# Impact Analysis Suncor Steepbank Mine Environmental Wildlife Component

**April , 1996**

Prepared for:

Suncor Inc.

Prepared by:

Golder Associates

Westworth, Brusnyk & Associates Ltd.

952-2307

## ACKNOWLEDGMENTS

This assessment report was prepared for Suncor Inc., Oil Sands Group (Suncor) by Westworth, Brusnyk & Associates Ltd. as part of the Suncor Steepbank Mine Environmental Impact Assessment (EIA). Mr. Don Klym was the Suncor project manager and Ms. Sue Lowell was the Suncor project coordinator. Mr. Steve Tuttle was Suncor's task leader for the wildlife resources component. Mr. Hal Hamilton of Golder was the EIA project manager.

The component leader for the wildlife resources impact assessment was Mr. Lawrence Brusnyk. Mr. David Westworth and Mr. Doug Skinner also served as principal authors of the report. The field work was led by Mr. Brusnyk and the crew included Mr. Skinner, Mr. Greg McCormick, Mr. Don Albright, Ms. Sharilyn Johnston, Mr. John Orr and Mr. C. Fisher. Mr. Dave Prescott and Mr. Ernie Ewaschuk were responsible for avifauna inventories. Mr. Julian Powder, Mr. Willie Boucher, Mr. Jules Flobert and Mr. Basil McDonald of Fort MacKay provided information on wildlife and trapping in the study area. Ms. Kari Donnelly and Ms. Carol Brittain were responsible for word processing and report formatting.

Ms. Sue Lowell (Suncor), Mr. John Gulley (Suncor), Ms. Bette Beswick (Golder) and Mr. Hal Hamilton reviewed various drafts of the report.

# TABLE OF CONTENTS

**SECTION** **PAGE**

## LIST OF TABLES



## LIST OF FIGURES

## LIST OF APPENDICES

# A INTRODUCTION

In 1992, the Suncor Inc. Oil Sands Group announced a number of initiatives designed to sustain oil sands operations into the future. These initiatives, which included increasing production and meeting corporate environmental commitments, resulted in a fundamental change in mining technology and operational improvements, various environmental improvements (particularly in relation to air quality), and the acquisition of new leases. It is expected that oil sands deposits within the current mining area (Leases 86/17) will be depleted by the year 2001. To continue production, a new mining area must be integrated into Suncor's operations by the year 2000.

Based on a preliminary study conducted in 1994, Lease 97 and Fee Lots 1 and 3 on the east side of the Athabasca River were selected as the site for the new mine area. This area, which is referred to as the Steepbank Mine Project area, contains good quality ore and is close to Suncor's existing processing plants. Operating rates for the Steepbank Mine Project supports production of 107,000 barrels of upgraded crude oil daily. An important requirement for the development of the Steepbank Mine Project is the preparation of an Environmental Impact Assessment (EIA) in support of the project application to the Alberta Government. The EIA will assess the environmental effects of the Steepbank Mine Project and will identify mitigation opportunities that can be incorporated into project design to minimize environmental impacts.

As part of the EIA for the Steepbank Mine Project, Westworth, Brusnyk & Associates Ltd. conducted studies to determine the potential effects of the proposed mine development on wildlife and wildlife habitats within the area. These studies were centered in a 380 $km^2$ Local Study Area, that included Suncor's existing Lease 86/17 mine area and the area that would be encompassed by the Steepbank Mine development (Figure A-1), although the EIA also considers impacts that might extend beyond the development area into the surrounding region (Figure A-2). The wildlife assessment included baseline surveys to determine the status of important wildlife populations in the development area, habitat suitability modelling to determine the quality of habitat that would be affected by mine development for selected wildlife species, and a detailed assessment of a number of specific concerns raised by stakeholders and/or by the study team during the assessment process. The following report, which presents the results of the wildlife impact analysis, is one of eight components that comprise the environmental impact analysis for the Steepbank Mine application (Figure A-3).

# B SCOPE OF STUDY

During the initial stages of planning for the Steepbank Mine project, a series of meetings and stakeholder consultations was held to help define the scope of the environmental assessment studies. The initial scoping process included the identification of Valued Ecosystem Components (VECs), which Beanlands and Duinker (1983) indicate as an essential step in environmental impact assessment. They noted that "it is impossible for an impact assessment to address all potential environmental effects of a project. Therefore, it is necessary that the environmental attributes considered to be important in project decisions be identified at the beginning of an assessment. This will normally require some form of public consultation or social scoping exercise to determine the values attached to various ecosystem components. Both the views addressed by the general public and those of the professional community should be considered when determining these values".

## B1.0 VALUED ECOSYSTEM COMPONENTS

### B1.1 CRITERIA FOR THE SELECTION OF VALUED ECOSYSTEM COMPONENTS

Valued Ecosystem Components for the Steepbank Mine EIA were identified on the basis of the following criteria:

- **Special Status** - Wildlife species of concern at the federal (COSEWIC 1996) and/or provincial (Alberta Forestry, Lands and Wildlife 1991) levels;
- **Economic Importance** - Wildlife species of commercial and/or subsistence importance;
- **Recreational Importance** - Wildlife species of consumptive and/or non-consumptive importance;
- **Ecological Importance** - Wildlife species of professional/scientific concern (e.g., keystone species or important prey species);
- **Habitat Specificity** - Wildlife species that are especially vulnerable to habitat changes and/or losses, such as those with specific habitat requirements or that occur in relatively isolated subpopulations; and
- **Inherent Land Capability** - Reflects the capability of the land to support a species.

In the case of special status, both federal and provincial agencies have formal systems in place that classify flora and fauna based on their potential for extinction. Information from these agencies was used to determine the status of wildlife species in the Steepbank Mine study area and surrounding region. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) establishes the official status of wildlife species considered in jeopardy nationally, and provides relevant literature on classified species. Three separate lists are maintained by COSEWIC including 1) species with a designated status, 2) species that were considered but are designated as not at risk, and 3) an indeterminate list which includes species whose status cannot be assigned because of the lack of scientific information (COSEWIC 1996). The 1996 list of Canadian species at risk includes plants, birds, fish, mammals and herpetofauna.

With respect to designated species, five risk levels may be assigned by COSEWIC. Information is considered from a number of knowledgable sources, and if the evidence is clear, the committee assigns a species to one of the following status categories (COSEWIC 1996):

- **Extinct** - A species that no longer exists;
- **Extirpated** - A species no longer existing in the wild in Canada, but occurring elsewhere;
- **Endangered** - A species facing imminent extirpation or extinction;
- **Threatened** - A species likely to become endangered if limiting factors are not reversed;
- **Vulnerable** - A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events;
- **Not at Risk** - A species that has been evaluated and found to be not at risk; and
- **Indeterminate** - A species for which there is insufficient scientific information to support status designation.

Similarly, the Alberta government publishes a list that evaluates the status of all wildlife species found in the province. Although the evaluation process is unique to Alberta, it is patterned after similar systems being used in other North American jurisdictions. The initial classification of individual species is based on current knowledge within Land and Forest Services, Alberta Environmental Protection, supplemented with input from a limited number of provincial experts. The status evaluation system separates Alberta wildlife into one of five categories (Alberta Forestry, Lands and Wildlife 1991):

- **Red:** These species are in serious trouble. Their populations are nonviable or at immediate risk of declining to nonviable levels in Alberta. They have been or will be considered for designation as endangered species in Alberta.
- **Blue:** These species are also at risk, but the threats they face are less immediate. They are particularly vulnerable to noncyclical declines in population or habitat, or to reductions in provincial distribution. Species that are generally suspected of being vulnerable, but for which information is too limited to clearly define their status, have also been placed in this category.
- **Yellow:** These are sensitive species that are not at risk. They may require special management to address concerns related to low natural populations, limited provincial distribution, or particular biological features (e.g., colonial nesting, narrow habitat requirements).
- **Green:** These species are not at risk. Their populations are healthy and often widespread, and their key habitats are generally secure. This category also includes nonresident migrants and species whose occurrence in Alberta is accidental or at the periphery of their normal distribution.
- **Status Undetermined:** This category includes those species not considered at risk but for which the information currently available is insufficient to determine an accurate status.

## B1.2 VALUED ECOSYSTEM COMPONENTS IN THE STEEPBANK MINE STUDY AREA

Based on the criteria discussed in the previous section, VECs were selected for the Steepbank Mine EIA. In the case of wildlife, some species were selected because of their rare or endangered status in Alberta or Canada, whereas others were selected because they are vulnerable to long-term reduction in critical habitats or are susceptible to human disturbance. Although these species have been identified as key species for impact assessment purposes, they are not the only species that could be affected by the proposed Steepbank Mine Project. Implicit in the environmental impact assessment methodology is the understanding that the species being considered are part of a complex, functional ecosystem and that changes in the status of one species will affect a great number of interrelated species at a number of trophic levels.

Of the more than 200 wildlife species that could potentially occur in the vicinity of the Steepbank Mine Project area (Russell and Bauer 1993, Semenchuk 1992, Smith 1993), 19 species (or species groups) were selected as VECs:

| | |
|---|---|
| • **Ungulates** | - Moose |
| | - Woodland Caribou |
| • **Carnivores** | - Black Bear |
| | - Timber Wolf |
| | - Marten |
| | - Fisher |
| | - Wolverine |
| | - Lynx |
| • **Semi-Aquatic Furbearers** | - Beaver |
| | - River Otter |
| • **Small Herbivores** | - Red-backed Vole |
| | - Snowshoe Hare |
| • **Waterfowl and Shorebirds** | - Waterfowl |
| | - Whooping Crane |
| • **Raptors** | - Bald Eagle |
| | - Osprey |
| | - Great Gray Owl |
| • **Terrestrial Birds** | - Terrestrial Songbirds |
| | - Ruffed Grouse |

### B1.2.1 Ungulates

#### a) Moose

The moose is the most economically important big game species in Alberta. This species is the focus of much of the recreational and subsistence hunting that occurs in the province, particularly in northern forested areas. Moose, which appear to be sustaining their populations after a province-wide decline in the early 1980s, are on the yellow list in Alberta (Alberta Forestry, Lands and Wildlife 1991).

**b) Woodland Caribou**

The woodland caribou is listed as vulnerable in western Canada by COSEWIC (1996) and is on the red list in Alberta (Alberta Forestry, Lands and Wildlife 1991). The caribou is associated with mature coniferous forests, particularly those that support an abundance of terrestrial and arboreal lichens, which provide most of the forage used by caribou. Because mature coniferous forest is attractive to the forestry industry, increased access and habitat reduction is thought to have greatly reduced the population of woodland caribou in Alberta.

### B1.2.2 Carnivores

**a) Black Bear**

The black bear is the most abundant large carnivore in northeastern Alberta. Black bears prey opportunistically on the young of ungulate species and thus, may be ecologically important in regulating population levels of big game animals. It is also an economically important species for hunters in the region.

**b) Timber Wolf**

The timber wolf is also an important predator of ungulates and regulator of game populations. Wolves have been eliminated or reduced over much of their former range in southern Canada and the United States and at the present time, the timber wolf is designated a yellow list species (Alberta Forestry, Lands and Wildlife 1991). Although the annual harvest of wolves has declined, populations are considered to be relatively stable.

**c) Marten**

The marten, which is an economically important species for trappers throughout its range, prefers climax coniferous forest habitats. At the present time, trapping and habitat loss are two factors which can significantly influence marten populations.

**d) Fisher**

Like the marten, the fisher is also an economically important species for trappers in forested areas of Alberta. The harvest of fisher, however, has been declining since the mid-1980s. The status of fisher populations in the province is poorly known, and as a result the fisher has been designated as a yellow list species in Alberta (Alberta Forestry, Lands and Wildlife 1991).

e) **Wolverine**

Although the status of the wolverine in northeastern Alberta is not known, it is typically sparsely distributed throughout its range. The wolverine is designated as vulnerable by COSEWIC (COSEWIC 1996) and as a blue list species in Alberta (Alberta Forestry, Lands and Wildlife 1991).

f) **Lynx**

Although the lynx has been designated as a species not at risk in Canada (COSEWIC 1996), it is considered to be a blue list species in Alberta (Alberta Forestry, Lands and Wildlife 1991). Populations have been declining since the mid-1980s and trapping harvest is now regulated by quota. Lynx populations are highly dependent on snowshoe hare populations and as a result, cyclic peaks in lynx populations generally occur one or two years after a peak in snowshoe hare populations.

### B1.2.3 Semi-Aquatic Furbearers

a) **Beaver**

The beaver is an economically important species throughout Alberta, often accounting for a significant amount of annual revenues for trappers. The beaver is also important ecologically as a modifier of aquatic habitats and as a prey species for some carnivores such as the wolf.

b) **River Otter**

The river otter is much more abundant in northeastern Alberta than elsewhere in the province. Although the river otter has been designated as a blue list species in Alberta (Alberta Forestry, Lands and Wildlife 1991), its current status is not known. Otters prefer riparian zones of lakes, streams and rivers where a variety of aquatic and semi-aquatic foods such as fish, invertebrates and amphibians may be found.

### B1.2.4 Small Herbivores

#### a) Red-backed Vole

The red-backed vole is perhaps the most abundant and widely distributed microtine in undisturbed forested areas of Alberta. It is also an important prey species for various species of carnivores and raptors which include weasels, marten and great-horned owls.

#### b) Snowshoe Hare

The snowshoe hare is a relatively abundant herbivore in Alberta, although populations are known to fluctuate widely approximately every 10 years (Keith et al. 1984). The snowshoe hare, which prefers habitats with a well-developed shrub layer, is an important prey species for a number of terrestrial furbearers including lynx, marten and fisher.

### B1.2.5 Waterfowl and Shorebirds

#### a) Waterfowl

In the early 1990s many species of ducks were at their lowest levels since systematic population surveys began in 1955. Continental breeding populations of mallard, northern pintail, and blue-winged teal decreased substantially between the 1970s and 1991 in response to a combination of factors including agricultural expansion and intensification (i.e., wetlands drainage) on major breeding grounds, drought conditions that have persisted since the early 1980s, and hunting. During this period, mallard populations decreased from 8.7 million to 5.4 million, pintails from 6.3 million to 1.8 million, and blue-winged teal from 5.3 million to 3.8 million (CWS and USFWS 1986, 1991). American wigeon, blue-winged teal, green-winged teal, canvasback, mallard, lesser scaup, northern pintail and the northern shoveler are all yellow-listed species in Alberta (Alberta Forestry, Lands and Wildlife 1991). Improvement in the condition of prairie and parkland breeding habitat during the past few years appears to be helping to reverse this trend.

#### b) Whooping Crane

The whooping crane has been designated as an endangered species in Canada (COSEWIC 1996) and as a red-listed species in Alberta (Alberta Forestry, Lands and Wildlife 1991). The whooping crane, which is close to extinction in Canada (Godfrey 1966), is known to nest only in Wood Buffalo National Park.

### B1.2.6 Raptors

a) <u>Bald Eagle</u>

The bald eagle is a blue list species in Alberta (Alberta Forestry, Lands and Wildlife 1991), however, this species is endangered in the continental United States and is at risk over much of its central North American range. The bald eagle prefers to nest in large trees in the vicinity of fish-producing rivers and lakes; however, the nests are vulnerable to human disturbance.

b) <u>Osprey</u>

The osprey is currently on the blue list in Alberta. Population levels are believed to be low in Alberta and may be declining in North America (Alberta Forestry, Lands and Wildlife 1991). Like the bald eagle, the osprey prefers to nest in the vicinity of fish-producing rivers and lakes and nest sites are vulnerable to human disturbance.

c) <u>Great Gray Owl</u>

The great gray owl had been considered vulnerable across its Canadian range, but was removed from the COSEWIC list in 1996 (COSEWIC 1996). It is a blue list species in Alberta (Alberta Forestry, Lands and Wildlife 1991). The status of the gray owl population in Alberta is uncertain, although the species is known to be widely distributed in boreal forest habitats in the province.

### B1.2.7 Terrestrial Birds

a) <u>Songbirds</u>

Over 50 species of terrestrial songbirds are known to reside in the Suncor study area. These species include the Cape May warbler, which is a blue-listed species in Alberta (Alberta Fish and Wildlife 1991) that prefers mature forest habitats. However, like many other tree-nesting warblers in the boreal forest region of Alberta, little is known about its breeding biology (Semenchuk 1992) or its population status (Alberta Forestry, Lands and Wildlife 1991).

b) <u>Ruffed Grouse</u>

The ruffed grouse is important economically, as an upland game bird species and ecologically, as a prey species for various raptors and carnivores. The ruffed grouse is abundant in deciduous-dominated and mixedwood forests throughout Alberta.

# B2.0 PROJECT SPECIFIC ISSUES AND CONCERNS

During the various meetings with stakeholders, a number of specific issues or concerns were raised in relation to the proposed Steepbank Mine Development. A list of issues related to wildlife is provided in Table B2.0-1. A series of Impact Hypotheses were developed to evaluate these concerns. These hypotheses (numbers 18 through 23), along with the impact hypotheses for the other reports in this series are presented in Table B2.0-2. Report sections relating to each of the wildlife issues are also referenced in Table B2.0-1.

**TABLE B2.0-1**

**RESPONSE TO ISSUES ON STAKEHOLDER'S DATABASE**

| ISSUE | REPORT SECTION |
|---|---|
| Will the study boundaries consider migratory routes and facilities? | D3.0 |
| There should be consideration of spatial impacts and species | D2.0, D3.0 |
| Will unique wildlife habitats in the Athabasca/Steepbank confluence area and north of the proposed centre pit be protected? | C4.2, D4.1, D4.2, D4.4, D4.6 |
| Will the utility corridor location in river valley affect productive wildlife habitats (e.g., moose overwintering, noise, dust, movement corridor)? | D4.1, D4.2, D4.4, D4.6 |
| What will be the effect on wildlife from air emissions and water quality changes? | D4.1, D4.3 |
| Caribou migrations -- do they cut across the study area? | C1.1.1, D4.1, D4.4 |
| Will the project create a barrier to wildlife movement? Will valley development (bridge, hydrotransport line, pipelines; dykes) be a barrier to wildlife movement? | D4.4 |
| Dyke: will.it interfere with wildlife river valley movement and habitat use? | D4.1, D4.4 |
| Will tailings ponds be used by waterfowl and shorebirds during migration? | D4.1, D4.3 |
| How many beaver will be affected? | C1.4.1, D4.1, D4.3, D4.4 |
| Will wildlife collisions with vehicles and buildings, and wildlife harassment be a problem? | D4.2, D4.3 |
| Wolverine are in the study area | C1.3.4, D4.1, D4.6 |
| Will increased access result in increased hunting, poaching and trapping? | D4.3, D4.5 |
| Will direct and indirect mortality lead to changes in biodiversity? | D4.6 |
| Will changes in predator-prey relationships occur as a result of the project? | D4.1 |
| Will there be removal of problem wildlife (beaver, bear)? | D4.3 |
| Will heated pipeline attract wildlife? | D4.1, D4.2 |

## TABLE B2.0-2

## 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 affected 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. |

# C PRESENT STATUS OF WILDLIFE IN THE STEEPBANK MINE AREA

During 1995 a number of surveys were conducted to determine the abundance and distribution of wildlife in the Steepbank Mine area. This included a variety of aerial and ground-based inventory methods designed to obtain information on the different faunal groups present in the study area, along with an assessment of the potential of each of the habitat types present in the area to support specific wildlife species (VECs). Values derived from habitat suitability modelling were used in conjunction with data collected during field inventories to provide an overall rating of habitat important for each ecotype in the study area. The results of the wildlife baseline studies are described in detail by CIRC (1995), Fisher (1995), Prescott and Ewaschuk (1995), McCormick and Skinner (1996), and Westworth, Brusnyk & Associates (1996a, b, c). The following section provides a summary of existing information on each of the wildlife species identified as VECs for the Steepbank study area.

## C1.0 MAMMALS

### C1.1 UNGULATES

#### C1.1.1 Woodland Caribou

Woodland caribou or their sign were not recorded in the Suncor study area during either aerial or ground surveys. However, several caribou herds are known to occur in the study region, in the vicinity of Muskeg Mountain, the Birch Mountains and Thickwood Hills (B. Rippen, Alberta Environmental Protection, pers. comm.). In a recent study, Bradshaw et al. (1995) used the peatland classification of Vitt et al. (1994) to examine habitat selection by caribou in northeastern Alberta. They found that the characteristics of peatlands selected overall and those selected as foraging areas differed somewhat. However, based on the results of that study, it appears that very little suitable caribou habitat is present in the Suncor Local Study Area.

Studies conducted in the Birch Mountains of northeastern Alberta indicate that caribou prefer lowland habitat for much of the year (Fuller and Keith 1981). In that area, black spruce muskegs contained 44% of all caribou observations and were used at all times of the year. In comparison, black spruce forest and jack pine-spruce forest, the second and third most frequently used habitat types, contained only 13 and 12% of all caribou observations, respectively. Deciduous and mixedwood forests were rarely used by caribou. The use of black spruce muskeg peaked in December when 61% of all caribou observations were recorded in that habitat type. In contrast, only 21% of the caribou were observed in black spruce muskeg in August.

The provincial government, in conjunction with industry, is currently conducting research to improve our understanding of woodland caribou range use and movement patterns in northeastern Alberta (B. Rippin, pers. comm.). Although some movement between the different herds in the region is likely, it is not known whether movements occur across the Steepbank project area.

### C1.1.2 Moose

Seventy-five moose were recorded during February 1995 aerial survey of the Suncor Local Study Area, which resulted in an estimated moose density of 0.22/km$^2$. Similar results were obtained from the December 1995 aerial survey, which was conducted over a somewhat smaller area. During December, 58 moose were recorded for a population density of 0.27 moose/km$^2$.

These densities are well within the ranges reported from other studies conducted in the Fort McMurray area. Densities in these studies have ranged from 0.10 moose/km$^2$, recorded near the Fort Hills in 1981 (Skinner and Westworth 1981) to 0.32 moose/km$^2$, recorded near Calumet Lake in 1982 (Westworth and Brusnyk 1982).

The February survey indicated that moose in the Suncor study area prefer deciduous and mixedwood forests, which contained densities of 0.70 and 0.74 moose/km$^2$, respectively. Overall, 77% of the moose recorded during the February survey were observed in these 2 habitat types, which together comprised only 23% of the study area.

In contrast, moose were more evenly distributed among habitat types in December 1995 than they were in February. Moose did not exhibit a significant preference for any habitat type during this period and most habitats, including deciduous and mixedwood forest, were used in proportion to their availability. However, moose densities of 0.48 and 0.46 moose/km$^2$ in deciduous and mixedwood forests, respectively, were the highest recorded in any habitat type. Other studies conducted in Alberta have also shown that moose prefer stands of aspen for much of the year (Nowlin 1978, Hauge and Keith 1981, Mytton and Keith 1981), although remote lowland habitats are frequently used as calving areas (Leptich and Gilbert 1986).

During February, a disproportionate number of moose in the eastern portion of the Suncor study area was recorded on the terraces and floodplains of the Athabasca River. Twenty-two percent of the moose were associated with these landscape features, which comprise only about 11% of the eastern portion of the survey area. A number of other studies in the Fort McMurray region have also shown that moose often move from upland to lowland areas along the Athabasca River in late winter (Penner 1976; Westworth 1979, 1980; Hauge and Keith 1981).

## C1.2 LARGE CARNIVORES

### C1.2.1 Black Bear

Field studies were not conducted to determine black bear densities in the Suncor study area; however, based on frequent observations of black bears by study personnel, the species is believed to be abundant. Young (1978) estimated that the black bear density for the AOSERP area, which includes the Suncor study area, was 0.18 to 0.25 bears/km$^2$ but indicated that density varied widely among habitat types. Black bears were most abundant in deciduous forest, which supported 0.60 bears/km$^2$. In comparison, mixedwood forest, coniferous forest, and muskeg supported 0.41, 0.22, and 0.18 bears/km$^2$, respectively.

A study of black bears conducted near Cold Lake, Alberta indicated that black bears usually occupy overlapping home ranges. In that study, home range size varied from 20 to 119 km$^2$ with males occupying larger territories than females (Young and Ruff 1992). In Idaho, movements within home ranges and among habitat types were found to be associated with the phenology of plants preferred as food (Amstrup and Beecham 1976).

Near Cold Lake, Alberta, black bears usually move to den sites between mid-September and late October (Tietje and Ruff 1980). Dens occupied by females are usually located near the periphery of their summer home ranges, whereas males den well beyond the boundaries of their summer home ranges. Eighty-six percent of the bear dens found during the study were located in mature forest and 14% were in regenerating forest. Bears usually selected mixedwood and white spruce forests for den sites, whereas muskeg was avoided. Most (56%) of the bear dens found in that study were under downed or leaning trees; however, 25% were dug into a hillside, and 20% were dug into level ground.

### C1.2.2 Wolf

Wolves were relatively abundant in the Suncor study area; 48 wolf tracks, all of which were observed in the eastern portion of the study area, were recorded during track count surveys for an overall track frequency of 0.10 tracks/km track-day. These frequencies are much higher than those recorded in other tracking studies in the Fort McMurray region. Only 0.01 and 0.05 wolf tracks/km track-day were recorded near the Fort Hills (Skinner and Westworth 1981) and Calumet Lake (Westworth and Brusnyk 1982), respectively. C. Graves (pers. comm.) believes that 2 wolf packs, one of which is composed of 5 or 6 individuals, have ranges that include portions of the Suncor study area.

Wolf track frequencies in the Suncor study area were highest in mixed coniferous forest and open black spruce/Labrador tea habitats, which contained 0.28 and 0.23 tracks/km track day respectively. Track frequencies in these habitat types were almost twice those in closed deciduous forest and disturbed habitats, which contained 0.11 and 0.15 tracks/km track-day. Track frequencies in the remaining habitat types were less than 0.06 tracks/km track-day. Wolves in the Suncor study area were not evenly distributed among landscape features; the frequency of wolf tracks was highest on the Athabasca River escarpment in both December and February.

Wolf packs in the Fort McMurray region were the subject of an intensive study conducted from 1975 to 1978 (Fuller and Keith 1980b). Four wolf packs, which included the Louise Creek, Syncrude, Black, and Muskeg River packs, were identified during that study. The Syncrude Pack, which comprised 6 to 12 individuals, occupied a territory that abutted the northern limit of the western portion of the Suncor study area, whereas the Black Pack, which was composed of three animals, occupied a territory that included the eastern portion of the Suncor study area north of the Steepbank River.

The Muskeg River Pack, which occupied a territory immediately to the north of the Black Pack, was the most intensively studied of the four packs in the area. This pack, which was composed of nine to 13 wolves, averaged a moose kill every 4.7 days and annually killed between 10 and 15% of the moose in their territory (Fuller and Keith 1980b). Eighty-eight percent of the moose killed by the Muskeg River Pack were taken in lowland habitat types, even though moose and wolf activity was almost evenly divided between upland and lowland habitats.

Although the Black Pack is reported to have occupied a den during the natal period, no den sites were described during Fuller and Keith's (1980b) study. However, Mech (1970) reported that wolves usually dig dens in sandy soils but that some denning takes place in hollow trees, abandoned beaver lodges, and natural caves. Dens are usually constructed near water in an elevated area such as a hillside or ridge.

## C1.3 TERRESTRIAL FURBEARERS

### C1.3.1 Lynx

On the basis of the number of tracks observed, lynx tracks were uncommon in the Suncor study area. No lynx tracks were recorded during December and only four lynx tracks, all of which were observed in the eastern portion of the study area, were recorded in February for a track frequency of 0.01 tracks/km track-day for that period. This frequency is much lower than those recorded in other studies in the region; Skinner and Westworth (1981) recorded 0.06 tracks/km near the Fort Hills, whereas Westworth and Brusnyk (1982) recorded 0.13 tracks/km track-day near Calumet Lake. During February 1995, a single lynx track was observed in each of 4 different habitat types: closed deciduous forest, mixed coniferous forest, closed black spruce-tamarack, and disturbed habitat.

Low lynx populations in the Suncor area reflect the current scarcity of snowshoe hares, their principal prey species. During periods of abundance, snowshoe hares comprise 75 to 95% of the diet of lynx (van Zyll de Jong 1966, Nellis et al. 1972, Brand et al. 1976, Koonz 1976, Parker 1981).

Because lynx rely so heavily on snowshoe hares for food, lynx populations may change over 4-fold in response to fluctuations in snowshoe hare abundance. Lynx population cycles usually lag those of the snowshoe hare by 1 to 2 years (Brand et al. 1976, Brand and Keith 1979).

Lynx usually forage in early successional forests in which snowshoe hares are abundant (Koehler and Aubry 1994). However, mature forests that contain woody debris, which is used for security and thermal cover for kittens, are used as denning habitat. Important features of denning sites include a lack of human disturbance and close proximity to foraging habitat (Koehler and Aubry 1994).

**C1.3.2 Marten**

Based on the overall track frequency 0.09 tracks/km track-day, marten appear to be common in the Suncor study area; however, the track frequency for this species in the portion of the study area east of the Athabasca River was over twice that in the western portion. Todd (1976) reported that marten were uncommon and sparsely distributed in northeastern Alberta in the 1970s; however, marten populations in the region have apparently increased since that time (F. Neumann pers. comm.).

In the Suncor study area, marten were associated primarily with closed white spruce forest, which contained 1.00 marten tracks/km track-day. In comparison, mixed coniferous forest, the second-ranked habitat type, contained 0.44 tracks/km track-day and 5 habitat types, which included closed jack pine forest, closed deciduous forest, mixedwood forest, closed black spruce-tamarack, and open black spruce/labrador tea, contained from 0.05 to 0.15 tracks/km track-day. Marten tracks were not recorded in any of the remaining habitat types.

Marten were also associated with specific landscape features in the Suncor study area. Track frequencies of 0.14 and 0.13 marten tracks/km track-day were recorded on the Athabasca River escarpment and in riparian floodplain/terraces, respectively, whereas only 0.05 tracks/km track-day were recorded in upland landscapes.

The habitat preferences of marten as indicated by this study are similar to those reported by other workers. Marten have more specific habitat preferences than most other carnivores and many studies have indicated that the species prefers late-successional or climax coniferous or mixedwood forests, particularly those in which numerous deadfalls provide denning opportunities and access to microtine prey in the subnivian environment (Koehler and Hornocker 1977, More 1978, Hargis and McCullogh 1984, Bateman 1986, Slough 1989). Buskirk and Ruggiero (1994) indicated that two types of dens, natal dens and whelping dens, are used by marten, and that both types were associated with old growth forests.

Microtine rodents, particularly the red-backed vole, are considered the principal prey of the marten (Weckworth and Hawley 1962, More 1978); however, some studies have indicated that snowshoe hares are important prey when they are abundant (Bateman 1986, Raine 1987).

### C1.3.3 Fisher

Thirty-seven fisher tracks were recorded in the Suncor study area for an overall track frequency of 0.08 tracks/km track-day. Among habitat types, the highest track frequency for fisher was recorded in closed black spruce-tamarack forest followed by fen, closed deciduous forest, and open tamarack/bog birch.

Fisher sign was much more abundant in riparian floodplains/terraces than in other landscape features in the Suncor study area. Riparian floodplains/terraces contained 0.13 tracks/km track-day as compared with 0.07 and 0.03 in upland landscapes and the Athabasca River escarpment, respectively.

Few studies have been conducted to determine the habitat preferences of fishers and they are therefore poorly known. However, a survey of Ontario trappers indicated that 23% of the winter habitat use by fishers was in wetlands, 21% was in old mixedwood forest, 21% was in young mixedwood forest, 11% was in old deciduous forest, 8% was in old coniferous forest, 8% was in young deciduous forest, 6% was in young coniferous forest, and 2% was in other habitat types (Douglas and Strickland 1987). Fishers in Wisconsin are reported to prefer lowland mixedwood forest and avoid lowland coniferous forest (Kohn et al. 1993). In contrast, Powell and Zielinski (1994) indicated that late-successional coniferous forests provide preferred habitat for the fisher. In the eastern United States, most natal and maternal dens of fishers are located in cavities high in trees, which suggests that mature forest stands are important in the reproduction of the species

(Powell and Zielinski 1994). However, Douglas and Strickland (1987) reported that the habitat preferences of this species are probably related primarily to prey availability.

### C1.3.4 Wolverine

Although no wolverine tracks were recorded during the winter tracking study, the species is known to occur in the Suncor Regional Study Area. During the 1993-94 trapping season, a wolverine was trapped on Registered Fur Management Area (RFMA) #587, which occupies part of the western portion of the study area.

The absence of wolverine tracks recorded during this study reflects the sparse distribution of this species throughout its range. Wolverines, which are much rarer than other similar-sized carnivores in Canada (van Zyll de Jong 1975), are considered the rarest furbearer in Alberta (Todd and Geisbrecht 1979).

The habitat preferences of the wolverine are not well understood, although Hornocker and Hash (1981) reported that remote wilderness with little human activity was important in maintaining viable wolverine populations. Home ranges of this species, which vary in size from less than 100 $km^2$ to more than 900 $km^2$, are extensive (review in Banci 1994).

## C1.4 SEMI-AQUATIC FURBEARERS

### C1.4.1 Beaver

A survey conducted in the eastern portion of the Suncor study area by CIRC (1995) indicated that the density of beaver colonies in the area is low; only 82 active beaver colonies were recorded for an overall density of 0.24 colonies/$km^2$. CIRC (1995) reported that 41% of the active colonies were associated with willow and alder shrubland and that 36% were associated with mixedwood forest. The remaining 24% of the colonies were located in a variety of habitat types. Five areas with high beaver abundance were identified by CIRC (1995). These areas include Shipyard Lake, Leggett and Wood Creeks immediately above the Athabasca River escarpment, and sites in the southeast and northeast corners of the Local Study Area.

The bark of trees and shrubs usually provides the bulk of the winter diet of beavers residing at northern latitudes (Novakowski 1967, Slough 1978, Jenkins 1981), although herbaceous forage is often consumed during the growing season. Several studies have indicated that, where trembling aspen is available, beavers prefer it to other shrub and tree species (Hall 1960, Northcott 1971, Slough and Sadlier 1977, Pinkowksi 1983). However, studies conducted in central Alberta indicate that balsam poplar is also a preferred forage species (Schwanke and Baker 1977, Skinner 1984) and willows are also reported to be important in the ecology of beavers, particularly where aspen and balsam poplar are sparsely distributed or absent (Hall 1960, Aleksiuk 1970). Although riverine habitats frequently support beaver populations, rivers that flow in V-shaped valleys, have strong currents, or have high annual water fluctuations are usually not occupied by beavers (Yeager and Rutherford 1957).

### C1.4.2 River Otter

Based on winter track counts, the river otter appears to be uncommon in the Steepbank Mine study area. Only three otter tracks were recorded during tracking studies conducted in 1995 for an overall track frequency of 0.01 tracks/km-track day. In other studies conducted in the Fort McMurray region, otter track frequencies have ranged from 0.001 to 0.05 tracks/km track-day (Brusnyk and Westworth 1982, Skinner and Westworth 1981). Boyd (1977) reported that, based on fur harvest data, otter were less abundant in mapsheet 74D, which includes the Suncor study area, than in most other areas of northeastern Alberta.

Otters prefer habitats that provide denning and resting sites in addition to an adequate food supply (Melquist and Hornocker 1983). Riparian vegetation is also reported to be an important factor in habitat selection by otters because they are often associated with beaver ponds and lodges, which serve as foraging and denning habitat (Melquist and Dronkert 1987). Although otters are usually associated with streams and ponds, they sometimes travel up to 3 km overland; however, during such movements, small streams and ditches are used as much as possible (Melquist and Hornocker 1983). Studies of otters in the Muskeg River drainage in northeastern Alberta indicated that fish are by far the most important component of the otter's diet. Fish remains, principally brook stickleback, occurred in 87% of otter scats, whereas mammals and birds occurred in only 7 and 8% of the scats, respectively (Gilbert and Nancekivell 1982).

## C1.5 SMALL HERBIVORES

### C1.5.1 Snowshoe Hare

The frequency of snowshoe hare tracks was low in the Suncor study area during both February and December 1995; track frequencies during these months were 0.49 and 4.14 tracks/km track-day, respectively. In contrast, other studies in the Fort McMurray region have recorded 21 (Skinner and Westworth 1981) to 76 tracks/km track-day (Westworth and Brusnyk 1982).

Snowshoe hare track frequencies were highest in mixed coniferous and closed jack pine forest; however, track frequencies in mixedwood forest and open black spruce/labrador tea were also high. Some other studies conducted in northeastern Alberta and elsewhere have indicated that snowshoe hares are most abundant where both coniferous cover and a well-developed shrub layer are present (Skinner and Westworth 1981, Rogowitz 1988), although Keith (1966) reported that snowshoe hares near Rochester, Alberta preferred shrubby habitats.

The track frequency of snowshoe hares in the Suncor study area differed among landscape features. The track frequency in upland landscapes was over twice that in riparian floodplains/terraces and on the Athabasca River escarpment. The distribution of hares among landscape features appeared to be related to the distribution of mixedwood and coniferous forests, which were preferred by hares and occur primarily in upland landscapes.

Snowshoe hare populations undergo cyclic fluctuations approximately every 10 years, during which abundance may change over 20-fold (Keith and Windberg 1978, Keith et al. 1984). Although snowshoe hare populations in the Fort McMurray area have been low for several years (C. Graves, K. Schmidt, pers. comm.), data obtained by the Alberta Fish and Wildlife Division show that numbers are beginning to increase throughout most of the province (F. Kunnas pers. comm.). Most cyclic events for snowshoe hares in Alberta occur initially in the northeastern part of the province and then spread across Alberta (Smith 1983). Consequently, snowshoe hare populations in the Suncor study area could increase to high levels over the next few years.

### C1.5.2 Red-backed Vole

Although no studies were conducted to determine the abundance and distribution of the red-backed vole in the Suncor study area, it is probably the most common microtine rodent in mature forests. Numerous studies have shown that the red-backed vole is usually associated with forested habitats (Clough 1964, Grant 1969, Morris 1969, Grant 1970, Iverson and Turner 1973, Miller and Getz 1973, Crowell and Pimm 1976). Some studies in the United States have indicated that coniferous forest supports the highest number of red-backed voles (Rickard 1960, Armstrong 1977, Merrit 1981, Millar et al. 1985); however, a study conducted near Slave Lake, Alberta indicated that they were most abundant in deciduous forest (Bondrup-Nielsen 1984).

The availability of free water may affect red-backed vole distribution (Miller and Getz 1973) but understory characteristics also appear to be important. Miller and Getz (1977) reported that red-backed vole abundance was associated with the amount of herbaceous cover and Iverson and Turner (1973) found that red-backed voles were captured most frequently in areas with high forb diversity. Other studies have indicated that red-backed vole densities are higher in areas with a well developed shrub understory than in more open areas (Iverson and Turner 1973, Miller and Getz 1973).

# C2.0 BIRDS

## C2.1 RAPTORS

### C2.1.1 Osprey

No ospreys or osprey nests were observed during raptor surveys conducted in the Suncor study area in 1995. Based on a survey conducted in 1976, which detected only 5 breeding pairs, Francis and Lumbis (1979) also considered the osprey rare in the AOSERP study area.

Osprey habitat consists of permanent rivers and lakes that provide an adequate supply of fish (Semenchuk 1992). Water clarity may be an important factor in determining habitat quality and hunting success. Flemming and Smith (1990) found that the number of foraging birds decreased when water became murky, although the success rate of those that foraged under these conditions increased. However, clear water is thought to provide better foraging opportunities for osprey than turbid water (McNichol and Robertson 1982, Vana-Miller 1987).

Ospreys nest near the tops of trees, cliffs, or on man-made structures such as wooden power poles located near water (Semenchuk 1992). Trees selected as nest sites usually have basket-like branching structures at the top, a broken top, or are taller than adjacent trees (Vana-Miller 1987). In Labrador and northeastern Quebec, nests were constructed in tall white spruce or balsam fir trees in dense woodlands bordering streams, shallow lakes, or rivers (Wetmore and Gillespie 1976). Vana-Miller (1987) suggested that various types of human activity, particularly those that are abrupt and disruptive, and which occur during the breeding season, can reduce nesting success for this species.

### C2.1.2 Bald Eagle

An active bald eagle nest was identified across the Athabasca River from Tar Island during the May 1995 raptor survey. Although it appeared that the nest had experienced prolonged use during the summer, it is not known if any young were successfully fledged. Single adult bald eagles were also recorded on three occasions during fall waterfowl surveys; one was sighted near the Poplar Creek Reservoir and two were observed near the east shore of the Athabasca River; however, the number of individuals represented by these sightings is unknown.

The bald eagle exists in low densities throughout the boreal forest region (Semenchuk 1992). However, it does not appear to be common within the AOSERP study area; only 18 productive and eight non-productive nests were identified in a survey conducted in 1976 (Francis and Lumbis 1979).

Fish are the principal prey of the Bald Eagle (Semenchuk 1992, Petersen 1986), although Boyd (1972) also lists other birds and mammals that are taken as prey. The composition of the diet apparently depends on prey availability, with the more abundant prey species comprising most of the diet (Boyd 1972, Petersen 1986).

Bald eagle habitat includes large lakes or rivers with good fish populations, and suitable nesting and roosting sites in close proximity to the water (Semenchuk 1992); however, the presence of silt in the water may reduce the suitability of habitat for bald eagles (McNichol and Robertson 1982). In

Saskatchewan, numbers of breeding bald eagles are thought to be correlated with number of cisco residing in lakes (Gerrard et al. 1992).

Large mature trees that are substantially larger than those in the surrounding canopy are selected as nest sites by bald eagles. Jack pine, spruce, or aspen located within 20 m of shore are frequently selected as nesting trees (Semenchuk 1992, Roseneau and Bente 1993). Because bald eagle nests can be massive structures up to 3 m in height, trees selected as nest sites generally possess a large crotch that can support the weight of the nest (Semenchuk 1992). Tree form is considered more important than tree species in determining the suitability of nesting sites; however, eagles will also occasionally nest on the ground on isolated treeless islands and on cliffs (Petersen 1986).

Human disturbance may result in a reduction in eagle populations (Semenchuk 1992). LGL Ltd. (1972) indicated that bald eagle populations declined as a result of helicopter surveys and people climbing to nests. Recreational activity and road development have also been cited as factors responsible for declining bald eagle populations in northern Saskatchewan (Gerrard et al. 1985).

### C2.1.3 Great Gray Owl

Great gray owls were not recorded during avifauna surveys in the Suncor study area in 1995; however, no surveys specifically for the purpose of obtaining information about the species composition and abundance of owls were undertaken. Nevertheless, the great gray owl is known to nest in the Fort McMurray region and has been recorded in the vicinity of the Suncor study area (Semenchuk 1992).

The great gray owl is considered uncommon but widespread within Alberta; its range includes the boreal forest and eastern slopes regions of the province (Semenchuk 1992). Within the boreal forest region, the great gray owl usually occurs in undisturbed forested areas interspersed with bogs, muskegs, or other openings (Spreyer 1987, Semenchuk 1992, Duncan and Hayward 1994). Home range size varies from 2.6 to 4.5 km$^2$, depending on food supply (Duncan and Hayward 1994).

Nests are usually situated in forested habitat near an open area, such as a muskeg or wet meadow. Duncan and Hayward (1994) found that nests were often in areas dominated by black spruce and tamarack, and were an average of 256 m away from open habitat (range 0-1000 m). In Alberta, nesting trees may include tamarack, trembling aspen, balsam poplar, Douglas fir, and white spruce (Duncan and Hayward 1994). In Minnesota, mean tree height and canopy cover at nest sites was 18 m and 14%, respectively (Spreyer 1987); however, mean canopy cover was greater than 60% at nest sites in Oregon (Duncan and Hayward 1994). Great gray owls often nest in old hawk or corvid nests in old trees, although nests situated on the ground or on cliffs have also been reported.

Meadow voles are the principal prey of the great gray owl. In southern Manitoba, meadow voles comprise 64 to 84% of the diet, whereas other small mammals and birds comprise 5 to 34%, and 1 to 2%, of the diet, respectively (Servos 1987, Duncan and Hayward 1994). Because meadow voles, which are uncommon in dense forests (Hayward 1994), are used extensively as prey, comparatively open areas provide important foraging habitat for the great gray owl. In southern Manitoba, preferred foraging areas include open forests of pure or almost pure tamarack, which provide abundant prey as well as perching sites (Servos 1987).

## C2.2 TERRESTRIAL AVIFAUNA

### C2.2.1 Ruffed Grouse

The ruffed grouse is known to reside and breed in the Suncor study area (Semenchuk 1992) and over 60 grouse tracks, which were likely those of ruffed grouse, were recorded in deciduous forests during tracking surveys. However, this species was recorded at only low densities during avifauna surveys conducted in the Suncor study area in 1995. The distribution of the ruffed grouse is strongly influenced by the distribution and characteristics of aspen forest. Aspen forest, which provides forage, cover, and drumming sites (Kubisiak et al. 1980, Gullion 1984, Kubisiak 1985), is the principal habitat type used by ruffed grouse during all life phases. The catkins of male aspen trees are the principal item in the diet of ruffed grouse, and clones of male aspen are also selected by drumming males and nesting hens (Gullion 1984). Gullion (1984) reported that three classes of aspen are required by ruffed grouse. Stands four to 15 years old are used for brood cover; stands 16 to 25 years old are used for spring and fall cover; and older stands are used for foraging, wintering, and nesting.

Studies conducted in Alberta similarly indicate that ruffed grouse are associated with aspen forest. Near Rochester, Alberta, 74% to 96% of all ruffed grouse observed throughout the year were located in aspen forest as were 96% of the drumming males (Rusch and Keith 1971a). In Alberta, drumming logs are usually found in aspen stands at sites that have a high density of woody stems and few low shrubs (Boag and Sumanik 1969, Rusch and Keith 1971a).

The population dynamics of ruffed grouse are strongly influenced by predation. Rusch and Keith (1971b) found that at least 25% of the annual mortality and 80% of the overwinter mortality resulted from predation by great horned owls, goshawks, and lynx. However, the amount of predation on ruffed grouse was related to the phase of the snowshoe hare cycle because most predators shifted from grouse to snowshoe hares in response to increased hare abundance.

### C2.2.2 Terrestrial Songbirds

Avifauna surveys conducted in 1995 indicated that the Tennessee warbler was the most abundant and widespread species in the Suncor study area (Prescott and Ewaschuk 1995). This species was present in 59% of all counts and in 10 of the 11 habitat types surveyed. Other commonly observed species included the white-throated sparrow, red-eyed vireo, ruby-crowned kinglet, American robin, ovenbird, Swainson's thrush, and chipping sparrow. In contrast, 24 species were recorded in only a single habitat type.

The characteristics of bird populations in the Suncor study area differed among habitat types. Riparian deciduous forest and closed shrub complex, both of which contained 28 bird species, followed by closed deciduous forest (aspen dominant), which contained 25 species, supported the highest number of bird species. Riparian deciduous forest and closed shrub complex also supported the greatest species diversity and the highest number of unique species of any habitat type. Shannon-Weaver diversity in ripian deciduous forest and closed shrub complex was 1.31 and 1.25, respectively, as compared with a maximum value of 1.18 in other habitat types surveyed. Similarly, these habitat types contained 6 and 9 unique species, respectively, although several of the unique species recorded in closed shrub complex are not considered songbirds. Unique species in riparian deciduous forest included the cedar waxwing, warbling vireo, black-throated green warbler, American redstart, song sparrow, and brown-headed cowbird, whereas those in closed shrub complex included the great-blue heron, sandhill crane, spotted sandpiper, eastern kingbird, barn swallow, marsh wren, swamp sparrow, red-winged blackbird, and rusty blackbird.

## C2.3 WATERFOWL AND SHOREBIRDS

### C2.3.1 Waterfowl

During May 1995, the density of breeding waterfowl in the Suncor study area was 3.42 indicated breeding pairs (IBP)/km of shoreline. The mallard, which was present at a density of 0.86 IBP/km, was the most abundant waterfowl species breeding in the area, followed by the lesser scaup, ring-necked duck and American wigeon, which were present at densities of 0.58, 0.51, and 0.40 IBP/km, respectively. Overall, the highest breeding pair density (16.85 IBP/km) was recorded in the Steepbank wetland, whereas the lowest (0.53 IBP/km) was recorded on the Steepbank River. A comparison of natural wetlands, beaver impoundments, reservoirs, man-made channels and rivers indicated that natural wetlands supported the highest density of breeding waterfowl. Natural wetlands supported 12.64 IBP/km as compared with densities of 9.75, 6.91, 4.57, and 0.76 in beaver impoundments, reservoirs, channels and rivers, respectively.

