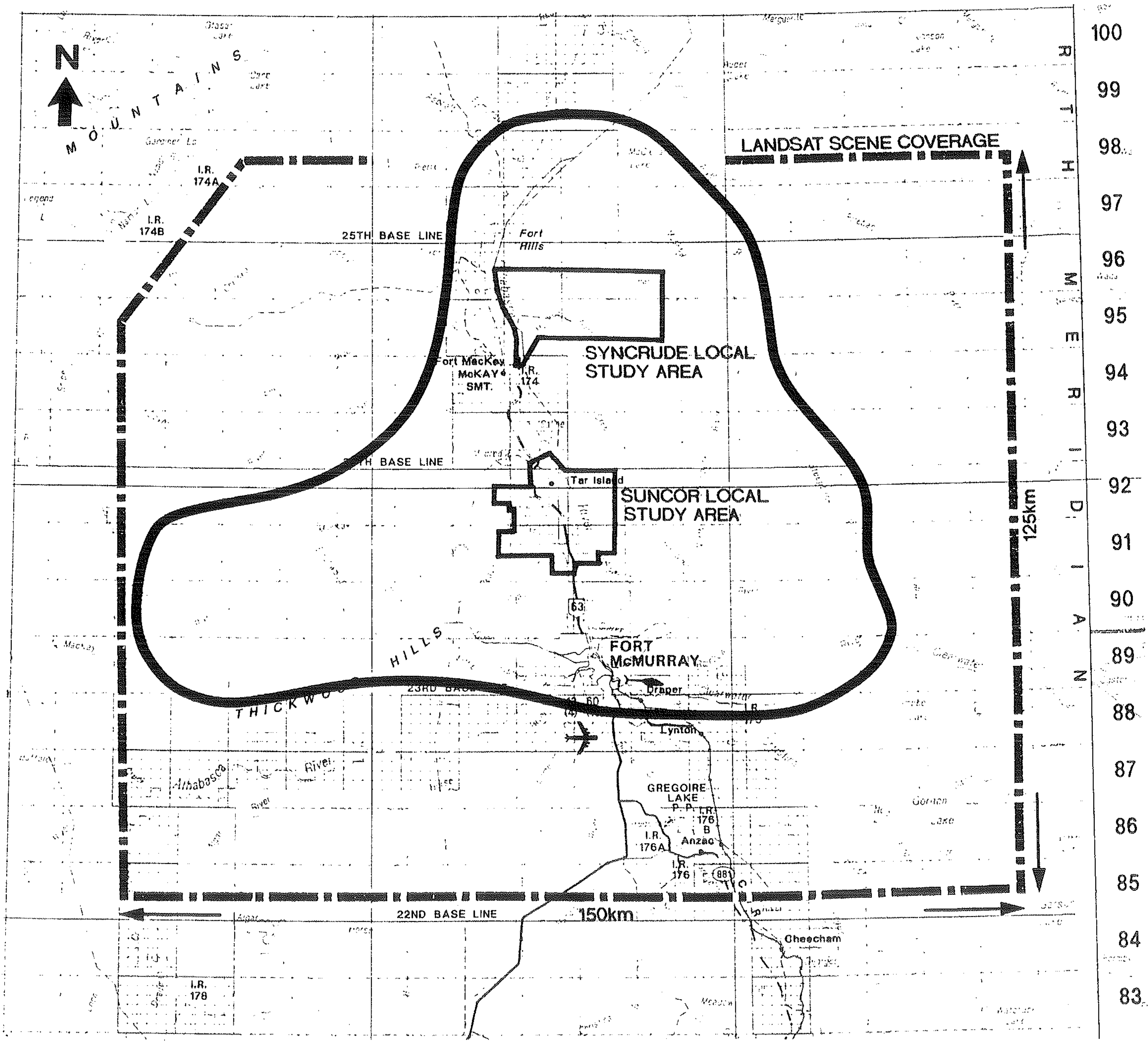