Between 736 and 1,166 waterfowl were recorded during the 3 fall waterfowl surveys conducted in the Suncor study area. Overall, dabbling ducks, the vast majority of which appeared to be mallards, comprised 65% of the waterfowl sighted. Lesser scaup appeared to be the most abundant diving duck, followed by common goldeneye and bufflehead. During fall, waterfowl were far more abundant in reservoirs, particularly Ruth Lake, than elsewhere in the study area.

### C2.3.2 Whooping Crane

Although the whooping crane has been occasionally observed in the Fort McMurray area, no whooping cranes were recorded during avifauna surveys conducted in the Suncor study area in 1995. This species, which winters in Texas, breeds and nests only in isolated marshy wetlands in Wood Buffalo National Park, approximately 250 km to the north of the Suncor study area (Semenchuk 1992).

# C3.0 REPTILES AND AMPHIBIANS

No reptiles and only two species of amphibians were recorded during surveys conducted in the Suncor study area in May 1995 to determine the distribution and abundance of these faunal groups (Fisher 1995). The boreal chorus frog, which was recorded primarily in wetlands with sedge margins, and abundant submergent and emergent vegetation, was the most common amphibian. This species occurred in 46% of the wetlands surveyed. In comparison, wood frogs, which occurred principally in sedge-dominated wetlands and wetlands with emergent macrophytes, were found at 38% of the wetlands investigated. Neither of these species was abundant in reservoirs or large wetlands.

During recent years, scientists have reported world-wide declines in amphibian populations, although the reasons for these declines are not clearly known. Global warming, increased ultraviolet radiation, habitat loss and air and water pollution have been suggested as reasons for these declines. In Alberta, dramatic declines in populations of northern leopard frogs and the canadian toad have been recorded (W. Roberts, Univ. of Alberta, pers. comm.).

# C4.0 HABITAT ASSESSMENT

## C4.1 BASIS FOR THE HABITAT EVALUATION

The results of field studies conducted in the Suncor study area in conjunction with HEP modelling were used to evaluate habitat quality as excellent, good, moderate, poor, or very poor for various groups of wildlife. However, specific factors considered in the evaluation differed among wildlife groups.

The evaluation for moose combined the results of early and late winter aerial surveys for ungulates, winter track counts, pellet group counts, browse utilization data, and HEP modelling to provide a rating for the various ecotypes. In contrast, the evaluation for terrestrial furbearers considered track count frequencies for eight species of furbearer, which included the lynx, wolf, coyote, red fox, fisher, marten, weasel and red squirrel. Thus, the evaluation considered both the relative abundance and diversity of terrestrial furbearers. In addition, the snowshoe hare and the red-backed vole, both of which are important prey for a large number of carnivores, were considered in the evaluation for terrestrial furbearers. Track frequencies were used to evaluate ecotypes for the snowshoe hare, whereas the results of HEP modelling were used in the evaluation for the red-backed vole. Similarly, a beaver HEP model was used to evaluate habitat for semiaquatic furbearers, such as the beaver and otter. Because otters are often associated with beaver ponds (Melquist and Dronkert 1987), the beaver model likely provides some indication of habitat importance for otters. The evaluation for breeding birds considered a number of variables, which include the density of breeding birds, the total number of species present (species richness), species diversity, and the number of unique species present.

## C4.2 PRESENT HABITAT SUITABILITY

### C4.2.1 Moose

Based on the habitat evaluation for moose, three ecotypes were considered excellent moose habitat, three were considered good, seven were considered moderate, twenty were considered poor, and six were considered very poor (Table C4.0-1). Excellent habitat included closed deciduous forest in all landscape features. Moderate moose habitat included closed shrub complex in all landscape features, closed black spruce-tamarack in escarpment and upland features, reclaimed conifer/aspen in escarpment features, and tamarack/bog birch in upland landscapes. All other ecotypes were rated as poor or very poor moose habitat.

This evaluation indicated that the escarpment and floodplain of the Athabasca and Steepbank Rivers contained most of the excellent moose habitat in the Suncor study area (Figure C4.0-1). Good habitat was also associated primarily with riparian and escarpment landscape features, although mixedwood forests in upland landscapes also provided good habitat. In contrast, most moderate and poor quality habitats were associated with upland landscapes.

### C4.2.2 Terrestrial Furbearers

The habitat evaluation for terrestrial furbearers indicated that three ecotypes provided excellent habitat for this group of mammals, eighteen provided good habitat, nine provided moderate habitat, three provided poor habitat, and six provided very poor habitat (Table C4.0-1). Ecotypes classified as excellent furbearer habitat included closed deciduous forest in riparian landscapes, and closed mixed coniferous forest in both escarpment and upland landscapes. Good quality habitat for furbearers included disturbed sites, closed mixedwood (white spruce dominant), and closed white spruce in all landscape features; open black spruce, open tamarack/bog birch, closed black spruce-tamarack, and closed black spruce in escarpment and upland landscapes; and closed deciduous forest in escarpment landscapes. Habitats rated as moderate for furbearers included closed jack pine and closed mixedwood in all landscape features, reclaimed conifer/aspen in escarpment and upland landscapes, and closed deciduous forest in upland landscapes. The remaining ecotypes were rated as poor or very poor.

This evaluation indicated that the floodplains and escarpments of the Athabasca and Steepbank Rivers provide most of the excellent furbearer habitat in the Suncor study area (Figure C4.0-2). However, because a number of species, which preferred a variety of habitats, were combined to assess furbearer habitat, the evaluation rated most of the remaining study area as good.

### C4.2.3 Semi-Aquatic Furbearers

A HEP model indicated that most of the aquatic features on the east side of the Athabasca River provided poor beaver habitat, primarily because only low quality woody forage is available or else steep banks are present along streams and rivers (Figure C4.0-3). However, a few areas of excellent habitat were identified; these included Steepbank Wetland, Shipyard Lake, and short reaches of Wood and McLean Creeks at the top of the escarpment. In contrast, many of the aquatic features in the Suncor study area on the west side of the Athabasca River provide excellent or good quality habitat for beavers.

## TABLE C4.0-1

## HABITAT RATINGS FOR WILDLIFE IN THE SUNCOR LOCAL AREA

| Ecotype | Current Habitat Suitability Ratings* | | |
|---|---|---|---|
| | Breeding Birds | Terrestrial Furbearers | Moose |
| **Riparian** | | | |
| Disturbed/Herb and Grass Dominant | M | G | P |
| Closed Shrub Complex | E | P | M |
| Closed Deciduous | E | E | E |
| Closed Mixedwood | M | M | G |
| Closed Mixedwood-White Spruce | G | G | P |
| Closed White Spruce | E | G | P |
| Closed Jack Pine | G | M | P |
| Open Water | VP | VP | VP |
| Industrial/Non-vegetated | VP | VP | VP |
| **Escarpment** | | | |
| Disturbed/Herb and Grass Dominant | M | G | P |
| Closed Shrub Complex | E | P | M |
| Closed Deciduous | G | G | E |
| Closed Mixedwood | M | M | G |
| Closed Mixedwood-White Spruce | G | G | P |
| Closed White Spruce | E | G | P |
| Open Black Spruce | G | G | P |
| Open Larch/Bog Birch | M | G | P |
| Closed Jack Pine | G | M | P |
| Closed Mixed Conifer | G | E | P |
| Closed Black Spruce/Larch | G | G | M |
| Closed Black Spruce | G | G | P |
| Reclaimed Conifer/Aspen | M | M | P |
| Open Water | VP | VP | VP |
| Industrial/Non-vegetated | VP | VP | VP |
| **Upland** | | | |
| Disturbed/Herb and Grass Dominant | M | G | P |
| Closed Shrub Complex | E | P | M |
| Closed Deciduous | G | M | E |
| Closed Mixedwood | M | M | G |
| Closed Mixedwood-White Spruce | G | G | P |
| Closed White Spruce | E | G | P |
| Open Black Spruce | G | G | P |
| Open Larch/Bog Birch | M | G | M |
| Closed Jack Pine | G | M | P |
| Closed Mixed Conifer | G | E | P |
| Closed Black Spruce/Larch | G | G | M |

| | | | |
|---|---|---|---|
| Closed Black Spruce | G | G | P |
| Reclaimed Conifer/Aspen | M | M | P |
| Open Water | VP | VP | VP |
| Industrial/Non-vegetated | VP | VP | VP |

* Habitat Suitability Ratings

E = excellent

G = good

M = moderate

P = poor

VP = very poor

### C3.2.4 Terrestrial Birds

The habitat evaluation indicated that excellent, good, moderate, and very poor breeding bird habitat were provided by seven, 16, ten, and six ecotypes, respectively, in the Suncor study area (Table C4.0-1). Excellent habitat for breeding birds included closed shrub complex and closed white spruce in all landscape features, and closed deciduous forest in riparian landscapes. Good habitats included closed mixedwood (white spruce dominant) and closed jack pine in all landscape features as well as closed deciduous, open black spruce, closed mixed coniferous, closed black spruce-tamarack, and closed black spruce in escarpment and upland landscapes. Ecotypes rated as moderate for breeding birds included disturbed sites and closed mixedwood in all landscape features, and open tamarack/bog birch and reclaimed conifer/aspen in escarpment and upland landscapes. All remaining ecotypes were rated as very poor terrestrial breeding bird habitat.

The habitat evaluation for terrestrial birds indicated that most of the excellent habitat for breeding birds in the Suncor study area is concentrated along the floodplain and escarpment of the Athabasca and Steepbank Rivers, although some areas of excellent habitat are associated with white spruce stands near the eastern boundary of the Local Study Area (Figure C4.0-4). On an areal basis, most of the remainder of the Suncor study area provides good habitat for terrestrial birds.

# D IMPACT ANALYSIS RESULTS

## D1.0 IMPACT ASSESSMENT APPROACH

The evaluation of potential impacts of the Steepbank Mine development on wildlife involved a number of stages of study, as summarized in Figure D1.0-1. At the beginning of the study, discussions were held with regulatory agencies and stakeholder groups to identify environmental concerns related to the proposed project and to define the scope of the impact evaluation. The study process began with the identification of Valued Ecosystem Components (VECs). Environmental components considered to be of ecological, economic, or social importance in the area affected by the project were identified as a means of focussing the environmental assessment studies on those resources that are of greatest public and scientific concern. Based on this process, 19 wildlife species were identified as VECs in the Suncor study area.

Field studies to determine the status of particular VECs and baseline habitat conditions in the project area were carried out through 1995. These studies resulted in the elimination of three species considered as VECs. The woodland caribou was eliminated because no evidence of caribou was recorded during aerial and ground surveys of the Suncor study area, and the results of a study conducted in the Fort McMurray area (Bradshaw et al. 1995) suggest that the types of habitat that occur in the proposed development area are generally of poor quality for this species. Similarly, no ospreys or their nests were recorded in the study area during surveys conducted in 1995. Moreover, based on surveys conducted by Francis and Lumbis (1979), where only five osprey nests were recorded in the AOSERP study area, it is unlikely that the species resides in the area that will be affected by mine development. The whooping crane, which nests in Wood Buffalo National Park and winters in Texas, is also unlikely to be affected by the proposed Suncor development. There are no records of whooping cranes landing in the Suncor study area, although a few birds were recorded on the ground near Ruth Lake in the late 1970s (J. Gulley, pers. comm.).

The initial mine development plan was reviewed to determine potential interactions between VECs and project components or activities. This was an interactive process between the environmental impact assessment team and the project planning and design team, involving a number of meetings and workshops at which various environmental concerns were discussed and potential mitigative or redesign options were evaluated.

The impact assessment process involved the formulation and assessment of six 'impact hypotheses' that describe potentially significant effects of the project on wildlife:

**Hypothesis 18.** Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populations.

**Hypothesis 19.** Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.

**Hypothesis 20.** Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.

**Hypothesis 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.

**Hypothesis 22.** Mine development will cause a reduction in wildlife resource use (hunting, trapping, non-consumptive recreational use).

**Hypothesis 23.** Development of the Steepbank Mine will contribute to a loss of natural biodiversity.

It is also recognized that changes in air quality resulting from plant emissions could effect wildlife in the project area, either directly through ingestion, inhalation or absorption of pollutants, or indirectly through changes in habitat. Potential health risks to wildlife resulting from exposure to chemicals or the Suncor site were evaluated as part of an ecological risk assessment by Golder (1996a). These findings are summarized under Hypothesis 20. Impacts related to potential changes in the quality or availability of habitat are considered under Hypothesis 18. This assessment is based on the evaluation of emissions impacts on vegetation as described in the Terrestrial Resources Impact Assessment (Golder 1996b).

Each impact hypothesis was comprised of a number of 'testable hypotheses' or 'linkages' that define the mechanisms or pathways by which an impact could occur. The impact analysis involved the evaluation of each linkage with respect to:

- necessary assumptions;
- evidence for and against the linkage; and
- confidence in the information.

The results of field data, literature review, and professional judgement were used to determine the validity of each linkage in each hypothesis. When a linkage was judged to be **valid**, it was assumed that a plausible mechanism exists for causing an environmental impact. An **invalid** linkage would indicate that such a mechanism does not exist. If insufficient information existed to determine the validity of a linkage, the validity was stated as **unknown**.

## D2.0 STUDY BOUNDARIES

The spatial boundaries for the environmental impact assessment study were defined as follows:

- **Local:** Any impact occurring on the areas directly associated with or adjacent to the Suncor Leases;
- **Regional:** Any impacts caused by the Steepbank Mine development that extend beyond the local area into the surrounding region; and
- **Cumulative:** Any effects caused by the Steepbank Mine development that contribute in a cumulative manner to the effects caused by other projects or development in the region.

The temporal boundaries for the Impact Analysis were defined as follows:

- Baseline (1995-1996)
- Construction Phase (1997 - 2000)
- Operational Phase (2000 - 2020)
- Final Closure

These time periods were selected because the characteristics of the project's impacts are significantly different between the construction and operational phases, and a long-term view of the project following the completion of mining and mine closure is required to assess the likely success of proposed reclamation/mitigation measures.

Following mine closure, it is possible that the presence of Suncor's bridge would result in increased access to the site of the proposed Steepbank Mine, as a result of increasing industrialization, timber harvesting, or other land use factors. Although it is recognized that increased access to remote areas is one of the principal concerns for wildlife in Alberta, it is beyond the scope of this impact assessment to attempt to predict the demand for access after mining has ceased. It is our understanding that the proposed bridge would be built, owned, and operated by Suncor for the express purpose of developing its leases on the east side of the Athabasca River. Consequently, in assessing the magnitude of impact following closure of the Steepbank Mine, the following assumptions were made regarding mine decommissioning and reclamation procedures:

- At the cessation of mining all equipment, including machinery, conveyors, pipes and pipe racks, vessels, retention basins, buildings, electrical lines and power poles, will be removed from the site;
- Roads will be reclaimed by restoring natural contours, rolling back slash and planting native plant species; and
- The bridge will not be designed to provide access to the east side of the Athabasca River after the mining operations have ended.

## D3.0 IMPACT ASSESSMENT CRITERIA

In the case of each impact hypothesis for which the linkages were judged to be valid, an effort was made to classify each impact according to its direction, severity, duration, and geographic extent:

- **Direction:** The expected direction of impact to the wildlife resource:

  ***Negative (-):*** Adversely affects the wildlife resource.

  ***Positive (+):*** Benefits the wildlife resource.
- **Severity:** The expected degree of change to the wildlife resource:

  *Low (L):* Affects less than 10% of the population or habitat base.

*Moderate (M):* Affects 10 - 25% of the population or habitat base.

*High (H):* Affects greater than 25% of the population or habitat base.

- **Duration:** The length of time that the environmental effect occurs:

  *Short Term (S):* Impact is expected to last less than 10 years.

  *Medium Term (M):* Impact that lasts between 10 - 25 years.

  *Long Term (L):* Impact that extends more than 25 years.

- **Geographic Extent:** The area affected by the impact:

  *Local (L):* Impact occurs within the Suncor Local Study Area.

  *Regional (R):* Impact occurs within the Suncor Regional Study Area.

  *Beyond Regional (BR):* Impact extends beyond the Regional Study Area.

Study area boundaries were selected to describe the potential impacts of the Steepbank Mine project on lands within and immediately adjacent to the Suncor leases (Local Study Area) and on the surrounding region (Regional Study Area). The boundaries for the Regional Study Area were developed in consultation with Syncrude Canada and other stakeholders, and considered a number of biophysical criteria, including watershed boundaries, ecological boundaries (based on ecological land classification criteria) and the regional airshed (based on existing air emission and deposition data). Use of a broad Regional Study Area also enabled the study team to consider potential effects of the project on wildlife species that undergo extensive movements between seasonal ranges. The criteria and process used in establishing study boundaries are more fully described in Section E of the Steepbank Mine Project Application (Suncor 1996).

In some cases, the study team was uncertain about the magnitude of the impact on a particular VEC. This uncertainty may have been related to a lack of scientific information on the status of particular VECs, on the nature of their interactions with particular project components, or to uncertainty related to the final project design and mining plan. In these cases, a range of values is provided, which reflects the precision of the assessment. The degree of confidence the study team had in the impact ratings is identified for each of the hypotheses evaluated.

Section D4.8 of the report contains a summary of the impact analysis for each of the wildlife groups identified as Valued Ecosystem Components, wildlife biodiversity, and wildlife resources use in the region. This is expressed as an overall Degree of Concern rating, which incorporates the severity, geographical extent, and duration of impact for the Construction/Operation Phase and following

Mine Closure. The overall Degree of Concern indicates the expected impact to wildlife following implementation of the mitigative measures recommended.

## D4.0 IMPACT ANALYSIS

The types and levels of impacts that will result from development of the Steepbank Mine will be different during the various project phases. For that reason, an effort was made to distinguish between impacts that would occur during the construction phase (1997 - 2000), during mine operations (2000 - 2020), and following mine closure. The latter is intended to provide a final 'snapshot' of the condition of the development area after the cessation of mining, facility decommissioning and final reclamation.

The validity of each of six hypotheses formulated during the initial assessment and scoping process is evaluated in the following section. Prior to arriving at an overall conclusion about the validity of each hypothesis, each of the component linkages (or 'links') was analyzed to determine whether a valid impact mechanism exists. Available information or data pertaining to each link was evaluated and any uncertainties or assumptions that affect the conclusions drawn by the study team were identified and stated. If, after evaluating each of the component linkages, a hypothesis was found to be valid, the resulting impact was classified according to its severity, duration, and geographic extent.

In the case of some of these hypotheses, the environmental effects may be different for each wildlife species. For convenience, each of the major faunal groups are dealt with in the following order:

1. Ungulates
2. Large Carnivores
3. Small Herbivores
4. Terrestrial Furbearers
5. Semi-aquatic Furbearers
6. Raptors
7. Terrestrial Birds
8. Waterfowl

This organization permitted consideration of impacts on prey species before considering the impact of various project components or activities on their predators. Each hypothesis begins with a background section describing the environmental components at risk and the project components or activities which could result in an impact.

## D4.1 HYPOTHESIS 18

**Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populations.**

This hypothesis evaluates the effects of Steepbank Mine development on changes in the quantity, quality or structure of habitat for wildlife species identified as VECs (Figure D4.0-1).

### D4.1.1 Linkages/Testable Hypotheses

Link 1. Construction of access roads, bridges, plant facilities and utilities corridors will result in the loss or alienation of wildlife habitat.

Link 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining activities will result in loss or alienation of wildlife habitat.

Link 3. Drainage alterations resulting from mine dewatering and stream diversion will result in the loss of wetland habitat or alter community structure and composition.

Link 4. Emissions resulting from mining operations and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats.

Link 5. Loss, alteration or alienation of habitat resulting from mine development will result in the reduced abundance of wildlife.

### D4.1.2 Background

Changes in the availability and quality of wildlife habitat could result from:

- Construction of facilities;
- Mining operations;
- Mine dewatering and drainage alteration;
- Air emissions; and
- Reclamation.

**a) Construction of Facilities**

A variety of facilities will be needed to support the Steepbank Mine project. Construction of these facilities is expected to begin in 1997 and be completed by the end of Year 2000. This report considers only the construction of facilities related to the Steepbank Mine project. Construction associated with proposed modifications to existing upgrading, utilities and bitumen production facilities at the Suncor oil sands plant are the subject of a separate regulatory application and are not dealt with in this report. The main facilities required for development of the Steepbank Mine are detailed in the Steepbank Mine Application (Suncor 1996). These include:

- **Athabasca River Bridge** - There will be a requirement to construct a bridge across the Athabasca River to provide vehicle access between Lease 86/17 and the Steepbank Mine;
- **Hydrotransport Facilities** - The proposed operation would employ hydrotransport to move oil sand from the Steepbank Mine to Suncor's extraction plant on the west side of the Athabasca River. The principal components of the hydrotransport system are a cyclofeeder station, hydrotransport pumphouse and a variety of pipelines. The cyclofeeder station, which would be fed ore from the mine via conveyor, would be located at the head of the hydrotransport system, at the south end of Lease 97; and
- **Maintenance/Office Complex** - There will be a need to construct facilities to house office space, warehouse, shop facilities for mine equipment, mine support and ancillary equipment, and a light vehicle shop on the Steepbank Mine site (Suncor 1996). The proposed location for these facilities is in the Athabasca River valley south of the proposed Athabasca Bridge.

**b) Mining Operations**

Prior to the start of mining operations, initial mining and waste dump areas will be cleared of natural vegetation using bulldozers and other heavy equipment. Over the 24 year period extending from

1997 to 2020, an estimated 3,850 hectares of land would be cleared for the Steepbank Mine (Suncor 1996). Overburden will be removed using large capacity trucks and hydraulic shovels.

Overburden will be hauled to waste dumps for disposal or used to construct dykes for tailings ponds. Once mining operations are underway, mined out pits will be used for the storage of Consolidated Tailings. The mine plan details four out-of-pit overburden dumps, two of which would be placed along the escarpment of the Athabasca River valley and two of which would be placed in upland areas. A network of temporary and permanent access roads will be constructed in the development area in support of mining operations. It has been estimated that over a 20 year period, approximately 30 km of permanent roads and 125 km of temporary roads would be constructed (Suncor 1996). The locations of temporary access roads will change as mining proceeds.

**c) <u>Mine Dewatering</u>**

Mine development will include the implementation of a mine drainage program to intercept and divert clean runoff around the mine site and to collect contaminated runoff from the mine area itself. The program will be in place between the year 2000 and 2020. A preliminary mine drainage plan has been developed consisting of a series of diversion channels around much of the perimeter of the mine site and a series of channels and retention basins to collect runoff from mine areas and overburden dumps.

Most of the mine area currently drains westward into the Athabasca River. This occurs primarily through five small watercourses, the largest of which is Wood Creek, situated at the south end of the mine site. In addition to these five streams, a number of small microdrainages contribute intermittent runoff to the Athabasca River from the escarpment and western perimeter of the mine area.

Mine drainage would involve diversion or alteration to each of these four drainages. Creek 1, which drains the area that would be encompassed by Pit 1, would disappear entirely. Unnamed Creek (Creek 2) presently flows westward across the proposed mine site near the southern limit of Pit 1, into Shipyard Lake. The lower portion of the creek would be diverted into the south diversion ditch for the Centre Pit. The present drainage plan would also involve diverting the upper reaches of Unnamed Creek southward into Wood Creek. Creek 3, which presently flows into the south end of Shipyard Lake, would also disappear in its entirety with mining of Pit 2. Much of the lower portion of Leggett Creek would also disappear with development of the Pit 2 and Overburden Dump 4. The upper reaches of Leggett Creek would be diverted southward along the southeast interception channel into Wood Creek. Wood Creek would be relatively unaffected by mine development, except at its lower reach, where the natural channel would be used to carry runoff received from the southeast interception channel.

#### d) <u>Air Emissions</u>

The construction and operation of oil sands facilities results in the release of a number of pollutants, which include sulphur dioxide ($SO_2$), volatile organic compounds (VOCs), carbon dioxide ($CO_2$), oxides of nitrogen ($NO_x$), hydrogen sulphide ($H_2S$), and particulates. Some of these compounds have the potential to affect vegetation growth and survival, which could in turn affect habitat suitability for wildlife. The effects of air emissions on vegetation in the Suncor Local Study Area are evaluated in the Terrestrial Resources Impact Analysis (Golder 1996b).

#### e) <u>Reclamation</u>

The reclamation of disturbed areas is an integral component of Suncor's operations. Specific objectives include the control of erosion and the establishment of viable native plant communities; however, the overall goal of the reclamation program is the establishment of maintenance-free, self-sustaining ecosystems which have equivalent capability to the ecosystems that were present prior to disturbance. The program has several components, which include recontouring and revegetation to reflect natural landscape and vegetation patterns, the creation of wetlands in Consolidated Tailings ponds, and the establishment of drainage patterns similar in function to those present prior to mine establishment.

### D4.1.3 Evaluation of Linkages

#### a) <u>Link 1</u>

**Construction of access roads, bridges, plant facilities and utilities corridors will result in the loss or alienation of wildlife habitat.**

Habitat losses for wildlife are based on predicted changes in vegetation cover through mine advance as described in the Suncor Mine Advance Plan and Cumulative Effects Assessment (Golder 1996d). The data used in calculating the habitat changes are provided in Appendix I.

In evaluating Link 1, it has been assumed that during construction, noise and human disturbance are likely to result in the reduced use of adjacent habitat. Based on a review of literature, it has been assumed than the zone of habitat likely to be affected will extend 250 m from the disturbance for most groups of wildlife. This effect is due to the influence of a number of factors, including sensory disturbance (see Section D4.2), reduced hiding and thermal cover values, reduced palatability of forage due to dust accumulation, and, in the case of birds, increased risk of nest predation by invading edge species.

**i. *Ungulates***

During the construction phase of the Steepbank Mine Project, 4% (300 ha) of the good to excellent moose habitat in the Suncor Local Study Area will be lost to the development of various facilities required for mining operations (Tables D4.0-1 and D4.0-2; Figure D4.0-2). A breakdown of these losses indicates that most losses of high quality moose habitat will occur in the valley and escarpment of the Athabasca River valley, with smaller losses occurring on upland sites. Habitat loss due to construction will affect 8% (247 ha) of the good and excellent moose habitat in the valley and escarpment areas as compared with only 1% of these habitats (53 ha) on upland sites. During the February 1995 aerial survey, 6 of 50 moose observed in the Suncor study area east of the Athabasca River were recorded in the portion of the valley that would be directly affected by facility construction. It is therefore concluded that link 1 is valid for moose.

**ii. *Terrestrial Furbearers/Small Herbivores***

Clearing of forested habitat for facilities construction will result in loss of habitat for both red-backed voles and snowshoe hares. Because both species are important prey for a variety of terrestrial furbearers, habitat values for these species were included in the assessment of habitat suitability for terrestrial furbearers.

The construction phase of the Steepbank Mine project will result in the loss of 2% (518 ha) of the good to excellent terrestrial furbearer habitat in the Suncor Local Study Area (Tables D4.0-3 and D4.0-4; Figure D4.0-3). Most of losses of high quality furbearer habitat will take place in escarpment and floodplain areas, where 422 ha (7%) of the good and excellent habitat for furbearers will be lost. In comparison, only 96 ha (<1%) of the good and excellent furbearer habitat will be lost in upland landscapes. These losses will be offset to some extend by reclamation of lease 86/19, which will reclaim 262 ha of good furbearer habitat during the construction period.

**Table D4.0-1** Habitat losses and gains (ha) for moose in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| Terrain Class | Suitability Classes | 1995 | 2001 | 2020 | Longterm |
| Riparian | | | | | |
| | Class 1 - Excellent | 0 | -211 | -718 | 202 |
| | Class 2 - Good | 0 | 0 | 0 | 21 |
| | Class 3 - Moderate | 0 | -48 | -160 | -47 |
| | Class 4 - Poor | 0 | -178 | -112 | -188 |
| | Class 5 - Very Poor | 0 | 122 | 229 | 17 |
| | **Subtotal Area** | **0** | **-315** | **-761** | **5** |
| Escarpment | | | | | |
| | Class 1 - Excellent | 0 | -34 | -382 | 137 |
| | Class 2 - Good | 0 | -2 | -13 | 560 |
| | Class 3 - Moderate | 0 | -16 | -305 | -281 |
| | Class 4 - Poor | 0 | -57 | -211 | -449 |
| | Class 5 - Very Poor | 0 | 79 | 888 | 6 |
| | **Subtotal Area** | **0** | **-30** | **-24** | **-27** |
| Upland | | | | | |
| | Class 1 - Excellent | 0 | -30 | -65 | 35 |
| | Class 2 - Good | 0 | -23 | -60 | 301 |
| | Class 3 - Moderate | 0 | -33 | -671 | -449 |
| | Class 4 - Poor | 0 | -90 | -627 | -252 |
| | Class 5 - Very Poor | 0 | 28 | 883 | 227 |
| | **Subtotal Area** | **0** | **-148** | **-540** | **-138** |
| Suncor Leases 86/17 | | | | | |
| | Class 1 - Excellent | 0 | 0 | 34 | 34 |
| | Class 2 - Good | 0 | 0 | 384 | 1526 |
| | Class 3 - Moderate | 0 | -9 | 20 | 229 |
| | Class 4 - Poor | 0 | 262 | 969 | 457 |
| | Class 5 - Very Poor | 0 | -253 | -1407 | -2246 |
| | **Subtotal Area** | **0** | **0** | **0** | **0** |

**Table D4.0-2.** Habitat losses and gains (% change) for moose in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| Terrain Class | Suitability Classes | 1995 | 2001 | 2020 | Longterm |
| Riparian | | | | | |
| | Class 1 - Excellent | 0 | -16 | -55 | 15 |
| | Class 2 - Good | 0 | 0 | 0 | 209900 |
| | Class 3 - Moderate | 0 | -7 | -23 | -7 |
| | Class 4 - Poor | 0 | -11 | -7 | -12 |
| | Class 5 - Very Poor | 0 | 134 | 251 | 19 |
| | **Subtotal** | **0** | **100** | **166** | **209916** |
| Escarpment | | | | | |
| | Class 1 - Excellent | 0 | -2 | -23 | 8 |
| | Class 2 - Good | 0 | -3 | -21 | 888 |
| | Class 3 - Moderate | 0 | -2 | -43 | -40 |
| | Class 4 - Poor | 0 | -4 | -13 | -28 |
| | Class 5 - Very Poor | 0 | 1470 | 16538 | 111 |
| | **Subtotal** | **0** | **1459** | **16437** | **939** |
| Upland | | | | | |
| | Class 1 - Excellent | 0 | -1 | -2 | 1 |
| | Class 2 - Good | 0 | -1 | -2 | 12 |
| | Class 3 - Moderate | 0 | 0 | -10 | -7 |
| | Class 4 - Poor | 0 | -1 | -4 | -2 |
| | Class 5 - Very Poor | 0 | 20 | 636 | 163 |
| | **Subtotal** | **0** | **17** | **617** | **168** |
| Suncor Leases 86/17 | | | | | |
| | Class 1 - Excellent | 0 | 0 | 110 | 110 |
| | Class 2 - Good | 0 | 0 | 19200 | 76300 |
| | Class 3 - Moderate | 0 | -5 | 11 | 129 |
| | Class 4 - Poor | 0 | 21 | 77 | 36 |
| | Class 5 - Very Poor | 0 | -11 | -58 | -93 |
| | **Subtotal** | **0** | **5** | **19339** | **76482** |

**Table D4.0-3.** Habitat losses and gains (ha) for terrestrial furbearers in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| **Terrain Class** | **Suitability Classes** | **1995** | **2001** | **2020** | **Longterm** |
| **Riparian** | | | | | |
| | Class 1 - Excellent | 0 | -211 | -718 | 202 |
| | Class 2 - Good | 0 | -131 | -86 | -161 |
| | Class 3 - Moderate | 0 | -47 | -26 | -6 |
| | Class 4 - Poor | 0 | -48 | -160 | -47 |
| | Class 5 - Very Poor | 0 | 122 | 229 | 17 |
| | **Subtotal Area** | **0** | **-315** | **-761** | **5** |
| **Escarpment** | | | | | |
| | Class 1 - Excellent | 0 | -16 | -93 | -94 |
| | Class 2 - Good | 0 | -64 | -623 | -344 |
| | Class 3 - Moderate | 0 | -27 | -154 | 418 |
| | Class 4 - Poor | 0 | -3 | -42 | -14 |
| | Class 5 - Very Poor | 0 | 79 | 888 | 6 |
| | **Subtotal Area** | **0** | **-30** | **-24** | **-27** |
| **Upland** | | | | | |
| | Class 1 - Excellent | 0 | -4 | -40 | -19 |
| | Class 2 - Good | 0 | -92 | -1145 | -766 |
| | Class 3 - Moderate | 0 | -65 | -209 | 280 |
| | Class 4 - Poor | 0 | -14 | -29 | 140 |
| | Class 5 - Very Poor | 0 | 28 | 883 | 227 |
| | **Subtotal Area** | **0** | **-148** | **-540** | **-138** |
| **Suncor Leases 86/17** | | | | | |
| | Class 1 - Excellent | 0 | 0 | 0 | 0 |
| | Class 2 - Good | 0 | 262 | 944 | 432 |
| | Class 3 - Moderate | 0 | 0 | 443 | 1686 |
| | Class 4 - Poor | 0 | -9 | 20 | 128 |
| | Class 5 - Very Poor | 0 | -253 | -1407 | -2246 |
| | **Subtotal Area** | **0** | **0** | **0** | **0** |

**Table D4.0-4.** Habitat losses and gains (% change) for terrestrial furbearers in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| **Terrain Class** | **Suitability Classes** | **1995** | **2001** | **2020** | **Longterm** |
| **Riparian** | | | | | |
| | Class 1 - Excellent | 0 | -16 | -55 | 15 |
| | Class 2 - Good | 0 | -9 | -6 | -11 |
| | Class 3 - Moderate | 0 | -30 | -17 | -4 |
| | Class 4 - Poor | 0 | -7 | -23 | -7 |
| | Class 5 - Very Poor | 0 | 134 | 251 | 19 |
| | **Subtotal** | **0** | **72** | **150** | **12** |
| **Escarpment** | | | | | |
| | Class 1 - Excellent | 0 | -7 | -39 | -39 |
| | Class 2 - Good | 0 | -2 | -20 | -11 |
| | Class 3 - Moderate | 0 | -5 | -29 | 79 |
| | Class 4 - Poor | 0 | -1 | -22 | -7 |
| | Class 5 - Very Poor | 0 | 1470 | 16538 | 111 |
| | **Subtotal** | **0** | **1455** | **16428** | **133** |
| **Upland** | | | | | |
| | Class 1 - Excellent | 0 | 0 | -3 | -2 |
| | Class 2 - Good | 0 | -1 | -7 | -5 |
| | Class 3 - Moderate | 0 | -1 | -3 | 4 |
| | Class 4 - Poor | 0 | -1 | -2 | 9 |
| | Class 5 - Very Poor | 0 | 20 | 636 | 163 |
| | **Subtotal** | **0** | **17** | **622** | **170** |
| **Suncor Leases 86/17** | | | | | |
| | Class 1 - Excellent | 0 | 0 | 0 | 0 |
| | Class 2 - Good | 0 | 21 | 75 | 34 |
| | Class 3 - Moderate | 0 | 0 | 1197 | 4557 |
| | Class 4 - Poor | 0 | -5 | 12 | 74 |
| | Class 5 - Very Poor | 0 | -11 | -58 | -93 |
| | **Subtotal** | **0** | **5** | **1225** | **4572** |

It is therefore concluded that link 1 is valid for terrestrial furbearers and small herbivores, although habitat losses would be small.

iii. *Semi-Aquatic Furbearers*

Based on information contained in CIRC (1995) and Skinner and Brusnyk (1996), facilities construction will not directly affect any streams or lakes that provide suitable habitat for beavers or otters. It is therefore concluded that Link 1 is invalid for these species.

iv. *Breeding Birds*

The construction phase of the Steepbank Mine project will result in the direct loss of 678 ha (2%) of the good to excellent habitat for breeding birds in the Suncor Local Study Area (Tables D4.0-5 and D4.0-6; Figure D4.0-4). Among landscape features, the loss of excellent and good quality habitat is most severe in escarpment and floodplain areas, where 7% (541 ha) of the high quality habitat for breeding birds will be lost. In comparison, less than 1% (137 ha) of the good and excellent breeding bird habitat will be lost in upland landscapes. Activities on Lease 86/17 will result in additional loss of 12 ha of good to excellent breeding bird habitat. It is therefore concluded that Link 1 is valid for breeding birds.

v. *Waterfowl*

Facilities construction is not expected to directly affect any important breeding or staging habitat for waterfowl. Link 1 is therefore assumed to be invalid for waterfowl.

b) <u>Link 2</u>

**Site clearing, overburden stripping, waste disposal, and other activities associated with mining activities will result in loss or alienation of wildlife habitat.**

As in the case of Link 1, the evaluation for Link 2 assumes that during mining operations, noise and human disturbance are likely to result in the reduced use of adjacent habitat. It has therefore been assumed that the zone of disturbance will extend 250 m from the affected area.

**Table D4.0-5.** Habitat losses and gains (ha) for breeding birds in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| **Terrain Class** | **Suitability Classes** | **1995** | **2001** | **2020** | **Longterm** |
| **Riparian** | | | | | |
| | Class 1 - Excellent | 0 | -317 | -1169 | 27 |
| | Class 2 - Good | 0 | -120 | -52 | -55 |
| | Class 3 - Moderate | 0 | 0 | 231 | 16 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | 122 | 229 | 17 |
| | **Subtotal Area** | **0** | **-315** | **-761** | **5** |
| **Escarpment** | | | | | |
| | Class 1 - Excellent | 0 | -4 | -117 | -90 |
| | Class 2 - Good | 0 | -100 | -994 | -460 |
| | Class 3 - Moderate | 0 | -4 | 199 | 517 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | 79 | 888 | 6 |
| | **Subtotal Area** | **0** | **-30** | **-24** | **-27** |
| **Upland** | | | | | |
| | Class 1 - Excellent | 0 | -27 | -54 | 115 |
| | Class 2 - Good | 0 | -110 | -2019 | -749 |
| | Class 3 - Moderate | 0 | -39 | 650 | 270 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | 28 | 883 | 227 |
| | **Subtotal Area** | **0** | **-148** | **-540** | **-138** |
| **Suncor Leases 86/17** | | | | | |
| | Class 1 - Excellent | 0 | -9 | 68 | 174 |
| | Class 2 - Good | 0 | -3 | 324 | 1189 |
| | Class 3 - Moderate | 0 | 265 | 1015 | 883 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | -253 | -1407 | -2246 |
| | **Subtotal Area** | **0** | **0** | **0** | **0** |

**Table D4.0-6.** Habitat losses and gains (% change) for breeding birds in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| **Terrain Class** | **Suitability Classes** | **1995** | **2001** | **2020** | **Longterm** |
| **Riparian** | | | | | |
| | Class 1 - Excellent | 0 | -11 | -41 | 1 |
| | Class 2 - Good | 0 | -17 | -7 | -8 |
| | Class 3 - Moderate | 0 | 0 | 401 | 28 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | 134 | 251 | 19 |
| | **Subtotal** | **0** | **106** | **604** | **40** |
| **Escarpment** | | | | | |
| | Class 1 - Excellent | 0 | -1 | -21 | -16 |
| | Class 2 - Good | 0 | -3 | -30 | -14 |
| | Class 3 - Moderate | 0 | -2 | 99 | 257 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | 1470 | 16538 | 111 |
| | **Subtotal** | **0** | **1464** | **16585** | **338** |
| **Upland** | | | | | |
| | Class 1 - Excellent | 0 | -1 | -1 | 3 |
| | Class 2 - Good | 0 | -1 | -11 | -4 |
| | Class 3 - Moderate | 0 | -1 | 12 | 5 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | 20 | 636 | 163 |
| | **Subtotal** | **0** | **18** | **635** | **167** |
| **Suncor Leases 86/17** | | | | | |
| | Class 1 - Excellent | 0 | -5 | 39 | 101 |
| | Class 2 - Good | 0 | -1 | 92 | 338 |
| | Class 3 - Moderate | 0 | 28 | 108 | 94 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 0 | -11 | -58 | -93 |
| | **Subtotal** | **0** | **12** | **180** | **439** |

During the mining operation, 3,850 ha of forest located primarily above the escarpment will be lost due to mine development. This represents a substantial loss of habitat for several wildlife species and especially those that depend on coniferous-dominated, peatland habitats.

Apart from the direct habitat losses associated with site clearing and mining operations, habitat losses through habitat fragmentation or alienation will be minimized as a result of the proposed layout for the Steepbank Mine. Overburden dumps, mine pits, tailings ponds, and other mine facilities are compactly arranged rather than widely dispersed; consequently, there would be little additional loss of habitat resulting from alienation of patches of residual habitat within the mine area itself.

**i.** ***Moose***

Seventeen percent (1,238 of 7,099 ha) of the good and excellent moose habitat in the Suncor Local Study Area will be lost during mining operations (Tables D4.0-1 and D4.0-2; Figure D4.0-2) although 418 ha will be restored on lease 86/17. Thus, mining operations will result in the loss of an additional 938 ha (13%) over that lost during the construction period. The most significant loss of good and excellent moose habitat will occur in the floodplain and escarpment of the Athabasca River valley. In this area, 37% (1,113 ha) of the good and excellent moose habitat will be lost to facilities construction and mine operations. In contrast, only 2% (125 ha) of the good and excellent moose habitat in upland areas will be lost to the Steepbank Mine development.

During aerial surveys conducted in February and December 1995, 28 and 31%, respectively, of the moose recorded in the Local Study Area east of the Athabasca River were observed on sites that would be affected by mine development and overburden storage. It is therefore concluded that Link 2 is valid for moose.

Following reclamation of the Steepbank Mine and Lease 86/17, there would be an overall increase in the extent of good to excellent moose habitat compared to 1995. The amount of good to excellent moose habitat in the Suncor Local Study Area would increase by 2,816 ha, whereas the amount of moderate habitat and the amount of poor to very poor moose habitat would decrease by 548 and 2,428 ha, respectively.

**ii.** ***Terrestrial Furbearers/Small Herbivores***

As in the case of Link 1, small herbivores were combined with terrestrial furbearers to assess changes in habitat availability.

During the operations phase, the Steepbank Mine project will result in the loss of 13% (2,705 of 21,344 ha) of the good to excellent terrestrial furbearer habitat in the Suncor Local Study Area, whereas reclamation of Lease 86/17 would result in an additional 944 ha of good furbearer habitat (Tables D4.0-3 and D4.0-4; Figure D4.0-3). This loss represents a loss of 2,187 ha over that due to construction. Most losses of high quality furbearer habitat will take place in escarpment and floodplain areas. In that area, 25% (1,520 ha) of the high quality habitat for furbearers will disappear as a result of the development of the Steepbank Mine. In comparison, only 7% (1,185 of 17,978 ha) of the good and excellent furbearer habitat will be lost in upland landscapes. It is therefore concluded that Link 2 is valid for terrestrial furbearers and small herbivores.

Following reclamation of the Steepbank Mine and Lease 86/17, there would be an overall increase in the extent of excellent furbearer habitat and a decrease in good habitat compared to 1995. After reclamation, the amount of excellent terrestrial furbearer habitat in the Suncor Local Study Area would increase by 89 ha, whereas the amount of good habitat would decrease by 839 ha. In contrast, the amount of moderate furbearer habitat would increase by 3,378 ha.

**iii.** ***Semi-Aquatic Furbearers***

Most habitat losses as result of mining operations will occur above the escarpment, although some valley areas, such as Shipyard Lake, will be affected by overburden storage. Mining development in upland landscapes will result in the loss of some moderate to poor quality habitat for beavers, which are known to be present in the area. Similarly, overburden storage near Shipyard Lake, which provides excellent habitat for beavers, could also result in the direct loss of beaver habitat. Based on surveys conducted by CIRC (1995), which indicate that the Suncor study area east of the Athabasca River supports 82 beaver colonies (0.24 colonies/$km^2$), it is assumed that development of the Steepbank Mine will result in the loss of approximately 9 beaver colonies. It is therefore concluded that Link 2 is valid for beavers.

Tracking studies conducted during 1995 indicated that otters are uncommon in the Suncor study area. No tracks were recorded in areas that would be directly affected by mining operations (Skinner and Brusnyk 1996). However, beaver impoundments in the development area may provide suitable denning or foraging habitat for this species (Melquist and Dronkert 1987); it is also possible that drainages in the mining area are utilized by dispersing otters. However, because it is unknown if otters use these areas, the validity of Link 2 is unknown for this species.

iv. *Terrestrial Birds*

During the operations phase, the Steepbank Mine project will result in the loss of 18% (4,405 of 24,441 ha) of the good to excellent habitat for breeding birds in the Suncor Local Study Area (Tables D4.0-5 and D4.0-6; Figure D4.0-4). This represents a loss of 3,727 ha over that as a result of facilities construction, although reclamation on Lease 86/17 will result in an increase of 392 ha of good and excellent habitat in the area west of the Athabasca River. Among landscape features, the loss of excellent and good quality habitat is most severe in escarpment and floodplain areas. In these areas, 31% (2,332 ha) of the high quality habitat for breeding birds will be lost due to the development of the Steepbank Mine. In comparison, 9% (2,073 ha) of the good and excellent breeding bird habitat will be lost in upland landscapes. It is therefore concluded that Link 2 is valid for breeding birds.

Following reclamation of the Steepbank Mine and Lease 86/17, the extent of good to excellent terrestrial bird habitat would increase by 151 ha over 1995 levels. In contrast the amount of moderate habitat for birds would increase by 1,686 ha.

vi. *Waterfowl*

Within the area that will be directly affected by mining operations, beaver impoundments provide most of the habitat for breeding waterfowl. Based on the results of aerial surveys for breeding waterfowl, which indicated that beaver impoundments supported 9.75 breeding pairs of waterfowl/km of shoreline, it is estimated that mining operations will remove habitat for approximately 130 pairs of breeding ducks and that an additional 40 pairs could be lost as a result of the overburden dump at Shipyard Lake. These losses are considered small because they will affect less than 10% of the estimated 1,800 waterfowl breeding pairs that breed in the Local Study Area. Link 2 is therefore assumed to be valid for waterfowl.

Following reclamation some wetland habitat will be established on the CT ponds and surface drainage channels will be established on the mine area. The length of these re-established channels will exceed the present length of streams that will be lost through diversion (Figure D4.0-5). Once these channels are recolonized by beaver, it is likely that waterfowl production will approach baseline levels.

c) <u>Link 3</u>

**Drainage alterations resulting from mine dewatering and stream diversion will result in loss of wetland habitat or alter community structure and composition.**

There are three primary concerns related to the probable effects of the mine drainage program on wildlife:

- Loss or alteration of aquatic and riparian habitat along the five stream courses that presently intersect the mine area;
- Loss or alteration of floodplain wetland habitat, particularly Shipyard Lake; and
- Changes in the structure and composition of terrestrial habitats adjacent to the mine area due to reductions in water table.

As described previously, a mine drainage program would have to be implemented to divert surface runoff around the working area of the mine and to collect contaminated runoff waters from the mine site itself. With the exception of the northern part of the mine area, most of the mine area consists of relatively flat peatland that is poorly to very poorly drained. These areas are characterized by organic soils (Muskeg and McLelland Map Units) and support a mixture of treed fens and bogs. Five small streams that currently flow westward across the mine area would be diverted or extensively modified by the proposed development (Figure 4.0-5). Creeks 1 and 3 would be lost entirely to mine development. The lower portion of Unnamed Creek would be lost and flows in the upper reaches would be reduced through diversion. The lower half of Leggett Creek would be lost and flows in the upper reach would be diverted southward into Wood Creek. Wood Creek would be unaffected by mine development except at the lower reach, where the natural channel would be used to carry runoff from the southeast diversion ditch.

Cooperative research conducted by Forestry Canada and the Alberta Forest Service in the 1980s to determine the feasibility of employing peatland drainage to improve coniferous tree growth (Hillman and Johnson 1990, Hillman 1991, Mugasha et al. 1993) provide a basis for understanding the probable effects of mine drainage on adjacent habitats. These authors examined the changes in vegetation that resulted from drainage of forested peatlands in several areas of Alberta's boreal mixedwood region. Although the results differed somewhat from site to site, a number of pronounced changes in community structure and composition were observed including increased growth of alder, willow, birch, aspen and balsam poplar; and reduced growth of ground vegetation, particularly species preferring wetter site conditions.

Over the long term, mine drainage could result in the conversion of shrub-dominated wetlands and black spruce-tamarack forest to upland coniferous and deciduous forest types. However, the proportion of the Local Study Area affected by off-site water table changes may not be large. Hydrogeological studies have shown that, south of the Steepbank River, the direction of groundwater flow is to the west, into the Athabasca River Valley (Klohn-Crippen 1995b). This reflects the topography of the mine area, which gently slopes westward toward the Athabasca River. For that reason, most of the landscape affected by the mine drainage program would be within the mine area itself. The greatest effects would likely occur in the portion of the mine area situated between Pits 1 and 2, which is presently drained by Unnamed Creek. The proposed drainage plan for the year 2015 would entail the construction of a diversion ditch into the headwaters of Unnamed Creek, east of the mine area. This could lower the water table in the area between the diversion ditch and the mine area, which could potentially affect approximately 214 ha of Open Black Spruce/Labrador Tea and Closed Black Spruce/Tamarack habitat. Although it is not known for certain how far drainage effects would extend from the mine, D. Thomson (Klohn-Crippen, pers. comm.) indicates that overburden stripping could influence the water table as far as 300 m from the affected area.

The proposed mine drainage plan could also affect the hydrology and ecological conditions within Shipyard Lake. Shipyard Lake has been described as "a marsh-swamp-shallow open-water complex that is periodically flooded by the Athabasca River" (Klohn-Crippen 1995a). A hydraulic assessment of the wetland (Klohn-Crippen 1996) indicates that the wetland receives surface water inflow from two unnamed creeks that drain the upland area to the east of the wetland and that groundwater flow into the wetland is minimal.

The effects of mine development on Shipyard Lake are assessed in the Terrestrial Resources Impact Assessment (Golder 1996b). Shipyard Lake will be affected by establishment of an overburden dump on the eastside and by input of discharge water from the mine. It was estimated that 42 ha

(28%) of the wetland would be lost as a result of the overburden pile. Most of this (38 ha) is presently composed of closed shrub vegetation. Although measures will be implemented to prevent flooding due to inflow of mine discharge water, the water retention time and nutrient inputs to the wetland are expected to change. These changes could alter the suitability of wetland habitat in Shipyard Lake for wildlife, although the extent of change is difficult to predict.

Reclamation of the Steepbank Mine development will involve the development of drainage channels designed to replicate natural drainage systems (Suncor 1996). Under the reclamation plan, the extent of drainages channels in the area of the Steepbank Mine would increase substantially over that at present after the mine ceased operations.

**i.** ***Moose***

Moose are often associated with drainages and wetlands, which frequently produce a high biomass of woody browse. During aerial surveys of the Suncor study area conducted in 1995, moose were commonly observed in these habitats. Moose also sometimes forage in lakes and ponds to obtain emergent and submergent wetland vegetation (Fraser et al. 1980); however, with the exception of Shipyard Lake, most of the wetlands that would be affected by mine development do not appear to provide aquatic foraging opportunities. It is likely that the alteration of drainage patterns in the mining area will result in the loss of riparian shrub communities, therefore Link 3 is considered valid for moose.

**ii.** ***Large Carnivores***

In northeastern Alberta, the highest density of black bears is found in deciduous and mixedwood forest, whereas poorly-drained muskeg supports few bears (Young 1978). It is therefore unlikely that the loss of streams and wetlands as a result of mining operations will directly affect black bears; however, the conversion of muskeg to upland forest could increase the amount of high quality habitat available for black bears. In contrast, the loss of wetlands and concomitant reduction of beaver populations could adversely affect wolves. Fuller and Keith (1980) indicated that beavers, which were present in 13 to 52% of all wolf scats analyzed, were an important prey item for wolves during summer. Link 3 is therefore considered invalid for black bears, but valid for wolves.

### iii. *Small Herbivores*

There is little evidence that snowshoe hares in northeastern Alberta are associated with riparian habitat types. Studies conducted in the Suncor study area in 1995 indicated that the snowshoe hares was less common in shrub complexes, which were often associated with wetland and riparian habitats (Skinner and Brusnyk 1996). Link 3 is therefore considered invalid for the snowshoe hare.

Miller and Getz (1973) indicate that the red-backed vole, which apparently has trouble maintaining its water balance, is often associated with streams and wetlands. Link 3 is therefore assumed to be valid for this species.

### iv. *Terrestrial Furbearers*

There is little evidence marten or lynx are associated with wetland or riparian habitat types. Marten usually occur in mature mixedwood and coniferous forests (Hargis and McCullogh 1984, Slough 1989), whereas lynx are associated with habitats in which snowshoe hares are abundant (Koehler and Aubry 1994). In contrast, Douglas and Strickland (1987) reported that the territories of fishers in Ontario are often aligned with drainages. It is therefore assumed that Link 3 is valid for fishers and invalid for marten and lynx. Our knowledge of the habitat requirements of wolverines is insufficient to evaluate the effects of drainage alterations on that species.

### v. *Semi-Aquatic Furbearers*

Based on surveys by CIRC (1995), it is estimated habitat alterations to wetlands and streams could result in the loss of approximately 9 beaver colonies in the mining area. Consequently, Link 3 is considered valid for beavers. However, because it is unknown if the development area provides habitat for otters, the validity of Link 3 is unknown for this species.

### vi. *Raptors*

Although bald eagles consume fish (Gerrard et al. 1992, Semenchuk 1992), no fish are known to occur in wetlands that will be affected by mine development. In contrast, it is possible that drainage of mining areas will result in changes in the species composition of prey available to great gray owls; however, the impact of any such changes are unknown. Link 3 is therefore considered invalid for bald eagles, but unknown for the great gray owl.

**vii.** ***Terrestrial Birds***

Although the loss or alteration of wetland habitat will result in reduced habitat availability for some species of terrestrial birds, it is not likely to affect the ruffed grouse, which depends on aspen forest to meet its habitat requirements (Rusch and Keith 1971, Gullion 1984). In contrast, the alteration of habitat could affect a number of species of terrestrial songbirds, which are considered VECs in this assessment. Link 3 is therefore assumed to be invalid for the ruffed grouse but valid for terrestrial songbirds.

**viii.** ***Waterfowl***

As mentioned in the previous section (Link 2), the loss of beaver impoundments in the mining area and disturbance to Shipyard Lake could result in the loss of habitat for approximately 170 breeding pairs of ducks. Consequently, Link 3 is considered valid for waterfowl.

**d)** **Link 4**

**Emissions resulting from mining operations and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats.**

Biomonitoring studies being conducted in the region by Syncrude Canada Ltd. have shown that both coniferous and deciduous vegetation in the vicinity of the Syncrude and Suncor plants have been affected by $SO_2$ emissions (Hardy Associates 1985, Hardy BBT 1991, BOVAR Environmental 1996). The symptoms include physiological stress and defoliation. Research has shown that some species are more sensitive to air emissions than others. Jack pine, white birch, and tamarack are known to be highly sensitive to sulphur dioxide stress, whereas aspen and balsam poplar are moderately sensitive, and white spruce and black spruce are relatively tolerant (Malhotra and Blauel 1980). It is therefore conceivable that over time selective mortality or reduced growth of less tolerant species could result in changes in community structure and composition that could affect wildlife.

These biomonitoring studies have shown that the area affected by $SO_2$ exposure is concentrated within the Athabasca River Valley and adjoining tributaries, including the lower reaches of the Steepbank River. One of the most heavily exposed areas is the portion of the Athabasca River valley adjacent to the proposed Steepbank Mine. In that region, $SO_2$ emissions have resulted in ambient $SO_2$ levels that sometimes exceed ambient guidelines (BOVAR Environmental 1996).

In 1994, Suncor began incorporating new technology to reduce sulphur dioxide emissions. Improvements implemented in 1994 reduced sulphur dioxide emissions from the upgrader by one-half, improving recovery from 96% to 98% and a series of process improvements throughout the upgrading plant further decreased emissions by reducing flared or upset conditions. In 1996, a flue gas desulphurization (FGD) project will be completed, which will eliminate 95% of the $SO_2$ emissions from the utilities plant. In conjunction with improvements in the upgrader, the FGD project will reduce plant-wide $SO_2$ emissions by 75% from current levels. Daily emission rates of $SO_2$ are expected to decrease from 230 tonnes per day that occur currently to 51 tonnes per day. As part of the Terrestrial Resources Impact Analysis for the Steepbank Project, Golder Associates conducted a comprehensive evaluation of the potential effects of emissions on vegetation in the Suncor study area (Golder, 1996b). They found that, although effects on vegetation have been observed in the area that are likely attributable to emissions of sulphur compounds, no causal relationship has been quantified with respect to the pattern and concentration of $SO_2$ emissions from oil sands plants and vegetation responses. It was concluded that, with the predicted reductions in overall air emissions by 2001, no additional impacts on vegetation in the Local or Regional Study Areas are likely. The areal extent of areas that are currently affected by high $SO_2$ concentrations is expected to decrease dramatically. The predicted decreases in $SO_2$ emissions would also reduce the risk of long-term acidification of soils and aquatic ecosystems. On the basis of the vegetation impact analyses, it was concluded that emissions associated with Steepbank Mine development will not have an incremental impact on wildlife habitat in the study area and that link 4 is invalid for all VECs.

e) Link 5

**Loss or alienation of habitat resulting from mine development will result in the reduced abundance of wildlife.**

The degree to which habitat losses resulting from mine development will affect wildlife populations will depend on a number of factors, including the quantity and quality of habitat that will be lost, the availability and quality of alternative habitat, and the potential for animal displacement to cause overcrowding and increased competition for food, nest sites, or other resources in adjacent habitats. Loss of relatively low quality habitat would likely have less effect at the population level, than would loss of preferred winter range, important calving or nesting habitat, or habitat that comprises part of an important migration route. Animals with very large home ranges may be better able to cope with localized habitat losses than species that have small home ranges.

**i.** ***Moose***

Based on 1995 aerial survey results, it is believed that the direct loss of habitat from facility construction and mining operations will affect at least 20% moose in the Local Study Area. Of greatest concern is the loss of riparian shrub and closed deciduous habitat on the floodplain and escarpment of the Athabasca River valley. In addition to direct habitat losses, there is potential for mine development to cause fragmentation and alienation of floodplain habitat between the mine site and the Athabasca River. Link 5 is therefore considered valid for moose.

**ii.** ***Large Carnivores***

Because moose are the principal prey of wolves in northeastern Alberta (Fuller and Keith 1980), the impact of facilities construction and mine development on wolves is likely to reflect their impact on moose populations. Similarly, based on information presented in Young (1978), the loss of deciduous and mixedwood forest as a result of the mining development could remove habitat for approximately 7 black bears. Link 5 is therefore assumed to be valid for wolves and black bears.

**iii.** ***Small Herbivores***

Snowshoe hare populations in the Suncor study area are extremely low at the present time; however, during cyclic population highs, snowshoe hares often saturate high quality habitat, resulting in the displacement of individuals into adjacent areas. Because this effect could be exacerbated by mine development and result in increased mortality, Link 5 is considered valid for this species.

Because red-backed voles seldom undergo extensive movements, they are susceptible to local population declines as a result of habitat alteration or loss. Consequently Link 5 is assumed to be valid for the red-backed vole.

**iv.** ***Terrestrial Furbearers***

Because lynx rely heavily on snowshoe hares for prey, population dynamics of lynx reflect those of snowshoe hares (Brand et al., Brand and Keith 1979). Consequently, competition for resources between displaced and resident lynx may become a mortality factor if lynx saturate suitable habitats during periods of abundance. Loss of denning habitat could also affect lynx, which prefer to den where woody debris is available. In the Suncor Local Study Area, most of the mature forests, which usually provide more debris than other forest types, is within the Athabasca River valley. Link 5 is therefore assumed to be valid for lynx.

Facility construction and mining operations would result in the loss or alteration of approximately 560 ha of white spruce and mixed coniferous forest, which provides much of the suitable habitat for marten in the study area. Because this species exhibits a high degree of habitat specificity, these losses could result in reduced marten populations. Link 5 is therefore considered valid for marten.

Because fishers are often associated with drainages (Douglas and Strickland 1987), the alteration of drainage patterns as a result of mining operations could result in reduced populations of this species. Thus, Link 5 is assumed to be valid for fishers.

Because the home range size of wolverines (100 to 900 $km^2$, Banci 1994) is much larger than the mine development area, there may be less potential for resulting habitat losses to affect abundance of this species. However, since their specific habitat preferences are not well understood and their status in the region is uncertain, we are unable to assess the impact of habitat loss on wolverine populations and the validity of Link 5 is unknown.

v. ***Semi-Aquatic Furbearers***

As discussed previously, mine development will result in the direct loss of some beaver colonies; however, the impact of drainage alterations on otters is unknown. Link 5 is therefore considered valid for beavers and unknown for otters.

vi. ***Raptors***

Development of the Steepbank Mine could result in the alienation of the bald eagle nest site across from Tar Island. Consequently, Link 5 is considered valid for this species. Although population densities of great gray owls are unknown, this species is usually associated with large tracts of larch forest, which provides both perching sites and prey in the form of meadow voles (Servos 1987). Because habitat alteration would likely involve the conversion of some open tamarack forest to closed coniferous forest, Link 5 is assumed to be valid for the great gray owl.

### vii. *Terrestrial Birds*

Because ruffed grouse are highly dependent on aspen forest, the loss of approximately 1,300 ha of this habitat type to mine development and operation will likely result in reduced populations of this species. Habitat loss and alteration would likely result in reduced populations of some species of songbirds residing in the area. Thus, Link 5 is assumed to be valid for ruffed grouse and terrestrial songbirds.

### viii. *Waterfowl*

As discussed previously, habitat losses and alienation could result in the loss of breeding habitat for approximately 170 pairs of breeding ducks. Link 5 is therefore assumed to be valid for waterfowl.

## D4.1.4 Mitigation and Monitoring

The preceding section has described the potential effects of habitat loss and alteration on a variety of wildlife species identified as VECs in the Suncor Steepbank Mine study area. The following measures can be used to mitigate these impacts:

- The area cleared for the construction of facilities should be the minimum area required to contain any such facilities;
- Because a number of the species identified as VECs are associated with mature deciduous forest during at least part of their life cycle, including the natal period, the amount of development occurring in these habitat types should be minimized;
- Development of the mine should be planned so as to minimize habitat losses. Clearing should occur only when required and reclamation should begin as soon as is feasible after the cessation of mining;
- Water level control should be incorporated into drainage channel design so that Shipyard Lake is not used as a surge basin, or subjected to increasing water levels during the nesting season;
- Reclamation and management of Shipyard Lake should attempt to optimize use of this wetland by wildlife. This would include managing water levels to enhance shoreline habitat development and to maintain an optimal interspersion of emergent and open water habitat;

- A shallow littoral zone should be established at the base of the overburden stockpile where it infringes on Shipyard Lake, and the overburden slope should be well vegetated to reduce siltation;
- A more detailed inventory and evaluation of use of Shipyard Lake by birds, mammals and herpetofauna is required prior to the start of construction to serve as a baseline for monitoring future changes in use of this wetland by wildlife; and
- Permanent sampling locations should be established around the Steepbank Mine area to monitor wildlife use of adjacent habitats during mine construction and operation.

#### D4.1.5 Impact Rating

The impact ratings pertaining to the effects of habitat loss or alteration on Valued Ecosystem Components are summarized in Appendix II, Figure II-1. The impact of Steepbank Mine development was rated as low for a number of wildlife VECs, which include the black bear, snowshoe hare, red-backed vole, beaver, and terrestrial songbirds. This rating was assessed because it was believed that habitat losses as a result of mine development were likely to affect only a small proportion of the animals residing in the Local Study Area. However, the impact on moose was rated as low during the construction phase and as moderate during the operational phase. Negligible impacts were assessed for most of these species after closure, although it was assumed that an increase in the extent of deciduous forest a result of the reclamation program would result in improved habitat quality for the moose, black bear, and beaver after closure. The impact of mine development on wolves was rated as low during construction and moderate during operations.

A range of impact ratings was assessed for wolves, lynx, fishers, marten, wolverine, otter, bald eagles, and ruffed grouse. The impact on the otter was rated as negligible during construction and as negligible to low during the operational phase, whereas impacts on lynx, fisher, marten, bald eagle, and ruffed grouse were rated as low to moderate for most of the life of the project. The impact on ruffed grouse and marten was rated as positive after the cessation of mining operations. The assessment for the ruffed grouse is based on an expected increase in the amount of deciduous forest, whereas that for marten is based on a projected increase in the extent of coniferous and mixedwood forest. However, because marten inhabit mature conifer-dominated forest types, marten would not benefit from the reclamation program until at least 50 years after closure. For wolverines, the impact of habitat losses resulting from the Steepbank Mine development was rated as negligible to low during both phases of the project. Wolverines were not detected in the study area during winter track count surveys and the large home ranges of wolverines (up to 900 $km^2$) lessens the likelihood that mine development would affect the wolverine population. The impact on bald eagles was rated as negligible to moderate during both construction and mining phases.

### D4.1.6 Degree of Confidence

The impact ratings for Hypothesis 18 were made with a high degree of confidence in the case of moose, black bear, marten, beaver, otter, snowshoe hare, red-backed vole, waterfowl and terrestrial birds. The study team has moderate confidence in the impact ratings for wolf and lynx, reflecting uncertainties about the locations of denning sites and the effects of mine development on habitat alienation. Our degree of confidence is low for fisher and wolverine, because information on their habitat requirements is lacking and the available literature is sometimes contradictory. It is also relatively low for bald eagle and great gray owl because the importance of the study area as nesting habitat for these species is not yet well understood.

## D4.2 HYPOTHESIS 19

**Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

This hypothesis evaluates the effects of mechanical noise and human activity associated with mine development on wildlife species identified as VECs (Figure D4.0-6).

### D4.2.1 Linkages/Testable Hypotheses

Link 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife.

Link 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife.

Link 3. Sensory disturbance will result in decreased reproductive success.

Link 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats.

Link 5. Sensory disturbance of wildlife will result in increased energy expenditures and stress.

Link 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges.

Link 7. Avoidance of traditionally used habitats will result in increased predation.

Link 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability;

Link 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife;

Link 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife;

Link 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife.

Link 12. Decreased reproductive success will result in reduced abundance of wildlife.

### D4.2.2 Background

Increased noise and human activity associated with facilities construction has the potential to disturb wildlife in the Steepbank Mine area. It has been estimated that manpower requirements for construction of the Steepbank Mine will peak in late in 1999 when 435 workers will be required (Suncor 1996). Currently, Suncor's work force numbers 1,708 workers, which include 1,383 employees and 325 contractors. It is expected that, after 2007, 100 additional workers will be required for mining operations.

The proposed mine will operate 24 hours a day, 365 days a year with shift changes taking place every 12 hours. Based on this work schedule and the expected manpower requirement, it is estimated that between 100 and 150 workers will be active on the site throughout the year after the mine is in full operation.

Mining operations may affect wildlife because of disturbances resulting from blasting and the operation of heavy equipment. During some years, as many as 89 pieces of heavy equipment are expected to be used in mining operations. This equipment includes as many as 38-218 tonne haul trucks and 4-85 tonne haul trucks; 8 shovels, which range in capacity from 17 to 44 $m^3$; 14 bulldozers; and other miscellaneous equipment. In addition, winter mining operations will involve the use of explosives to facilitate the removal of overburden and oil sands.

The noise levels associated with oil sands mining operations are not known, however, Westworth et al. (1989) provide sound level measurements taken in forested and clearcut habitats at various distances from an open pit copper mine in British Columbia that may be comparable (Table D4.0-7). In addition to the maximum and minimum noise levels, Leq and peak impulse noise levels were also recorded. The Leq is a statistic used for measuring the sound levels associated with fluctuating machinery noise. It is defined as the steady sound pressure level, which, over a given period of time, has the same total energy level as the actual fluctuating noise. Peak impulse levels refer to the peak noise levels associated with impulse sounds such as those generated by blasting, hammering, and certain machinery noises. Impulse sounds, which are characterized by a rapid rise time and a duration of less than 1 second, are usually considered to have greater potential for eliciting a startle reaction by wildlife than continuous sound.

The authors reported that the Leq generated by normal mining operations ranged from 44 dBa at a distance of 250 m from the mine to 32 dBa at a distance of 2,000 m. In contrast, peak impulse noise levels were much higher; levels of 80 and 66 dBa were recorded at distances of 250 and 2,000 m, respectively. The highest peak impulse noise levels of 88 to 135 dBa were recorded during blasting operations with large explosive charges, which consisted of 6,464 to 19,323 kg of explosives.

Compared to the types of noises to which wildlife populations are normally exposed, sudden or intense noises are more likely to stimulate a "startle reflex" (Moller 1978, Harrington and Veitch 1990). In addition to the potential for injury or accidental death, startle reactions result in increased energy expenditure (Geist 1978) and may cause eggs or young birds to be trampled or dislodged from the nest. Vulnerability to predation could increase if predators rely on movement to detect prey (Harrington and Veitch 1990) and disruption of the bond between females and their offspring could decrease survival of young (Miller and Broughton 1974, Miller et al. 1988).

## TABLE D4.0-7

## NOISE LEVELS ASSOCIATED WITH VARIOUS MINING ACTIVITIES IN THE VICINITY OF AN OPEN PIT COPPER MINE IN NORTH-CENTRAL BRITISH COLUMBIA, 1989.[1]

| Source | Distance (m) from Pit | Noise Level Readings (dBa) Max. | Min. | Leq | Peak Impulse |
|---|---|---|---|---|---|
| General Mine Noise | 100 | 63 | 42 | 55 | 84 |
| Open/Clearcut Areas | 100 | 102 | - | 65 | 86 |
| | 300 | 57 | 35 | 39 | 86 |
| | 400 | 60 | 35 | 39 | 86 |
| | 500 | 64 | 29 | 46 | 63 |
| | 700 | 69 | 37 | 43 | 71 |
| | 1250 | 57 | 22 | 29 | 70 |
| | 1300 | 59 | 27 | 36 | 74 |
| Forested | 250 | 57 | 37 | 44 | 80 |
| | 400 | 53 | 35 | 39 | 77 |
| | 1650 | 62 | 25 | 43 | 67 |
| | 2000 | 60 | - | 32 | 66 |
| Bulldozer | 50 | 132 | 132 | 132 | 132 |
| | 250 | 71 | 52 | 58 | 75 |
| Warning Whistle | 200 | - | - | - | 80 |
| Blasting: small[2] | 200 | - | - | - | 69-84 |
| large[3] | 200 | - | - | - | 88-135 |

1 Source: Westworth et al. 1989.

2 <45 kg of explosives.

3 6464 - 19323 kg of explosives.

The responses of wildlife to these types of disturbance may include the abandonment of high quality range and reduced reproduction, especially if exposure to noise events is prolonged or repeated. Over the long term, these types of responses could result in reduced wildlife populations.

### D4.2.3 Evaluation of Linkages

**a) Link 1**

**Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife.**

**i. *Moose***

A number of studies have indicated that moose habituate to disturbance fairly quickly. For example, Kuck (1984) reported that, although displacement of moose may have initially occurred in areas adjacent to a surface phosphate mine in Idaho, the effect was temporary and localized. Based on pellet-group distributions, moose were not using areas within 200 m of the mines any less than areas farther away.

Similarly, Westworth et al. (1989) studied winter habitat use by moose in the vicinity of a large open pit copper mine in north-central British Columbia. The mine, which had a work force of 280, operated continuously seven days a week. Ore was moved from the mine pit to the plant with large volume electric shovels and 59 tonne haul trucks. Blasting ore occurred two or three times per week throughout the year. To determine whether moose avoided the mine area, browse surveys and pellet-group counts were conducted along transects placed near the mine (100-300 m) and away from the mine (1,000-2,000 m). Both open (clearcut) and forest (aspen, mixedwood, spruce-fir) habitats were sampled at each distance category. In terms of both pellet group density and browse use, differences between the 2 distance categories were not significant ($P>0.05$), whereas highly significant ($P<0.01$) differences were detected among the 6 habitat types sampled. In the case of all habitat types, pellet group densities and browsing intensity were as high or higher within 300 m of the mine as they were in the 1,000 to 2,000 m distance category (Westworth et al. 1989). The authors suggested that restrictions on hunting in the vicinity of the mine site and the aversion of wolves to high levels of industrial and human activity may have provided a degree of security for moose that was not available farther from the mine site.

Syncrude has been monitoring moose population levels on an annual or biannual basis using early (December) and late winter (February) helicopter surveys on a 500 $km^2$ survey area since the mid-1970s when vegetation clearing for the mine began (Pauls 1987). Observed moose densities have been highly variable in the Syncrude study area; however, they have been consistent with regional densities recorded by the Alberta Fish and Wildlife Division. Although densities of moose have varied over the years of the monitoring program, the distribution of moose in relation to the Syncrude site has reportedly changed very little (Dr. R. Pauls, Environmental Affairs, Syncrude Canada Ltd., pers. comm.). Pauls (1987) has observed small numbers of moose continually using areas in the immediate vicinity of the mine, plant, and tailings areas. Increased browse supplies associated with regenerating habitats have attracted moose to these areas. The moose population appears to move in and out of the study area in response to winter weather and appears to have adjusted to the presence of the mine site.

In contrast, in a study to assess the effects of seismic operations on ungulates, moose were found to stay at least 1 km from active seismic lines (Horejsi 1979). Similarly, in a study conducted near Rochester, Alberta, Rolley and Keith (1980) found that moose were generally observed farther from roads, dwellings, and agricultural areas than expected (when compared to 50 random locations) throughout the year. However, these differences were significant only in December and January when avoidance of these types of disturbance peaked.

Hancock (1976) studied moose populations in "low", "moderate", and "high" disturbance zones in Newfoundland. In selecting these zones, the author considered the degree of cottage development, and the presence of communities, forest access roads, and snowmobile routes. In that study, browse availability was found to be similar among the three zones; however, more trees (9.4/site) were browsed in the low zone than in the moderate (4.3) or high zone (1.3). Moose density was also found to differ among disturbance zones. Moose density in the low disturbance zone (0.82 moose/$km^2$) was over three times those in moderate (0.20) and high disturbance zones (0.25). Hancock (1976) concluded that disturbance affects animals 1-2 km away and that, because of human disturbance factors, there was often a difference between "habitat suitability" and "habitat availability".

The results of these studies indicate that moose are capable of habituating to noise and sensory disturbances that occur frequently or are sustained, such as those associated with open-pit mining operations, after a short period of time; however, they appear to be less capable of habituating to random or infrequent disturbances. Link 1 is therefore considered valid for moose, although the period of time during which sensory disturbances would have an impact on moose is presumed to be less than 1 year.

**ii.** ***Large Carnivores***

Black bears are known to have a very high capacity to habituate to human disturbance. Studies conducted in the Cold Lake Air Weapons Range have shown that black bears are tolerant of intense noises associated with weapons deployment by jet fighter aircraft (Spencer Environmental Management Ltd. 1989, D.A. Westworth & Associates Ltd. 1994). Those authors reported that black bears continued to use target ranges during strafing, rocket firing, and practice bombing, and made extensive use of seeded roadsides, paying little attention to passing vehicles.

Studies conducted near Cold Lake, Alberta indicated that oil development has little effect on black bears (Tietje and Ruff 1983). In that study, the age and sex structure of black bear populations was found to be virtually identical on sites slated for development both before and after development had occurred. Similarly, there was no apparent difference between population structure on and off of development sites after development was completed. Moreover, oil development did not cause most bears to alter traditional patterns of use on their home ranges or alter home range size. Bears also continued to den within oil development areas.

However, in another study conducted near Cold Lake, Alberta, approximately 9% of 145 bears abandoned their dens in response to continued disturbance by investigators (Tietje and Ruff 1980). Two of these bears, which were radio-tracked following disturbance, temporarily occupied at least two alternate dens before permanently occupying a den for the winter. Although bears disturbed at their dens lost more weight than those who were not disturbed, disturbed bears suffered no mortality and reproductive performance did not appear to suffer. However, the authors speculated that weight loss caused by den abandonment could contribute to reproductive failure if it caused the weight of female bears to fall below the threshold required to produce cubs.

Little information is available about the direct responses of wolves to disturbances associated with industrial development. Fuller and Keith (1980a) describe the distribution and home range uses of wolves in the vicinity of the Syncrude development from 1975-77, during the time of project construction. At the time of their study, a 50 $km^2$ area had been cleared for plant construction and mine development and up to 4 000 workers were housed on site. The territory of the Syncrude wolf pack encompassed the development area and 21% of telemetry relocations were reported to be within 2 km of the clearing. Although the results of the study suggest that wolves may be able to habituate to industrial developments, the degree to which wolves were disturbed is unclear.

However, other studies have shown that human disturbance, if severe enough, may cause wolves to abandon dens or young (Joslin 1966 cited in Mech 1970, Chapman 1977 cited in Shank 1979). A study of wolves in Alaska indicated that human disturbance resulted in wolves moving their dens an average of 3 km (Chapman 1977 cited in Shank 1979). The author reported that wolves usually abandoned dens within 1 km of human disturbance, whereas those more than 2.4 km away were usually viable. Recent radio-telemetry studies of wolves in Banff National Park indicate that wolves usually avoid areas of high human activity, including the portion of the Lower Bow Valley containing the Trans Canada Highway (Purves et al. 1992, Paquet 1993 cited in Parks Canada 1995). Link 1 is therefore considered valid for wolves and valid for bears if disturbances are repeated and directed at denning animals.

#### iii. *Small Herbivores*

To our knowledge, no studies have been conducted to determine the effects of sensory disturbances resulting from mining activities on snowshoe hares. Red-backed voles however, are often observed in forest habitats adjacent to highways and other high-noise environments. Near Swan Hills, Alberta, the demographic characteristics of red-backed voles on study plots adjacent to a chemical facility did not differ from those in control plots placed up to 23 km away (D. Skinner, unpubl. data).

To our knowledge, there is little information available regarding the effects of human disturbance on snowshoe hares; however, the species is known to occupy forested habitats immediately adjacent to roads, farms and industrial sites, as well as within urban areas. As a result, Link 1 is believed to be invalid for both the snowshoe hare and red-backed vole.

#### iv. *Terrestrial Furbearers*

Little information is available regarding the effects of disturbance on terrestrial furbearers. For example, Johnson and Todd (1985) reported incidents of fishers hunting and travelling near roads;

however, this type of evidence cannot be considered conclusive. It has been suggested that human disturbance can affect lynx and wolverines. Koehler and Aubry (1994) reported that lack of human disturbance was an important factor in the selection of denning sites by lynx, whereas Hornocker and Hash (1981) indicated that remote undisturbed wilderness was important in maintaining viable wolverine populations. Banci (1994) reports that wolverines tend to avoid areas of human activity. Link 1 is therefore assumed to be valid for the lynx and wolverine; however, its validity is unknown for the fisher and marten.

### v. *Semi-Aquatic Furbearers*

To our knowledge, no studies have been conducted to determine the effects of sensory disturbances to otters. However, beavers are believed to readily habituate to disturbances caused by a variety of human disturbances. This species frequently constructs dams and lodges adjacent to highways with high traffic volumes and is also common in urban areas. Consequently, Link 1 is considered to be invalid for beaver and unknown for otters.

### vi. *Raptors*

Although a number of studies have been conducted to determine the effects of disturbance on raptorial birds, including the bald eagle, few involve the effects of construction or mining on great gray owls, which are considered a VEC in this study. A principal concern for raptors is the possibility of nest desertion as a result of human disturbance. Many raptors may desert nests and sometimes territories in response to disturbance, particularly early in the reproductive season (Fyfe and Olendorff 1976).

Grubb et al. (1992) studied the response of bald eagles to various types of disturbances including vehicular, pedestrian, boat, and aircraft traffic, as well as artillery firing and gunshots. The results of the study indicated that the response of bald eagles to vehicular traffic was greater than that to most other disturbances; ATV and automobile traffic elicited a visible response 74% of the time at a median distance of 250 m. In comparison, pedestrian, boat, and aircraft traffic elicited responses 45, 48, and 29% of the time at median distances of 185, 100, and 500 m, respectively. The authors also found that, although artillery firing resulted in no visible response by bald eagles, gunshots resulted in a visible response 76% of the time.

A similar study by Grubb and King (1991) examined the effect of sonic booms and gunshots on bald eagles in addition to other types of disturbance. The results of that study indicated that, although bald eagles reacted more frequently to sonic booms, gunshots elicited more severe responses. Although sonic booms elicited a visible reaction 63% of the time, a flushing response was recorded for only 2% of sonic booms. In contrast, eagles exhibited a visible reaction to only 52% of gunshots; however, 10% of all gunshots resulted in a flushing response. Bald eagles also flushed 37% of the time in response to foot traffic as compared to 12% of the time for boats and 4% of the time for aircraft. However, reactions to helicopters were found to be more severe than those to either jet or propeller driven fixed-wing aircraft. Helicopters caused birds to flush 11% of the time, compared with 2% of the time other types of aircraft.

A study conducted in Washington to determine the response of bald eagles to human disturbance indicated that eagles were affected by close approaches by boats (McGarigal et al. 1981). Boat approaches to within 100 m of breeding eagles caused the birds to flush 38% of the time; however, the frequency of flush responses declined rapidly as approach distance increased. At distances of 101-200 m, eagles flushed only 18% of the time and at distances greater than 200 m, less than 3% of the birds flushed. However, other types of human activity had a greater effect than boats. Boats visibly disturbed bald eagles during 6% of 765 approaches to within 500 m. In contrast, automobile traffic within 500 m of bald eagles resulted in visible disturbance to the birds on 25% of 12 occasions, whereas approaches by pedestrians disturbed the birds on 18% of 22 occasions.

In a study to quantify the reaction of bald eagles to helicopters, Watson (1993) recorded the results of encounters between helicopters and 270 perched eagles. Of these, 53% exhibited a reaction, which involved either flushing (68%) or becoming agitated (32%). Most (56%) of the flushed eagles soared and circled the area; however, other responses included evading the helicopter (21%), returning to the nest (12%), or attacking the helicopter (11%). Watson (1993) noted that brooding eagles flushed but that those feeding young exhibited no obvious response to the approach of a helicopter. He also noted that eagles were most likely to be disturbed when there were no young in the nest, when they were perched more than 60 m from the nest, or when the helicopter hovered instead of moving toward the nest.

LGL Limited (1972) indicated that human disturbance is often a factor responsible for population declines of bald eagles; they cite studies that indicate that the production of young may decline by

65% as a result of people climbing to nest sites. Increased recreational activity, as well as associated road and recreational site development, is thought to have caused a local reduction in eagle populations in Saskatchewan (Gerrard et al. 1985). Link 1 is therefore considered valid for bald eagles; however, because there is little information about the effect of industrial disturbance on great gray owls, the validity for this species is unknown.

**vi.** ***Terrestrial Birds***

Because vocalizations are an important part of territory establishment and breeding for most species of terrestrial birds, disturbances that reduce the frequency of singing have the potential to reduce the reproductive success of this group of birds.

D.A. Westworth & Associates Ltd. (1994) found that, as a group, songbirds did not appear to be seriously affected by military activities taking place on the Cold Lake Air Weapons Range. Songbird abundance, species richness, and diversity were similar in training ranges and in other areas used as controls. Direct observations indicated that the behavioural response of most songbirds, as indicated by territorial song was slight. However, some of the rarer, more specialized species were uncommon or did not occur in heavily-used training ranges, and no rare or uncommon species sang on training areas while training missions were in progress. Link 1 is considered valid for songbirds because it appears that disturbance may affect some of the more sensitive species; however, Link 1 is unknown for ruffed grouse because to our knowledge, there is no information available about the effects of sensory disturbance on this species.

**viii.** ***Waterfowl***

Although we are not aware of any research that documents the behavioral responses of waterfowl to disturbance associated with mining, waterfowl appear to be able to habituate to this activity. Wildlife monitoring studies conducted on Lease 86/17 since 1976, show that waterfowl continue to use wetlands within or adjacent to the mine area (Gulley 1987). Suncor currently operates a bird deterrent program to discourage waterfowl use of tailings ponds.

D.A. Westworth & Associates Ltd. (1994) conducted studies in the Cold Lake Air Weapons Range to determine the response of waterfowl to fighter aircraft training missions which involved the deployment of cannons, rockets, and practice bombs. Visible reactions to training missions were classified as minor or major. Minor responses included changes in posture, vocalizing, awakening, slight deviations in flight path, and slow movements away from the disturbance, whereas major responses included flushing, rapid evasive flight, and rapid swimming away from the disturbance. Training missions were found to elicit minor responses from 6% of the 49 ducks included in the study and major responses in 35% of the ducks. In contrast, 10 and 90% of 20 geese observed during the study exhibited minor and major responses, respectively.

A number of studies have indicated that human disturbance can affect nesting success by waterfowl. Livezey (1980) concluded that nest desertion was a problem in studies involving nest searches; however, he found that the potential for desertion depended on the stage of the nest. Disturbance prior to egg laying resulted in nest abandonment by 73% of nesting hens, whereas, human disturbance after eggs were laid caused only 2 to 21% of the nests to be abandoned. Similar results were obtained by Gloutney et al. (1993) who found that the timing of disturbance was also an important factor in nest abandonment for a variety of waterfowl species. Disturbance by boats is also reported to affect waterfowl. Korschgen et al. (1985) reported that canvasbacks frequently flushed in response to boating activity and suggested that repeated disturbances could result in an increase in the daily energy budget of birds of almost 20%. Similarly, Figley and VanDruff (1982) found that wild mallards often flushed 60 m in advance of boats, although tame ducks exhibited little response. Link 1 is therefore considered valid for waterfowl.

**b) Link 2**

**Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife.**

For safety reasons, access to the Steepbank Mine area will be restricted to the personnel required for construction and mining operations. As a consequence, it is expected that noise and other types of disturbance will not increase over the levels resulting from mine development and operation. Link 2 is therefore assumed to be invalid for all VECs.

**c) Link 3**

**Sensory disturbance will result in decreased reproductive success.**

**and**

### d) <u>Link 12</u>

**Decreased reproductive success will result in reduced abundance of wildlife.**

#### i. *Moose*

Little is known about the effect of sensory disturbance on the reproductive performance of moose. LeReshe (1966 cited in Shank 1979) reported finding abandoned moose calves during a moose tagging program, although these calves were subsequently accepted by cows. The author suggested, however, that disturbance during and after calving could reduce the survival of neonates. It is also possible that disturbances that elicit a startle or panic response could result in moose injuring or abandoning calves, which could in turn result in increased calf mortality. Links 3 and 12 are therefore considered valid for moose.

#### ii. *Large Carnivores*

Black bears are unlikely to exhibit a startle response that could injure cubs. Moreover, based on information presented by Tietje and Ruff (1980), it is believed that, unless disturbance is persistent and directed at dens, it is unlikely to affect the reproductive success of black bears. However, the abandonment of dens in the vicinity of human disturbance could reduce the reproductive success of wolves (Chapman 1977 cited in Shank 1979). Links 3 and 12 are therefore considered valid for wolves and valid for black bears under conditions of repeated disturbances at dens.

#### iii. *Small Herbivores*

Because Links 1 and 2 are invalid for both snowshoe hares and red-backed voles, all higher links are also assumed to be invalid for both species of small herbivores.

#### iv. *Terrestrial Furbearers*

Koehler and Aubry (1994) reported that lack of human disturbance was an important factor in the selection of denning sites by lynx; thus, reproductive success of this species could be reduced if disturbance results in alienation from suitable denning sites, which may be associated primarily with the Athabasca River valley. However, to our knowledge, information is not available about the effects of sensory disturbance on denning or reproduction by fisher, marten, or wolverine. Consequently, Links 3 and 12 are considered valid for lynx but their validity for wolverine is unknown. Because Link 1 is unknown for the fisher and marten, the validity of most higher links is also unknown.

**v.** ***Semi-aquatic Furbearers***

Because Links 1 and 2 are considered invalid for beavers, all higher linkages are also considered invalid. Similarly, because the validity of Link 1 is unknown for otter, the validity of most higher links is also unknown.

**vi.** ***Raptors***

Although Watson (1993) reported that nesting bald eagles are less likely to react to sensory disturbance than other individuals, some other studies have indicated that bald eagles are likely to decline in response to various types of human disturbance (LGL Limited 1972, Gerrard et al 1985). Because it is likely that reduced reproductive success is at least partly responsible for such population declines, Links 3 and 12 are assumed to be valid for bald eagles. In contrast, because the validity of Links 1 and 2 are unknown, the validity of most higher links is unknown for the great gray owl.

**vii.** ***Terrestrial Birds***

Although studies to determine the effect of military training on songbirds suggest that sensitive species could be affected by disturbance, it is unknown if reproductive success will be affected. Similarly, to our knowledge, no information is available regarding the effect of disturbance on the ruffed grouse. The validity of Links 3 and 12 is therefore unknown for these species, as is the validity of all higher links for the ruffed grouse.

**viii.** ***Waterfowl***

Several authors have reported that disturbance of waterfowl nests by humans often causes nest abandonment by duck hens (Livezey 1980, Gloutney et al. 1993). Links 3 and 12 are therefore assumed to be valid for waterfowl.

**e)** **<u>Link 4</u>**

**Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats.**

**i.** ***Moose***

Studies conducted by Hancock (1976), Horejsi (1979), and Rolley and Keith (1980) indicate that moose avoid areas affected by human disturbance including areas within 1 km of active seismic lines

(Horejsi 1979) and close to roads, communities and snowmobile routes (Hancock 1976). Other authors, however, have reported that moose continue to use habitats in the immediate vicinity of operating surface mines (Kuck 1984, Westworth et al. 1989, Pauls 1987). Kuck (1984) found that displacement of moose from the site of a phosphate mine was temporary and localized.

It therefore appears that moose might avoid areas in response to disturbances of an occasional or unpredictable nature but habituate to non-threatening disturbances that are constant or on-going. Displacement of moose may be more likely to occur during periods of mine exploration or construction than during the period of mine operations.

Baseline studies conducted in the Suncor study area indicate that the Athabasca River escarpment and floodplain, both of which will subjected to an increase in human activity, provide important winter habitat for moose (Skinner and Brusnyk 1996). Link 4 is therefore considered valid for moose, although it is expected that advance of adjacent habitats would occur primarily during the exploration and construction phases, and that advance of the mine area during the operations period would be highly localized (i.e., less than 200-300 m).

**ii.** ***Large Carnivores***

Various studies have indicated that bears continue to use all portions of their home ranges, despite various types of sensory disturbances (Tietje and Ruff 1983, Spencer Environmental Management Ltd. 1989, D.A. Westworth & Associates Ltd. 1994), whereas wolves exposed to human disturbance are reported to frequently abandon denning areas (Chapman 1977 cited in Shank 1979). Based on field studies and information provided by Mech (1970) on den site characteristics, it appears that much of the suitable wolf denning habitat in the Suncor study area is associated with the Athabasca River escarpment. As well, tracking studies indicated that wolves were associated with this landscape feature during winter (Skinner and Brusnyk 1996). Link 4 is therefore considered valid for wolves but invalid for black bears. Because Link 4 is not valid for black bears, Links 6 through 11 are also assumed to be invalid for this species.

**iii.** ***Terrestrial Furbearers***

Koehler and Aubry (1994) reported that undisturbed sites which contain woody debris are preferred by lynx as denning habitat. Thus, much of the suitable denning habitat in the Suncor area is probably associated with mature riparian balsam poplar forest, which occurs primarily in the floodplain of the Athabasca River. Because some of these stands are situated near proposed development areas, Link 4 is considered valid for lynx.

Similarly, Hornocker and Hash (1981) reported that remote, undisturbed areas are required to maintain viable wolverine populations. Link 4 is therefore also assumed to be valid for the wolverine.

iv. *Raptors*

Bald eagles exhibit strong nest site fidelity (Boyd 1972, Gerrard et al. 1992); in a study conducted in Saskatchewan, some females returned to the same nest for 13 consecutive years (Gerrard et al. 1992). Because bald eagle populations are known to decline in response to some forms of human activity (LGL Limited 1972, Gerrard et al. 1985), it is assumed that disturbance from activities in the Athabasca River valley could potentially cause bald eagles to abandon the nest across from Tar Island. Link 4 is therefore assumed to be valid for the bald eagle.

vii. *Terrestrial Birds*

Studies to determine the effect of training exercises by military aircraft in the Cold Lake Air Weapons Range on terrestrial songbird populations indicated that there were some differences in species composition between disturbed and undisturbed areas (D.A. Westworth & Associates Ltd. 1994). Because it is assumed that disturbance associated with construction and mining operations could reduce the density of sensitive bird species, Link 4 is considered valid for these species.

viii. *Waterfowl*

Although waterfowl react to disturbances, there is little evidence that they abandon portions of their range in response to disturbance. D.A. Westworth & Associates Ltd. (1994) found that, in the Cold Lake Air Weapons Range, disturbed areas were more heavily used than undisturbed areas, presumably reflecting the better habitat quality in the more heavily used portion of the training area. Similarly, Figley and VanDruff (1982) reported that mallards readily adapted to urban disturbance. Link 4 is therefore considered invalid for waterfowl.

f) Link 5

**Sensory disturbance of wildlife will result in increased energy expenditures and stress.**

Sensory disturbances that cause responses such as assuming alert postures, moving away from disturbances, or fleeing will result in increased the energy expenditure by affected animals. Thus, Link 5 is considered valid for moose, wolves, bald eagles, and some species of terrestrial birds. Studies conducted by Korschhen et al. (1985) and Figley and VanDuff (1982) indicated that waterfowl frequently flush in response to disturbance. Link 5 is therefore considered valid for waterfowl; however, the demands associated with these types of reactions would likely comprise only a small part of the annual energy budget of most wildlife species.

**g) <u>Link 6</u>**

**Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges.**

**and**

**h) <u>Link 9</u>**

**Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife.**

**i. *Moose***

Data collected during field studies conducted in the Suncor study area indicate that browse utilization by ungulates approaches or exceeds the carrying capacity in preferred deciduous and mixedwood habitats in the Athabasca River valley (Skinner and Brusnyk 1996). Thus, the displacement of moose from preferred areas could result in the overuse and deterioration of the remaining moose wintering range in the study area. Consequently, Links 6 and 9 are assumed to be valid for moose.

**ii. *Wolf***

Because moose are the principal prey of wolves in northeastern Alberta (Fuller and Keith 1980a, b), it is assumed that the displacement of moose from preferred areas will also cause wolves to abandon these areas. If displacement results in declining moose populations, predation by wolves could cause the moose mortality rate to exceed the recruitment rate and lead to a concomitant decline in wolf populations. Links 6 and 9 are therefore assumed to be valid for wolves.

### iii. *Terrestrial Furbearers*

Because lynx populations in the study area are currently at low levels (Skinner and Brusnyk 1996), disturbance is unlikely to result in the species overusing habitats; however, the validity of Links 6 and 9 during the peak of the population cycle is unknown. Wolverines are sparsely distributed (van Zyll de Jong 1975) and occupy extensive home ranges (see review in Banci 1994). It is assumed that they are unlikely to overuse portions of their territories in response to disturbance. Thus, Links 6 and 9 are assumed to be invalid for wolverines.

### iv. *Bald Eagle*

Because bald eagles are sparsely distributed in the Fort McMurray area, displacement as a result of disturbance is unlikely to result in the overuse of remaining habitats. Links 6 and 9 are therefore considered invalid for the bald eagle.

### v. *Terrestrial Birds*

Because many songbirds are strongly territorial and have specific habitat requirements, displacement as a result of disturbance could cause the overuse of remaining habitats. Links 6 and 9 are therefore considered valid for some species of songbirds.

### vi. *Waterfowl*

Because waterfowl are unlikely to abandon habitat in response to sensory disturbance, Links 6 and 9 are considered invalid for this group of birds.

### i) Link 7

**Avoidance of traditionally used habitats will result in increased predation.**

**and**

### j) Link 10

**Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife.**

Decreased use of traditional habitats by moose as a result of disturbance could result in the use of less familiar and less secure areas. The use of such areas may increase the vulnerability of moose to predators. Effects on terrestrial birds are assumed to be similar. Links 7 and 10 are therefore considered valid for moose and terrestrial songbirds. In contrast, because carnivores, such as the wolf, lynx, wolverine, fisher, otter, bald eagle, and great gray owl are seldom preyed upon, Links 7 and 10 are considered invalid for these species.

**k) Link 8**

**Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability.**

Because moose generally prefer habitat types in which forage is readily available, displacement as a result of disturbance could result in an increase in the search time required to find suitable food. Similarly, energy expenditures by wolves could increase if search time for prey increases as a result of declining moose populations. Consequently, Link 8 is considered valid for moose and wolves. In contrast, because the effects of sensory disturbance on the foraging activities of lynx is unknown, the validity of Link 8 is unknown for this species. Link 8, however, is considered invalid for wolverines because their extensive territories make it unlikely that displacement from disturbed areas will result in their use of unfamiliar habitats. The potential displacement of bald eagles from the nest across from Tar Island could result in renesting and a concomitant increase in energy expenditure. Link 8 is therefore considered valid for this species. Similarly, because the displacement of songbirds could result in renesting and an increase in energy expenditure, Link 8 is also considered valid for these species.