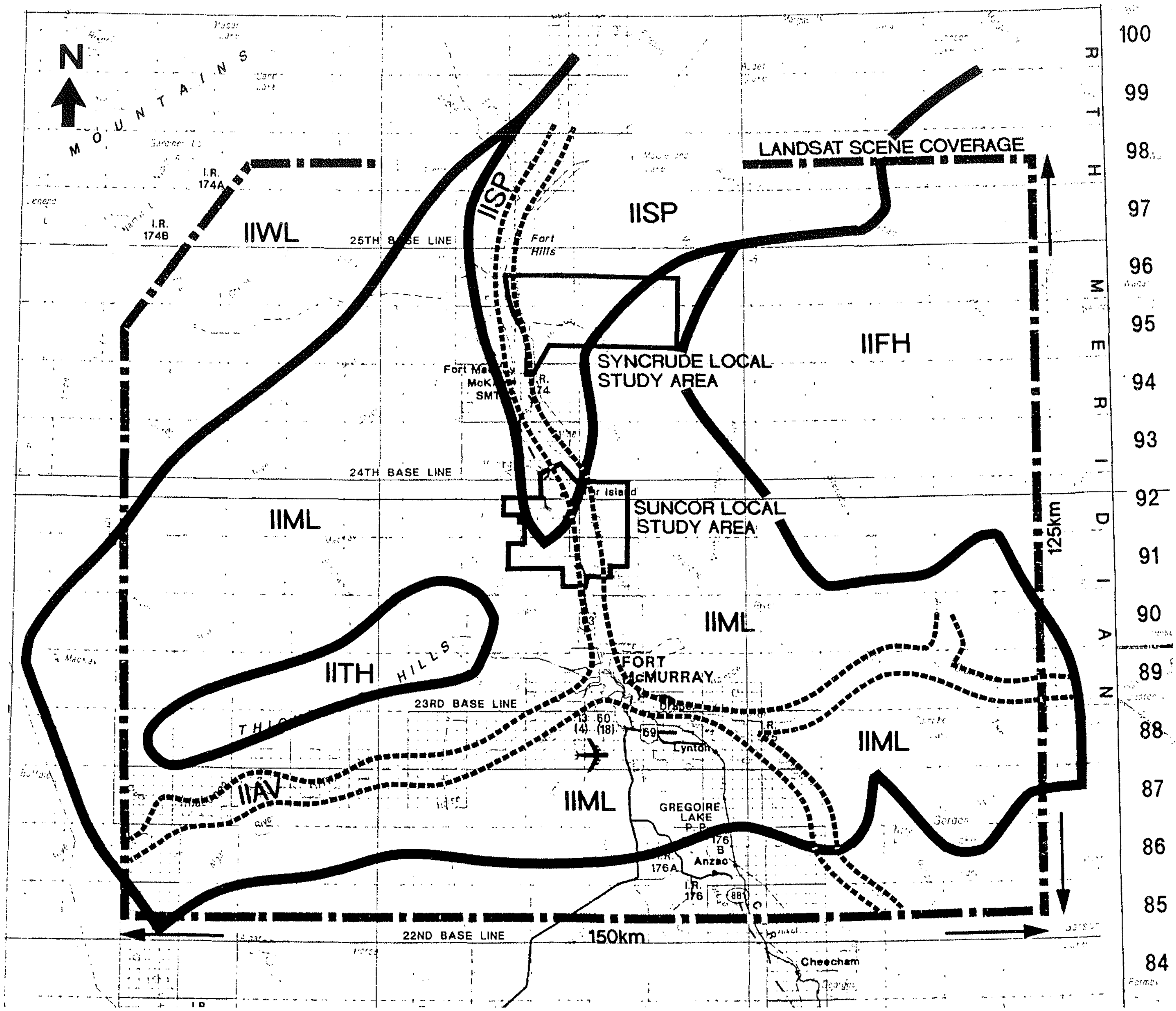