**l) Link 11**

**Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife.**

Because forage use by moose is near the carrying capacity in most of the study area, increased energy expenditure coupled with low forage availability could decrease the viability of moose and result in reduced moose populations. Similarly, reduced moose populations could decrease the viability of wolf populations by decreasing prey availability while increasing foraging effort. Link 11 is therefore considered valid for both moose and wolves. In contrast, the validity of Link 11 is unknown for both lynx and wolverines. This assessment was made for lynx because both Links 5 and 8 were unknown, whereas, for wolverines, Link 5 was unknown and Link 8 was assumed to be invalid. Although Link 8 is considered valid for both the bald eagle and terrestrial songbirds, it is unknown if energy expenditures from startle responses or renesting would be sufficient to cause populations to decline. The validity of Link 11 is therefore unknown for both VECs. However, it is assumed that the energy demands associated with disturbance to waterfowl could decrease reproductive success and result in lower populations; consequently, Link 11 is assumed to be valid for waterfowl.

### D4.2.4 Mitigation and Monitoring

The preceding section has described the potential impacts of sensory disturbance as a result of human activity on a variety of wildlife species. The following measures are recommended to mitigate these impacts:

- Place berms and buildings in a manner that reduces sound transmission into adjacent areas;
- Maintain treed buffers around industrial and mechanical sites to reduce the potential for sensory disturbance in adjacent habitats;
- Clearing, construction, and blasting activities should be scheduled so as to avoid critical periods for sensitive wildlife species;
- Workers should be instructed to avoid disturbing any active natal or winter dens identified in the study area;
- During the breeding and nesting season, activities within 250 m of the bald eagle nest across from Tar Island should be prohibited;
- During both construction and mining operations, privately-owned firearms, ATVs, trucks, and automobiles should be prohibited in the Steepbank Mine area; and
- A wildlife monitoring program should be implemented prior to the start of construction to monitor the effects of the project on species considered potentially sensitive to disturbance (e.g., carnivores, bald eagle).

### D4.2.5 Impact Rating

Sensory disturbance to wildlife resulting from the Steepbank Mine development would last through the construction and operations phases, a period of approximately 24 years; however, these impacts would not extend beyond the cessation of mining operations in 2020.

For most of the wildlife classified as VECs, the impact of sensory disturbance resulting from the construction and operation of the Steepbank Mine was considered negligible to low locally and negligible regionally (Appendix II, Figure II-2). Negligible local impacts were assessed for the black bear, red-backed vole, snowshoe hare, and beaver, whereas impacts on moose, bald eagles, songbirds, and waterfowl were considered low. Although it was thought that moose could be affected by disturbance for a brief period at the beginning of construction and mining, it is believed that they would rapidly habituate to disturbance. The low rating for the bald eagle was based on the fact that the nest across from Tar Island Dyke became active for the first time in 1995 and that nesting opportunities do not appear to be a limiting factor for this species in the study area.

In contrast, impacts on the wolf, lynx, and wolverine were believed to be higher. The impact on wolves was rated as low to moderate for both the construction and operation phases of the Steepbank Mine. This assessment was made because the Athabasca River escarpment appears to provide much of the suitable wolf denning habitat in the Local Study Area; however, no wolf dens were encountered in wildlife studies conducted in the area in 1995 and 1996. The impact of sensory disturbance on lynx was assessed as low to moderate during construction and operations. This assessment was based principally on the potential for disturbance of denning lynx during the natal period. In contrast, the impact of sensory disturbance on wolverines was assessed as negligible to low during construction and negligible to moderate during mining operations.

Because insufficient information is available, we were unable to assess the effects of sensory disturbance on a number of VECs. These species include the fisher, marten, otter, great gray owl, and ruffed grouse.

### D4.2.6 Degree of Confidence

The degree of confidence in the impact ratings for most of the wildlife VECs is considered high, providing that suitable mitigation measures are implemented. These species include the moose, black bear, red-backed vole, snowshoe hare, beaver, bald eagle, songbirds, and waterfowl. In contrast, the degree of confidence is considered low for the wolf, lynx, and wolverine. Although wolves are known to occur within the Suncor Local Study Area, specific information about the movement patterns and denning ecology of wolves currently using the area is not available. Similarly, it is unknown to what extent areas that would be affected by noises related to construction and mining are used by foraging and denning lynx. Although wolverines are known to occur in the Local Study Area it is unknown if any utilize the area that will be affected by mine development; moreover, although wolverines are believed to be sensitive to disturbances, little information on the effects of noise on the species is available.

## D4.3 HYPOTHESIS 20

**Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

Hypothesis 20 evaluates the potential for activities and structures associated with the Steepbank Mine development to result in an increase in wildlife mortality (Figure D4.0-7).

### D4.3.1 Linkages/Testable Hypotheses

Link 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife.

Link 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife.

Link 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife.

Link 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife.

Link 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife.

### D4.3.2 Background

Direct mortality of wildlife could result from:

- Clearing and stripping operations;
- Removal of problem wildlife;
- Increased numbers of vehicle-wildlife collisions;
- Increased hunting, poaching or trapping; and
- Exposure to environmental hazards.

a) <u>Clearing and Stripping Operations</u>

Over the life of the mine, approximately 4,400 ha of habitat will be cleared for facilities construction, overburden disposal and mining operations. This will be carried out using bulldozers and other heavy equipment.

b) <u>Removal of Problem Wildlife</u>

Some loss of wildlife is expected to result from deliberate removal of pest or problem animals. The species that will be most affected by this are black bear and beaver. Black bears that become habituated to humans pose a potential safety risk and may have to be destroyed or removed from the mine area. Beavers create an operational problem because of their tendency to dam drainage ditches, block culverts or water intakes, and destroy trees in shelter belts or buffer strips.

c) <u>Vehicle-Wildlife Collisions</u>

Increased traffic associated with an increase in the size of the workforce during project construction and operation could cause an increase in the number of vehicle-wildlife accidents. This is primarily a concern along Highway 63, where a number of collisions with wildlife are reported each year.

The increased traffic volume that would be associated with Steepbank Mine development is expected to be minimal. Initial planning studies indicate a net manpower increase of 100 over the life of the project. Most of the manpower required to operate the Steepbank Mine would come from a reallocation of manpower from the present Lease 86/17 mine. During the construction phase Suncor has estimated that 800 truck loads of materials will be transported along Highway 63. Most of the contractors would be housed on site, with minimal busing requirements to town for recreational purposes. The overall increase in traffic volume is expected to be 1 - 2%. During the operations phase, when the additional employees are travelling, the traffic volume is expected to increase by about 1%.

**d) Environmental Hazards**

The primary hazard for wildlife in the Steepbank Mine area is expected to be the tailings ponds. With current oil extraction technology, there is a need to maintain one or more large tailings ponds to dispose of the processed oil sand. These tailings contain small proportions of unrecovered bitumen, which may form floating mats on the surface, sink to the bottom, or become dispersed throughout the pond. Birds and other wildlife that come in contact with the floating bitumen may be directly or indirectly killed as a result of the exposure. Both Syncrude and Suncor operate bird deterrent programs to deal with the problem of bird mortality in tailings ponds.

### D4.3.3 Evaluation of Linkages

**a) Link 1**

Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife.

Although the likelihood of large mammals and adult birds being killed or injured during clearing and grubbing operations is low, large numbers of small mammals (eg., squirrels, mice, voles and shrews) will be lost along with herpetofauna, and immature birds and mammals. During the nesting period there is potential for loss of eggs or young birds. Link 1 is therefore considered valid for red-backed vole, snowshoe hare, and all bird VECs known to breed in the development area. It may also be valid for black bear, marten, fisher, and beaver because of the possible destruction of natal dens. The likelihood of direct mortality of larger mammals is low, because of their greater mobility. The likelihood of neonatal mortality of wolves, lynx and wolverines due to den destruction is considered low, since these are considered sensitive species that are likely to move their denning sites as soon as intensive development activity begins.

**b) Link 2**

**Removal of nuisance or problem wildlife will result in reduced abundance of wildlife.**

Observations made during the course of this study, indicate that black bears are very common in the Steepbank Mine study area. Based on past experience in the region, it is considered likely that, even with rigorous application of measures designed to avoid the problem, some interactions between bears and humans will take place. When these conflicts take place, removal of the offending bears is usually considered the only feasible option. This normally involves either destroying the bears or livetrapping and translocating them. Many biologists now believe that translocating bears is not very effective, since bears rarely remain in the unfamiliar territory, often travelling extensive distances back to their home range or into unfamiliar areas where the likelihood of survival is low.

Problems with black bears are likely to occur most frequently during the construction phase. During this period it is estimated that 2 or 3 black bears per year may be directly or indirectly killed as a result of the project.

Beaver are a likely to be a management problem throughout the life of the project, causing blockage of diversion ditches and drains, backflooding of roads and facility areas, and tree loss in greenbelts and buffer strips. This species is currently common throughout the development area. Selective removal of offending animals on a site-specific basis is the most practical method of dealing with these problems. This would preferably be carried out by local trappers. The number of beaver that would be removed each year is expected to be in the range of 10 to 20 animals.

**c) <u>Link 3</u>**

**Increased vehicular traffic associated with mine development will result in increased mortality of wildlife.**

Numerous studies have been conducted in the past have assessed wildlife responses to high-speed transportation corridors. Leedy (1975) presented a comprehensive review on this topic, which included over 450 references and annotated bibliography summarizing an additional 305 studies.

Studies that have been conducted show that the incidence of ungulate-vehicle collisions is particularly high where high volume highways are located in areas of high ungulate densities or where highways intersect movement or migration corridors. This is the case in the mountain parks of Alberta and B.C. where very high rates of ungulate mortality have been recorded (Poll et al. 1984). Although few studies have been conducted to assess moose responses to highways, those that have been undertaken indicate that moose are often attracted to highways to satisfy their seasonal requirements for salt. In several regions of Quebec, highway collisions involving moose are a serious problem (Grenier 1973). In Laurentides Provincial Park, 324 moose were killed over an eleven year period from 1962 to 1972, representing 10%-20% of the moose population in the area. Grenier (1973) found that the mortality rate was correlated with an observed increase in traffic volume through the park over that period, and was related to the presence of road accumulations of salt. Other studies in Ontario have verified that salt along roadside ditches and ponds often serves as a major attractant for moose, especially during the spring period (Fraser 1979).

Highways can constitute a major mortality factor for large carnivores as well. For example, recent research has shown that 18% of the wolf population using the Bow River valley is killed each year on the TransCanada highway (T. Hurd, Parks Canada pers. comm.).

With respect to the Steepbank Mine Development, the greatest concern relates to potential mortality of ungulates and large carnivores along Highway 63 between Fort McMurray and the Suncor turnoff. This is a high speed thoroughfare that traverses portions of the Athabasca River valley. Various surveys have shown that the Athabasca valley provides important habitat for wildlife. In the case of moose for example, Highway 63 bisects a traditional winter range and may also intersect travel routes between upland summer ranges and river valley wintering areas.

Alberta Transportation and Utilities have maintained records of the number of animals killed as a result of wildlife-vehicle collisions along Highway 63 north of Fort McMurray, although it is likely that wildlife mortality resulting from collisions with vehicles is substantially underestimated. These records indicate that 41 mammals were involved fatal wildlife-vehicle collisions in the 10-year period from 1985 to 1994. Deer were involved in the greatest number of these collisions; 18 deer were reported killed along this stretch of highway, as well as 9 black bears, 6 moose, 2 wolves, 3 coyotes, and 3 red foxes. However, because most collisions with smaller species such as coyotes or foxes would cause only minimal damage to most vehicles, they were likely not reported.

Although the exact relationship between traffic volumes and wildlife mortality levels is not known, we do know that the frequency of collisions is a function of traffic volume and that an increase in traffic is likely to result in higher numbers of ungulates and other wildlife being killed. Based on the expected increase in Highway 63 traffic volume of just 1 to 2%, the corresponding increase in mortality of ungulates and large carnivores is likely to be small. In the case of moose and black bear for example, the incremental mortality would likely not exceed one animal over the life of the project.

Link 3 is considered valid for moose, black bear, and wolf, although the overall increase in mortality that will result from Steepbank Mine development is negligible. Other wildlife VECs could also suffer mortality as a result of collisions with vehicles. Data are not available on current levels of mortality of smaller species, but the numbers killed are likely not significant from a population standpoint. Because of the lack of suitable wetland habitat along Highway 63, waterfowl and other wetland wildlife are probably affected very little.

**d) Link 4**

**Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife.**

In the past the Steepbank Mine development area has been relatively inaccessible to the general public, except by boat along the Athabasca River, by snowmobile during winter, and perhaps by all-terrain vehicle. Public access is not expected to increase as a result of mine development, at least during the construction and operation phases. Use of the Athabasca River bridge will be restricted to project personnel and site access will be strictly controlled by Suncor security. Mine workers are not allowed to carry firearms on the site. For these reasons, there is little likelihood that increased levels of hunting, poaching, or trapping will occur within or adjacent to the development area. Although it is possible that the Athabasca River bridge will be used for public access to the Steepbank River area, once mining is completed we have assumed that it will remain closed. Link 4 is therefore considered invalid.

**e) Link 5**

**Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife.**

Waterfowl and gulls are the species groups most often affected by tailings ponds, although other birds and semi-aquatic mammals may also be affected. In some cases birds that attempt to land on the tailings ponds become entrapped by the thick, sticky bitumen mats and suffocate. Birds may also die from of thermal stress, resulting from oiling of the plumage, which causes a loss of insulative properties (Hartung 1965, McEwan and Koelink 1973). Ingestion of oil during preening may also have toxic effects (Hartung and Hunt 1966).

Monitoring of bird mortality on the Lease 86 tailings ponds during the 1970s and 1980s has shown that levels of mortality are variable between years (Gulley 1985, 1987, 1988). Waterfowl and shorebirds are the groups that comprise most of the documented mortality, although a variety of other species have also been recovered from the tailings ponds (Table D4.0-8). The highest recorded mortality occurred in 1979, when 237 waterfowl were found along the shoreline of Pond 1 on Lease 86 (Gulley 1985). During most years, waterfowl mortality is highest during April and May, when spring migration is occurring.

Both Suncor and Syncrude have operated bird deterrent programs since the 1970s to reduce bird mortality in their tailings ponds. The Suncor deterrent system involves the use of human effigies on the surface of the tailings ponds, along with propane scare cannons along the pond shorelines, (Gulley 1988). A long-term bird monitoring program has been conducted on Lease 86 to improve Suncor's understanding of the factors influencing bird mortality and to improve the operation of the deterrent programs. These programs are considered effective for migrating birds, which only come into contact with the tailing ponds during annual migrations, but are less effective for resident birds that have been able to habituate to the sight and sound of the deterrent devices (J. Gulley, pers. comm.). Both weather conditions and the timing of spring break-up are thought to be important in determining levels of bird mortality. Spring temperature appears to be a particularly critical factor. During years in which northward migration is slowed or halted by cold temperatures in the northern part of their range, waterfowl may congregate in open water areas along the Athabasca River. Under these conditions there is a greater likelihood of birds attempting to land on tailings ponds.

The consolidated tailings program proposed by Suncor will involve substantial changes in terms of both process characteristics and disposal technique as compared to conventional diluted tailings handling. Under the initial project design, all tailings disposal will be carried out on Lease 86/17 until 2006, with tailings disposal on the Steepbank Mine beginning in 2007. Tailings will be delivered to the tailings ponds through a 24 inch pipeline (or twin 20 in. lines) capable of handling the maximum consolidated tailings flow rate of 17,400 USgpm. The tailings mixture will consist

## TABLE D4.0-8

## BIRDS RECOVERED FROM SUNCOR'S LEASE 86 TAILINGS PONDS DURING 1984, 1987, AND 1988.[1]

| Species | 1984 | 1987 | 1988 |
|---|---|---|---|
| **Waterfowl** | | | |
| Common Loon | | | 1 |
| Horned Grebe | | 2 | 4 |
| Greater White-fronted Goose | 1 | | |
| Green-winged Teal | | | 2 |
| Teal spp. | 1 | | |
| Mallard | 6 | 5 | 2 |
| Northern Pintail | 2 | 3 | 3 |
| Northern Shoveler | 3 | 2 | 1 |
| American Wigeon | 3 | 2 | 2 |
| Aytha spp. | 7 | 10 | 2 |
| Lesser Scaup | | 1 | 4 |
| Common Goldeneye | | | 1 |
| Bufflehead | 1 | 3 | 1 |
| Canvasback | | 1 | |
| American Coot | 5 | 4 | 12 |
| Unidentified Duck | | 7 | |
| Total | 29 | 42 | 35 |
| **Shorebirds** | | | |
| Killdeer | 4 | 2 | 1 |
| Lesser Yellowlegs | | 3 | 3 |
| Greater Yellowlegs | | 1 | |
| Lesser Golden Plover | | 6 | |
| Caladris spp. | 3 | 13 | 2 |
| Total | 7 | 25 | 6 |
| **Passerines** | | | |
| Cliff Swallow | | | 2 |
| Swallow spp. | | 2 | |
| American Crow | | 1 | |
| Lapland Longspur | | 1 | |
| Water Pipit | 1 | | 1 |
| Unidentified Passerine | 6 | 3 | 4 |
| Total | 7 | 7 | 7 |
| **Other** | | | |
| Red-tailed Hawk | | | 1 |
| American Kestrel | 1 | | 1 |
| Great Horned Owl | 1 | | |
| Snowy Owl | | | 1 |
| California Gull | | | 1 |
| Northern Flicker | | 1 | |
| Total | 2 | 1 | 4 |
| **Total All Species** | **45** | **75** | **52** |

1 Source: Gulley 1985, 1987, 1988.

primarily of sand and water, with smaller amounts of silts and clays, mixed with calcium sulphate to produce a non-segregating tailings mixture. The tailings will also include small quantities of non-recoverable bitumen. Under Suncor's proposed CT program, tertiary bitumen recovery is expected to result in less bitumen released to tailings than with conventional tailings technology. This may lessen the degree of impact to wildlife. The life of the tailings ponds will also be reduced with the CT process.

Along with the tailings ponds, a number of mine drainage retention basins will be situated along the perimeter of the Steepbank Mine. Potentially contaminated runoff water from mine areas, overburden dumps, or facility areas will be collected in these retention basins. Some of this runoff will be used as process water, while the remainder will be pumped to the tailings ponds. These basins are expected to present a minimal hazard to wildlife. Absorbent booms or other techniques will be used to remove floating hydrocarbons and it is expected that these ponds will be closely monitored to ensure that hazardous substances are not released to the environment.

In addition to the hazard associated with bitumen contamination during the operation of the tailings ponds, there is concern related to the health of wildlife exposed to plant emissions or chemical uptake from the reclaimed environment. The effects of oil sands-related chemicals on wildlife have been investigated by Golder (1996a) as part of an ecological risk assessment. Figure D4.0-8 shows the various pathways that may lead to exposure of ecological receptors. The validity of these pathways is discussed below.

Potential effects of Suncor's air emissions on wildlife are primarily indirect, involving alterations in vegetation that may lead to reductions in availability and/or quality of food and shelter. However, wildlife can also be affected directly through ingestion, inhalation or adsorption of gaseous emissions and fugitive dust.

Information on the acute and chronic effects of airborne chemicals on wildlife species is lacking. Most studies have used laboratory animals (e.g., guinea pigs and rats) and are low in ecological realism. The direct responses of wildlife to air emissions is expected to be highly variable, dependent on the habitat preferences and ages of the animals, as well as the concentration, duration and frequency of exposure. In the absence of specific information regarding the effects of air emissions on wildlife, Bovar (1996) recommends using human health ambient guidelines in evaluating the effects of direct exposures of wildlife to air. Golder (1996d) summarized the effects of air emissions on off-site air quality and human health, and found that health risks due to inhalation of air are likely low or negligible for people who live, work or engage in recreational activities near Suncor's operations. Further, once reclamation is complete and access to the site is no longer restricted, air emissions from the reclaimed landscape, hence risks for humans and wildlife, are expected to decrease.

Chemicals associated with Suncor's reclaimed landscape also have the potential to affect the health of wildlife species through the ingestion of water, soils and biota (Figure D4.0-8). Golder (1996a) performed a quantitative ecological risk assessment to determine the risks to wildlife associated with chemicals present on the site.

Chemicals detected in water and soils were screened against published criteria, background levels and risk-based concentrations to identify chemicals that may be present at concentrations that could potentially lead to adverse effects. Potential ecological receptors were screened, from a list of species known to occur in the area, for their societal relevance, biological relevance, accessibility to prediction and measurement and sensitivity to the potential chemicals of concern. Wildlife species identified as Valued Ecosystem Components (VECs) for the current Suncor EIA and those considered potential food sources for local people were given extra weight.

Chemical transport and fate pathways were also evaluated to determine the potential routes through which ecological receptors could be exposed to chemicals and the relative significance of operable exposure pathways (Figure D4.0-8). A chemical represents a risk to wildlife only if it can reach receptors through an exposure pathway at a concentration that could potentially lead to adverse effects. If there is no pathway for a chemical to reach a receptor, there can be no risk, regardless of the source concentration.

The results of these screening activities identified plant ingestion as the critical pathway for the exposure of ecological receptors to chemicals at concentrations that may potentially lead to adverse effects. Plants may potentially accumulate process-related chemicals via root uptake, particularly those plants with roots that might penetrate through the capping soils into the CT deposits. Limited data from laboratory and field investigations suggest that wetlands and terrestrial plants grown directly in CT soils accumulate concentrations of metals to levels slightly above plants grown in control soils (Xu 1995, 1996). Data on the uptake of organic oil sands chemicals from CT into plants is lacking. It is expected that this pathway will be effectively eliminated for most plants by the proposed capping sequence using sand and muskeg.

In 1996, Suncor intends to create a CT reclamation demonstration site. This site will be used to demonstrate the integrity of the CT consolidation process and will provide a field-scale experimental platform to quantify bioaccumulation of chemicals in edible plants under capping scenarios and evaluate any potential impacts of volatile chemicals on burrowing animals. This will provide the information necessary to fully characterize risks to wildlife.

Although there is also potential for bird mortality to result from collisions with overhead wires, buildings, and other structures, the principal concern relates to the Athabasca River bridge. The Athabasca River is believed to be a major migration route for waterfowl and shorebirds travelling to or from breeding areas on the Peace-Athabasca Delta or in the Arctic. It is probable that many passerine species also use the Athabasca River valley as a migration corridor. There is potential for migrating birds to collide with the bridge and its associated structures (transmission lines, pipes), particularly during periods in which inclement weather forces birds to fly at low altitudes. The number of birds that might be killed in this manner is not known, but is likely to be relatively small.

### D4.3.4 Impact Mitigation and Monitoring

Because of the large size of the project, considerable mortality of small mammals, amphibians, and other wildlife with small home ranges will inevitably result from project clearing and stripping operations. These impacts can be minimized by scheduling clearing operations to avoid the nesting period in important habitats (i.e., riparian forest and natural wetlands). It is recommended that, to the extent possible, clearing operations in the Athabasca River Valley be scheduled to avoid destruction of nests and young during the period from May 1 to July 15.

Problem wildlife will be handled in accordance with procedures specified by Fish and Wildlife Services, Alberta Environmental Protection. Suncor will implement procedures to minimize habituation of bears and other wildlife. This will include prohibitions on feeding wildlife or disposing of lunch bags and other refuse on the development site, and the implementation of a waste management plan designed to minimize scavenging by wildlife.

Measures should be implemented to minimize mortality of wildlife due to collisions with vehicles. Although the numbers of recorded instances of wildlife mortality along Highway 63 are low, this is a non-compensatory form of mortality that is cumulative. It is also recognized that recorded statistics likely understate the problem, since many collisions that result in injury or death of wildlife are unreported. Measures that could be used to minimize collisions are:

- Restrict speed limits for vehicles in the Steepbank Mine area to 60 km/hr or less, particularly within the Athabasca River valley;
- Use warning signs to make drivers aware of wildlife crossing locations and areas of important habitat; and
- Sodium chloride should not used as a de-icing compound on plant roads. Attraction to NaCl has been implicated as an important factor affecting highway mortality of moose and other wildlife species. Calcium chloride has been suggested as an alternative de-icing agent that does not attract ungulates (Damas and Smith 1982).

Suncor will implement a comprehensive deterrent program to minimize mortality or contamination of wildlife within the tailings ponds. The design of the deterrent program will be based on procedures that are currently being carried out on Lease 86/17. This will involve maintaining the tailings ponds in a condition that is unattractive to birds and other wildlife, and deploying floating deterrent devices (scarecrows and propane cannons) throughout the ponds. The effectiveness of the bird deterrent program has been extensively monitored and improvements to the program have been made, resulting in fewer incidents of mortality than occurred during the initial years of operation (J. Gulley, pers. comm.). The bird deterrent program is described in detail by Gulley (1985, 1987, 1988).

Monitoring is required to evaluate the risk of the CT ponds to waterfowl and other wildlife and to measure the effectiveness of the wildlife mitigation program.

### D4.3.5 Impact Rating

The severity, duration and geographic extent of impacts associated with direct mortality of wildlife due to mine development are indicated in Appendix II, Figure II-3.

Although mortality of small mammals, nesting birds, and denning furbearers will occur during clearing operations, the area directly affected comprises less that 10% of the Local Study Area and the resulting impact will be of low severity. These impacts are largely unmitigatable, although losses to birds would be lessened by scheduling clearing operations to avoid the nesting period. Removal of problem bears and beavers is expected to occur throughout the construction and operation period, however the severity of impact in the Local Study Area is low. Wildlife mortality resulting from collisions with vehicles will be of low severity and would not be measurable at a population level. The Steepbank Mine Project is not expected to result in increased levels of hunting, trapping or poaching. Mortality of waterfowl and other birds will result from contact with tailings ponds, however the severity of impact is likely to be low locally and negligible to low regionally.

### D4.3.6 Degree of Confidence

Our degree of confidence in these impact ratings is generally high, since the assessment was based on recorded levels of accidental mortality of wildlife associated with existing oil sands operations. The major area of uncertainty concerns the CT ponds. Although the consolidated tailings technology is considered likely to reduce the incidence of bird mortality in comparison to conventional technology, the extent to which this will occur is not currently known. Long-term monitoring is required to assess the potential for food-chain contamination as a result of chemical uptake from the reclaimed landscape.

## D4.4 HYPOTHESIS 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.**

Hypothesis 21 evaluates the potential for the Steepbank Mine development to interfere with movements related to seasonal habitat use and dispersal (Figure D4.0-9).

### D4.4.1 Linkages/Testable Hypotheses

Link 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area.

Link 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements in the project area.

Link 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources.

Link 4. Obstruction of movements due to the presence of various physical facilities and structures will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation.

Link 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources.

Link 6. Sensory disturbance of wildlife due to various development activities will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation.

Link 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife.

Link 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced abundance of wildlife.

### D4.4.2 Background

Research has shown that in predominantly forested landscapes, a variety of natural and man-made features can affect the movement patterns of wildlife. Home range boundaries and movement patterns can be constrained by natural features such as wide waterbodies, rugged terrain, or areas of unsuitable habitat. Human disturbance can also affect movements and habitat use by forest wildlife. Clearcuts and other large disturbances that involve loss of overhead cover may restrict movements of wildlife species adapted to the closed forest conditions that characterize the Boreal Mixedwood Region.

There are two types of movements that are of concern: (1) movements that occur within a home range, and (2) movements that extend beyond home range boundaries, including migration, emigration and dispersal. Most wildlife species inhabit distinct territories or home ranges in which they partition resources both spatially and temporally. The size of home ranges varies widely between species, and within a species can change seasonally in response to changes in food availability and reproductive requirements. Man-induced disturbances that affect an animal's ability to access critical resources within its home range can potentially affect the ability of that animal to survive and reproduce successfully.

Of greater concern from a population standpoint are those disturbances that potentially affect migratory or dispersal movements. Populations that undergo extensive movements between seasonal ranges are vulnerable to disturbances that affect the connectivity of these ranges. Although this is a greater concern for mammals that undergo migratory movements, bird populations have also been affected by the loss of important feeding and resting habitat along their flyways.

Dispersal is the mechanism by which juvenile animals leave their maternal home ranges in search of vacant habitat in which to live and reproduce (Ruggiero et al. 1994). Emigration is the process by which adult animals, forced to move because of food shortages or other factors, attempt to find suitable vacant habitat (Thompson and Colgan 1987). Both dispersal and emigration are important population mechanisms, serving as the means by which geographic ranges are expanded, vacant habitat is colonized or recolonized, and metapopulations are maintained (Ruggiero et al. 1994).

The importance of dispersal in maintaining population viability for a species depends on the way in which populations are distributed across a landscape. In the boreal mixedwood region, survey data show that some species, such as moose, tend to be continuously distributed, at varying densities, across broad geographic landscapes; whereas, other species, such as woodland caribou, tend to occur in widely dispersed population centers. In cases where a species does occur in isolated population centers, corridors or habitat linkages between these population centers may be important as a means of insuring against local extinctions. Lyon et al. (1994) postulate that some species of forest carnivores, including marten, fisher, and lynx, which characteristically undergo population fluctuations in excess of an order of magnitude in relation to changes in prey populations, may periodically undergo episodes of local extinction and recolonization. If this occurs, dispersal could be important in maintaining the larger metapopulations.

Although the proposed mine development, because of its size, represents a potential barrier to the movement of many mammal species, it is a particular concern for those species of large mammals that occupy extensive ranges, that undertake movements between geographically separated seasonal ranges, or whose status indicates that periodic dispersal may be essential for maintenance of the larger metapopulations. This group includes moose and some of the large and medium sized carnivores (wolf, black bear, wolverine and lynx). The assessment of Hypothesis 21 relates primarily to this group of wildlife, and focuses specifically on the potential for the project to cause disruption of wildlife movements along the Athabasca River Valley, given the importance that has been ascribed to the valley as a zone of diverse habitat, ungulate wintering areas, and travel corridors (Alberta Environmental Protection 1995).

### D4.4.3 Current Knowledge of Wildlife Movement Patterns in the Study Region

#### i. *Moose*

Much of our understanding of movement patterns of moose in the region is derived from radiotelemetry studies conducted in the late 1970s under the auspices of the Alberta Oil Sands Environmental Research Program (AOSERP) (Hauge and Keith 1981). From 1976 to 1978, 66 moose were radiocollared in a 1,685 km$^2$. study area located north of the Steepbank River near Bitumount. The study area extended to both the east and west sides of the Athabasca River. That study showed that 76% of radiocollared moose exhibited seasonal shifts in home range, while 24% remained in the same area year around. Of the moose that did move between seasonal ranges, two types of movement pattern were recorded. Most (62%) undertook relatively short movements, with distances between home range centers that averaged 6 km. The remaining 38% undertook movements of greater than 20 km, between higher elevation summer ranges in the Birch Mountains or Muskeg Mountain area and winter ranges near the Fort Hills and Athabasca River. The data indicate that a substantial portion of the moose population did move toward the Athabasca River in winter, but do not suggest seasonal movements of moose along the axis of the Athabasca River valley (Figure D4.0-10).

The timing of movements between seasonal ranges appears to be influenced primarily by snow conditions. Hauge and Keith (1981) report that most of the movements to winter ranges occurred during December and January, although earlier movements may be prompted by heavy snowfall. Movements to summer range began with spring thaw and loss of snow cover, with most movements recorded during April and May. They found that seasonal home ranges were of comparable size during winter and summer but ranged widely between 1 $km^2$ and 141 $km^2$. The mean size of annual home ranges for moose that did not undergo seasonal shifts was 97 $km^2$ (60-183 $km^2$).

### ii. *Wolf*

Research on the population dynamics and movement patterns of wolves in the Fort McMurray region was carried out from 1975 to 1978 through AOSERP (Fuller and Keith 1980a,b). Ten wolves in four packs and two lone wolves were radiocollared and monitored at weekly intervals from fixed-wing aircraft. The Muskeg River pack was monitored in greater detail than the other packs, with relocations occurring at least once daily during the periods of 15 January-10 March, 1977 and 21 January-28 March 1978. Trapper surveys were also conducted to obtain information on wolf distribution throughout the Fort McMurray region.

Results of that study suggest that the Athabasca River may act as a natural boundary between wolf pack territories (Figure D4.0-11). If the river does in fact constrain wolf movements, at least in the ice-free period, it would support the notion that the river valley may serve as a movement corridor. Results of the radiotelemetry monitoring however, do not seem to bear this out. Fuller and Keith (1980a,b) provide information on the daily movements of the Muskeg River pack during the late winter periods of 1977 and 1978 (Figure D4.0-12). The pack, which contained 8 to 10 wolves, occupied a home range estimated to be 1,627 $km^2$ in 1977 and 1,023 $km^2$ in 1978. The smaller home range size and shorter daily movements (11.6 km vs. 14.6 km) recorded in 1978 were attributed to deeper snow conditions during the winter of 1977-78. The authors reported no evidence of predictable or recognizable circuits of travel in either year. Although the pack did make a foray into the Athabasca River valley in January 1977, there was no evidence that the valley served as a major winter travel route (Figure D4.0-12).

Unfortunately, those authors do not present comparable data on the movement patterns of the Syncrude or Black packs or on movements of the Muskeg pack during the snow free period. Other authors have reported that watercourses figure more prominently in the movement patterns of wolves during summer. Joslin (1966 cited in Mech 1970) found that the main summer travel routes for wolves studied in Ontario were along waterways. Waterways are also used for summer travel in Minnesota, along with dirt roads, game trails and long ridges (Mech 1966). Increased travel along watercourses during summer may be related to a shift in food habits. Fuller and Keith (1980a) report that, in the Fort McMurray region, adult moose comprise most of the diet of wolves during spring and summer, as they do during winter, but that calf moose and beaver are also important constituents of the diet during those seasons. Cow moose with calves are often observed in riparian areas during spring and early summer.

The data provided by Fuller and Keith (1980a) provide some indication of the way in which wolves respond to large industrial disturbances. At the time of their study, the Syncrude project was under construction. The territory of the Syncrude pack, which numbered 6 to 8 animals during the winters of 1975-76 and 1976-77, encompassed the 50 km$^2$ site cleared for plant conservation and mine development and 21% of the relocations reportedly were within 2 km of the clearing. The movement patterns of the Syncrude pack were believed to have been influenced by the presence of one or more dump sites, since the pack had become partially dependent on refuse as a source of food (Fuller and Keith 1980a).

### D4.4.4 Evaluation of Linkages

**a) <u>Link 1</u>**

**The presence of physical facilities or structures will obstruct the movements of wildlife in the project area.**

Facilities structures that could potentially affect wildlife movements include:

- Structures associated with mine access and utility corridors, including the Athabasca River bridge, access roads, hydrotransport lines, and conveyor systems;
- Overburden dumps and mine pits; and
- Structures associated with the processing area or shop facilities.

**i.** ***Access and Utility Corridors***

It has been estimated that over a 20 year period, 30 km of permanent roads and 125 km of temporary roads will be constructed in the Steepbank Mine area. By themselves, mine access roads are not expected to provide a significant restriction to wildlife movements. Studies conducted near Cold Lake, Alberta showed that, although moose and deer were almost always successful crossing access roads associated with heavy oil development, the movement of deer across corridors containing roads was sometimes restricted by berms created by snow plowing (Skinner and Westworth 1990).

On the basis of initial feasibility studies related to an access corridor across the Athabasca River (see "Steepbank Mine Application"), an interim design has been developed for a two lane, concrete, five span bridge that would extend across the river from near the north end of the Tar Island Dyke. The bridge would be of sufficient capacity to support empty 330,000 lb mine haul trucks as well as proposed and future pipeline requirements between the extraction plant and the Steepbank Mine area. Electrical transmission lines needed to support Steepbank Mine operations would be supported from the bridge as well.

Approaches to each end of the bridge would be constructed of compacted fill. The embankment slopes would be established at 3 horizontal:1 vertical. At the edge of the river, the embankments would be in the order of 7 to 8 m high.

Under the proposed mine development plan, a pipe and utility corridor would extend across the bridge to the cyclofeeder and mine area (Figures D4.0-13, D4.0-14). This corridor would contain a number of above-ground pipelines, including:

- One 915 mm insulated hot process water line;
- Two 690 mm insulated hydrotransport lines (with space for a third to be installed at a later date);
- Six 510 mm tailings pipelines;
- A 1220 mm recycle pipeline; and
- A natural gas line.

On the east side of the Athabasca River bridge these pipes will be placed on pads located along either side of the main access road. The various pipes will be placed close to the ground surface and routed through culverts where haul roads or other access roads intersect the main mine access road.

Although the main access road and the bridge embankment itself may not present a complete barrier to wildlife movements, it is believed that the road and bridge embankment, together with the associated pipe corridor will provide a major obstruction. Studies of the effects of above-ground pipelines on wildlife movements near Cold Lake, Alberta showed that moose were much less successful than deer in crossing corridors with single above-ground pipelines (Skinner and Westworth 1990). Approximately 40% of attempted crossings were unsuccessful, with successful crossings by moose occurring only where pipe height above ground was greater than 135 cm. It is probable that a corridor containing five or more closely spaced pipes would present a physical and psychological barrier to all species of large mammals.

An above-ground conveyor system will be constructed to convey oil sand between the truck dumps/crushers, surge bin, cyclofeeder building, and rejects building. The location of the conveyors will change during the life of the mine, as the location of the ore crushers, which will be located near the edge of the mine pits, changes. The conveyor belts, which will be 84" (2.123 m) wide, will operate continuously 365 days per year. The conveyor system is expected to provide a significant barrier to movements of ungulates and large carnivores in the mine area, unless specific provisions for wildlife movements are incorporated into the design. Brusnyk and Westworth (1987) reported that ungulates and large carnivores were able to habituate to the sound and sight of an above-ground coal conveyor system in the Athabasca River valley near Hinton and made extensive use of specially-designed underpasses.

**ii.** ***Overburden Dumps, Mine Pits and Tailings Ponds***

In the absence of human disturbance, moose, wolves, black bears and other large mammals are known to be capable of crossing clearings several kilometres in width. For these species, the presence of large clearings within the mine area and at facility locations would not likely represent significant obstacles to movement, at least prior to the start of mine excavation. Medium-sized carnivores, such as marten and fisher, which generally avoid habitats lacking overhead cover (Buskirk and Ruggiero 1994, Powell and Zielinski 1994, Soutiere 1979), may not cross openings more than 200 to 300 m in width however. This would include the overburden dumps, which range in size from 145 to 750 ha.

Although the slopes of the dykes and overburden dumps will be quite steep (3:1 slopes for dykes, berms and waste dumps), they will not be steeper than many slopes that presently exist along the escarpment of the Athabasca and Steepbank Rivers. Once revegetation has progressed to a level that meets the various species requirements for security cover, it is unlikely that the overburden dumps or dykes will present a physical obstruction to wildlife movements.

The mine pits themselves will represent a barrier to movement of all mammalian wildlife across the mine area during the operation phase of the project. The tailings ponds will also present a barrier to movement until at least three years after tailings consolidation.

This link is therefore considered valid for ungulates and for large and medium sized carnivores. The principal concern is the potential to disrupt movements of moose into riparian wintering areas from upland habitats east of the mine area. Access to riparian habitat between the Steepbank Mine and the Athabasca River could still occur from the Steepbank River to the north and Wood Creek to the south, although these tributaries are at least 10 km apart.

**iii.** ***Processing Area and Shop Facilities***

The major concern for movements of ungulates and large carnivores are linear structures that block wildlife movements over long distances. Most of the facilities and structures associated with the Hydrotransport Area and Service Area are not large and by themselves do not present major physical obstructions to wildlife movements. The principal concern is the arrangement of these facilities within the valley, particularly facilities associated with the Hydrotransport Area. The Hydrotransport Area, which would be situated close to the east end of the bridge would contain a number of structures, including the cyclofeeder building, truck dumps, the surge bin, rejects building, an electrical substation, a construction laydown area, and oil sands stockpile area, and waste water ponds (Figure D4.0-14). Because of the limited space available within the river valley, the proposed arrangement of these facilities occupies most of the space between Dyke 10 and the Athabasca River.

**b)** **<u>Link 2</u>**

**Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements in the project area.**

Under Hypothesis 19, it was concluded that, although moose have a relatively high capacity to habituate to noise and human activity associated with large industrial developments, there is potential for decreased use of habitats immediately adjacent to the development area. Hauge and Keith (1981) noted that moose frequently move into the Athabasca River valley in winter, presumably as a response to increasing snow accumulations. Sensory disturbance could restrict these movements, resulting in reduced use of river valley wintering habitat in the vicinity of the Steepbank Mine.

It was also concluded that some of the larger carnivores, including wolf and lynx, are sensitive to disturbance during the denning period (Joslin 1966 cited in Mech 1970, Koehler and Aubry 1994). Sensory disturbance associated with mine development could potentially cause alienation of suitable denning habitat along the escarpment and floodplain of the Athabasca River. Link 2 is therefore considered valid for moose, wolf, and lynx during the construction and operation phases. Since wolverines are known to avoid areas of intensive human activity, the link is also considered to be valid for this species. There is insufficient information to assess whether the link is also valid for fisher and marten.

**c) Link 3**

**Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources.**

Link 1 indicated that the presence of the various structures and facilities associated with the Steepbank Mine would provide an obstacle to wildlife movements through the development area, during the construction and mine operation periods. Our research has also shown that riparian habitats within the floodplain of the Athabasca River are important habitats for a relatively large number of wildlife species. A portion of these riparian habitats on the west side of the mine area will remain after mine development; however, the degree to which they are used by wildlife will depend on each species ability to habituate to disturbance associated with the adjacent mine development and on the ability of these species to gain access to these remaining habitats through the mine area. In the absence of any facilities for wildlife movement past the bridge and main mine access corridor, it is likely that north-south movements along the valley would be interrupted at that point.

Although the mine development would largely preclude access to the river valley from the east, it is likely that remaining riparian habitats on the west side of the mine will continue to receive some use by wildlife moving into the area from the north or from the south, along the Athabasca River valley. However, because the number of directions by which these remaining areas of riparian habitat could be accessed would essentially be reduced from three to one, and the total distance over which access could occur would be reduced by over 90%, it is likely that use of these remaining habitat areas would be reduced. To this extent the hypothesis appears to be valid. The larger issue however, is whether the Steepbank Mine, by disrupting wildlife movements along the Athabasca River Valley would reduce the access to important habitats farther along the valley, beyond the footprint of the mine area. Although it is logical that animals that depend on riparian or other river valley habitats would move back and forth along these linear zones in search of food or other resources, the extent of these movements is not well known. Track count surveys conducted during the study indicate that moose move into areas of suitable winter habitat within the valley but tend to remain in these 'pockets' of habitat and do not move extensively up and down the river valley (Figure D4.0-15). Insufficient data were obtained during the present study to assess the importance of the river valley as a travel corridor by wolves. Previous studies of winter movements of wolves in the region (Fuller and Keith 1980a, b) suggest that the Athabasca River Valley may not be an important movement corridor for wolves, during winter at least. Studies conducted in other areas indicate that wolves tend to follow watercourses more in summer, when they use a wider variety of prey species (Mech 1966). The winter track count surveys conducted during the present study indicate that the Athabasca River valley is extensively used by coyotes, although comparison of track frequencies crossing transects aligned perpendicularly to the river with transects aligned parallel to the river do not show a well-defined pattern of movement along the valley (Figure D4.0-15). Similar results were obtained for fisher, although smaller valleys, such as the Steepbank, may be more important as movement corridors for some of these smaller carnivores (Figure D4.0-15).

In conclusion, it appears that obstruction of movements due to the presence of mine facilities could cause reduced access to important habitat by ungulates and most large and medium-sized carnivores, however it is likely that this effect would be localized and limited primarily to habitat immediately adjacent to the mine.

d) Link 4

**Obstruction of movements due to the presence of various physical facilities and structures will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation.**

Because of the technical difficulty of studying the long distance movements of carnivores, our knowledge of dispersal and emigration of these species is extremely limited. Mech (1966) points out that, although long distances movements involving 200 or 300 km have been reported for wolves, it is generally not known whether these movements represent dispersal, migration, or just a shift in home range. Because of their large home range sizes and ability to travel quickly over long distances, wolves are considered capable of bypassing large obstacles.

Magoun (1985 cited in Banci 1994) indicates that dispersal of wolverines, which most often involves young-of-the-year or subadult males, occurs from January through May. The longest documented movement was 378 km (Table D4.0-9) (Gardner et al. 1986). Because of their capacity for long movements, the presence of rivers, lakes, mountain ranges and other topographic features do not appear to block movements (Hornocker and Hash 1981). Rivers and streams are sometimes used as travel routes, likely reflecting the use of these travel routes by prey species (Banci 1994). Banci (1994) suggests that, in the case of males at least, the dispersal and travel corridors that connect refugia may not require the habitat attributes necessary to support wolverine populations. Relatively low quality habitats may suffice to connect otherwise isolated populations and allow for genetic exchange or recolonization. Females however, may have more specialized requirements for dispersal corridors, since their dispersal distances are less than for males and females tend to establish home ranges close to their natal area. Banci (1994) also points out that, in view of the tendency of wolverines to avoid areas of human activity, extensive human settlement and major access corridors may serve as barriers to dispersal.

Throughout its North American range, populations of lynx have been shown to closely follow fluctuations in snowshoe hare populations. The timing of dispersal and emigration appears to be aligned with this demographic pattern. Ward and Krebs (1985) found that abandonment of home ranges and nomadic behaviour was related to declining hare densities. Lynx have been recorded moving 164 km in Alberta (Table D4.0-9) (Nellis et al. 1972), although movements exceeding 1,000 km have been reported in other parts of North America (Koehler and Aubry 1994). The habitat requirements for dispersal movements are not known, although lynx are generally thought to require overhead vegetation cover for security. Koehler and Aubry (1994) report that lynx avoid large forest openings, and that "clearcuts >100 m wide may create barriers for lynx movements".

Although fishers become independent from their mothers in the fall, young fishers do not begin to disperse from their mother's home range until mid to late winter (Arthur et al. 1993). Dispersal distances of up to 42 km have been reported for young males (Powell and Zielinski 1994). Habitat selection during dispersal has not been studied, although Buck et al. (1983 cited in Powell and Zielinski 1994) suggested that forested saddles between drainages were important linkages for fisher movements. Powell and Zielinski (1994) point out that long distance movements by fishers may be restricted in landscapes with large nonforested openings.

In the case of marten, Archibald and Jessup (1984) report two annual dispersal periods, one extending from mid-July to mid-September, and the other over winter. Clark and Campbell (1976, cited in Buskirk and Ruggiero 1994) report a period of shifting in late winter and spring. Dispersal distances can be extensive. In Manitoba, one individual was recorded moving 61 km (Raine 1982). Little is known about the nature of dispersal movements in marten. In light of the species aversion to crossing large openings (Soutiere 1979), forest fragmentation may restrict the normal dispersal process. Buskirk and Ruggiero (1994) conclude that "the long dispersal distances of martens, to the extent that we understand them, in combination with the sensitivity of martens to overhead cover suggest that connectivity of habitat providing overhead cover is important to population dynamics and colonization".

It therefore appears that large developments, such as the Steepbank Mine, have potential to restrict dispersal movements of large mammals, although the significance of such disruptions varies among species. Species including moose, wolf, black bear and wolverine, which occupy large home ranges and are capable of travelling over very long distances, would likely be able to circumvent the proposed development area relatively easily. In size, the Steepbank project might be comparable to a medium-sized lake or other natural obstacle. Some of the smaller forest carnivores, such as marten and fisher, are not as wide ranging and dispersal movements might be more effectively disrupted by a project of this size. Although linear features, such as the Athabasca River Valley, may function as dispersal routes, the principal requirement for most of these species appears to be continuous overhead forest cover, and river corridors are likely not a requisite for emigration or dispersal.

**TABLE D4.0-9 MEAN HOME RANGE SIZES OF VARIOUS WILDLIFE SPECIES.**

| Species | Study Area | Mean Home Range Size ($km^2$)[1] | Timing of Movements | Dispersal Distance (km) | Reference |
|---|---|---|---|---|---|
| **Moose** | Ft. McMurray Region | Winter 30 (3-111) | Dec-Jan | | Hauge and Keith (1981) |
| | | Summer 47 (12-141) | Apr-May | | |
| **Black Bear** | Idaho | Adult Male 112 (109-115) | | | Amstrup and Beecham (1976) |
| | | Adult Female 49 (17-130) | | | |
| | Cold Lake, AB | Males 119 (42-196) | late May-June | Undetermined | Young and Ruff 1982 |
| | | Females 19.6 (3-63) | | | |
| | Minnesota | | | 61 (13-219) | Rogers (1987) |
| **Wolf** | Ft. McMurray Region | Winter 793 (95-1779) | Sep-Apr | | Fuller and Keith (1980) |
| | | Summer 386 (195-629) | May-Sep | | |
| **Lynx** | Rochester, AB | Winter 28 (19-50) | Nov-Apr | | Brand et al. (1976) |
| | Rochester, AB | | | 164 | Nellis et al. (1972) |
| **Fisher** | Manitoba | Winter 18 (15-21) | | | Raine (1982) |
| | Wisconsin | Male 39 (28-49) | | | Kohn (1993) |
| | | Female 8 (5-10) | | | |
| | Maine | | mid-late winter | 10 to 16 | Paragi (1990) cited in Powell and Zielinski (1994) |
| | Idaho | | | 26 to 42 | Powell and Zielinski (1994) |
| **Marten** | Montana | Male 2.4 | | | Hawley and Newby (1957) |
| | | Female 0.7 | | | |
| | Minnesota | Male 16 (11-20) | | | Mech and Rogers (1977) |
| | | Female 4.3 | | | |
| | Manitoba | | Nov | 61 | Raine (1982) |
| **Wolverine** | Montana | Male-winter 172 (97-248) | | | Hornocker and Hash (1981) |
| | | Male-spring 331 (180-481) | | | |
| | | Male-summer 158 (126-190) | | | |
| | | Male-fall 57 | | | |
| | | Female-winter 148 (86-210) | | | |
| | | Female-spring 267 (170-363) | | | |
| | | Female-summer 395 (274-515) | | | |
| | | Female-fall 144 (96-192) | | | |
| | Alaska | | | 378 | Gardner et al. 1986 |

1 Range of values in parentheses

Many wildlife species also undergo extensive movements associated with breeding and the search for mates. Obstacles that restrict such movements are potentially significant, since they could lead to reduced reproductive performance. However, our knowledge of movements patterns associates with breeding activity is lacking for all of the wildlife VECs being considered. The effects of the project on breeding activity are consequently unknown.

e) Link 5

**Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources.**

As indicated under Link 2, it is believed that disturbance associated with the Steepbank Mine development could restrict the use of wintering habitat associated with the Athabasca River floodplain and escarpment by moose. It was also concluded that the development could result in alienation from denning habitat in the river valley by wolves and lynx. It is therefore concluded that Link 5 is valid for these species.

f) Link 6

**Sensory disturbance of wildlife due to various development activities will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation.**

Because of their ability of travel long distances, moose, wolves, wolverines, and perhaps lynx, are capable of circumventing large obstacles, and it is unlikely that disturbance associated with mine development would restrict dispersal movements to a substantial degree. Black bears, which are highly tolerant of human activity, are also likely to be unaffected. The effect of sensory disturbance on dispersal of fisher and marten is not known. Because our knowledge of movement patterns related to breeding or reproduction is so incomplete, the effects of sensory disturbance on these types of movements is not known.

g) Link 7

**Reduced access to important habitat or critical resources will result in reduced abundance of wildlife.**

In evaluating Hypothesis 21, it has been concluded that mine development will reduce the use of important habitats by moose, wolves and lynx. The mechanisms involved include the creation of barriers, such as roads, hydrotransport lines, that may disrupt home ranges and interfere with seasonal movements, and the potential alienation of important areas because of noise and other disturbances associated with mine development and operation. Based on this evaluation it is concluded that impaired access to such areas has the potential to reduce seasonal foraging opportunities by moose, and interfere with the establishment of natal dens by wolves and lynx. This could result in lower rates of reproduction. Thus, Link 7 is assumed to be valid; however, it is believed that any decline in wildlife populations will be too slight to significantly affect local or regional wildlife populations.

**h) Link 8**

**Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced abundance of wildlife.**

Under Link 4 it was concluded that dispersal movements of large mammals such as moose, wolf, wolverine and black bear were not likely to be affected by the physical presence of the mine, but that some of the smaller carnivores, including fisher, marten, and lynx could be. On the same basis, it was concluded in Link 6 that sensory disturbance associated with construction or mining operations was not likely to restrict the dispersal of wide ranging species such as moose, wolves and wolverines, although the effects on smaller carnivores, such as marten, is not known. The effects of the project on movements associated with breeding or reproductive activity are not known. Since Links 4 and 6 were invalid for moose, wolf, wolverine, and black bear, Link 8 is also judged to be invalid for these species. It is not known whether the link is valid for the remaining species.

### D4.4.5 Mitigation and Monitoring

**a) Mitigation Strategy**

Mitigation should focus on methods of allowing continued movement of wildlife along the Athabasca River Valley. Maintaining riparian corridors through the development area is likely to be the most effective mitigation approach. This approach would require some restrictions on alignment of facilities within the river valley and could entail some costly modifications to the bridge design.

Winter track count surveys conducted within the valley during February and March 1996, indicate that activity of most ungulate and carnivore species is concentrated in riparian habitats close to the river, with less use of habitats in higher slope positions on the valley escarpment. It is likely that many wildlife species would continue to make extensive use of this zone during other seasons, because of the rich and diverse food sources that occur there. Black bears for example, which range over large areas, are generally believed to follow river systems as they seasonally forage on fish, carrion, horsetails and other aquatic plants. Retention of an effective riparian corridor between the development area and the river should therefore be the focus of the mitigation strategy. The development plan should incorporate development setbacks from the river to meet the needs for a wildlife corridor immediately adjacent to the river.

Although the literature contains many guidelines and criteria for the protection of wildlife corridors, there is a lack of experimental data on the effectiveness of different corridor dimensions (Hunter 1990, Schaefer and Brown 1992). Thomas (1979) indicated that the minimum effective width of hiding cover for elk in the northwestern United States was 183 m, based on the distance at which a standing animal would be 90% hidden by vegetation. Ewaschuk and Westworth (1983) used similar criteria to establish a minimum effective width of 80 m for white-tailed deer in undisturbed aspen forest in Alberta.

In an attempt to identify effective corridor widths that are more applicable to the present study, track count surveys were conducted across a variety of existing corridor widths at a number of locations within the Athabasca River valley north of Fort McMurray in February and March 1996 (Westworth et al. in prep.). The 20 corridors sampled ranged in width from 28 m to 685 m. Although the results of this initial survey are by no means conclusive, the results do indicate that moose make little use of corridors less than 100 m wide, although smaller mammals such as coyote and fisher are capable of using corridors as little as 75 m in width. On the basis of the information available at the present time, we feel that the minimum corridor width should not be less than about 100 m in undisturbed aspen, balsam poplar or mixedwood forest.

While the width of the corridor is probably the most significant factor affecting wildlife use, other factors, such as the length of the corridor and the nature of adjacent disturbance factors, might also have an important influence on the effectiveness of a corridor. Species that are capable of traversing narrow corridors for a short distance may be reluctant to follow such corridors over long distances.

As well, the presence of a significant human disturbance source may deter an animal from travelling along a corridor that otherwise meets its requirements for security cover. Efforts should therefore be made to plan the development in such a way that the length of 'narrow' corridors is minimized and potentially disturbing facilities (e.g., truck dumps, crushers, cyclofeeders) are set back as far as possible from the Athabasca River.

The Athabasca River bridge, along with potential noise and human disturbance associated with the use of the bridge, could restrict wildlife movements along the Athabasca River, although the extent of these movements for most wildlife species is poorly known. In view of the documented evidence that habitats within the Athabasca River valley are important for a large number of wildlife species, however, maintenance of the connectivity of riparian corridors along the Athabasca valley is considered an important management consideration. It is recommended that the proposed river crossing incorporate design features to facilitate wildlife movements along the valley.

Research conducted in other areas has shown that wildlife will use a variety of man-made structures to cross under or over highways and other linear obstacles. Ungulates will cross under elevated sections of above-ground pipelines (Eide et al. 1986, Skinner and Westworth 1990) and will use specially-designed underpasses under a coal conveyor system (Brusnyk and Westworth 1987). A number of wildlife underpasses were used in conjunction with a highway fencing program to reduce the impact of highway mortality of ungulates and other wildlife in Banff National Park (Woods 1990, Parks Canada 1995). These included both open span structures and large-diameter culverts. Monitoring studies indicated that both types of structures were used by elk and other ungulates, although Woods (1990) reported that "open-span underpasses were more acceptable to ungulates than culvert underpasses of suitable dimensions". Wolves, black bears, coyotes and other carnivores also made use of the underpasses, although wolves were reportedly more reluctant to use the underpasses, preferring to travel around the fenced portion of the highway (Parks Canada 1995, T. Hurd, Parks Canada, pers. comm.). Only one-half of the measured approaches to underpasses by wolves resulted in successful crossings; in some instances the packs split, with more habituated animals using the underpasses while less habituated animals travelled around the obstruction (T. Hurd, pers. comm.). Underpasses that were used were primarily span-type structures, with the only recorded use of a culvert by wolves occurring through a 4 m x 7 m wide box culvert. Box culverts are considered more effective as wildlife crossing facilities than are oval, metal culverts (T. Hurd, pers. comm.). Because of the reluctance of wolves to use underpasses, the next phase of

TransCanada Highway reconstruction in Banff will involve the construction of two wildlife overpasses; 60 m wide forested corridors extending over the highway right-of-way (T. Hurd, pers. comm.). On the basis of information available on the use of overpasses in Europe and other parts of North America, Parks Canada believes that overpasses will solve problems of fragmented habitat use related to highway construction and fencing.

Similar research was carried out by British Columbia's Ministry of Transportation and Highways to evaluate the effectiveness of various types of underpasses and an overpass as wildlife crossing structures along the recently constructed Okanagan Connector Freeway of the Coquihalla highway system (A. Buckingham, Mgr. Environmental Services, pers. comm.). Radiotelemetry studies of moose and elk movement patterns were initiated along the proposed route prior to highway construction. The highway was subsequently fenced to reduce vehicle-wildlife collisions, and 27 crossing structures were installed. These included several concrete pylon bridges, large multi-plate culverts (7 m inside height), small culverts (4 m inside height), and a single overpass structure. The overpass was approximately 4 m in width and covered with a 0.5 m layer of soil to support vegetation growth. Results of wildlife monitoring studies indicated that deer used the crossing structures much more readily than moose, with up to a 50% reduction in moose movements following highway construction and fencing (Simpson et al. 1995). Although both large and small culverts were used by both moose and deer, bridges and the single overpass were the structures that were most readily used by both species (Simpson and Gyug 1995). Placement, traffic, and nearby vegetation cover were important factors in determining wildlife use of the crossing structures.

In contrast, McDonald (1991) reported better success with use of a crossing by moose in Alaska. An underpass was constructed under the Glenn Highway, which underwent widening and fencing, by lengthening a bridge to provide a 3 m wide pathway at one end. The underpass was reportedly used readily by moose, with no resulting change in numbers of moose crossing before and after reconstruction.

On the basis of results reported in these other studies, it appears that a variety of wildlife crossing structures can be beneficial in mitigating wildlife movement impacts. It appears that either open-span underpasses or overpasses are likely to be more effective for a wide range of species than culvert crossings, although proper placement, vegetation management to ensure uninterrupted approaches to the crossing structure, and measures designed to attenuate noise and human disturbance, are likely to be as important as the type of crossing structure in ensuring wildlife use.

**b) Recommendations**

- Final development plans for the Steepbank Mine should incorporate a wildlife movement corridor along the east side of the Athabasca River.
- The movement corridor should provide a continuously forested zone of undisturbed habitat of sufficient width to meet the movement and dispersal requirements of all wildlife.
- The movement corridor should not be less than 100 m in width and sections of the corridor less than 200 m in width should not extend over distances of more than 400 m.
- Noisy and potentially disturbing facilities (such as truck dumps, crushers, cyclofeeder) should be set back as far as possible from the movement corridor.
- A wildlife bypass should be incorporated into the bridge design to allow wildlife unobstructed movement over or under the bridge approach and abutment, and utility corridor.
- Trees should be retained or replanted on both sides of the bridge bypass to maintain a continuously forested movement corridor. It is recommended that the final facilities siting attempt to retain a larger patch of 'secure' habitat on both sides of the bridge bypass to serve as a 'staging area' for animals that are hesitant to use the bridge bypass during periods in which the bridge is receiving high use.

**c) Monitoring Requirements**

There is a need to implement a well-designed monitoring program to determine the effects on wildlife movements along the Athabasca River valley and to evaluate the effectiveness of wildlife corridors and bridge bypass facilities.

### D4.4.6 Impact Rating

Hypothesis 21, which is concerned with the potential for the Steepbank Mine development to disrupt movement patterns of wildlife in the area, was evaluated for a number of ungulate and large and medium-sized carnivore species identified as VECs. Considering the size of the project, it was felt that this was a concern primarily for species with large home ranges, that might undertake movements between geographically separated seasonal ranges, or whose status indicates that periodic dispersal may be essential for recolonization of vacant range or for the maintenance of the larger metapopulations. Although the disruption of wildlife movements is to a large extent unavoidable with a project of this type, a number of mitigative strategies were described that could lessen the overall impact of the development on species of concern. The following section indicates the impact ratings that would exist for each of these VECs following mitigation. The impact ratings are summarized in Appendix II, Figure II-4.

**a) <u>Moose</u>**

Hypothesis 21 is assumed to be valid for moose during the construction and operation phases of the Steepbank Mine. There is evidence that portions of the moose population in the Fort McMurray region undergo seasonal movements to wintering areas along the Athabasca River. The Steepbank Mine could restrict access to some of these wintering areas, although this effect is expected to be localized to the portion of the valley immediately adjacent to the mine. Currently there is no evidence that moose move extensively along the valley. The severity of impact in the Local Study Area is rated as low and moderate during the construction and operation phases, respectively. In the Regional Study Area the impact would be either low or negligible.

**b) <u>Wolf</u>**

Since most of the links were found to be valid, it is also assumed that Hypothesis 21 is valid for this species. Facilities development in the river valley could interfere with movements of wolves along the Athabasca River, however the extent to which wolves use the valley as a movement corridor is not clear. Winter track count surveys indicated limited use of the valley as a movement corridor by wolves in 1995 and 1996, although results might have been affected to some extent by exploration activities that were underway during part of survey period. Other authors suggest that wolves follow river valleys more in summer. Because of their ability to traverse very long distances, wolves are expected to be able to circumvent the development area and dispersal movements are not likely to be affected. During the construction and operation phases, the severity of impact is rated as moderate for the Local Study Area, and low for the Regional Study Area.

**c) <u>Black Bear</u>**

Little information exists on the movement patterns of black bears in northeastern Alberta. The project could restrict movements of black bears along the Athabasca River valley and could limit access to good denning habitat in the valley. However, given the abundance of black bears in the region and their ability to habituate to high levels of human activity, the impact is rated as low in both the Local and Regional Study Areas.

**d) Wolverine**

Although the status of wolverines in the region is poorly known, this species is thought to be present at very low densities throughout remote portions of the study region. The movement patterns of wolverines is very poorly known. Given the very large home range sizes that have been reported for wolverines in other areas, it is expected that the seasonal movements of wolverines would not be greatly restricted by the Steepbank Mine development. Since wolverines are capable of bypassing large natural obstacles, such as lakes and mountains, it is also assumed that dispersal movements would be similarly unaffected. The overall degree of concern is rated as low for both the Local and Regional Study Areas, although there is potential concern over the long-term cumulative effects of development in the region on the ability of wolverines to disperse or emigrate between isolated population centers.

**e) Lynx**

Since most of the linkages were found to be valid, Hypothesis 21 is also considered valid for lynx. Although the movement patterns of lynx are not well known, there is concern that the project could restrict the movements of lynx between upland foraging habitats and denning habitat in the Athabasca River valley. There is also potential for the project to restrict dispersal movements by lynx. The severity of impact during the construction and operation phases is rated as low to moderate for the Local Study Area and low for the Regional Study Area.

**f) Fisher and Marten**

Although the validity of many of the links for fisher and marten were unknown, the project does appear to have potential to disrupt dispersal movements and restrict access to important denning and foraging habitat in the Athabasca River valley. Both species are known to avoid crossing non-forested openings more than 200-300 m in width. Both marten and fisher are more abundant in the region than the larger carnivores considered, and the impact is rated as low during the construction and operational phases of the project for both the Local and Regional Study Area. Following reclamation and mine closure movements of these species should be unaffected, however since both species show a preference for mature, coniferous - dominated forest, it could take many years for suitable habitat to reestablish.

### D4.4.7 Degree of Confidence

Our ability to confidently predict the impact of the Steepbank Mine project on wildlife is hampered by our poor understanding of the movement patterns of most species in the region. Our current knowledge of moose movements is better than our knowledge of carnivore movements and the level of confidence in our impact ratings for moose is moderately high. Because of their ability to habituate to high levels of noise and human activity we also have moderately high confidence in our assessment that impacts on black bears will be of low severity. Although we know very little about the movement patterns of wolves and wolverines in the area, the large home ranges and ability of both species to travel long distances allows us to predict with a moderate degree of confidence that seasonal and dispersal movements would not be greatly affected. The degree of confidence in our ratings for lynx, fisher and marten is considered low.

## D4.5 HYPOTHESIS 22

**Mine development will cause a reduction in wildlife resource use (hunting, trapping, non-consumptive recreational use).**

Hypothesis 22 evaluates the potential impact of mine development to trappers, hunters, and wildlife recreationists (Figure D4.0-16).

### D4.5.1 Linkages/Testable Hypotheses

Link 1. Mine development will result in loss of habitat for species of commercial, domestic, or recreational importance.

Link 2. Noise and human activity will cause behavioral disturbance of wildlife.

Link 3. Noise and other disturbances associated with mine development and operation will cause disturbance to hunters, trappers, and recreational users.

Link 4. Habitat loss resulting from mine development will reduce the availability of wildlife to hunters, trappers, and recreational users.

Link 5. Behavioral disturbance of wildlife will cause range abandonment, reduced survival, or changes in reproductive success that will affect the availability of wildlife.

Link 6. Mine development will result in reduced access to the land base for hunters, trappers, and recreational users.

Link 7. Noise, dust, and visual impairment will cause disturbance to hunters, trappers, and recreational users.

Link 8. Changes in the availability of wildlife will affect hunting and trapping success.

Link 9. Reduced access to hunting and trapping areas will affect hunting and trapping success;

Link10. Reduced access will affect the enjoyment or satisfaction of wildlife resource users and traditional lifestyles.

Link 11. Noise and visual impacts will affect the enjoyment or satisfaction of wildlife resource users and traditional lifestyles.

Link 12. Reduced hunting and trapping success will cause reductions in wildlife resource use.

Link 13. Reduced enjoyment will result in reduced wildlife resource use and loss of traditional lifestyles.

### D4.5.2 Background

Development of the Steepbank mine would reduce access to the area occupied by the mine and its associated facilities, and could result in a concomitant reduction in the use of wildlife resources in the Fort McMurray region. Typical uses of wildlife include recreational and subsistence hunting, fur trapping, and various non-consumptive uses such as wildlife viewing.

In Canada, the non-consumptive use of wildlife is an important recreational activity. Filion et al. (1983) reported that one in five Canadians made at least one outing annually for the express purpose of photographing, viewing, feeding, or studying wildlife. Individuals spent an average of $589 and 15.8 days per year on such outings. Hunting is also an important recreational activity in Canada (Filion et al. 1983). In 1981, approximately 10% of all Canadians participated in hunting. Hunters spent an average of 17.9 days and $602 per year on hunting.

Although the level of non-consumptive wildlife use has not been documented for the Suncor study area, hunting appears to be an important recreational activity. The Suncor study area includes portions of two Wildlife Management Units (WMUs). WMU 518 occupies an area of approximately 11,100 $km^2$ west of the Athabasca River, whereas WMU 530 occupies about 16,900 $km^2$ east of the river. Records maintained Alberta Environmental Protection (1995) indicate that 118 moose, 22 black bears, and 1,481 ruffed grouse were harvested by licensed hunters on these WMUs in 1993, the last year for which such records are available (Table D4.0-10). In general, hunters using WMUs 518 and 530 spent slightly more time hunting and were slightly more successful than hunters in the rest of the province.

Fur trapping is also an important wildlife-based activity. In the past, trapping has provided an important source of revenue for some people on subsistence incomes. However, Skinner and Todd (1988) suggested that, in Alberta, fur trapping was evolving from an activity undertaken primarily to supplement incomes to one in which the principal motive was personal enjoyment. The Suncor study area contains portions of four Registered Fur Management Areas (RFMAs). In the 10 years from 1984-85 to 1993-94, 3,566 animals were harvested by registered trappers on these RFMAs for total revenue of $63,924 (McCormick and Skinner 1996.). Trappers also use wildlife for a variety of other purposes. Some pelts are used for making clothing and some animals such as moose, which can be hunted throughout the year by three of the four senior partners, are an important source of food for trappers in the area. Two of these trapping areas (RFMAs #2297 and #2453) are located in the vicinity of the Steepbank River and thus, would be directly affected by mine development.

In contrast, use of the area that will be affected by the Steepbank Mine development by other traditional wildlife users appears to be limited by poor access (Fort McKay Environment Services Ltd. 1995). Most native hunting occurs along the Athabasca River and on islands within the study area. However, until about 30 years ago, Tar Island was an important meeting area for people engaged in hunting, fishing, and gathering over a wide area, which included the present Suncor study area. Fort McKay Environment Services Ltd. (1995) reported that local residents were concerned that cutlines and forest clearing would negatively affect wildlife and thus traditional wildlife users in the area. They also expressed concern that negative impacts on air, water, fish, and wildlife associated with increasing industrial development would reduce the potential for ecotourism in the region.

## TABLE D4.0-10

## COMPARISON OF HUNTER HARVEST AND EFFORT IN WILDLIFE MANAGEMENT UNITS (WMU) 518 AND 530, AND ALBERTA, 1993.

| Area | No. of Hunters | Hunting Effort (days/hunter) | Total Harvest | Hunter Days/Animal |
|---|---|---|---|---|
| **Moose** | | | | |
| WMU 518 | 184 | 6.2 | 65 | 17.4 |
| WMU 530 | 154 | 6.1 | 53 | 17.7 |
| Alberta | 35,930 | 5.8 | 8,232 | 21.3 |
| **Black Bear** | | | | |
| WMU 518 | 11 | 1.0 | 11 | 1.0 |
| WMU 530 | 43 | 4.3 | 11 | 16.6 |
| Alberta | 4130 | 5.6 | 1127 | 22.6 |
| **Ruffed Grouse** | | | | |
| WMU 518 | 76 | 11.4 | 959 | 0.9 |
| WMU 530 | 76 | 6.9 | 617 | 0.8 |
| Alberta | 13,666 | 6.0 | 37,600 | 2.0 |

### D4.5.3 Evaluation of Linkages

**a) Link 1**

**Mine development will result in loss of habitat for species of commercial, domestic, or recreational importance.**

Under Hypothesis 18, it was concluded that the Steepbank Mine would adversely affect wildlife habitat for a variety of wildlife species, including moose, terrestrial furbearers, semi-aquatic furbearers, and birds. It is therefore concluded that Link 1 is valid for Hypothesis 22.

**b) Link 2**

**Noise and human activity will cause behavioural disturbance of wildlife.**

Under Hypothesis 19, it was concluded that sensory disturbance resulting from the Steepbank Mine would adversely affect a variety of wildlife species, including moose and some species of terrestrial furbearers. Link 2 is therefore considered valid for Hypothesis 22.

**c) Link 3**

**Noise and other disturbances associated with mine development and operation will cause disturbance to hunters, trappers, and recreational users.**

For safety reasons, development and operation of the Steepbank Mine will preclude the access to the area by other users, such as hunters, trappers, and other outdoor recreationists. Link 3 is therefore considered invalid.

**d) Link 4**

**Habitat loss resulting from mine development will reduce the availability of wildlife to hunters, trappers, and recreational users.**

Under Hypothesis 18, it was concluded that habitat loss as a result of mine development and operation would result in reduced abundance of many of the wildlife species residing in the vicinity of the proposed Steepbank Mine. Link 4 is therefore considered valid for Hypothesis 22.

e) Link 5

**Behavioural disturbance of wildlife will cause range abandonment, reduced survival, or changes in reproductive success that will affect the availability of wildlife.**

Under Hypothesis 19, it was concluded that sensory disturbances had the potential to reduce populations of some wildlife species. It is therefore concluded that Link 5 is valid.

f) Link 6

**Mine development will result in reduced access to the land base for hunters, trappers, and recreational users.**

During mine development and operations, access to the Steepbank Mine area will be restricted to personnel involved in the mining program. As a result, an area of approximately 4,400 ha would become unavailable to recreational users. Link 6 is therefore assumed to be valid for Hypothesis 22.

g) Link 7

**Noise, dust, and visual impairment will cause disturbance to hunters, trappers, and recreational users.**

As discussed under Links 3 and 6, hunters, trappers, and other outdoor recreationists would be excluded from the site of the Steepbank Mine and thus, would be largely unaffected by noises and dust resulting from mining operations. However, the bridge and other facilities constructed in the Athabasca River valley could be considered an adverse visual impact by those travelling along the river. Link 7 is therefore assumed to be valid.

h) Link 8

**Changes in the availability of wildlife will affect hunting and trapping success.**

Because hunting and trapping will not be allowed in the Steepbank Mine development area, changes in wildlife abundance within the project area will not affect the wildlife harvest in the area. Moreover, it is unlikely that any reduction in wildlife availability will extend very far beyond the development area. Link 8 is therefore considered invalid for Hypothesis 22.

i) Link 9

**Reduced access to hunting and trapping areas will affect hunting and trapping success.**

Because Suncor will prohibit unauthorized personnel from the area of the Steepbank Mine, there will be no hunting or trapping within the area. Hunters and trappers that previously used the Steepbank Mine area will have to seek alternative hunting and trapping areas. Moving to less familiar or more heavily hunted areas could adversely affect their success. Link 9 is therefore considered valid.

j) Link 10

**Reduced access will affect the enjoyment or satisfaction of wildlife resource users and traditional lifestyles.**

Based on hunter harvest statistics for 1993 (Alberta Environmental Protection 1995), it appears that comparatively little hunting takes place in WMU 530, which includes the eastern portion of the Suncor study area. However, the mining area contains portions of two of the four RFMAs in the Suncor Local Study Area. Loss of these trapping areas will adversely affect the traditional lifestyles of the trappers involved. Consequently, Link 10 is assumed to be valid for Hypothesis 22.

k) Link 11

**Noise and visual impacts will affect the enjoyment or satisfaction of wildlife resource users and traditional lifestyles.**

As discussed under Link 7, because outdoor recreationists and traditional users would not be allowed on site of the Steepbank Mine, they would be largely unaffected by noises and dust resulting from mining operations. However, because the bridge and other facilities constructed in the Athabasca River valley may be considered an adverse visual impact by those travelling along the river, Link 11 is assumed to be valid.

l) Link 12

**Reduced hunting and trapping success will cause reductions in wildlife resource use.**

Development of the Steepbank Mine will result in the loss of portions of two RFMAs and some areas that may be used by hunters and other outdoor recreationists. Because the loss of these areas will likely result in a reduction in the use of wildlife resources, Link 12 is considered valid.

**m) <u>Link 13</u>**

**Reduced enjoyment will result in reduced wildlife resource use and loss of traditional lifestyles.**

The loss of portions of two RFMAs, which are sometimes used for hunting and recreational purposes as well as by trappers, will likely represent a significant change of lifestyle for at least three registered trappers. It could also affect the level of enjoyment of recreational hunters who may frequent the area. Thus, it is assumed that Link 13 is valid.

### D4.5.4 Mitigation

Under Hypothesis 22, it has been concluded that development of the Steepbank Mine will reduce use of wildlife resources in the Fort McMurray region by trappers, hunters, and non-consumptive users. The following mitigation measures are recommended to reduce these impacts:

- Provide financial compensation to trappers operating RFMAs that will be affected by mine development and operation;
- Implement measures designed to minimize the visual and aesthetic impacts of the project (see Terrestrial Resources Impact Assessment). This would include retaining a forested buffer strip along the Athabasca River to visually obscure mining facilities in the Athabasca River valley and contouring the overburden dumps along the Athabasca River escarpment to reflect natural terrain contours;
- Minimize dust by surfacing or regularly watering roads in the mining and facilities areas; and
- Revegetate mining areas as soon as possible after the cessation of mining.

### D4.5.5 Impact Rating

Although the proposed mitigation strategy for Hypothesis 22 will reduce the impact of mine development and operations on adjacent areas to some extent, the greatest concern is the loss of access to the Steepbank Mine area by trappers using two of the four RFMAs in the Local Study Area. However, there is also concern about the loss of opportunities for hunters, outdoor recreationists, and traditional land users to utilize the area that will be affected by the Steepbank Mine. Because of the importance of maintaining public safety, the direct impact on the lifestyle of these resource users cannot be mitigated while the mine is in operation. As a result, the severity of impact is rated as high for the Local Study Area and low for the Regional Study Area during mine development and operation (Appendix II, Figure II-5). However, after mining ceases, it is expected that wildlife utilization in the area will return to present levels. Consequently, the impact after closure is rated as negligible.

### D4.5.6 Degree of Confidence

The degree of confidence for Hypothesis 22 is high. It is clear that the development will affect trappers operating 50% of the RFMAs in the Local Study Area and that other recreational and traditional users will also be affected.

## D4.6 HYPOTHESIS 23

**Development of the Steepbank Mine will contribute to a loss of natural biodiversity.**

Hypothesis 23 evaluates the potential impact of mine development on changes in wildlife, habitat, and genetic composition as it relates to biodiversity (Figure D4.0-17).

### D4.6.1 Linkages/Testable Hypotheses

Link 1. Mine development will reduce the diversity of habitat types in the study region.

Link 2. Mine development will have an adverse effect on rare, threatened or endangered species or habitats in the study region.

Link 3. Mine development will result in fragmentation or loss of connectivity between habitats in the study region.

Link 4. Mine development will result in the introduction of non-native species.

Link 5. Increased habitat fragmentation or loss of connectivity between habitats will threaten the viability of certain wildlife species in the study region.

Link 6. Increased habitat fragmentation or loss of connectivity between habitats will result in reduced genetic diversity or genetic fitness of wildlife populations.

Link 7. Introduction of non-native species may result in reduced genetic diversity or genetic fitness due to competition with native species, introduction of diseases or parasites to which native species are not resistant, or interbreeding with native species.

Link 8. Reduced habitat diversity caused by the Steepbank Mine development will result in an overall loss of regional biodiversity.

Link 9. Adverse impacts on rare threatened or endangered species or habitats will result in an overall loss of regional biodiversity;

Link 10. Decreases in population viability caused by Steepbank Mine development will result in an overall loss of regional biodiversity.

Link 11. Decreases in genetic diversity or genetic fitness caused by Steepbank Mine development will result in an overall loss of regional biodiversity.

**D4.6.2 Background**

The maintenance of biodiversity has recently become a public issue, although it has been a concern of the scientific community for many years. The concept of biodiversity involves not only specific organisms but also their "genetic composition, the ecosystems in which they live, and the ecological and evolutionary processes which sustain them" (O'Connell and Noss 1992). Biodiversity is usually highest in sites with varied characteristics. For example, some species may require mature forest, some may require immature forest, and still others, such as the ruffed grouse, may require both types of forest to flourish.

Genetic diversity is also important in maintaining the viability of most wildlife populations. Ledig (1993) noted that, although species extinctions were the most conspicuous component of reduced biodiversity, the extirpation of locally-adapted populations and consequent loss of genetic diversity was a more serious problem. Homozygosity increases as genetic diversity is lost, resulting in a decrease in vigour and fecundity. Soule (1980) indicated that the fitness of most populations decreased rapidly with increasing homozygosity after populations had dropped below some threshold level. This threshold depended on the size of the population, which, in turn, depended on the amount of available habitat. Soule (1980) suggested that at least 50 breeding individuals were necessary to maintain an inbreeding rate of 1%. However, even this low rate of inbreeding would result in the loss of about 25% of a population's genetic variation in 20 to 30 generations and consequently reduce its potential to adapt to changing circumstances.

Samson and Knopf (1983) noted that most ecosystem managers emphasize alpha or within habitat diversity at the expense of beta (between habitat diversity) and gamma diversity (diversity over geographic areas). They indicated that this approach often ignores uncommon species that require large, contiguous tracts of habitat for their survival in favour of more common wildlife species, which are often associated with ecotones. O'Connell and Noss (1992) have also suggested that the replacement of specialized species with more adaptable ones is often undesirable because, although alpha diversity is increased, both regional and global diversity may be reduced.

Because biodiversity can be considered at a number of geographic scales, the evaluation of Hypothesis 23 for the Suncor study area is problematic. For example, an increase in alpha diversity could result in a reduction of gamma diversity if it resulted in the loss of uncommon species or those that required large blocks of homogenous habitat. We have therefore assumed that the maintenance of natural biodiversity, which we define as the species composition and abundance that was present in an area prior to disturbance, should be an objective of any development or reclamation program.

### D4.6.3 Evaluation of Linkages

a) <u>Link 1</u>

**Mine development will reduce the diversity of habitat types in the study region.**

**and**

**b) Link 8**

**Reduced habitat diversity caused by Steepbank Mine development will result in an overall loss of regional biodiversity.**

The percentage composition and coverage of various habitat types in the Suncor study area, before development, during construction and mining, and after closure is not expected to differ appreciably (Table D4.0-11). However, based on Suncor's reclamation plan for mining areas, it is expected that the distribution and patchiness of habitat types within the Suncor study area will change significantly. These changes will involve the creation of wetlands and upland mixedwood forest in areas that are currently covered by extensive complexes of black spruce and tamarack forest. Scott et al. (1995) indicated that management for habitat diversity should ensure that various successional stages are large enough to provide habitat for interior species. Thus, there is potential for a change to smaller habitat units to represent a reduction in the natural diversity of the study area. A further consideration is that, over time, wildlife residing in the study area have become adapted to the conditions that currently exist. Thus, the alteration of landscapes in the region has the potential to alter the relative abundance and distribution of wildlife populations. Links 1 and 8 are therefore assumed to be valid for Hypothesis 23.

**c) Link 2**

**Mine development will have an adverse affect on rare, threatened, or endangered species or habitats in the study region.**

**and**

**d) Link 9**

**Adverse impacts on rare, threatened, or endangered species or habitats will result in an overall loss of biodiversity.**

Although the bald eagle is not listed as an endangered, threatened, or vulnerable species by COSEWIC (1996), it is on the "blue" list in Alberta and is considered rare in the AOSERP study area. Francis and Lumbis (1979) recorded only 18 productive and 8 non-productive eagle nests

## TABLE D4.0-11

## CHANGES IN HABITAT COMPOSITION IN THE STEEPBANK MINE STUDY AREA

| Habitat Type | 1995 | | Construction Phase | | Operations Phase | | Closure | |
|---|---|---|---|---|---|---|---|---|
| | Area (ha) | % | Area (ha) | % | Area (ha) | % | Area (ha) | % |
| Closed Jack Pine | 2760 | 8 | 2701 | 8 | 2536 | 8 | 2532 | 7 |
| Closed White Spruce | 3443 | 10 | 3408 | 10 | 3265 | 10 | 3259 | 9 |
| Closed Deciduous | 5778 | 17 | 5643 | 17 | 5105 | 16 | 6174 | 17 |
| Closed Mixedwood | 2622 | 8 | 2596 | 8 | 2944 | 9 | 5028 | 14 |
| Closed Mixed Coniferous | 1440 | 4 | 1420 | 4 | 1329 | 4 | 1328 | 4 |
| Closed Black Spruce | 2995 | 9 | 2952 | 9 | 2604 | 8 | 2597 | 7 |
| Closed Black Spruce-Tamarack | 3453 | 10 | 3430 | 10 | 2626 | 8 | 2615 | 7 |
| Closed Mixedwood (white spruce dominant) | 845 | 2 | 825 | 2 | 1200 | 4 | 2804 | 8 |
| Open Black Spruce/Labrador Tea | 6032 | 18 | 6008 | 18 | 5277 | 17 | 5263 | 14 |
| Open Tamarack/Bog Birch | 2109 | 6 | 2098 | 6 | 2085 | 7 | 2085 | 6 |
| Closed Shrub Complex | 2673 | 8 | 2640 | 8 | 2586 | 8 | 2881 | 8 |
| **Total** | 34150 | 100 | 33721 | 100 | 31557 | 100 | 36566 | 99 |

during an aerial survey conducted in 1976. Similarly, only one bald eagle nest was located during surveys for raptors conducted in the Steepbank Mine Local Study Area in 1995. As discussed under Hypotheses 18 and 19 of this report, the activities related to mine development and operation taking place in the Athabasca River valley have the potential to disturb this nest and cause nest abandonment.

Because habitat maps of the study area do not distinguish between aspen and balsam poplar forests, the area covered by mature riparian balsam poplar forest is unknown; however, field studies conducted in 1995 indicate that these forests are limited in extent and occur almost exclusively on the floodplain of the Athabasca River. Mature balsam poplar forest is therefore considered rare in the study area. The construction of facilities on the Athabasca River floodplain will reduce the extent of this forest type, which likely provides important habitat for a variety of mammals. Riparian balsam poplar forests contain deadfalls and standing dead trees, which are frequently used as denning sites by a variety of species, such as the black bear, lynx and fisher. Riparian balsam poplar also provides important habitat for a variety of bird species (Prescott and Ewaschuk 1996). During avifauna surveys conducted in 1995, 28 species of birds were identified in this habitat type. Of these, 6 species, the cedar waxwing, warbling vireo, black-throated green warbler, American redstart, song sparrow, and brown-headed cowbird occurred only in this forest type. Similarly, riparian wetlands are considered rare in the area; only four natural wetlands occur on the Athabasca River floodplain in the Local Study Area. It is believed that overburden storage and mine drainage could significantly alter Shipyard Lake, which is one of these wetlands. Because of the potential impact of the project on the bald eagle nest, mature riparian balsam poplar forest, and natural wetlands, Links 2 and 9 are considered valid.

e) <u>Link 3</u>

**Mine development will result in fragmentation or loss of connectivity between habitats in the study region.**

Connectivity is considered an important component of biodiversity. The maintenance of connectivity facilitates gene flow among populations, decreases the rate of extinction among semi-isolated groups, increases the effective population size, and increases the potential for the recolonization of abandoned areas (Soule and Simberloff 1986). Noss (1983) noted that connections among habitat patches could be as important as patch size in the maintenance of biodiversity.

Although the potential for habitat fragmentation in upland landscapes will be reduced by the phased development of the Steepbank mine, the potential exists for the various facilities located in the floodplain to disrupt wildlife movements and reduce habitat connectivity. Of particular concern is the potential isolation of habitats located on the floodplain and escarpment of the Athabasca River valley. These landscape units will be affected by the presence of various buildings, as well as a corridor which will include a road and hydrotransport line. DeSanto and Smith (1993) reported that corridor construction could alter movements related to dispersal and migration, and could lead to the isolation of wildlife populations and gene pools. Consequently Link 3 is assumed to be valid for Hypothesis 23.

**f) <u>Link 4</u>**

**Mine development will result in the introduction of non-native species.**

**and**

**g) <u>Link 7</u>**

**Introduction of non-native species may result in reduced genetic diversity or genetic fitness due to competition with native species, introduction of diseases or parasites to which native species are not resistant, or interbreeding with native species.**

The introduction of non-native species is also considered a significant threat to biological diversity (Samson and Knopf 1993). Introduced species may occupy a similar niche but be competitively superior to native species. Moreover, because they are often ignored by predators, they can flourish and pose a substantial threat to native species.

Initially, the Suncor reclamation program involved high seeding rates for agronomic species, in order to provide for rapid ground cover establishment and erosion control. However, subsequent studies demonstrated that these agronomic species restricted the establishment of trees and shrubs, and the invasion of native plant species (AGRA 1996). In the early 1980s, the Suncor reclamation goal was changed to one in which the priority was the development of a self-sustaining ecosystem representative of those in the surrounding region. This more recent reclamation strategy involves the application of a thick organic layer composed of a mixture of peat and finer underlying soils, which allows root fragments and native seeds to grow and establish a diverse mixture of natural vegetation cover over the reclaimed site. The current approach involves seeding barley, an annual species, during the first growing season either by helicopter or hydroseeding, to act as a nurse crop. Studies have shown that the initial barley nurse crop provides a litter and root biomass that continues to control erosion in succeeding growing seasons but does not restrict the natural regrowth of native species. The next phase of the reclamation program involves planting a diverse mixture of native woody-stemmed species on the reclaimed areas. The seedlings are propagated from seed and cuttings collected from the Fort McMurray area. Thus, it appears that the reclamation will not result in the introduction of new species or genotypes. Links 4 and 7 are therefore assumed to be invalid for Hypothesis 23.

**h) Link 5**

**Increased habitat fragmentation or loss of connectivity between habitats will threaten the viability of certain wildlife species in the study region.**

Although it has been assumed that the mine development will reduce habitat connectivity, it is unlikely that the viability of most wildlife populations will be adversely affected. Facilities, which include buildings, roads, and a hydrotransport line will stretch approximately 4 km along the Athabasca River valley. However, portions of the valley to the north and south of these facilities will be accessible to most wildlife species. In contrast, wolves and some of the more sensitive species may be adversely affected by these developments. Westworth et al. (1989) reported that the use of habitats near an active mine by moose appeared to be a strategy to reduce predation by wolves, which avoided the mining area. If a similar strategy is used by moose in the Steepbank Mine area, the development of facilities in the river valley could reduce the foraging success of wolves and result in decreased wolf abundance in the Local Study Area. However, because of the small area affected, it is unlikely that the effect will significantly reduce the viability of any wildlife population. Link 5 is therefore assumed to be invalid.

**i) Link 6**

**Increased habitat fragmentation or loss of connectivity between habitats will result in reduced genetic diversity or genetic fitness of wildlife populations.**

Although the effect of habitat fragmentation on genetic diversity is expected to be minimal, there is potential for a loss of genetic diversity if fragmentation results in the loss of individual animals of sensitive species (see above). Link 6 is therefore assumed to be valid.

j) <u>Link 10</u>

**Decreases in population viability caused by Steepbank Mine development will result in an overall loss of regional biodiversity.**

As indicated under Link 5, construction and operation of the Steepbank Mine is not expected to significantly affect the viability of regional wildlife populations. Link 10 is therefore assumed to be invalid for Hypothesis 23.

k) <u>Link 11</u>

**Decreases in genetic diversity or genetic fitness caused by Steepbank Mine development will result in an overall loss of regional biodiversity.**

Under Link 6, it was concluded that the genetic diversity of some sensitive species could be reduced by the loss of individual animals in the Steepbank Mine area. However, because these losses are expected to be minimal and may not involve reproductive individuals, no significant loss of genetic diversity or the fitness of populations is expected. It is therefore concluded that Link 11 is not valid.

### D4.6.4 Mitigation and Monitoring

Measures that could be implemented to prevent the loss of biodiversity in the Fort McMurray region, include:

- Implement a reclamation strategy that includes the creation of some large expanses of homogenous habitat;
- Use only native plant species collected locally for reclamation;
- Reclaim Shipyard Lake as a natural wetland. This would involve using minimal bank slopes, an irregular shoreline (high shoreline development index), and revegetation using locally-collected seeds or plants;

- Minimize the loss of mature riparian balsam poplar forest by using the minimum possible area for the development of facilities;
- Minimize disturbance to the bald eagle nest across from Tar Island; and
- Establish a program to monitor changes in biodiversity over the life of the project.

### D4.6.5 Impact Rating

Based on the assessment of Hypothesis 23, it is concluded that the Steepbank Mine will have some effect on regional biodiversity. Although it is likely that any of the habitat types or wildlife species that will be affected by mine development will be lost from the study area, mine development will result in the temporary loss of habitat, and could result in a reduction of connectivity. In contrast, the objectives of Suncor's reclamation program include the recreation of the level of biodiversity present prior to development and the establishment of a self-sustaining forest cover of native plant species. For these reasons, the severity of impact with respect to loss of biodiversity in the Local Study Area is rated as low during construction and low to moderate during the operational phase (Appendix II, Figure II-6). In Regional Study Area, the degree of concern was rated as low during mining operations.

### D4.6.6 Degree of Confidence

The degree of confidence for Hypothesis 23 is rated as moderate. Although it appears that natural biodiversity will decline slightly as a result of the project, we are uncertain about the effects that the development of the Steepbank Mine will have on some wildlife species, such as the wolf and wolverine, that are considered sensitive to development or disturbance.

## D4.7 CUMULATIVE IMPACTS

The primary issues with respect to cumulative impacts on wildlife in the region are (1) habitat loss and fragmentation, (2) disruption of regional wildlife movement patterns, and (3) increased access.

### D4.7.1 Habitat Loss and Fragmentation

Golder (1996c) determined vegetation changes in the Suncor Regional Study Area from 1995 to 2020 due to industrial development and timber harvesting. In 1995, 28,460 ha of land in the Regional Study Area were classified as either industrial or disturbed. By 2020 this figure would increase to about 77,870 ha, an increase of more than 49,000 ha. Syncrude and ALPAC/Northland account for most of this increase, while Suncor accounts for 2,380 ha or 4.8% of the total increase.

In terms of habitat losses, the area covered by white spruce forest would be reduced by the greatest extent, followed by closed mixedwood forest (white spruce dominant). The area occupied by these habitat types would decline by approximately 20,580 and 18,730 ha, respectively, between 1995 and 2020. In contrast, the area covered by closed deciduous forest would increase from 78,740 to 95,840 ha over this period, an increase of 17,100 ha. This increase is entirely due to more extensive cover of aspen as a result of timber harvesting. These changes would reduce the amount of habitat available for species, such as the Cape May warbler, red squirrel, and marten, that require mature coniferous and mixedwood forest, and increase the amount of habitat for species, such as the moose and ruffed grouse, that are associated with deciduous forest. It has been estimated that, by the year 2020, there will be 47% cumulative loss of white spruce forest. This would be a major impact to species that are associated with coniferous forest; however, most of these losses are associated with timber harvesting, with losses resulting from Suncor's operations accounting for less than 1% of the total.

In the region, increasing development in the Athabasca River valley is considered a principal concern for wildlife. It can strongly be argued that the Athabasca River Valley represents a unique biological landscape feature that should be considered independently of other features. Other authors have described the importance of riparian or bottomland forests in terms of their complexity, diversity and productivity (Forsythe and Roelle 1990). These attributes are derived from the characteristics of river valleys, namely the combination of water, sediment, nutrients, and organic matter, interacting with environmental gradients such as hydroperiod, microclimate, and elevation (Forsythe and Roelle 1990). The natural zonation that occurs within a valley provides habitat for a high diversity of plant and animal species. The river itself, as well as inundated areas within the floodplain, provide habitat for phreatophytes and semi-aquatic species of birds and mammals. Major rivers, such as the Athabasca, are a dependable water source, and thus provide secure habitat for drought intolerant species. They also serve as a fire break, helping to ensure the preservation of mature forest conditions in a boreal landscape characterized by relatively short fire return periods. Higher elevation zones within the valley provide habitat for other species of terrestrial wildlife. Valley slopes provide a microclimate that offers thermal protection to various animals during severe winters or storm events. South and west-facing exposures are often characterized by shallower snow conditions and increased production of deciduous browse species, making these portions of the valley important as winter habitat for ungulates. Early snow release and early green-up of herbaceous vegetation also make these slopes important as spring feeding areas for black bears, deer, and other herbivores.

Because the different habitats that occur within a river valley exist in the form of relatively narrow zones, corresponding to differences in elevation, moisture regime and other environmental gradients, the linear continuity of these habitats along a valley is believed to be important for individual populations and for maintaining the biodiversity of the region as a whole. As this continuity or connectivity declines, the ecological integrity of remaining patches of riparian forest is reduced (Gosselink et al. 1990).

A preliminary assessment of development in the Athabasca River valley within the Regional Study Area indicates that a substantial amount of habitat has been lost since 1960. In 1960, only about 1% of the valley had been altered by the Town of Fort McMurray and a few unpaved roads. In contrast, by 1995, Fort McMurray had expanded into a city and portions of two oil sands operations, a sawmill, a 2-lane all-weather paved highway, and a number of other facilities occupied portions of the Athabasca River valley. At least two of these developments, Fort McMurray and Suncor, completely block portions of the west side of the Athabasca River valley. By the year 2020, Steepbank Mine development will result in additional habitat loss and loss of connectivity of riparian habitats along the valley on the east side of the Athabasca River. Consequently, there is potential for connectivity between riparian habitats on both sides of the river to be substantially reduced, which could affect wildlife by disrupting movements between seasonally important habitat types within the valley or isolating widely dispersed subpopulations of uncommon wildlife species.