Figure 4
REGIONAL STUDY AREA CRITERIA 3
ECOLOGICAL LAND CLASSIFICATION CRITERIA



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**

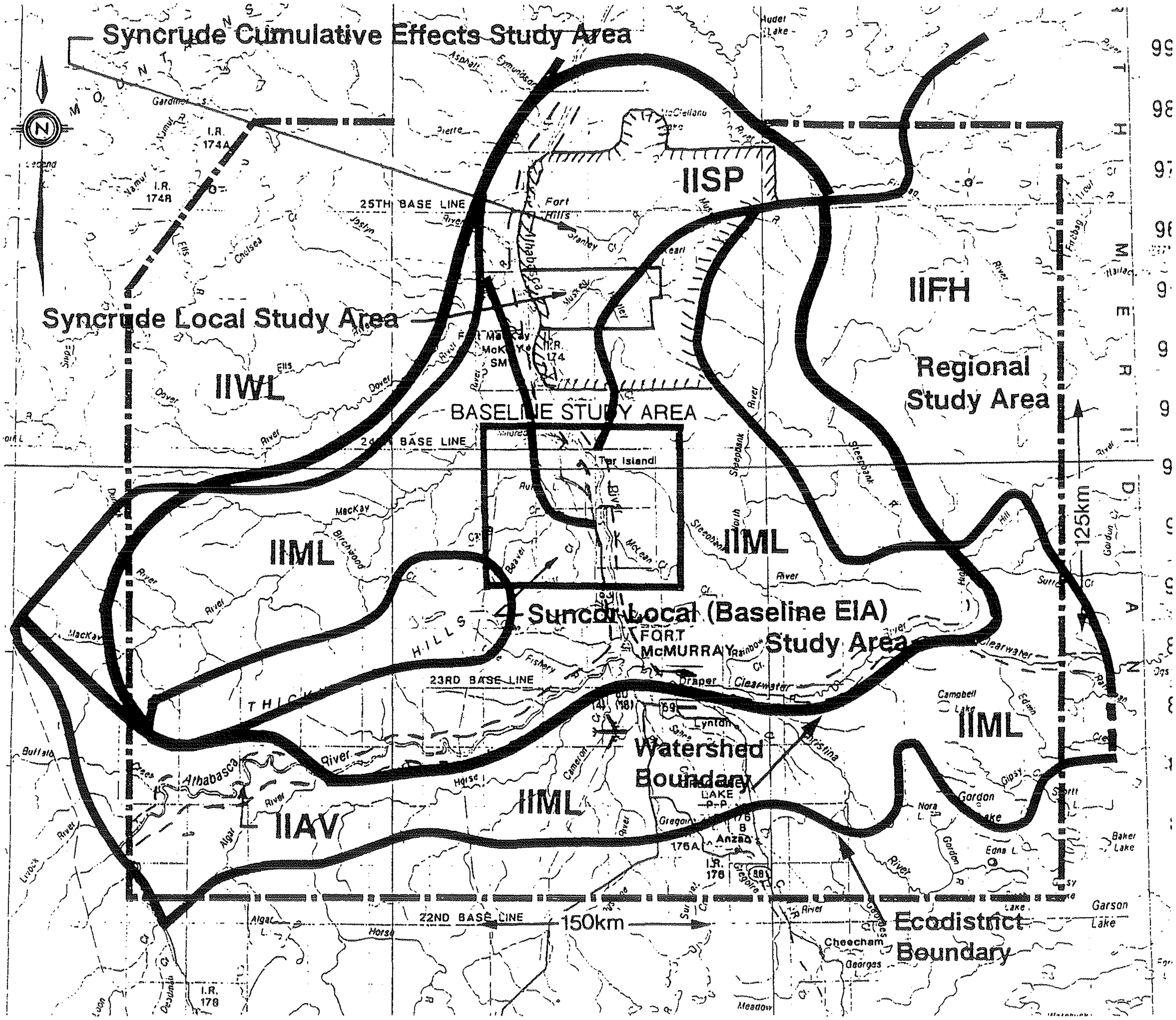
IIFH - **Undulating morainal plain: Mixedwood forests**