In addition to the contiguity of riparian and other valley habitats along the Athabasca River valley, we should also be concerned about maintaining the connectivity of the Athabasca valley to the adjacent uplands. In addition to supporting unique assemblages of plants and animals, the valley may be an important habitat feature for species of wildlife that range more widely over upland habitats in the region. Moose are certainly an example of a species for which seasonal movements between upland and valley habitats have been demonstrated in northeastern Alberta. Many other 'upland' species may also be dependent on resources (food, nest sites, denning sites, water) that occur within the valley. An effort should be made to identify and better understand these functions and to protect tributary watercourses, ridges, or other linear landscape features that may be important for movement of wildlife into and out of the valley.

### D4.7.2 Impact on Wildlife Movements

In addition to concerns related to wildlife movements associated with the Athabasca River valley, there is a broader concern related to the cumulative effects of development in the region on migration or dispersal movements of ungulates and carnivores. This is a particular concern for species that are relatively rare in the region or that exist in widely scattered populations or sub-populations.

Currently there is little development on the east side of the Athabasca River that would affect wildlife populations. It is therefore doubtful that the Steepbank Mine development would, by itself, threaten ungulate or carnivore populations in this area. It should be recognized, however, that on a regional scale and over the long term, there is potential for industrial development in the region to seriously affect some of these populations. Presently, the existing Suncor and Syncrude developments have coalesced into an extensive disturbed landscape that extends over a distance of more than 20 km. Expansion of the Syncrude Mildred Lake operation to the northwest side of the MacKay River along with the proposed Steepbank Mine development, which adjoins the existing development area to the southeast, will extend this zone of disturbance by perhaps another 15 km. Eventually, development of additional oil sands developments, including Solv-Ex and Syncrude's proposed Aurora Mine, will extend this zone of disturbance even more. In the very long term, reclamation of exhausted mine areas will result in reestablishment of suitable wildlife habitat; however, over the next 20 or 30 years, this extensive zone of development could disrupt wildlife populations and interfere with dispersal mechanisms that are essential for recolonization of vacant habitat or maintenance of metapopulations.

### D4.7.3 Impacts of Increased Access

Increased access resulting from construction of roads, utility corridors and other linear developments is a major wildlife management issue in Alberta. Popular game species, such as moose, are vulnerable to over exploitation, and in some areas, populations have been severely depleted. It is also believed that increased linear development can affect rates of predation on vulnerable species such as woodland caribou and can contribute to habitat fragmentation.

An assessment of the impact of increased access on wildlife in the region was beyond the scope of the present study. Although it is clear that access has increased dramatically in the region over the past 20 years, it appears that the Steepbank Mine project will result in little incremental impact. Roads constructed for the project will not be used for public access, and Suncor's reclamation plan calls for the removal and reclamation of all mine roads once the mine is closed. Unless plans to decommission all access roads change in the future, the incremental impact of the Steepbank Mine project should be minimal.

## D4.8 OVERALL DEGREE OF CONCERN

The following section summarizes the overall Degree of Concern with respect to the potential impact of the Steepbank Mine project on wildlife populations, wildlife biodiversity, and wildlife resource use in the region. The Degree of Concern incorporates the severity, duration and geographical extent of impact for each phase of the project. For example, impacts are considered to be of greater concern if they are long term in duration or extend beyond the Local Study Area. The Overall Degree of Concern assumes that the severity of impact will be reduced by implementation of the mitigative measures recommended, and therefore reflects the residual impact of the project.

### D4.8.1 Impact on Wildlife VECs

The potential for various types of impacts related to the development of the proposed Steepbank mine to adversely affect a number of wildlife VECs was evaluated in the preceding sections of this report. These evaluations were conducted by examining a number of hypotheses, each of which was concerned with a specific impact that could result from construction and operation of the mine. The degree of impact that remained after the cessation of mining and reclamation was also examined for each hypothesis. In the following section, all of these hypotheses are examined jointly to assess the overall effect of the Steepbank Mine on wildlife VECs.

**a) Moose**

The overall degree of concern for moose in the Local Study Area has been rated as moderate during the construction and operations phase of the Steepbank Mine (Table D4.0-12). Regional concern for moose during these phases has been rated as low (Table D4.0-13). Although there is some concern that seasonal movements will be affected by the project, this rating is based primarily on the loss of approximately 42% of the good and excellent habitat in the Athabasca River valley, an important wintering area for moose in the Local Study Area. Overall, 17% (1,238 ha) of the habitat rated as good to excellent for moose in the Local Study Area will be lost. It is estimated that, over the life of the mine, these losses could reduce the local moose population by 10 to 20 animals. Because of the predicted increase in the amount of deciduous habitat following reclamation, there could be a net increase in carrying capacity for moose after closure. As mentioned previously, the assessment for this period is based on the assumption that all facilities will be removed, that the area will be totally reclaimed, and that access opportunities will not increase over those at present.

**b) Large Carnivores**

In both the Local and Regional Study Areas, the overall degree of concern for the black bear, which is abundant in the Fort McMurray area, is rated as low during the construction and operations phases, and as negligible after closure. This rating stems principally from the loss of deciduous habitat, which is preferred by black bears in the Fort McMurray region (Young 1978) and from mortality resulting from the removal of problem bears at the mine site. In contrast, it is expected that an increase in the area covered in deciduous and mixedwood forest after the area has been reclaimed will enhance habitat suitability for this species.

The overall degree of concern for the wolf was rated as moderate in the Local Study Area and low in the Regional Study Area during construction and operation. This rating was based partly on a possible decline in the number of moose, their principal prey, and potential alienation from important habitat types. Sensory disturbance was also thought to have a potentially important impact on wolves because it could affect their reproductive success by causing wolves to abandon denning habitat, most of which appears to be associated with the escarpments of the Athabasca and Steepbank Rivers, in the Local Study Area. It was also felt that the presence of mining facilities

## TABLE D4.0-12 DEGREE OF CONCERN FOR WILDLIFE VECS IN THE SUNCOR LOCAL STUDY AREA

| Valued Ecosystem Component | Habitat Loss and Alteration (Hypothesis 18) | | Sensory Disturbance (Hypothesis 19) | | Direct Mortality (Hypothesis 20) | | Movement Corridors (Hypothesis 21) | | OVERALL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Construction and Operation | Closure | Construction and Operation | Closure | Construction and Operation | Closure | Construction and Operation | Closure | Construction and Operation | Closure |
| Moose | M | + | L | O | L | O | M | O | M | + |
| Black Bear | L | + | O | O | L | O | L | O | L | + |
| Wolf | M | O | L-M | O | L | O | M | O | M | O |
| Snowshoe Hare | L | O | O | O | L | O | O | O | L | O |
| Red-backed Vole | L | O | O | O | L | O | O | O | L | O |
| Lynx | L-M | O | L-M | O | L | O | M | O | M | O |
| Fisher | L-M | O | U | O | L | O | M | O | L-M | O |
| Marten | L-M | + | U | O | L | O | L | O | L-M | + |
| Wolverine | O-L | O | O-M | O | L | O | L | O | O-L | O |
| Beaver | L | + | O | O | L | O | O | O | L | + |
| Otter | O-L | O | U | O | L | O | O | O | L | O |
| Bald Eagle | O-M | O | L | O | L | O | O | O | L-M | O |
| Great Gray Owl | O-L | O-L | U | O | L | O | O | O | L | O-L |
| Ruffed Grouse | L-M | + | U | O | L | O | O | O | L | + |
| Terrestrial Songbirds | M | O | L | O | L | O | O | O | M | O |
| Waterfowl | L | O | L | O | L | O | O | O | L | O |

O - Negligible; L - Low; M - Moderate; H - High; U - Unknown; + - Positive Impact

TABLE D4.0-13 DEGREE OF CONCERN FOR WILDLIFE VECS IN THE SUNCOR REGIONAL STUDY AREA

| Valued Ecosystem Component | Habitat Loss and Alteration (Hypothesis 18) | | Sensory Disturbance (Hypothesis 19) | | Direct Mortality (Hypothesis 20) | | Movement Corridors (Hypothesis 21) | | OVERALL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Construction and Operation | Closure | Construction and Operation | Closure | Construction and Operation | Closure | Construction and Operation | Closure | Construction and Operation | Closure |
| Moose | L | O | O | O | L | O | L | O | L | O |
| Black Bear | O | O | O | O | L | O | L | O | L | O |
| Wolf | L | O | L | O | L | O | L | O | L | O |
| Snowshoe Hare | O | O | O | O | O | O | O | O | O | O |
| Red-backed Vole | O | O | O | O | O | O | O | O | O | O |
| Lynx | L | O | O | O | O | O | L | O | L | O |
| Fisher | L | O | O | O | O | O | L | O | L | O |
| Marten | L | O | O | O | O | O | L | O | L | O |
| Wolverine | O-L | O | O-L | O | O | O | L | O | O-L | O |
| Beaver | O | O | O | O | O | O | O | O | O | O |
| Otter | O | O | O | O | O | O | O | O | O | O |
| Bald Eagle | O-L | O | O | O | O | O | O | O | O-L | O |
| Great Gray Owl | O-L | O-L | O | O | O | O | O | O | O-L | O-L |
| Ruffed Grouse | O | O | O | O | O | O | O | O | O | O |
| Terrestrial Songbirds | L | O | O | O | O | O | O | O | L | O |
| Waterfowl | L | O | O | O | L | O | O | O | L | O |

O - Negligible; L - Low; M - Moderate; H - High; U - Unknown; + - Positive Impact could disrupt wolf movements, particularly those between foraging and denning habitat during the natal period or along drainages where they often prey on beavers in summer. The degree of concern is expected to be negligible after mine closure.

**c) Small Herbivores**

The overall degree of concern for both the snowshoe hare and red-backed vole in the Local and Regional Study Areas was rated as low and negligible, respectively, during construction and operations, and as negligible after closure. This assessment was based on the loss of habitat for these species and direct mortality resulting from clearing and grubbing operations. However, because both species are widespread in Alberta, have high reproductive rates, and are expected to rapidly recognize reclaimed landscapes, it was felt that the overall impact on populations of these species would be low.

**d) Terrestrial Furbearers**

The overall degree of concern for lynx during construction and operations was rated as moderate in the Local Study Area and low in the Regional Study Area. This evaluation was based on primarily the loss of potential denning habitat in riparian deciduous forests, although there is also potential for sensory disturbance to alienate lynx from much of the remaining denning habitat. After closure, the degree of concern for this species in the Local and Regional Study Areas was rated as negligible.

A low to moderate rating was assessed for marten based on its association with mature white spruce forests in riparian and escarpment landscape features, some of which would be lost as a result of mine development. Regionally there is a low degree of concern. Following reclamation and mine closure, a predicted increase in the amount of white spruce and conifer-dominated mixedwood forest could result in increased carrying capacity for this species.

The degree of concern for the fisher, which was also rated as low to moderate locally and low regionally, was based primarily on habitat loss, but also considered the potential for mine dewatering and drainage alterations to disrupt movement patterns and home ranges, which are often aligned with streams and rivers (Douglas and Strickland 1987). The degree of concern after mine closure has been rated as negligible.

Although there is concern about the effects of the proposed mine on wolverine populations, information about wolverine abundance and ecology in the Steepbank Mine area is not sufficient to allow an accurate evaluation of impacts. However, it is believed that the project could potentially affect only a small portion of wolverine's home range and would not directly affect more than a single family group. Consequently, the overall degree of concern for the wolverine in the Local and Regional Study Areas has been rated as negligible to low. This rating is based primarily on habitat loss and the potential for sensory disturbance to displace wolverines from productive habitat in the vicinity of the mine area.

#### e) Semi-Aquatic Furbearers

Because it has been estimated that development of the Steepbank Mine will result in the loss of approximately nine of 82 beaver colonies present in the eastern portion of the Local Study Area, the overall degree of concern for this species has been rated as low locally and negligible regionally during construction and operations. In contrast, the increased availability of aspen poplar, a preferred forage species, will likely increase habitat suitability for this species after closure.

Otters are uncommon in the Steepbank Mine area and there is little evidence that they are normally present in the area that will be affected by the proposed development. There appears to be little suitable foraging habitat in the development area; however, alteration of drainage patterns due to mine dewatering could affect dispersal and overland movements by this species. Therefore, the overall degree of concern for the otter in the Local Study Area was rated as low during construction and operation. There is a negligible degree of concern in the Regional Study Area.

#### f) Raptors

The overall degree of concern for both the bald eagle in the Local Study Area has been rated as low to moderate during the construction and operations phases. In contrast, the degree of concern for this species in the Regional Study Area has been rated as negligible to low. This rating was based primarily on the potential for abandonment of the nest across from Tar Island either through habitat alienation or sensory disturbance. In contrast, the degree of concern following closure is rated as negligible both locally and regionally.

The degree of concern for the great gray owl has been rated as low locally and negligible to low regionally. The principal source of concern is that mining operations will reduce the amount of area covered by open tamarack forest, which provides important foraging habitat for this species. Because the reclamation program will involve establishing upland forest types, this would result in the permanent loss of some larch forest; consequently, the overall degree of concern remains negligible to low after closure in both the Local and Regional Study Areas.

**g) Terrestrial Birds**

The overall degree of concern for the ruffed grouse in the Local Study Area was rated as low during construction and operation phases. The evaluation for the ruffed grouse was based on the loss of deciduous forest, which is the principal habitat type for this species during all of its life phases. In contrast, the degree of concern in the Regional Study Area was rated as negligible. An increase in the extent of deciduous forest would result in increased carrying capacity for this species after closure.

The degree of concern for terrestrial songbirds has been rated as moderate in the Local Study Area and low in the Regional Study Area. This rating is based on the loss of shrub complexes and riparian deciduous forest as a result of mine development. In contrast, the degree of concern after closure has been rated as negligible.

**h) Waterfowl**

A low overall degree of concern was assessed for waterfowl in the Local and Regional Study Areas based on the potential loss of breeding habitat for approximately 170 pairs of ducks as a result of mining operations and the potential for accidental mortality of waterfowl in tailings ponds. The degree of concern after closure was rated as negligible. Although permanent wetlands will be established on reclaimed tailings ponds, there are concerns that the suitability of reclaimed ponds for breeding ducks could be lower than the ponds which are currently available.

### D4.8.2 Loss of Biodiversity

The Steepbank Mine project would substantially change the composition of wildlife habitats in the development area over the next 50 to 100 years. Of particular concern is the loss of important and rare habitats in the region, including riparian balsam poplar forest and natural wetlands. For this reason, there is a moderate Degree of Concern with respect to the loss of wildlife biodiversity in the Local Study Area and a low Degree of Concern in the Regional Study Area. Following closure, the

Degree of Concern is negligible to low. A primary goal of Suncor's proposed reclamation program is to restore the natural biodiversity of the development area to the greatest extent possible. This includes plans to reclaim mine dumps and dykes in a manner that will approximate the natural landforms and habitats of the Athabasca River valley escarpment and to establish permanent wetlands and a self-sustaining mixedwood forest cover on CT ponds. The company's current revegetation approach, which utilizes native species collected locally rather than agronomic species, minimizes the potential for loss of genetic diversity or genetic fitness.

### D4.8.3 Changes in Wildlife Resource Use

During the construction and operation phases of the Steepbank Mine, the development area will not be accessible to other resource users for hunting, trapping, or other wildlife-based recreation. The greatest concern relates to the loss of two RFMAs in the Local Study Area. Present use of the development area by other wildlife users is limited by poor access. The Overall Degree of Concern during the period of mine operation is rated as high for the Local Study Area and low for the Regional Study Area. After mine closure and reclamation, wildlife resource use is expected to return to present levels.

### D4.8.4 Cumulative Impacts

A preliminary evaluation of long-term habitat trends in the study region indicates, that by the year 2020, industrial development in the region could significantly alter habitat supply for a number of important wildlife species. An estimated 47% loss of white spruce forest could cause substantial reductions in populations of marten and other species associated with coniferous forest. Most of these losses would result from timber harvesting, with Suncor's operations accounting for less than 1% of the total.

A greater degree of concern exists with respect to development in the Athabasca River valley. The valley is the most important habitat feature in the region and supports a higher diversity of wildlife than the surrounding uplands. The Athabasca River valley has also been identified as an important wintering area for ungulates and a potentially important wildlife movement corridor. Habitat loss or alienation in the valley has been associated with oil sands development, expansion of Fort McMurray, timber harvesting, and road and highway construction. With Steepbank Mine development, Suncor's oil sands operations will become the largest development in the valley. Because Suncor's operations will span both sides of the Athabasca River, there is concern over the loss of connectivity of riparian habitats in the valley and the potential disruption of wildlife movements along the valley. Although it is believed that Suncor's mitigation program can substantially reduce the impact of the development, the overall Degree of Concern related to cumulative impacts on the valley ecosystem is rated as moderate during the construction and operations phase of the Steepbank Mine.

# E REFERENCES


Alberta Environmental Protection. 1995. Harvest and effort by resident big game and game bird hunters in 1993. Natural Resources Service, Wildlife Management Division.

Alberta Forestry, Lands and Wildlife. 1991. The status of Alberta wildlife. Wildl. Manage. Branch, Fish and Wildl. Div., Alberta Forestry, Lands and Wildlife. No.:I/413. 49 pp.

Aldous, S.E. 1938. Beaver food utilization studies. J. Wildl. Manage. 2:215-222.

Aleksiuk, M. 1970. The seasonal food regime of arctic beavers. Ecology 31:264-270.

Allen, A.W. 1982. Habitat suitability index models: beaver. FWS/OBS-82/10.30. Fish and Wildl. Serv., U.S. Dept. of the Interior. 20 pp.

Allen, A.W. 1983. Habitat suitability index models: southern red-backed vole (western United States). FWS/OBS-82/10.42. Fish and Wildl. Serv., U.S. Dept. of the Interior. 14 pp.

Allen, A.W., P.A. Jordan, and J.W. Terrell. 1987. Habitat suitability index models: moose. Lake Superior region. Biol. Rep. 82(10.155). U.S. Dept. of the Interior, Fish and Wildl. Serv.

Amstrup, S.C. and J. Beecham. 1976. Activity patterns of radio-collared black bears in Idaho. J. Wildl. Manage. 40:340-348.

Armstrong, D.M. 1977. Ecological distribution of small mammals in the Upper Williams Fork Basin, Grand County, Colorado. Southwest. Nat. 22:289-304.

Arthur, S.M., T.F. Paragi and W.B. Krohn. 1993. Dispersal of juvenile fishers in Maine. J. of Wildl. Manage. 57:868-874.

Banci, V. 1994. Wolverine. Pages 99-127. In: L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (eds). The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Rocky Mountain Forest and Range Experimental Station. Tech. Rep. RM-254. 184 pp.

Bateman, M.C. 1986. Winter habitat use, food habits and home range size of the marten, *Martes americana*, in western Newfoundland. Can. Field-Nat. 100:58-62.

Beanlands, G.E. and P.N. Duinker. 1983. An ecological framework for environmental impact assessment in Canada. Institute for Resource and Environmental Studies, Dalhousie University. 132 pp.

Bent, A.C. 1961. Life histories of North American birds. Dover Publications Inc. 409 pp.

Bibby, C.J., N.D. Burgess, and D.A. Hill. 1992. Bird census techniques. Academic Press, New York. 257 pp.

Boag, D.A. and K.M. Sumanik. 1969. Characteristics of drumming sites selected by ruffed grouse in Alberta. J. Wildl. Manage. 33:621-628.

Bondrup-Nielsen, S. 1984. The role of habitat heterogeneity and female spacing behaviour in density regulation of *Clethrionomys gapperi*. Ph.D. Thesis. Univ. of Alberta.

BOVAR Environmental. 1996. Impact Analysis of Air Emissions Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

Boyd, M. 1977. Analysis of fur production records by individual fur-bearing species for registered trapping areas in Alberta, 1970-75. Alberta Recreation, Parks, and Wildlife. 72 pp.

Boyd, M.G. 1972. Bald eagles of the Peace-Athabasca delta. 19 pp.

Bradshaw, C.J.A., D.M. Hebert, A.B. Rippen, and S. Boutin. 1995. Winter peatland habitat selection by caribou in northeastern Alberta. Can. J. Zool. 73:1567-1574.

Brand, C.J. and L.B. Keith. 1979. Lynx demography during a snowshoe hare decline in Alberta. J. Wildl. Manage. 43:827-849.

Brand, C.J., L.B. Keith, and C.A Fischer. 1976. Lynx responses to changing snowshoe hare densities in central Alberta. J. Wildl. Manage. 40:416-428.

Brenner, F.J. 1962. Foods consumed by beavers in Crawford County, Pennsylvania. J. Wildl. Manage. 26:104-107.

Brusnyk, L.M. and D.A. Westworth. 1987. Ungulate monitoring studies in the Cold Lake project area-Year 2. Prep. by D.A. Westworth & Associates Ltd. for Esso Resources Canada Ltd., Calgary, Alberta. 77 pp.

Buck, S., C. Mullis and A. Mossman. 1983. Final report: Corral Bottom-Hayfork Bally fisher study. (Unpublished report): U.S. Department of Agriculture. In cooperation with : Arcata, CA: Humboldt State University.

Buskirk, S.W. and L.F. Ruggiero. 1994. American marten. Pages 7-37. In: L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (eds). The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Rocky Mountain Forest and Range Experimental Station. Tech. Rep. RM-254. 184 pp.

Chapman, J.A. and G.A. Feldhamer. 1982. Wild mammals of North America: biology, management and economics. John Hopkins University Press, Baltimore. 1147 pp.

Chapman, R.C. 1977. The effects of human disturbance on wolves (*Canis lupus* L.). M.S. Thesis, Univ. of Alaska, Fairbanks. 209 pp.

CIRC: Crozier Information Resources Consulting Ltd. 1995. Survey of wildlife, including aquatic mammals, associated with riparian habitat on the Suncor Inc. Steepbank mine site. Prep. for Fort McKay Environmental Services Ltd. 34 pp.

Clark, T.W. and T.M. Campbell III. 1976. Population organization and regulatory mechanisms of pine martens in Grand Teton National Park, Wyoming. In: Linn, R.M., ed. Conference on scientific research in national parks; Vol.1. Washington, D.C.:National Park Service Transactions and Proceedings, 1976, New Orleans, Louisiana. 5:293-295.

Clough, G.C. 1964. Local distribution of two voles: Evidence for interspecific interaction. Can. Field-Nat. 78:80-89.

Cowan, I.McT. and R.H. Mackay. 1950. Food habits of the marten (*Martes americana*) in the Rocky Mountain region of Canada. Can. Field-Nat. 64:100-104.

COSEWIC. 1996. Canadian species at risk: April 1996. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

Crowell, K.L. and S.L. Pimm. 1976. Competition and niche shifts of mice introduced onto small islands. Oikos 27:251-258.

D.A. Westworth & Associates Ltd. 1989. The impacts of mining activities on ungulates: A literature review. Prep. for Noranda Inc. 43 pp.

D.A. Westworth & Associates Ltd. 1990. Significant natural features of the eastern boreal forest region of Alberta. Prep. for Alberta Forestry, Lands, and Wildlife. 147 pp.

D.A. Westworth & Associates Ltd. 1994. National Defence: Environmental assessment - Cold Lake Air Weapons Range: Volume II: Environmental assessment.

Dabbs, D.L. 1985. Atmospheric emissions monitoring and vegetation effects in the Athabasca oil sands region. Environmental Research Monograph 1985-5. Syncrude Canada Ltd. 127 pp.

Darby, W.R. and W.O. Pruitt Jr. 1984. Habitat use, movements and grouping behaviour of woodland caribou, *Rangifer tarandus caribou*, in southeastern Manitoba. Can. Field-Nat. 98:184-190.

Damas and Smith, Ltd. 1982. Wildlife mortality in transportation corridors in Canada's National Parks - Impact and mitigation. Parks Canada. 2 volumes.

DeSanto, R.S. and D.G. Smith. 1993. Environmental Auditing: an introduction to issues of habitat fragmentation relative to transportation corridors with special reference to high-speed rail (HSR). Environ. Manage. 17:111-114.

DesGranges, J.L. 1980. Avian community structure of six forest stands in La Mauricie National Park, Quebec. Can. Wild. Serv., Occas. Paper No. 41. 34 pp.

Douglas, C.W. and M.A. Strickland. 1987. Fisher. Pages 511-529. In: M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch (eds). Wild furbearer management and conservation in North America. Ontario Trappers Association. 1150 pp.

Duncan, J.R. and P.H. Hayward. 1994. Review of technical knowledge: Great gray owls. In: Flammulated, Boreal and Great Gray Owls in the U.S. A technical conservation assessment. USDA FS Rocky Mountain Forest and Range Experiment Station. GTR-RM-253.

Ewaschuk, E. and D.A. Westworth. 1983. An evaluation of the Red Deer County habitat retention on private land program. Prep. by D.A. Westworth & Associates Ltd. for Alberta Energy and Natural Resources. 68 pp.

Eide, S.H., S.D. Miller and M.A. Chihully. 1986. Oil pipeline crossing sites utilized in winter by moose, *Alces alces*, and caribou, *Rangifer tarandus*, in southcentral Alaska. Can. Field-Nat., 100:197-207.

Figley, W.K. and L.W. VanDruff. 1982. The ecology of urban mallards. Wildl. Monog. No. 81. 39 pp.

Filion, F.F., S.W. James, J-L. Ducharme, W. Pepper, R. Reid, P. Boxall, and D. Teillet. 1983. The importance of wildlife to Canadians: Highlights of the 1981 national survey. Can. Wildl. Serv. 40 pp.

Flemming, S.P. and P.C. Smith. 1990. Environmental influences on osprey foraging in northeastern Nova Scotia. J. Raptor Res. 24: 64-67.

Forsythe, S.W. and J.E. Roelle. 1990. The relationship of human activities to the wildlife function of bottomland hardwood forests: Report of the wildlife workgroup. In: Ecological Processes and Cumulative Impacts, Gosselink, J.G., L.C. Lee and T.A. Muir (eds.), pp. 533-546. Lewis Publishers Inc., Chelsea, Michigan. 708 pp.

Fort McKay Environment Services Ltd. 1995. The community of Ft. McKay traditional uses of the renewable resources on the proposed Suncor Inc. Steepbank Mine Local Study Area. Prep. for Suncor Inc. Oil Sands Group. 36 pp.

Francis, J. and K. Lumbis. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Alberta Oil Sands Environmental Research Program. Project LS 22.1.1 365 pp.

Fraser, D., D. Arthur, J.K. Morton, and B.K. Thompson. Aquatic feeding by moose *Alces alces* in a Canadian lake. Holarctic Ecol. 3:218-233.

Fuller, T.K. and L.B. Keith. 1980a. Wolf population dynamics and prey relationships in northeastern Alberta. Prep. for the Alberta Oil Sands Environmental Research Program. AOSERP Report 102. 58 pp.

Fuller, T.K. and L.B. Keith. 1980b. Wolf population dynamics and prey relationships in northeastern Alberta. J. Wildl. Manage. 44:583-262.

Fuller, T.K. and L.B. Keith. 1981. Woodland caribou dynamics in northeastern Alberta. J. Wildl. Manage. 45:197-213.

Fyfe R.W. and R.R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Can. Wildl. Serv. Occas. Paper No. 23. 17 pp.

Gardner, C.L., W.B. Ballard and R.H. Jessup. 1986. Long distance movement by an adult wolverine. J. of Mammal. 67:603.

Geist, V. 1978. Behaviour. Pages 283-296. In: J.L. Schmidt and D.L. Gilbert (eds). Big game of North America: Ecology and management. Stackpole Books, Harrisburg, Pa. 494 pp.

Gerrard, J.M., Gerrard, P.L., Gerrard P.N., Bartolotti, G.R. and E.H. Dzus. 1992. A 24 year study of bald eagles on Besnard Lake, Saskatchewan. J. of Raptor Res. 26:159-166.

Gerrard, P.N., J.M. Gerrard, and G.R. Bortolitti. 1985. The impact of road development and tourist access on a bald eagle population at Besnard Lake, Saskatchewan. In: J.M. Gerrard and T.N. Ingram (eds), The bald eagles in Canada, Proc. of Bald Eagle Days, 1983. White House Plains Publ. Inc., Headingley, Manitoba. 272 pp.

Gilbert, F.F. and E.G. Nancekivell. 1982. Food habits of mink (*Mustela vison*) and otter *(Lutra canadensis*) in northeastern Alberta. Can. J. Zool. 60:1282-1288.

Gloutney, M.L., R.G. Clark, A.D. Afton, and G.J. Huff. 1993. Timing of nest searches for upland nesting waterfowl. J. Wildl. Manage. 57:597-601.

Godfrey, W.E. 1966. The Birds of Canada. National Museums of Canada. 428 pp.

Golder Associates Ltd. 1996a. Suncor reclamation landscape performance assessment. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

Golder Associates Ltd. 1996b. Impact Analysis of Terrestrial Resources Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sand Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996c. Impact Analysis of Human Health Issues Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta

Golder Associates Ltd. 1996d. Suncor Mine Advance Plan and Cumulative Effects Assessment. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Gosselink, J.G., M.M. Brinson, L.C. Lee and G.T. Auble. 1990. Human activities and ecological processes in bottomland hardwood ecosystems: Report of the ecosystem workgroup. In: Ecological Processes and Cumulative Impacts, Gosselink, J.G., L.C. Lee and T.A. Muir (eds), pp. 549-598. Lewis Publishers Inc., Chelsea, Michigan. 708 pp.

Grant, P.R. 1969. Experimental studies of competitive interactions in a two species system: I. *Microtus* and *Clethrionomys* species in enclosures. Can. J. Zool. 47:1059-1082.

Grant, P.R. 1970. Experimental studies of competitive interaction in a two-species system: II. The behaviour of *Microtus, Peromyscus* and *Clethrionomys* species. Animal Behaviour 18:411-426.

Grubb, T.G., W.W. Bowerman, J.P. Giesy, and G.A. Dawson. 1992. Responses of breeding bald eagles (*Haliaeetus leucocephalus*) to human activities in northcentral Michigan. Can. Field-Nat. 106:443-453.

Grubb, T.G. and R.M. King. 1991. Assessing human disturbance of breeding bald eagles with classification tree models. J. Wildl. Manage. 55:500-511.

Gulley, J.R. 1985. Investigations of avian activities on Crown lease no. 86 for Suncor Inc., Fort McMurray, Alberta. Prep. by Boreas Environmental Consulting Services Ltd. 90 pp.

Gulley, J.R. 1987a. Examination of waterfowl trends on crown lease no. 86 for Suncor Inc., Fort McMurray, Alberta. Prep. by Boreas Environmental Consulting Service Ltd.

Gulley, J.R. 1987b. Investigations of avian activities on Crown lease no. 86 for Suncor Inc., Fort McMurray, Alberta. Prep. by Boreas Environmental Consulting Service Ltd. 29 pp.

Gulley, J.R. 1988. The Suncor avifauna program, summary of the 1988 activities and results. Prep. by Boreas Environmental Consulting Services Ltd. 64 pp.

Gullion, G.W. 1984. Managing northern forests for wildlife. Misc. J. Ser., Minnesota Agricultural Experimental Station, St. Paul. Publ. No. 13,442. 71 pp.

Hall, J.G. 1960. Willow and aspen in the ecology of beaver on Sagehen Creek, California. Ecology. 41:484-494.

Hancock, J.A. 1976. Human disturbance as a factor in managing moose populations. Proc. N. Am. Moose Conf. and Workshop 12:155-172.

Hargis, C.D. and D.R. McCullogh. 1984. Winter diet and habitat selection of marten in Yosemite National Park. J. Wildl. Manage. 48:140-148.

Harrington, F.H. and A.M. Veitch. 1990. Impacts of low level jet fighter training on caribou populations in Labrador and northern Quebec. 142 pp.

Harrison, C. 1978. A field guide to the nests, eggs, and nestlings of North American birds. William Collins Sons & Co. Ltd., Glasgow. 416 pp.

Hauge, T.H. and L.B. Keith. 1981. Dynamics of moose populations in northeastern Alberta. J. Wildl. Manage. 45:573-597.

Hawley, V.D. and F.E. Newby. 1957. Marten home ranges and population fluctuations. J. Mammal. 38:174-184.

Hayward, G.D. 1994. Conservation status of great gray owls in the United States. In: Flammulated, boreal and great gray owls in the U.S. A technical conservation assessment. USDA FS Rocky Mountain Forest and Range Experiment Station. GTR-RM-253.

Hillman, G.R. 1992. Some hydrological effects of peatland drainage in Alberta's boreal forest. Can. J. For. Res. 22:1588-1596.

Hillman, G.R., J.D. Johnson and S.K. Takyi. 1990. The Canada-Alberta wetlands drainage improvement for forestry program. Forestry Canada and Alberta Forestry, Lands and Wildlife. 66 pp.

Horejsi, B.L. 1979. Seismic operations and their impacts on large mammals. Prep. for Mobil Oil Canada Ltd., Calgary. 86 pp.

Hornocker, M.G. and H.S. Hash. 1981. Ecology of the wolverine in northwestern Montana. Can. J. Zool. 59:1286-1301.

Iverson, S.L. and B.N. Turner. 1973. Habitats of small mammals at Whiteshell Nuclear Research Establishment. AECL-3956. 51 pp.

Jenkins, S.H. 1981. Problems, progress, and prospects in studies of food selection by beavers. Worldwide Furbearer Conf. Proc. 1:559-579.

Johnson, W.A. and A.W. Todd. 1985. Fisher, *Martes penantes*, Behaviour in proximity to human activity. Can. Field-Nat. 99:367-369.

Joslin, P.W.B. 1966. Summer activities of two timber wolf (*Canis lupus*) packs in Algonquin Park. M.S. Thesis. Univ. of Toronto. 99 pp.

Keith, L.B. 1966. Habitat vacancy during a snowshoe hare decline. J. Wildl. Manage. 30:828-832.

Keith, L.B., J.R. Cary, O.J. Rongstad, and M.C. Brittingham. 1984. Demography and ecology of a declining snowshoe hare population. Wildl. Monog. No. 90. 43 pp.

Keith, L.B., A.W. Todd, C.J. Brand, R.S. Adamcik, and D.H. Rusch. 1977. An analysis of predation during a cyclic fluctuation of snowshoe hares. Congress of Game Biologists 13:151-175.

Keith, L.B. and L.A. Windberg. 1978. A demographic analysis of the snowshoe hare cycle. Wildl. Monog. No. 58. 70 pp.

Klohn-Crippen Consultants Ltd. 1995a. DRAFT Technical memorandum No. 2, Hydrogeology baseline, Steepbank oil sands mine. Prep. by Klohn-Crippen Consultants Ltd. for Suncor Inc. 26 pp.

Klohn-Crippen Consultants Ltd. 1995b. DRAFT Technical memorandum No. 1, Hydrogeology baseline, Steepbank oil sands mine. Prep. by Klohn-Crippen Consultants Ltd. for Suncor Inc. 58 pp.

Koehler, G.M and K.B. Aubry. 1994. Lynx. Pages 74-98. In: L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (eds). The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Rocky Mountain Forest and Range Experimental Station. Tech. Rep. RM-254. 184 pp.

Koehler, G.M. and M.G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitteroot Wilderness. J. Wildl. Manage. 41:500-505.

Kohn, B.E., N.F. Payne, J.E. Ashbrenner, and W.A. Creed. 1993. The fisher in Wisconsin. Tech. Bull. No. 183, Dept. of Nat. Res., Madison, Wisconsin. 24 pp.

Koonz, W.H. 1976. A biological investigation of the lynx in Manitoba. Research Branch, Manitoba Dept. of Renewable Resources and Transportation Services. 76-2. 35 pp.

Korschgen, C.E., L.S. George, and W.L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. Wildl. Soc. Bull. 13:290-296.

Kubisiak, J.F. 1985. Ruffed grouse habitat relationships in aspen and oak forests of central Wisconsin. Tech. Bull. No. 151., Dept. Nat. Res., Madison. 22 pp.

Kubisiak, J.F., J.C. Moulton, and K.R. McCaffery. 1980. Ruffed grouse density and habitat relationships in Wisconsin. Tech. Bull. No. 118., Dept. Nat. Res., Madison. 14 pp.

Kuck, L. (ed). 1984. Cooperative wildlife-phosphate study. Phase 2: Mining impact studies. Final Rep. Idaho Dept. Fish and Game, Boise. 399 pp.

Ledig, F.T. 1993. Secret extinctions: The loss of genetic diversity in forest ecosystems. Pages 127-140. In: M.A. Fenger, E.H. Miller, J.F. Johnson and E.J.R. Williams. Our living legacy: proceedings of a symposium on biological diversity. Royal British Columbia Museum. 392 pp.

Leptich, D.J. and J.R. Gilbert. 1986. Characteristics of moose calving sites in northern Maine as determined by multivariate analysis: A preliminary investigation. Alces 22: 69-81.

LeResche, R.E. 1966. Behaviour and calf survival in Alaskan moose. M.S. Thesis, Univ. of Alaska, Fairbanks. 85 pp.

LGL Limited. 1972. Bald eagle surveys in southern Mackenzie district and Northern Alberta. May, July, August 1972. LGL Environmental Research Associates. 12 pp.

Livezey, B.C. 1980. Effects of selected observer-related factors on fates of duck nests. Wildl. Soc. Bull. 8:123-128.

MacArthur, R.H. 1958. Population ecology of some warblers of northeastern coniferous forest. Ecology 39: 599-619.

Magoun, A.J. 1985. Population characteristics, ecology and management of wolverines in northwestern Albaska. Fairbanks, AK: University of Alaska. Ph.D. Thesis. 197 pp.

Malhotra, S.S. and R.A. Blauel. 1980. Diagnosis of air pollutant and natural stress symptoms on forest vegetation in western Canada. Northern Forest Research Centre, Environment Canada, Information Report NOR-X-228.

McCormick, G. and D.L. Skinner. 1995. Baseline study of fur trapping in the Suncor study area. Prep. by D.A. Westworth & Associates Ltd. for Suncor Inc. 21 pp.

McDonald, M.G. 1991. Moose movement and mortality associated with the Glenn Highway expansion, Anchorage, Alaska. Alces 27:208-219.

McGarigal, K., R.G. Anthony, and F.B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildl. Mong. No. 115. 47 pp.

McNichol, M.K. and I. Robertson. 1982. Nesting of five raptor species along the Alaska highway gas pipeline corridor-north B.C. section. Beak Consultants Ltd., Vancouver, B.C. 20 pp.

Mech, L.D. 1970. The wolf: Ecology and Behaviour of an endangered species. The Natural History Press, Garden City, New York. 384 pp.

Mech, L.D. 1966. The wolves of Isle Royale. U.S. Nat. Park Serv. Fauna Ser. No. 7. 210 pp.

Mech, L.D. and L.L. Rogers. 1977. Status, distribution, and movements of martens in northeastern Minnesota. USDA Forest Service Research Paper NC 14.3. 7 pp.

Melquist, W.E. and A.E. Dronkert. 1987. River otter. Pages 627-641. In: M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch (eds). Wild furbearer management and conservation in North America. The Ontario Trappers Association. 1150 pp.

Melquist, W.E. and M.G. Hornocker. 1983. Ecology of river otters in west central Idaho. Wild. Monog. No. 83. 60 pp.

Merrit, J.F. 1981. *Clethrionomys gapperi.* Mammalian Species 146:1-9.

Millar, J.S., D.G.L. Innes, and V.A. Loewen. 1985. Habitat use by non-hibernâting small mammals of the Kananaskis Valley, Alberta. Can. Field-Nat. 99:196-204.

Miller, F.L. and E. Broughton. 1974. Calf mortality on the calving grounds of Kaminuriak caribou during 1970. Can. Wildl. Serv. Report Series No. 26.

Miller, F.L., E. Broughton, and A. Gunn. 1988. Mortality of migratory barren-ground caribou on the calving grounds of the Beverly herd, Northwest Territories, 1981-83. Can. Wildl. Serv. Envir. Can. Occas. Paper No. 66. 26 pp.

Miller, D.H. and L.L. Getz. 1973. Factors influencing the local distribution of the redback vole, *Clethrionomys gapperi*, in New England. Univ. of Connecticut Occas. Papers, Biol. Science Ser. 2:115-138.

Miller, D.H. and L.L. Getz. 1977. Factors influencing the local distribution and species diversity of forest small mammals in New England. Can. J. Zool. 55:806-814.

Mitchell, H.B. 1970. Rapid aerial sexing of antlerless moose in British Columbia. J. Wildl. Manage. 34:645-646.

Moller, A. 1978. Review of animal experiments. J. Sound Virat. 59:73-77.

Moorman, A.M., T.E. Moorman, G.A. Baldassarre, and D.M. Richard. 1991. Effects of saline water on growth and survival of mottled duck ducklings in Louisiana. J. Wildl. Manage. 55:471-476.

More, G. 1978. Ecological aspects of food selection in pine marten (*Martes americana*). M.Sc. Thesis, Univ. Alberta, Edmonton.

Morris, R.D. 1969. Competitive exclusion between *Microtus* and *Clethrionomys* in the aspen parkland of Saskatchewan. J. Mammal. 50:291-301.

Mugasha, A.G., D.J. Pluth and G.R. Hillman. 1993. Foliar responses of tamarack and black spruce to drainage and fertilization of a minerotrophic peatland. Can. J. For. Res. 23:166-180.

Mytton, W.R. and L.B. Keith. 1981. Dynamics of moose populations near Rochester, Alberta, 1975-1978. Can. Field-Nat. 95:39-49.

Nellis, C.H., S.P. Wetmore, and L.B. Keith. 1972. Lynx-prey interactions in central Alberta. J. Wildl. Manage. 36:320-329.

Northcott, T.H. 1971. Feeding habits of beaver in Newfoundland. Oikos 22:407-410.

Noss, R.F. 1983. A regional landscape approach to maintain diversity. BioScience 33:700-706.

Novakowski, N.S. 1967. The winter bioenergetics of a beaver population in northern latitudes. Can. J. Zool. 45:1107-1118.

Nowlin, R.A. 1978. Relationships between habitats, forages and carrying capacity of moose range in northern Alberta. Part I: Moose preferences for habitat strata - forages. Prep. for the Alberta Oil Sands Environmental Research Program by Alberta Fish and Wildlife Division. AOSERP Project TF 1.2. 63 pp.

O'Connell, M.A. and R.F. Noss. 1992. Private land management for biodiversity conservation. Environ. Manage. 16:435-450.

Paquet, P.C. 1993. Summary reference document: Ecological studies of recolonizing wolves in the central Canadian Rocky Mountains; Final report April 1989 to June 1993. Prep. by John/Paul & Associates, Canmore, AB for Parks Canada, Banff National Park Warden Service, Banff, AB. 219 pp.

Paragi, T.F. 1990. Reproductive biology of female fishers in southcentral Maine. University of Maine, Orono. 107 pp.

Parker, G.R. 1981. Winter habitat use and hunting activities of lynx (*Lynx canadensis*) on Cape Breton Island, Nova Scotia. Worldwide Furbearer Conf. Proc. 1:221-248.

Parker, G.R., D.G. Kimball, and B. Dalzell. 1994. Bird communities breeding in selected spruce and pine plantations in New Brunswick. Can. Field-Nat. 108: 1-9.

Parks Canada. 1995. Initial assessment of proposed improvements to the Trans Canada Highway in Banff National Park: Phase IIIA Sunshine interchange to Castle Mountain interchange. Parks Canada.

Pauls, R.W. 1987. Moose populations in the Syncrude area: Results of a February 1987 survey and a review of recent trends. Unpubl. Syncrude Canada Ltd. Report. 11 pp.

Pauls, R.W. and B.D. Arner. 1989. Small mammal trace metal concentrations in the Athabasca Oil Sands region. Environmental Operations and Affairs, Syncrude Canada Ltd. 23 pp.

Penner, D.F. 1976. Preliminary baseline investigations of furbearing and ungulate mammals using Lease No. 17. Syncrude Environmental Research Monograph 1976-3. 181 pp.

Petersen, A. 1986. Habitat suitability index models: Bald eagle (breeding season). Biological Report 82(10.126). Fish and Wildlife Service, U.S. Department of the Interior. 25 pp.

Peterson, D.J. and R.K. Murphy. 1992. Prey delivered to two Cooper's hawk (*Accipiter cooperi*), nests in northern mixed grass prairie. Can. Field-Nat. 106: 385-386.

Pinkowksi, B. 1983. Foraging behaviour of beavers (*Castor canadensis*) in North Dakota. J. Mammal. 64:312-314.

Powell, R.A. and W.J. Zielinski. 1994. Fisher. Pages 38-73. In: L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (eds). The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Rocky Mountain Forest and Range Experimental Station. Tech. Rep. RM-254. 184 pp.

Purves, H.D., C.A. White and P.C. Paquet. 1992. Wolf and grizzly bear habitat use and displacement by human use in Banff, Yoho, and Kootenay National Parks: A preliminary analysis. Canadian Parks Service, Banff, Alberta. 54 pp.

Quick, H.F. 1955. Food habits of marten (*Martes americana*) in northern British Columbia. Can. Field-Nat. 69:144-147.

Rabenold, K.N. 1978. Foraging strategies, diversity, and seasonality in bird communities of Appalachian spruce-fir forests. Ecol. Monog. 48: 397-424.

Raine, R.M. 1982. Ranges of juvenile fisher, *Martes pennanti,* and marten, *Martes americana,* in southeastern Manitoba. Can. Field-Nat. 96:431-438.

Raine, R.M. 1987. Winter food habits and foraging behaviour of fishers (*Martes pennanti*) and martens (*Martes americana*) in southeastern Manitoba. Can. J. Zool. 65:745-747.

Rickard, W.H. 1960. The distribution of small mammals in relation to the climax vegetation mosaic in eastern Washington and northern Idaho. Ecol. 41:99-106.

Rogers, L.L. 1987. Effects of food supply and kinship on social Behaviour, movements, and population growth of black bears in northeastern Minnesota. Wildl. Mong. No. 97. 72 pp.

Rogowitz, G.L. 1988. Forage quality and use of reforested habitats by snowshoe hares. Can. J. Zool. 66:2080-2083.

Rolley, R.E. and L.B. Keith. 1980. Moose population dynamics and winter habitat use near Rochester, Alberta, 1965-1979. Can. Field-Nat. 94:9-18.

Roseneau, D.G. and P.J. Bente. 1993. Bradley Lake Hydroelectric Project Bald Eagle Program, 1986-1991. Report prepared by Biosystems Alaska for the Alaska Energy Authority. Anchorage Alaska. 180 pp.

Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, L.J. Lyon and W.J. Zielinski. 1994. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Dept. of Agriculture, General Technical Report RM-254. Fort Collins, Colorado. 184 pp.

Rusch, D.H. and L.B. Keith. 1971a. Ruffed grouse-vegetation relationships in central Alberta. J. Wildl. Manage. 35:417-429.

Rusch, D.H. and L.B. Keith. 1971b. Seasonal and annual trends in numbers of Alberta ruffed grouse. J. Wildl. Manage. 35:803-822.

Salt, W.R. and J.R. Salt. 1976. The birds of Alberta. Hurtig Publishers Inc. Edmonton, Alberta. 498 pp.

Samson, F.B. and F.L. Knopf. 1983. In search of a biodiversity ethic for wildlife. North Am. Wildl. Conf. 47:421-431.

Samson, F.B. and F.L. Knopf. 1993. Managing biological diversity. Wildl. Soc. Bull. 21:509-514.

Schwanke, R. and K. Baker. 1977. The beaver of Elk Island National Park. Resource Conservation, Parks Canada, Western Region. 125 pp.

Scott, J.M., E.D. Ables, T.C. Edwards, Jr., R.L. Eng, T.A. Gavin, L.D. Harris, J.B. Haufler, W.M. Healy, F.L. Knopf, O. Torgerson, and H.P. Weeks, Jr. 1995. Conservation of biological diversity: Perspectives and the future for the wildlife profession. Wildl. Soc. Bull. 23:646-657.

Semenchuk, G.P. 1992. The atlas of breeding birds of Alberta. Federation of Alberta Naturalists. 390 pp.

Servos, M.L. 1987. Summer habitat use by great gray owls in southeastern Manitoba. In: Biology and conservation of northern forest owls. Symposium Proceedings February 3-7, 1987. Winnipeg, Manitoba.

Shank, C.C. 1979. Human-related disturbance to northern large mammals: A bibliography and review. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary.

Simpson, K. and L.W. Gyug. 1995. Effectiveness and maintenance of wildlife mitigation structures installed on new highways in southern British Columbia. Prep. by Keystone Wildlife Research for B.C. Ministry of Transportation and Highways. 55 pp.

Skinner, D.L. 1984. Selection of winter food by beavers at Elk Island National Park. M.Sc. Thesis, Univ. of Alberta, Edmonton. 73 pp.

Skinner, D.L. and A.W. Todd. 1988. Some characteristics of trappers and trapping in Alberta in 1987. Alberta Fish and Wildlife Division, Edmonton. 14 pp.

Skinner, D.L. and D.A. Westworth. 1981. Preliminary studies of mammals in the Project 80 study area. Prep. for Canstar Oil Sands Ltd. by D.A. Westworth & Associates Ltd. 62 pp.

Skinner, D.L. and D.A. Westworth. 1990. Cold Lake winter track study. Prep. for Esso Resources Canada Ltd. by D.A. Westworth & Associates Ltd. 27 pp.

Slough, B.G. 1978. Beaver food cache structure and utilization. J. Wildl. Manage. 42:644-646.

Slough, B.G. 1989. Movements and habitat use by transplanted marten in the Yukon territory. J. Wildl. Manage. 53:991-997.

Slough, B.G. and R.M.F.S. Sadlier. 1977. A land capability classification for beaver (*Castor canadensis* Kuhl). Can. J. Zool. 55:1324-1335.

Smith, C.H. 1983. Spatial trends in Canadian snowshoe hare, *Lepus americanus*, population cycles. Can. Field-Nat. 97:151-160.

Soule, M.E. 1980. Thresholds for survival: Maintaining fitness and evolutionary potential. Pages 151-169. In: M.E. Soule and B.A. Wilcox (eds). Conservation biology: an evolutionary-ecological perspective. Sinaver Associates, Sunderland, Mass.

Soule, M.E. and D. Simberloff. 1986. What do genetics and ecology tell us about the design of nature reserves? Biol. Conserv. 35:19-40.

Sousa, P.J. 1985. Habitat suitability index models: Blue-winged teal (breeding). Biol. Rep. 82(10.114). U.S. Dept. of the Interior, Fish and Wildl. Serv. 36 pp.

Soutiere, E.C. 1979. Effects of timber harvesting on marten in Maine. J. of Wildl. Manage. 43:850-860.

Spencer Environmental Management Services Ltd. 1989. Cold Lake Air Weapons Range impact study. Prep. for Department of National Defense, Ottawa.

Spreyer, M.F. 1987. A floristic analysis of great gray owl habitat in Aitkin County, Minnesota. In: Biology and conservation of northern forest owls. Symposium Proceedings February 3-7, 1987. Winnipeg, Manitoba.

Suncor Inc., Oil Sands Group. 1996. Steepbank Mine Project Application. April 1996. Fort McMurray, Alberta.

Terres, J.K. 1980. The Audubon Society encyclopedia of North American birds. Alfred A. Knopf Inc., New York. 1109 pp.

Tietje, W.D. and R.L. Ruff. 1980. Denning behaviour of black bears in the boreal forest of Alberta. J. Wildl. Manage. 44:858-870.

Tietje, W.D. and R.L. Ruff. 1983. Responses of black bears to oil development in Alberta. Wildl. Soc. Bull. 11:99-112.

Todd, A.W. 1976. Furbearer inventory of the oil sands area. Fish and Wildl. Div., Dept. of Recreation, Parks, and Wildlife.

Todd, A.W. and L.C. Geisbrecht. 1979. A review of Alberta fur production and management, 1920-21 to 1977-78. Alberta Energy and Natural Resources, Fish and Wildlife Division. 38 pp.

Vana-Miller, S.L. 1987. Habitat suitability index models: Osprey. Biological Report 82 (10.154). U.S. Department of the Interior, Fish and Wildlife Service. Research and Development. Washington, D.C. 46 pp.

van Zyll de Jong, C.G. 1966. Food habits of lynx in Alberta and the Mackenzie Delta, N.W.T. Can. Field-Nat. 80:18-23.

van Zyll de Jong, C.G. 1975. The distribution and abundance of the wolverine (*Gulo gulo*) in Canada. Can. Field-Nat. 89:431-437.

Vitt, D.H., B.J. Nicholson, L.A. Halsey, P. Paslowski, R. Craik, S. Lamoureaux, S. Gerber, and H. Taylor. 1994. The peatlands of Alberta: A 1:1,000,000 summary map. Province of Alberta Maps.

Ward, R.M.P. and C.J. Krebs. 1985. Behavioural responses of lynx to declining snowshoe hare abundance. Can. J. of Zoolo. 63:2817-2824.

Watson, J.W. 1993. Responses of nesting bald eagles to helicopter surveys. Wildl. Soc. Bull. 21:171-178.

Weckworth, R.P. and V.D. Hawley. 1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26:55-74.

Westworth, D.A. 1979. Moose populations on Syncrude's Leases 17 and 22: Results of the December 1978 survey and a review of recent trends and seasonal movements. Prep. for Syncrude Canada Ltd. by D.A. Westworth & Associates Ltd. 19 pp.

Westworth, D.A. 1980. Surveys of moose populations in the vicinity of the Syncrude development, winter 1979-1980. Prep. for Syncrude Canada Ltd. by D.A. Westworth & Associates Ltd. 13 pp.

Westworth, D.A. and L.M. Brusnyk. 1982. Wildlife resources of the Canstar leases. Section III: Terrestrial Furbearers. Prep. for Canstar Oil Sands Ltd. by D.A. Westworth & Associates Ltd. 51 pp.

Westworth, D.A., L. Brusnyk, J. Roberts, and H. Vedhuzien. 1989. Winter habitat use by moose in the vicinity of an open pit copper mine in north-central British Columbia. Alces 25:156-166.

Westworth, Brusnyk & Associates Ltd. 1996a. Abundance and distribution of moose in the Suncor study area. Prepared for Suncor Inc., Oils Sands Group. Prepared by Westworth, Brusnyk & Associates Ltd. Edmonton, Alberta.

Westworth, Brusnyk & Associates Ltd. 1996b. Herpetofauna in the Steepbank study area. Prepared for Suncor Inc., Oils Sands Group. Prepared by Westworth, Brusnyk & Associates Ltd. Edmonton, Alberta.

Westworth, Brusnyk & Associates Ltd. 1996c. Waterfowl, raptors and breeding terrestrial birds of the Suncor lease in 1995. Prepared for Suncor Inc., Oils Sands Group. Prepared by Westworth, Brusnyk & Associates Ltd. Edmonton, Alberta.

Wetmore, S.P. and D.I. Gillespie. 1976. Osprey and bald eagle populations in Labrador and Northeastern Quebec, 1969-1973. Can. Field-Nat. 90:330-337.

Wiggers, E.P. and K.J. Kritz 1994. Productivity and nesting chronology of the Cooper's hawk and sharp-shinned hawk in Missouri. J. Raptor Res. 28:1-3.

Woods, J.G. 1990. Effectiveness of fences and underpasses on the trans-Canada highway and their impact on ungulate populations project. Parks Service, Environment Canada. 103 pp.

Yeager, L.E. and W.H. Rutherford. 1957. An ecological basis for beaver management in the Rocky Mountain region. N. Am. Wildl. Conf. 22:269-299.

Young, B.F. 1978. Potential productivity of black bear habitat of the AOSERP study area. Alberta Oil Sands Environmental Research Program. Project TF 1.3. 19 pp.

Xu, J.G. (editor). 1996. Plant growth dewatering and contaminant uptake from oil sands fine tails and tailings (a progress report on 1995 field experiment). Alberta Environmental Protection Centre. Vegreville, Alberta. AECV 2600-M6*Cx10-3[R1.

Xu, J.G. (editor). 1995. Plant growth and metal uptake from two kinds of oil sands fine tailings (a progress report on greenhouse experiment). Alberta Environmental Protection Centre. Vegreville, Alberta. AECV 2600-M6*Cx10-2[R1.

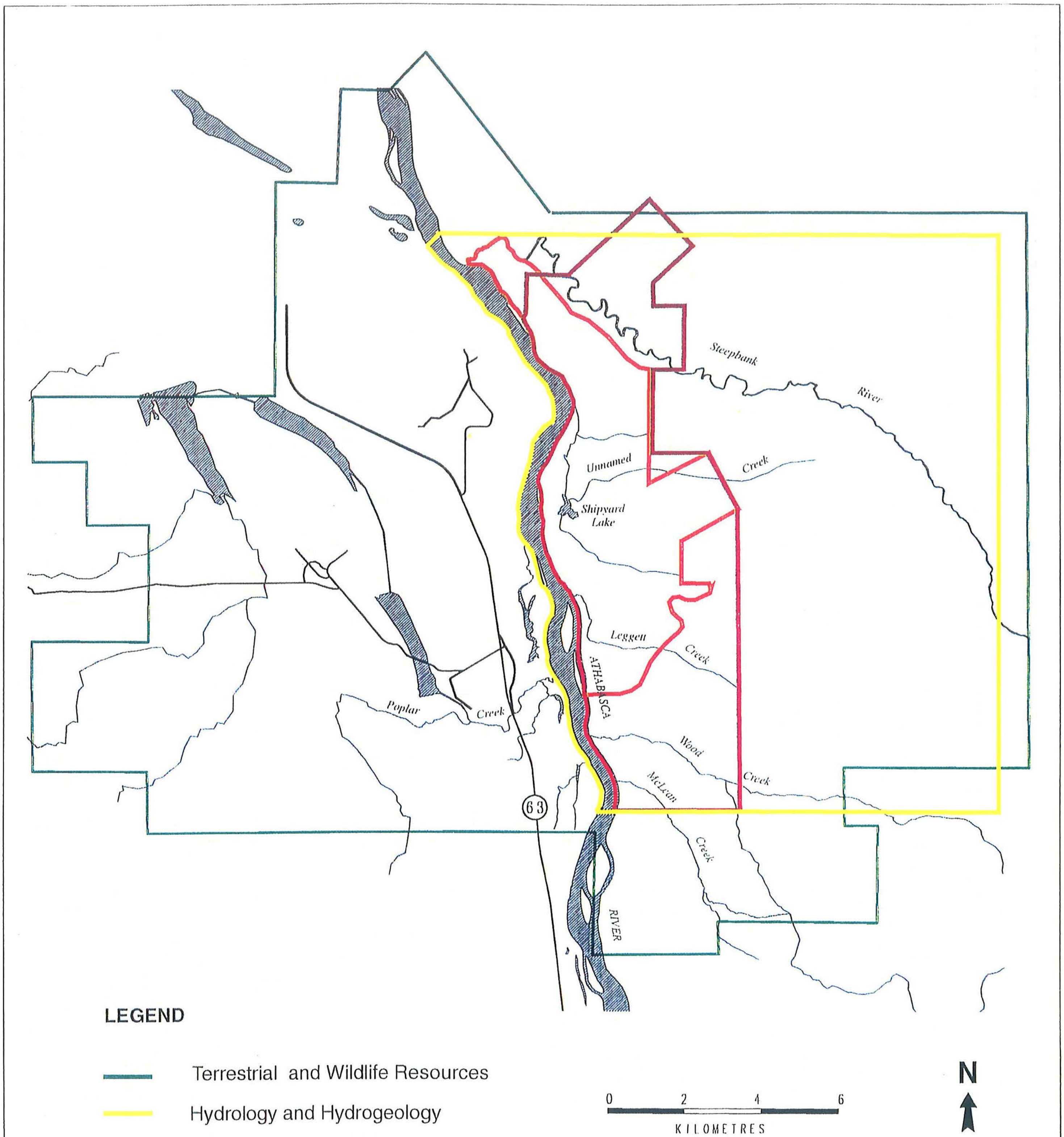
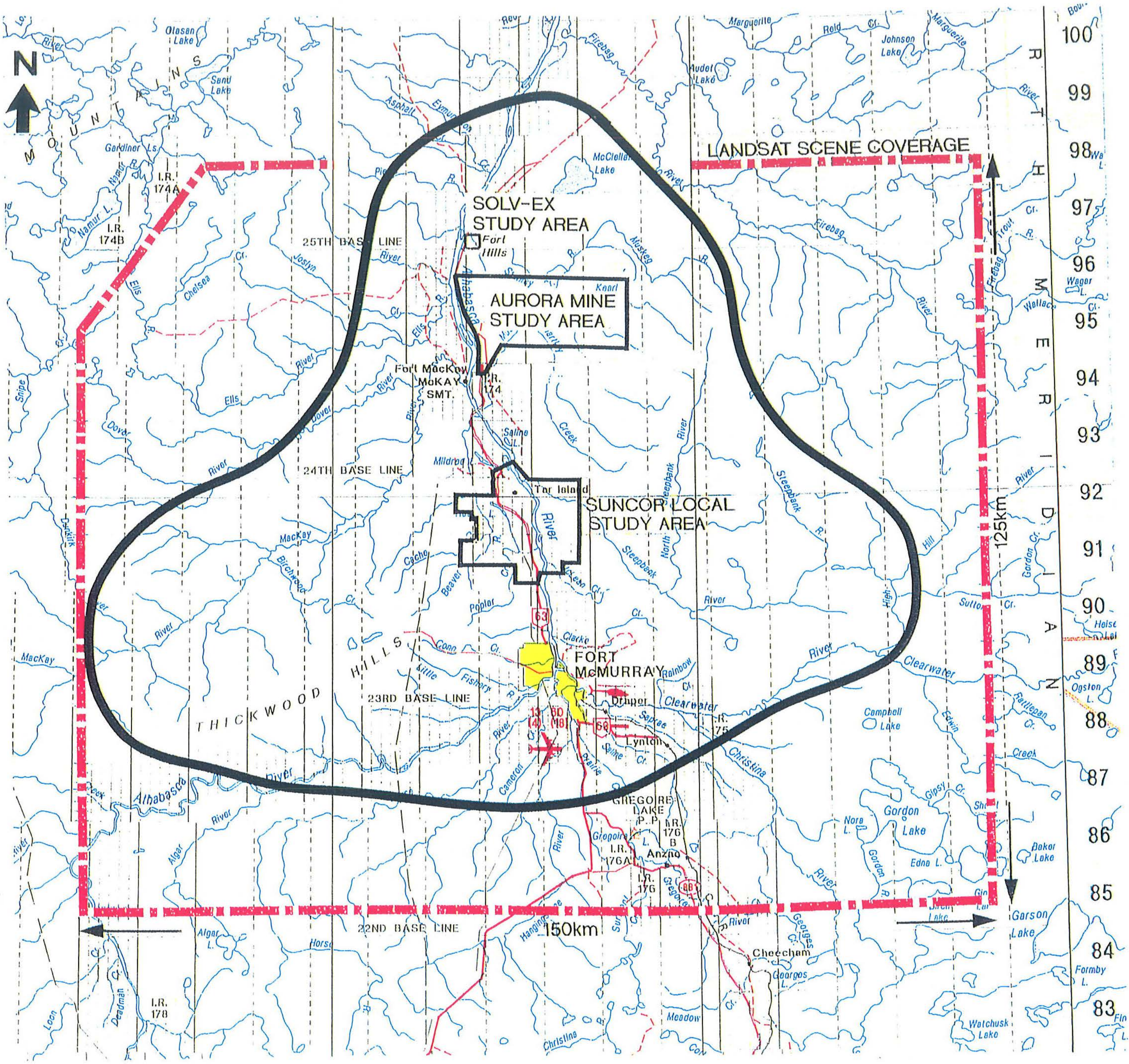



Figure A-1.
LOCAL STUDY AREA BOUNDARIES
FOR THE STEEPBANK MINE ENVIRONMENTAL ASSESSMENT PROGRAM

## Figure A-2

## SUNCOR REGIONAL AND APPROXIMATE LOCAL STUDY AREA



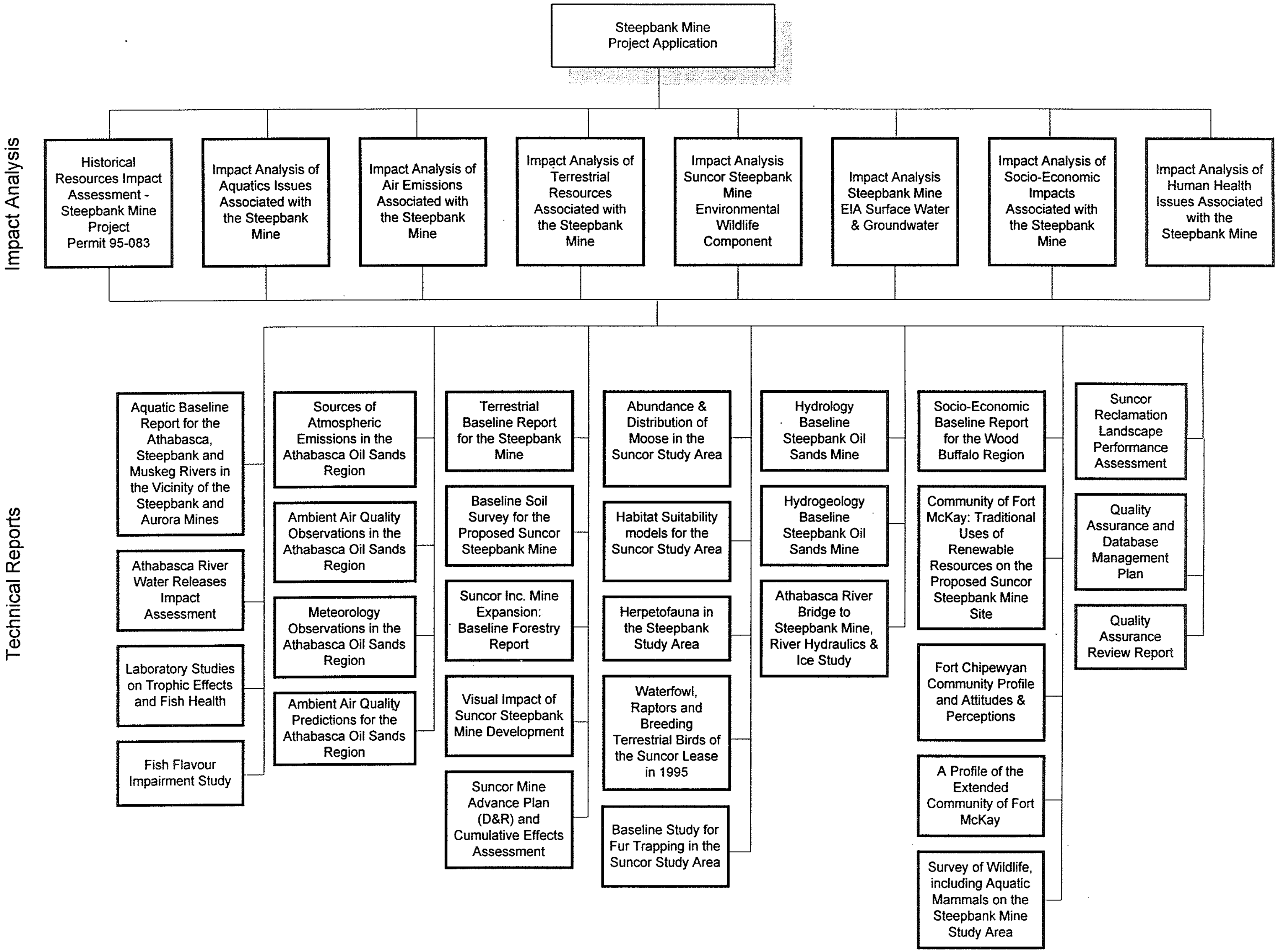



**Figure A-3 Reports Prepared for the Steepbank Mine Environmental Assessment**

r:\1995\2307\repprep5.040\rpt-sch.vsd

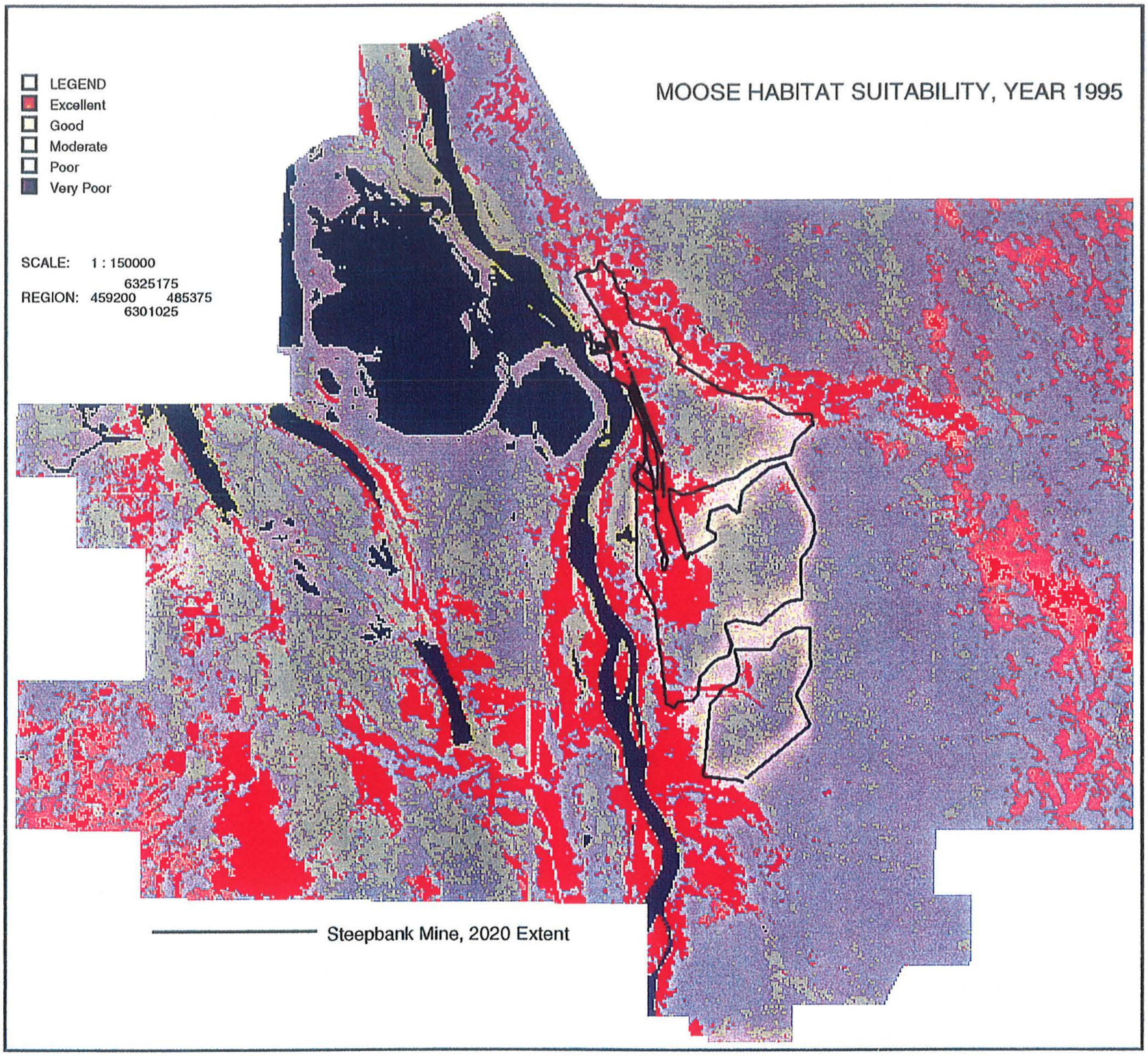



Figure C4.0-1
MOOSE HABITAT SUITABILITY RATING 1995
LOCAL STUDY AREA BASELINE

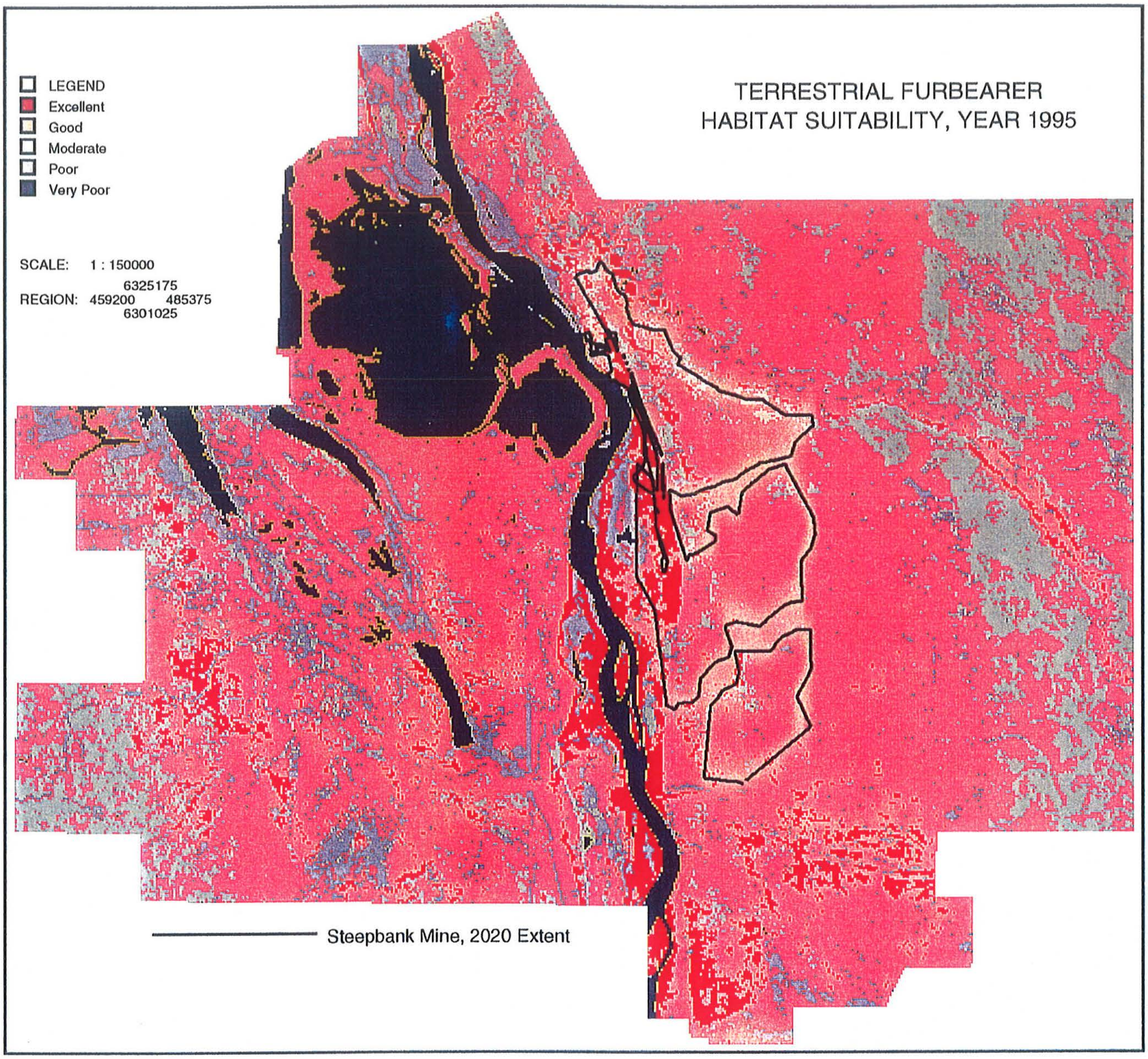



Figure C4.0-2
TERRESTRIAL FURBEARERS HABITAT SUITABILITY RATING 1995
LOCAL STUDY AREA BASELINE

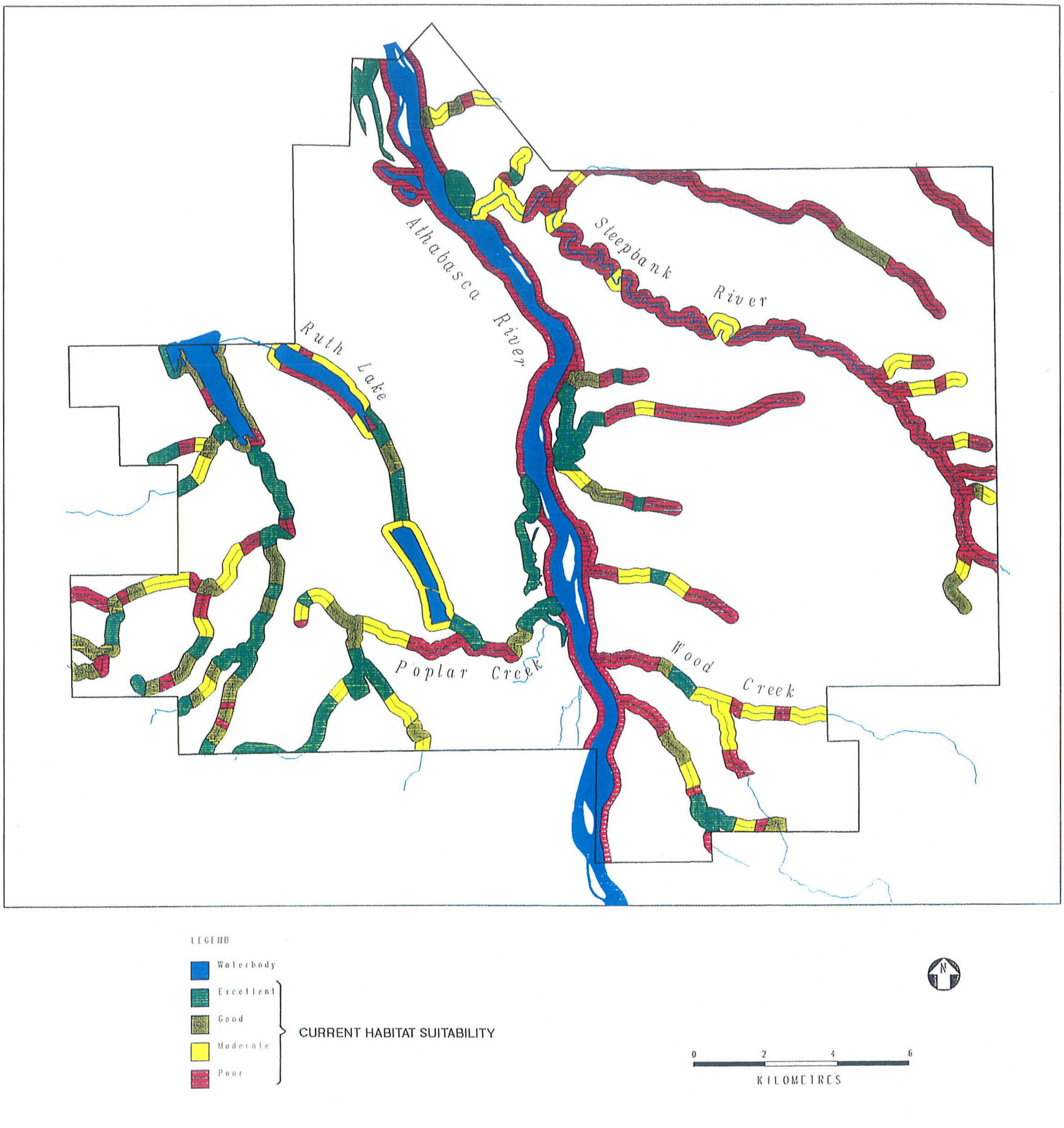



Figure C4.0-3
SEMI-AQUATIC FURBEARER HABITAT
SUITABILITY RATING

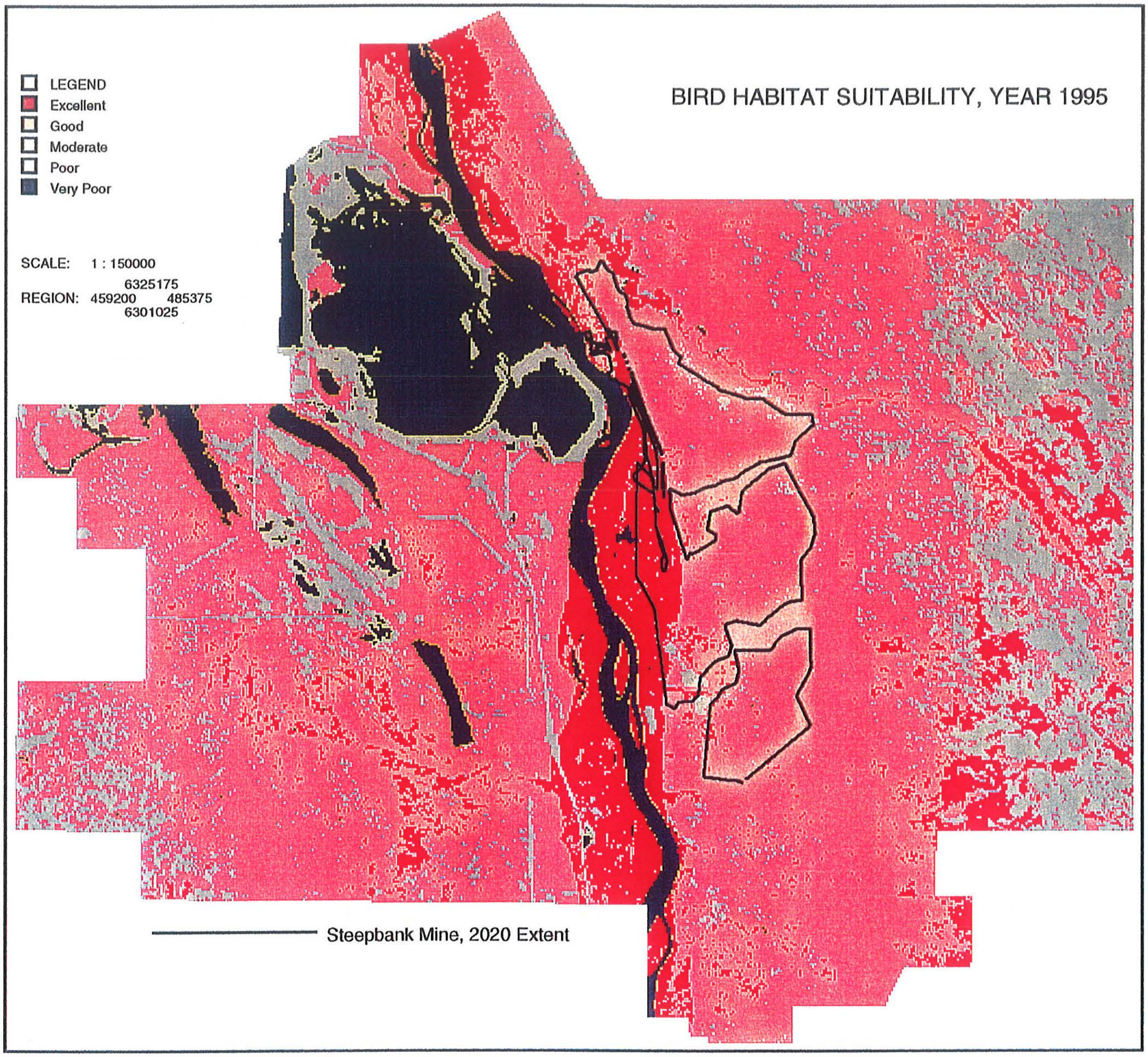



Figure C4.0-4
BIRD HABITAT SUITABILITY RATING 1995
LOCAL STUDY AREA BASELINE

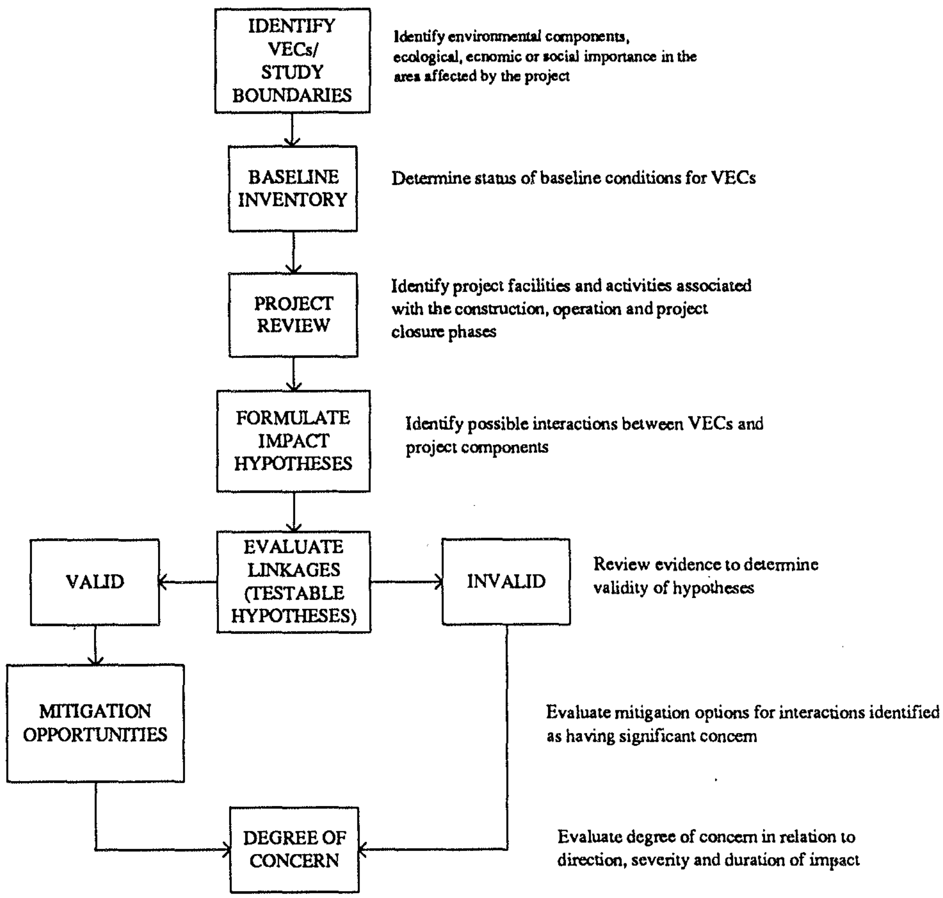



**Figure D1.0-1.** Impact assessment process for the Steepbank Mine EIA - Wildlife Component

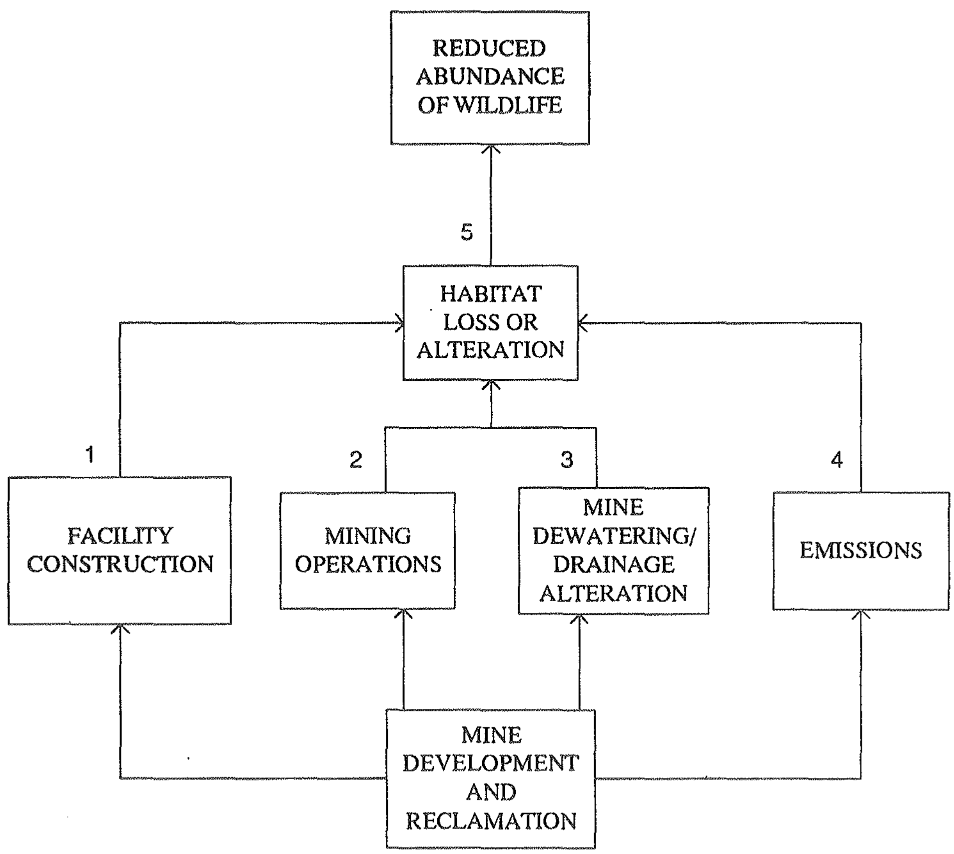
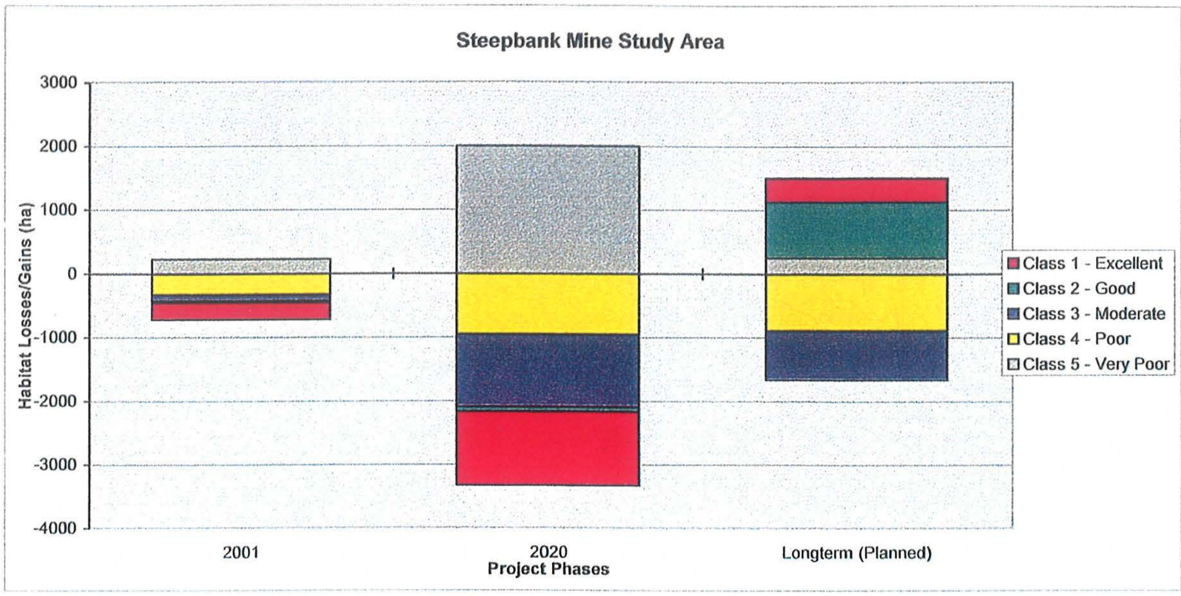
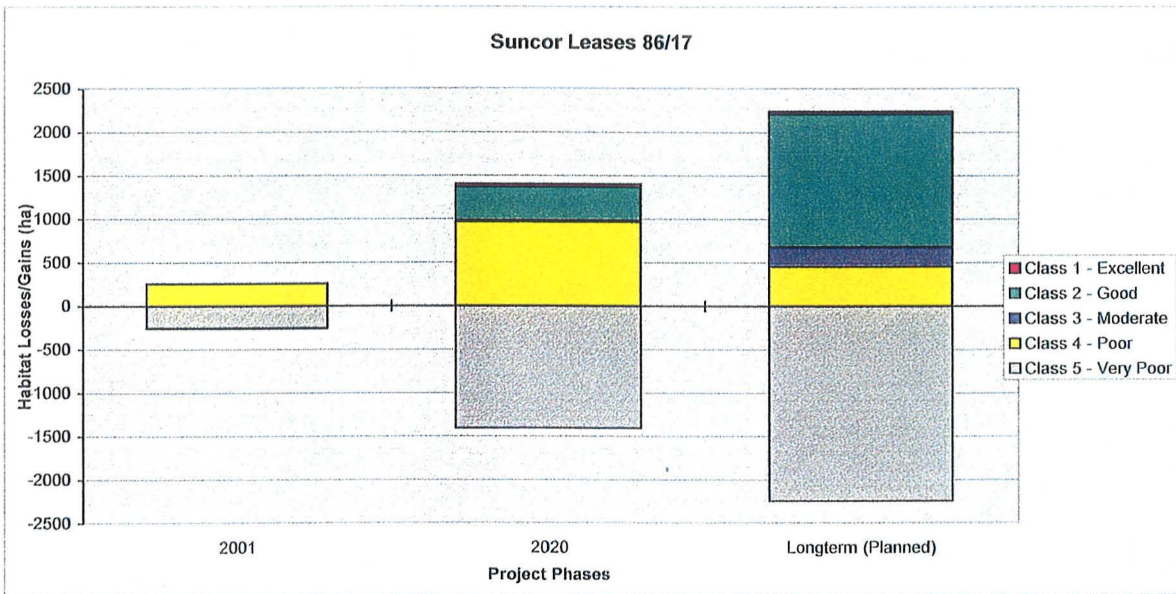



**Figure D4.0-1**
**HYPOTHESIS 18:** Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populations.



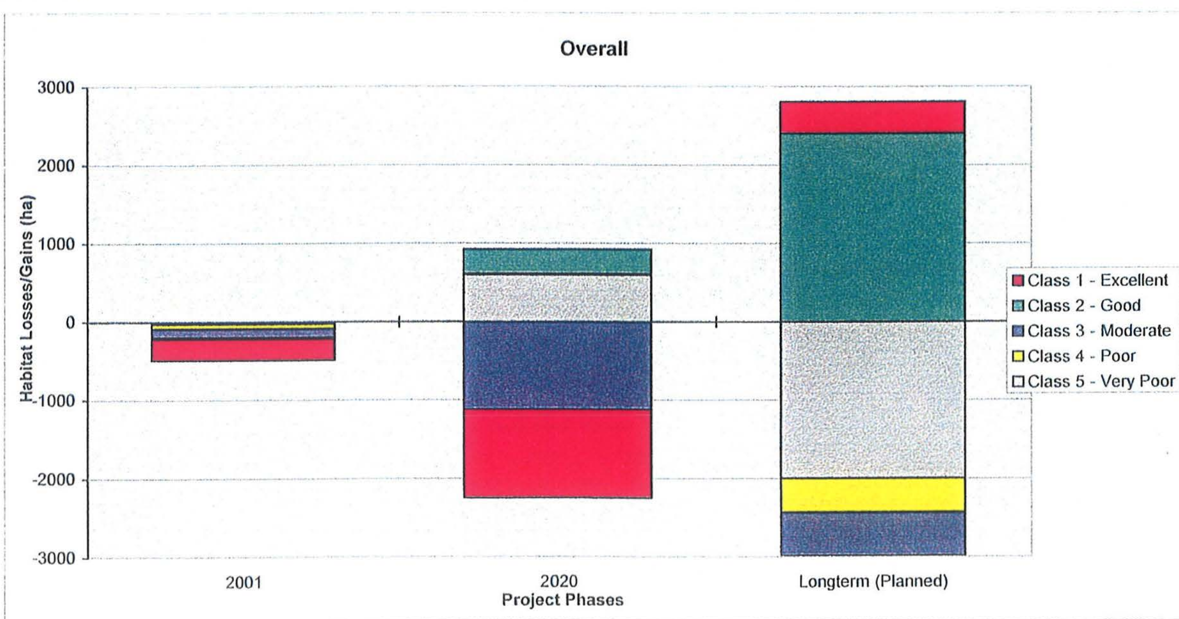
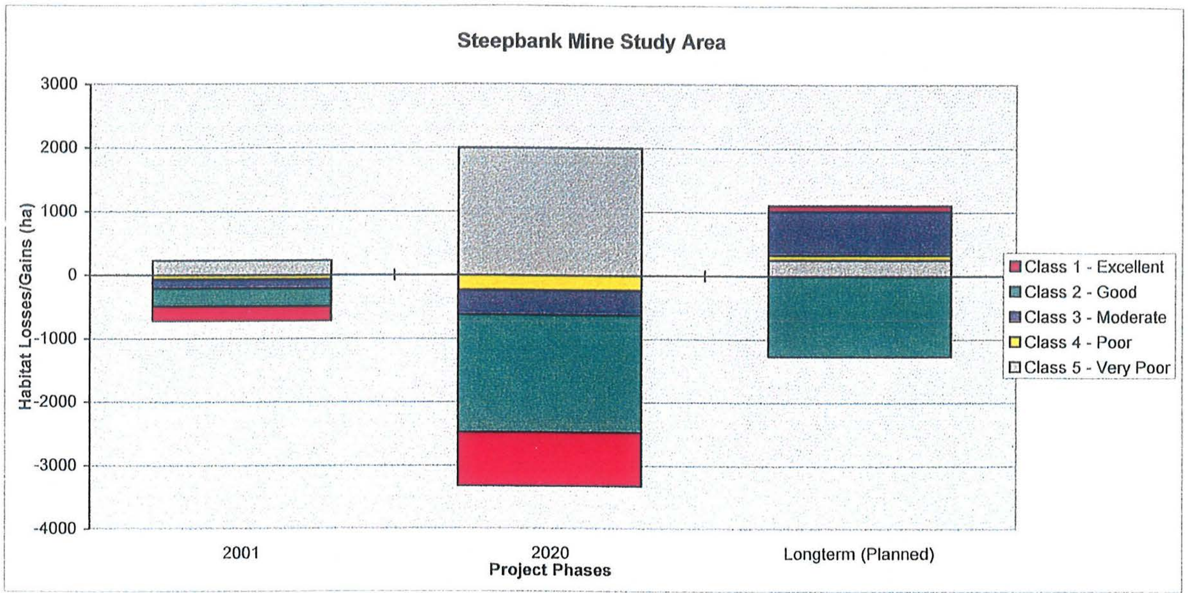
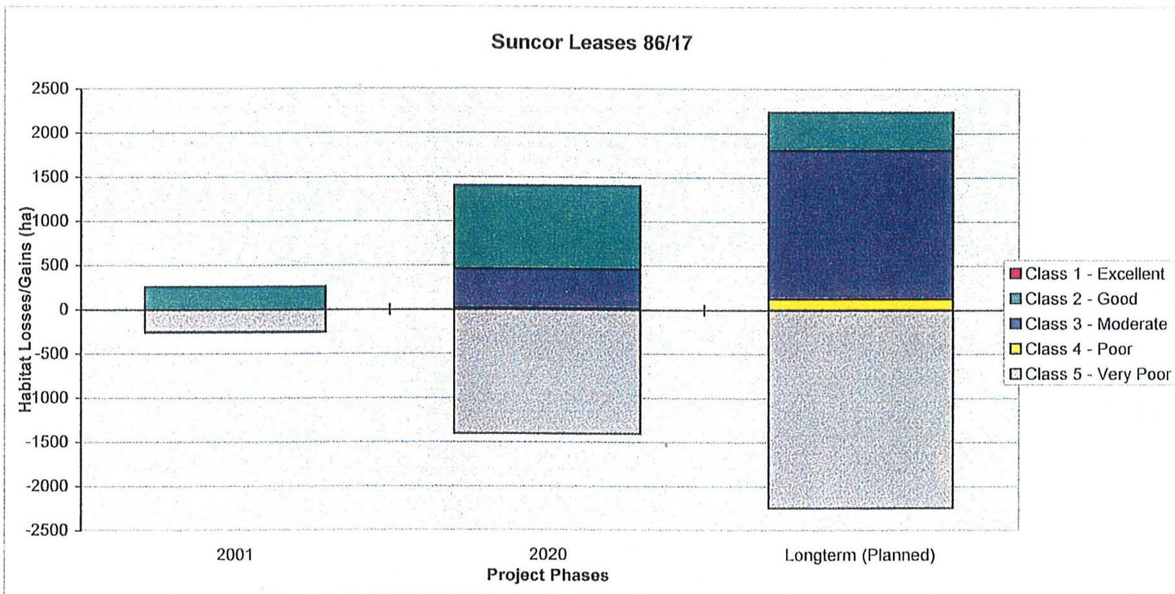




**Figure D4.0-2.** Habitat losses and gains for moose during the construction, operations and long-term closure phases of the Steepbank Mine Project.