IIAV - **River terraces and slopes**

ECODISTRICTS

952-2307.5660

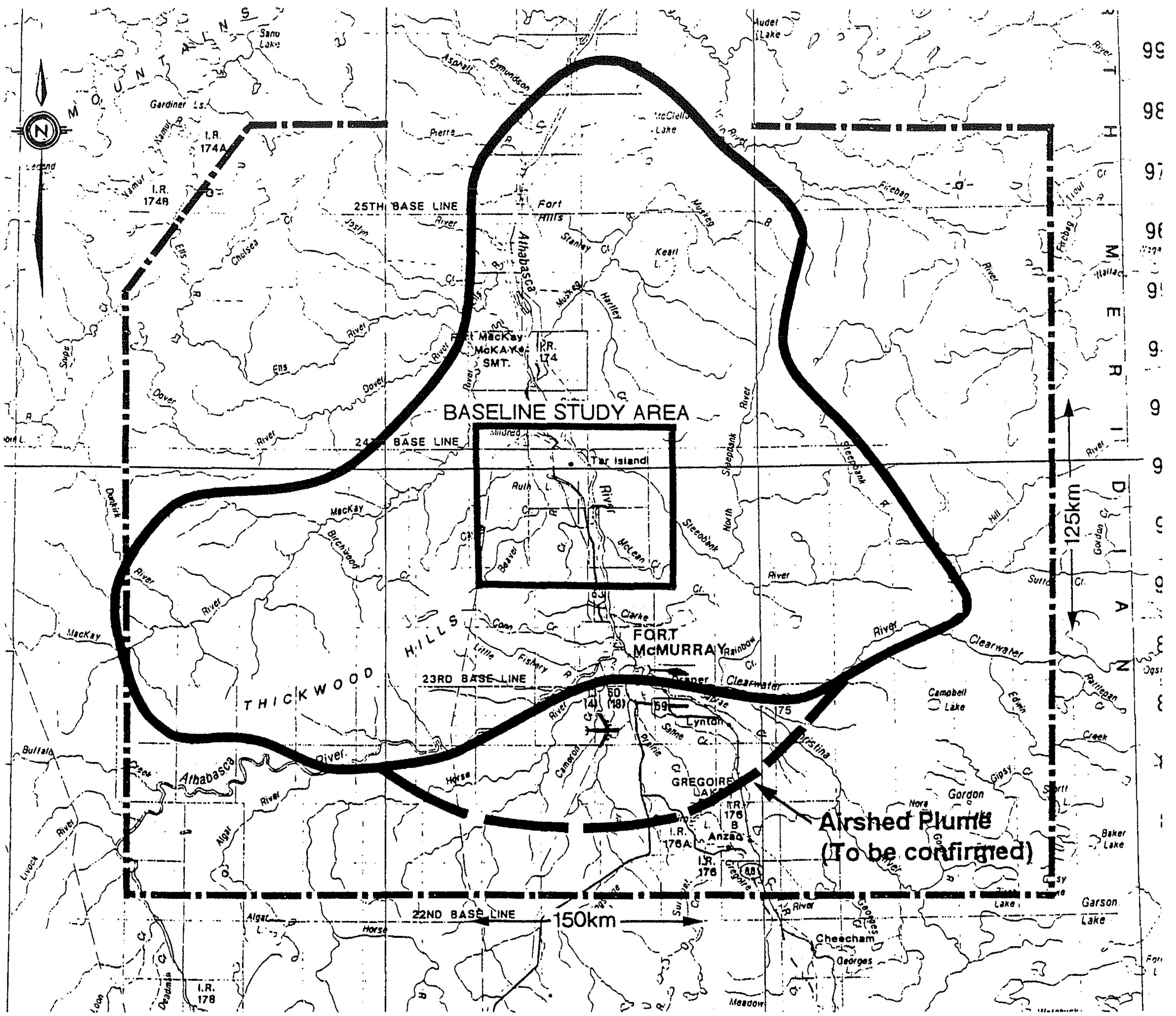
Figure 5
REGIONAL STUDY AREA
MODIFIED ECODISTRICTS/WATERSHEDS



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

952-2307.5660

Figure 6
PROPOSED REGIONAL STUDY AREA



952-2307.5660