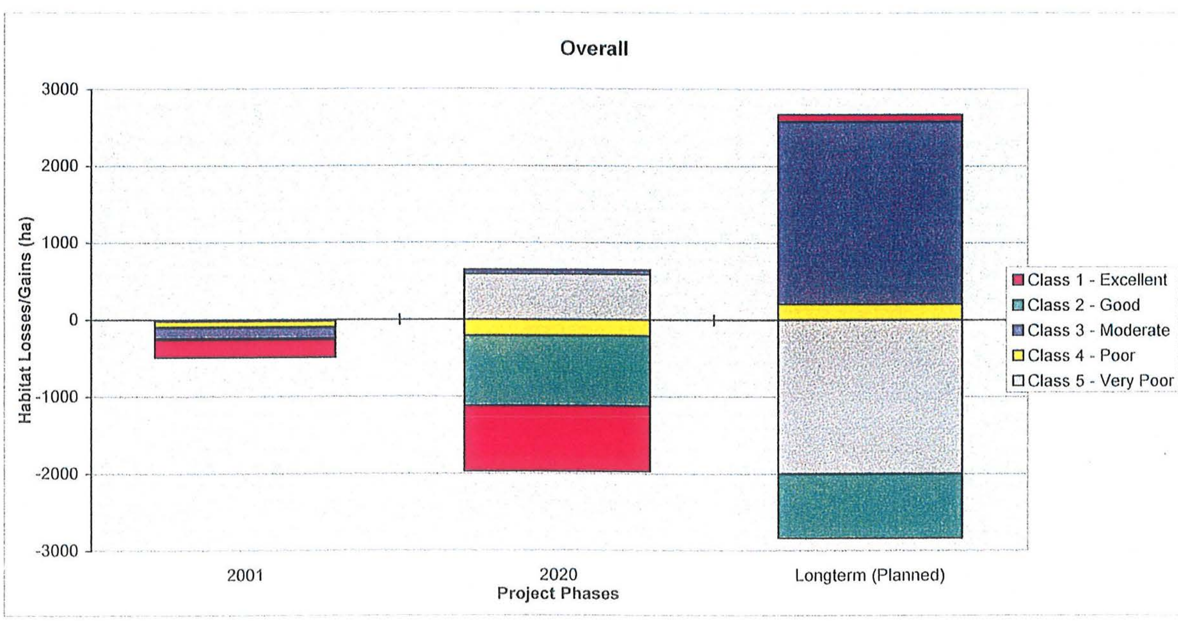




**Figure D4.0-3.** Habitat losses and gains for terrestrial furbearers during the construction, operations and long-term closure phases of the Steepbank Mine Project.

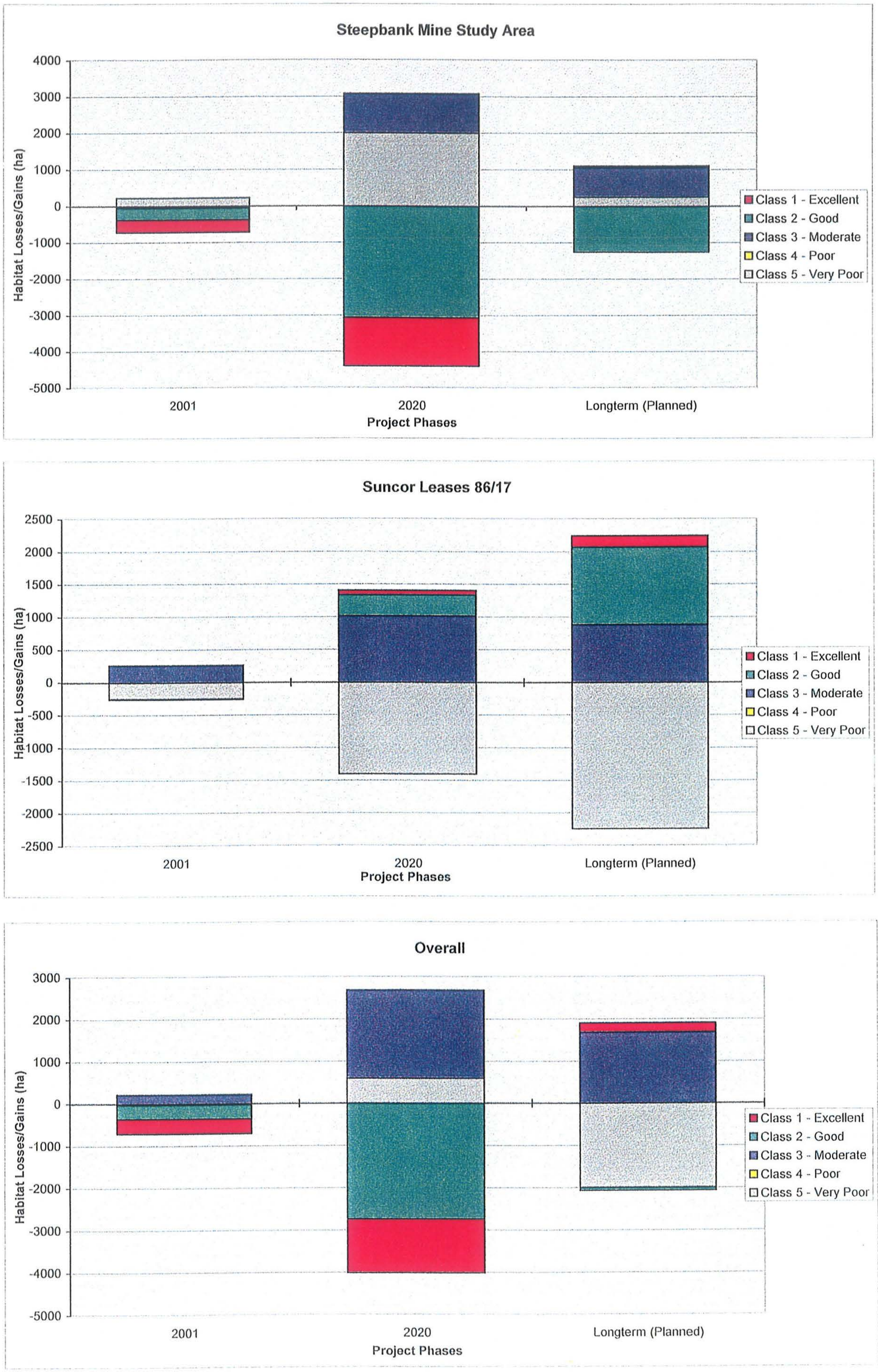



**Figure D4.0-4.** Habitat losses and gains for terrestrial birds during the construction, operations and long-term closure phases of the Steepbank Mine Project.

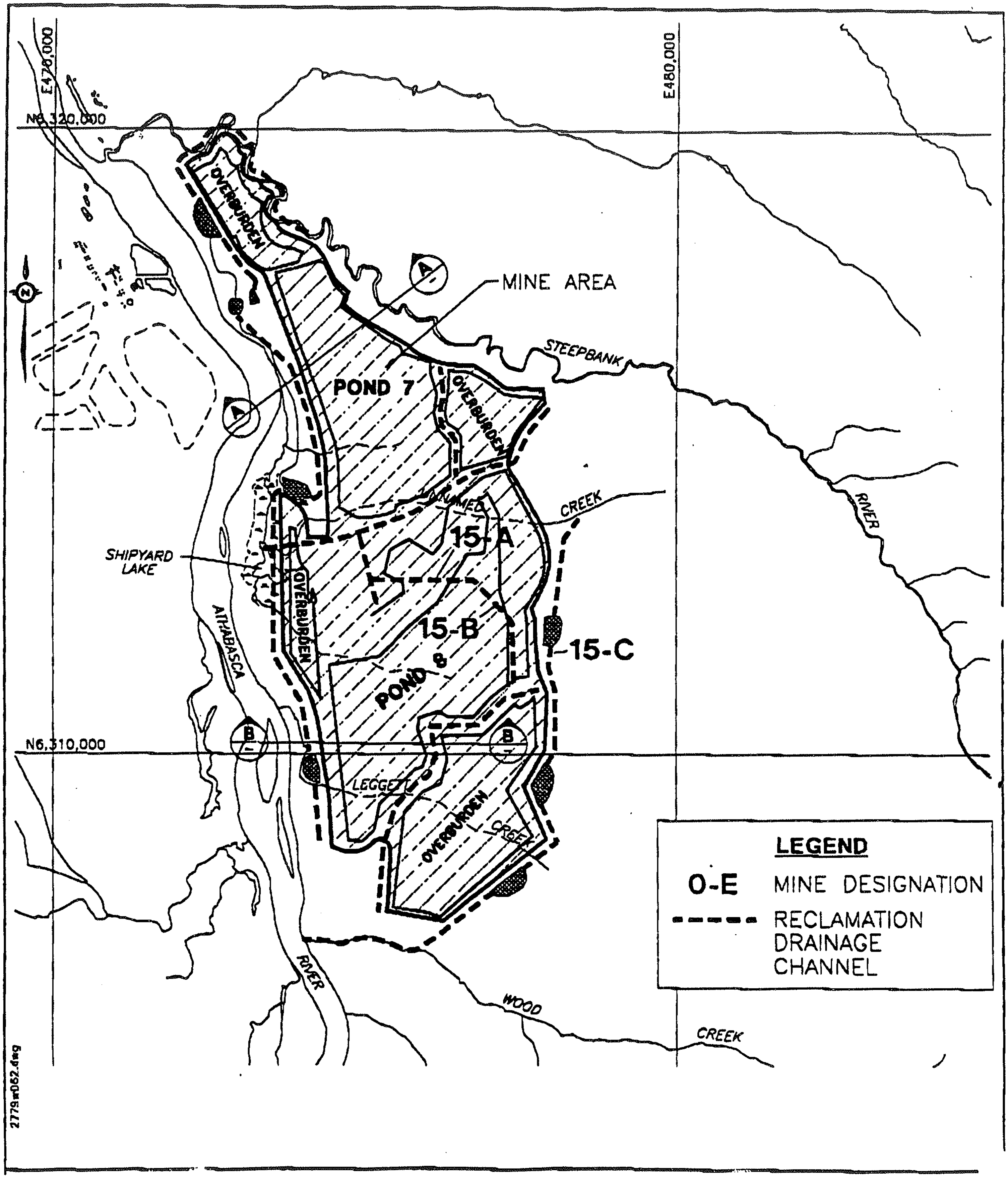



Figure D 4.0-5

RECLAMATION DRAINAGE PLAN
STEEPBANK MINE

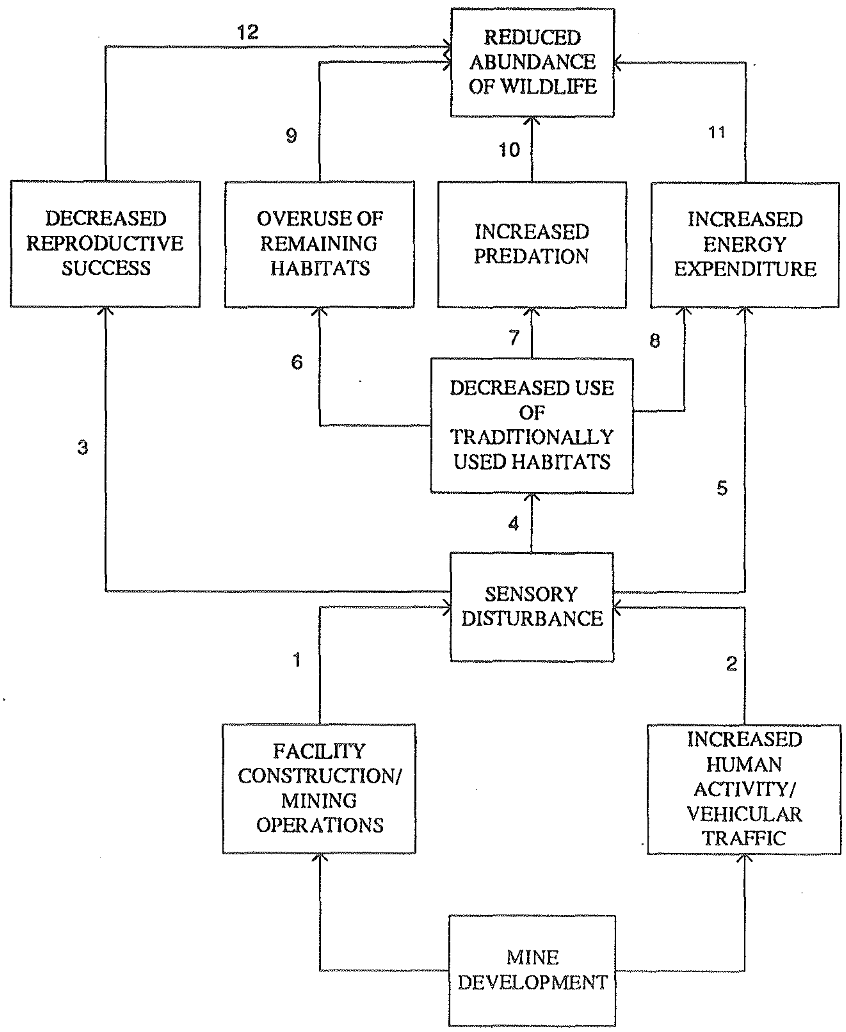



**Figure D4.0-6**
**HYPOTHESIS 19:** Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.

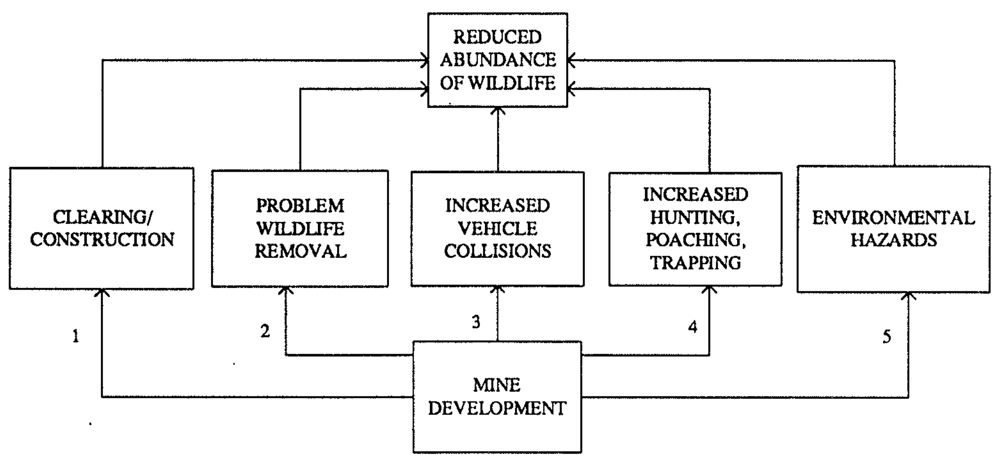
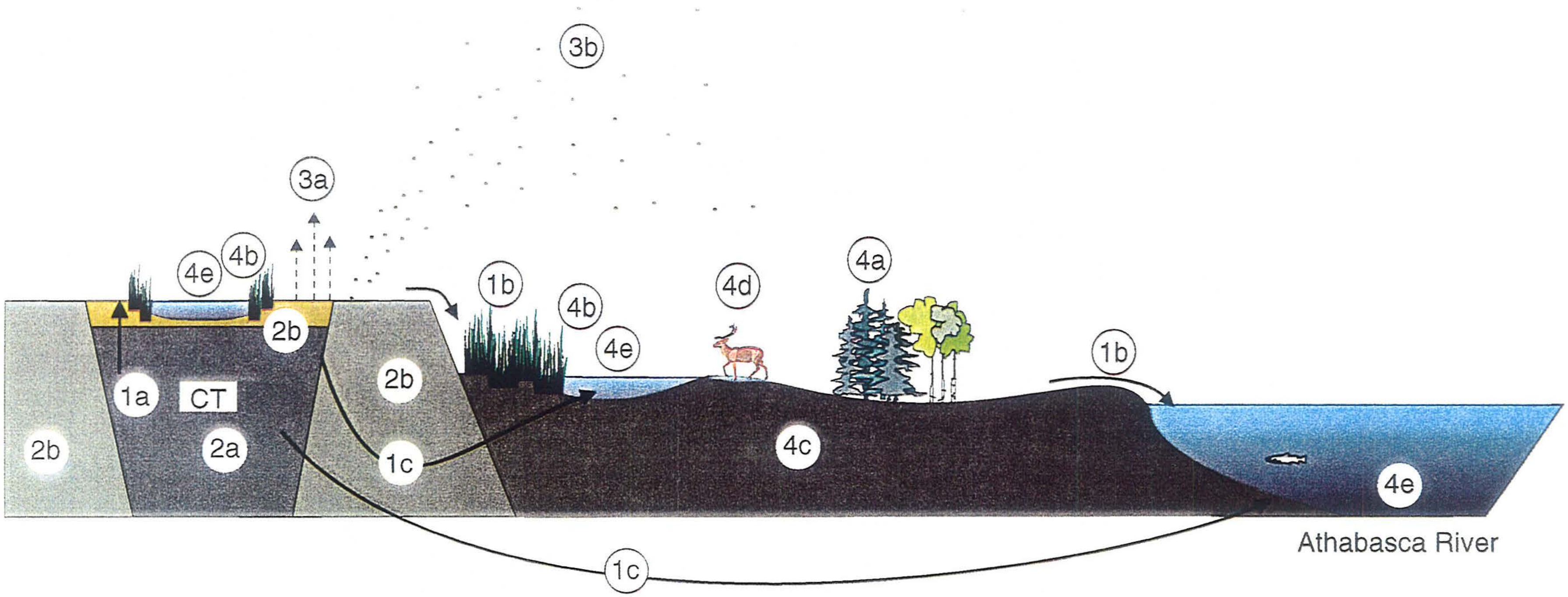



**Figure D4.0-7**
**HYPOTHESIS 20:** Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.

NOT DRAWN TO SCALE

# Figure D4.0-8 Conceptual Overview of Chemical Transport and Fate Pathways




**1. WATER**
- 1a. Exfiltration water
- 1b. Surface runoff
- 1c. Groundwater

**2. SOILS**
- 2a. Consolidated tails
- 2b. Tailings sand/overburden

**3. AIR**
- 3a. Volatilization
- 3b. Fugitive dust generation

**4. BIOTA**
- 4a. Terrestrial plants
- 4b. Wetland plants
- 4c. Terrestrial soil invertebrates
- 4d. Terrestrial vertebrates
- 4e. Aquatic organisms

Golder Associates

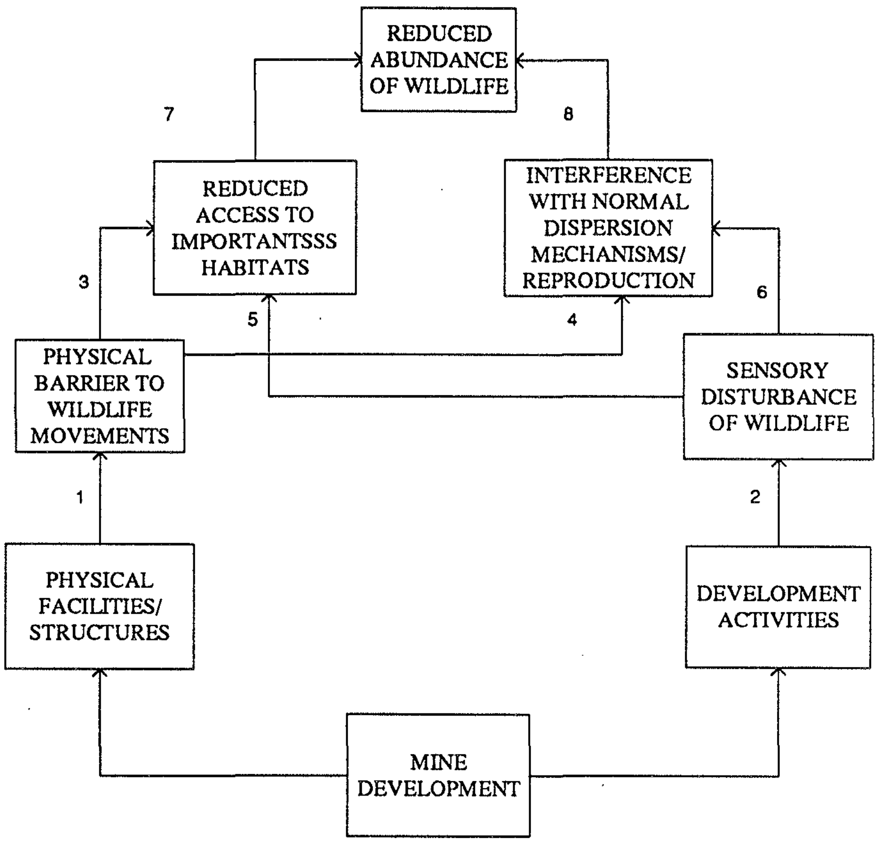



**Figure D4.0-9**
**HYPOTHESIS 21.** Mine development will disrupt the movement patterns of wildlife in the area of the Steepbank mine, thereby reducing access to important habitats or interfering with population mechanisms resulting in decreased abundance of wildlife.

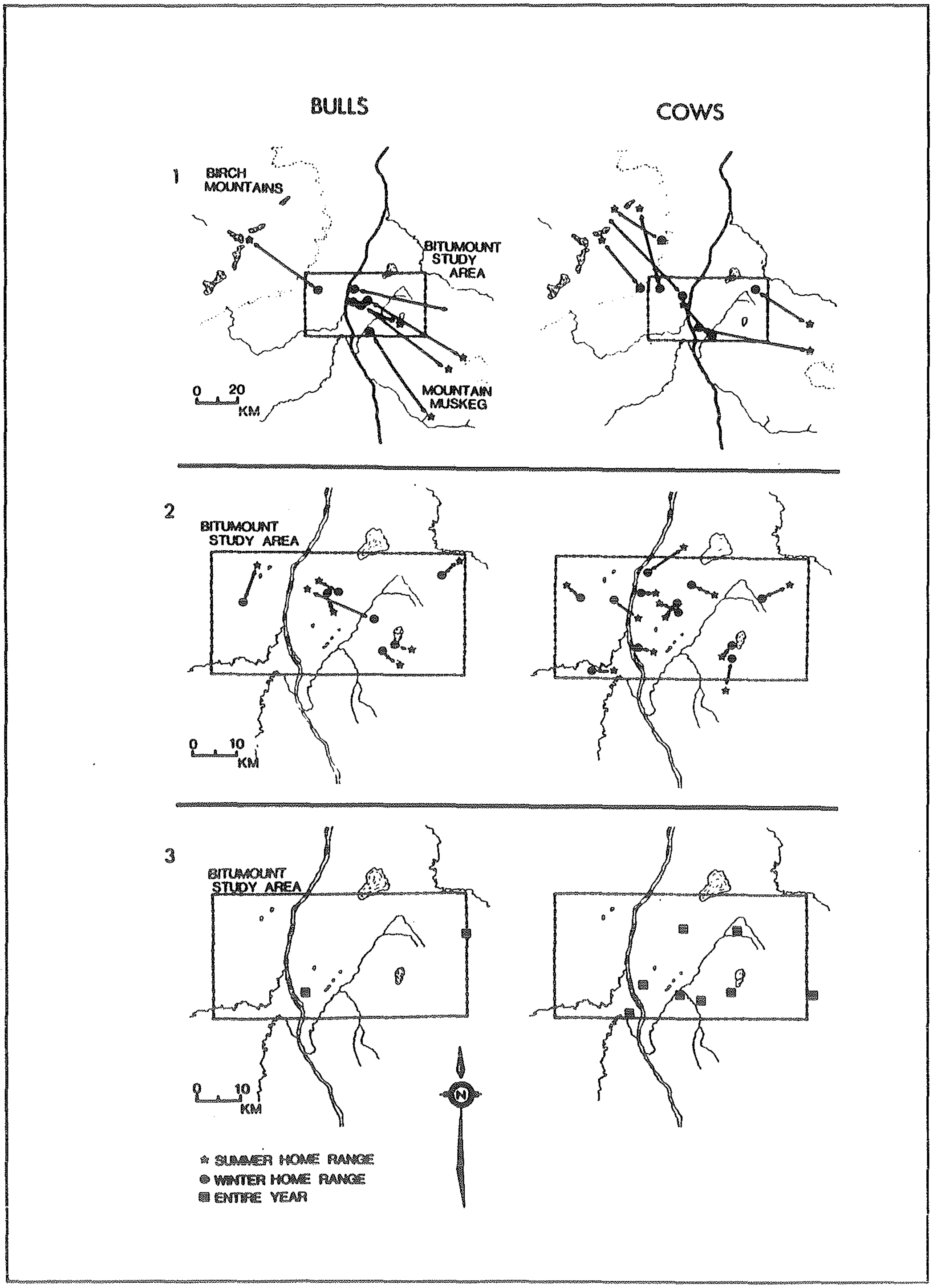



Figure D4.0-10 Seasonal movement patterns of radio-collared moose in the Bitumount area from 1976-1978. Moose exhibited (1) long-range (>20 km), (2) short-range and (3) no seasonal shifts in home range. (from Hauge and Keith 1981).

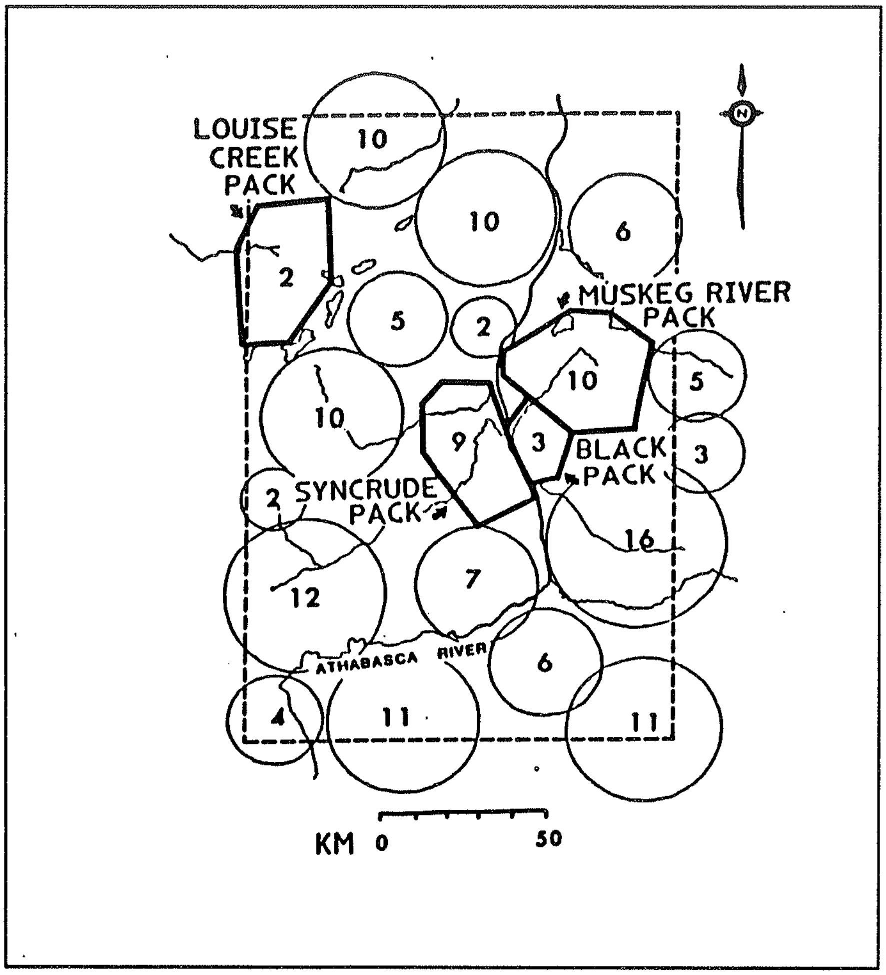



**Figure** D4.0-11 Location and number of wolves in radio-collared and non-radio-collared packs on the 25 000 km² AOSERP study area in winter, 1977-78. (from Fuller and Keith 1980).

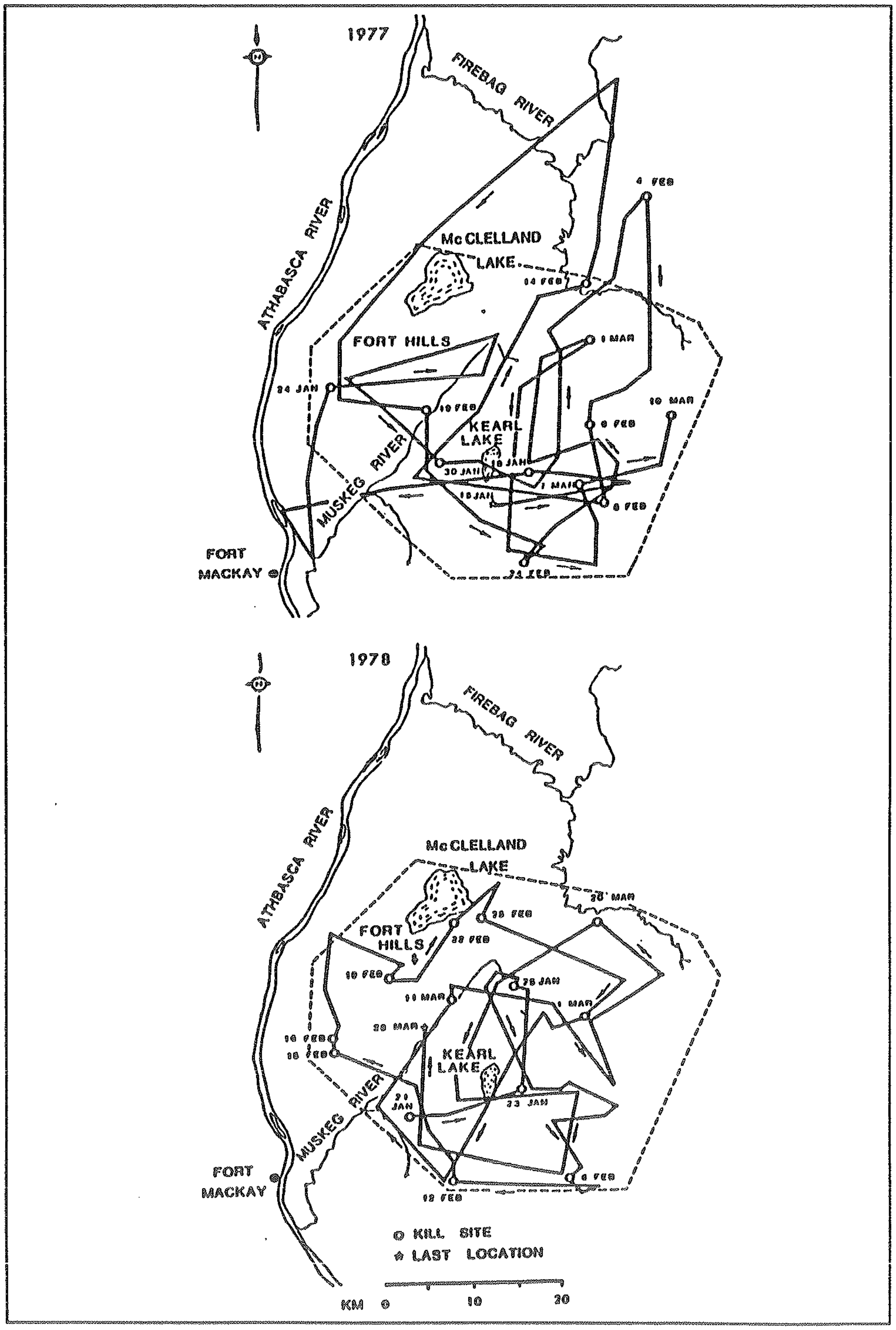



Figure D4.0-12 Daily movements of the Muskeg River wolf pack, 15 January - 10 March 1977 (top) and 21 January - 28 March 1978 (bottom). (from Fuller and Keith 1980)

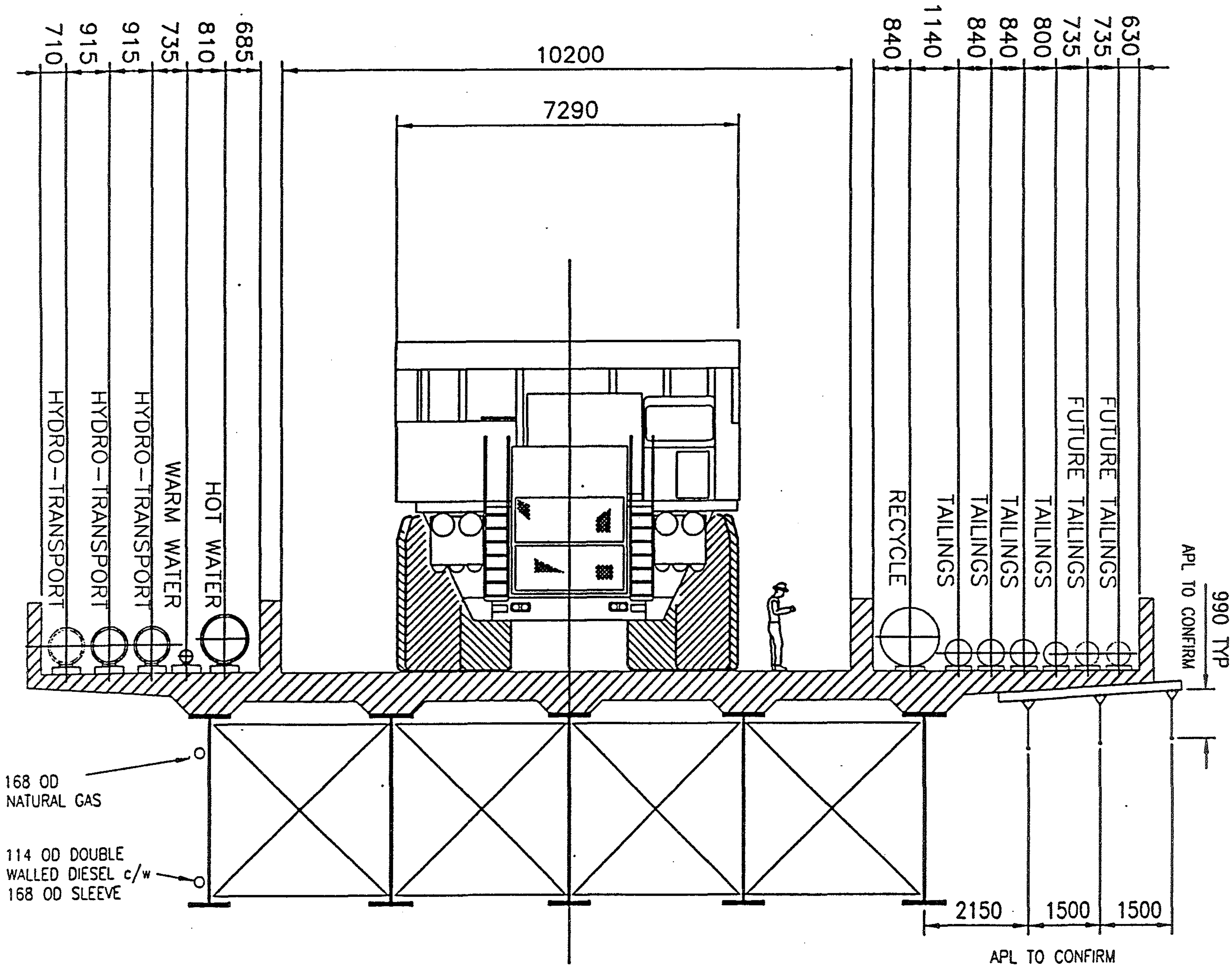



Figure D 4.0-13
BRIDGE DECK SECTION

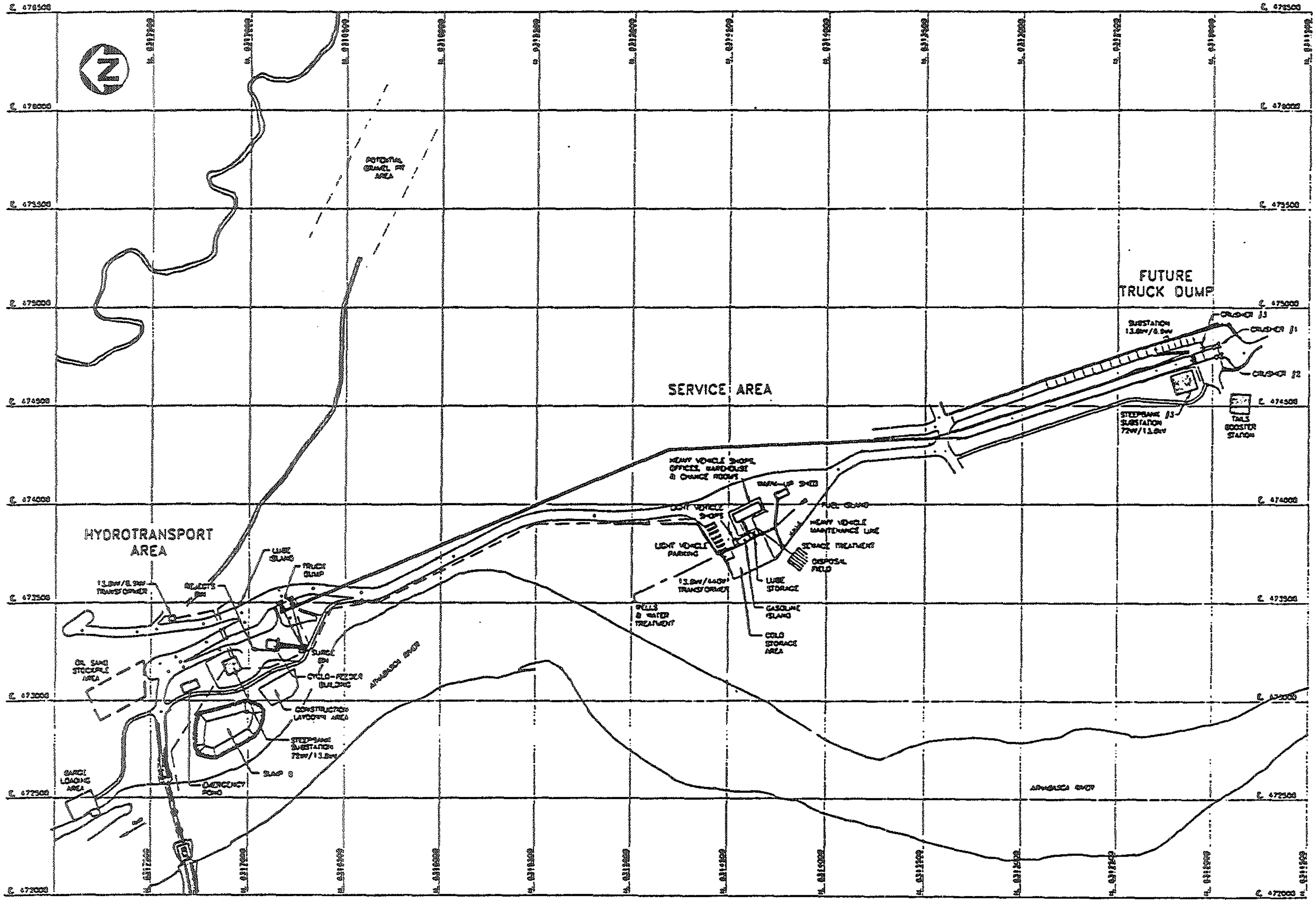
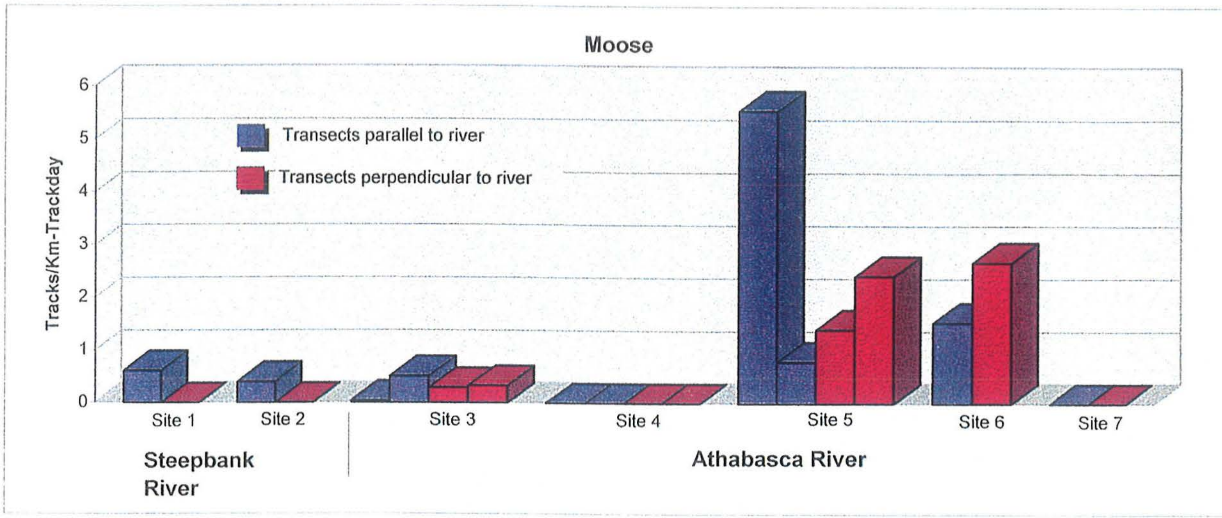
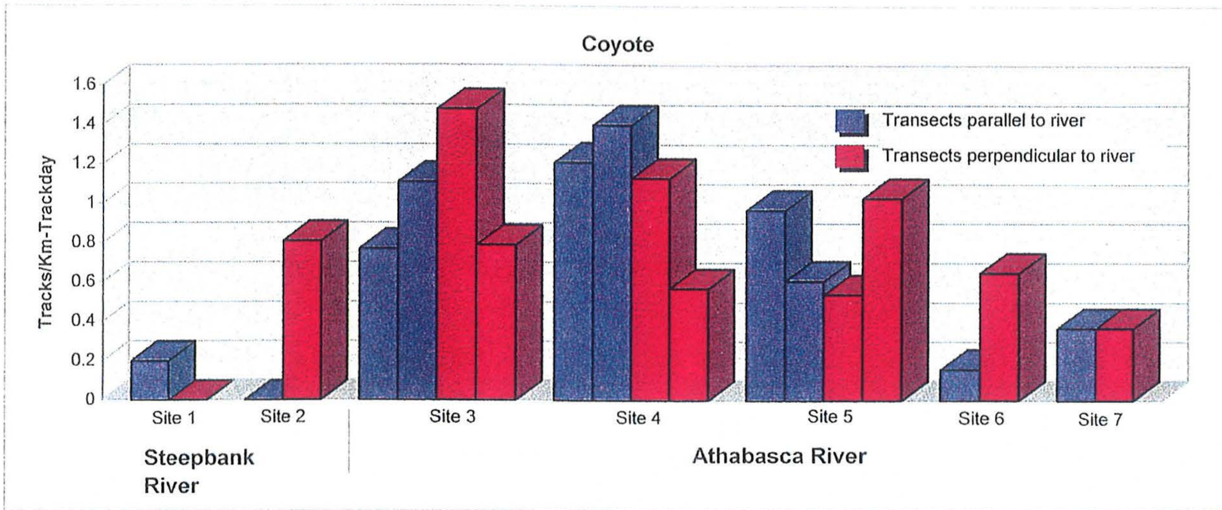



Figure D 4.0-14

STEEPBANK MINE FACILITIES SITE PLAN



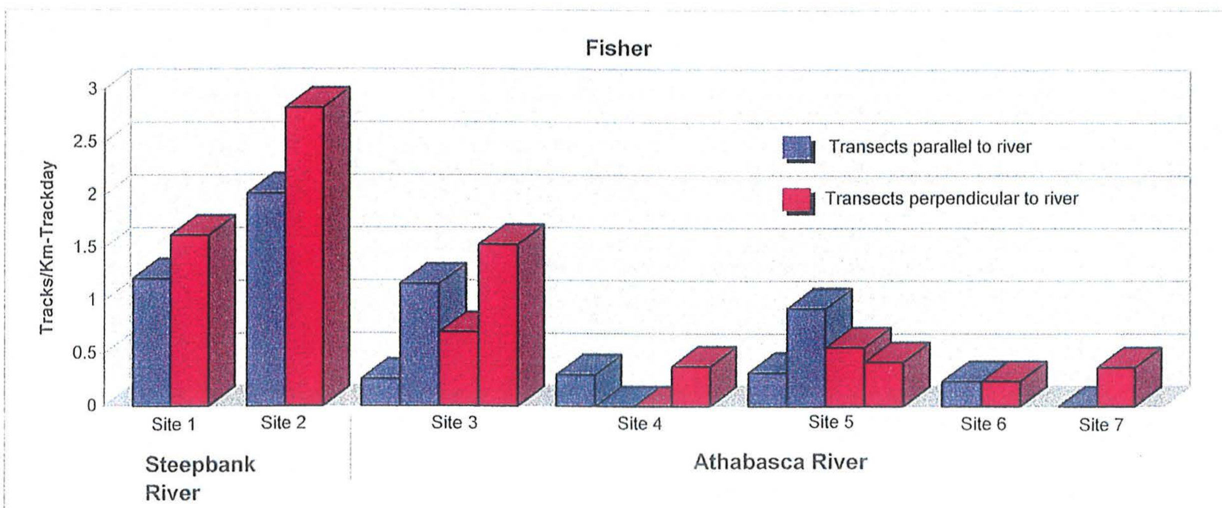




**Figure D4.0-15.** Direction of moose, coyote and fisher movements within the Steepbank River and Athabasca River valleys, February-March, 1996.

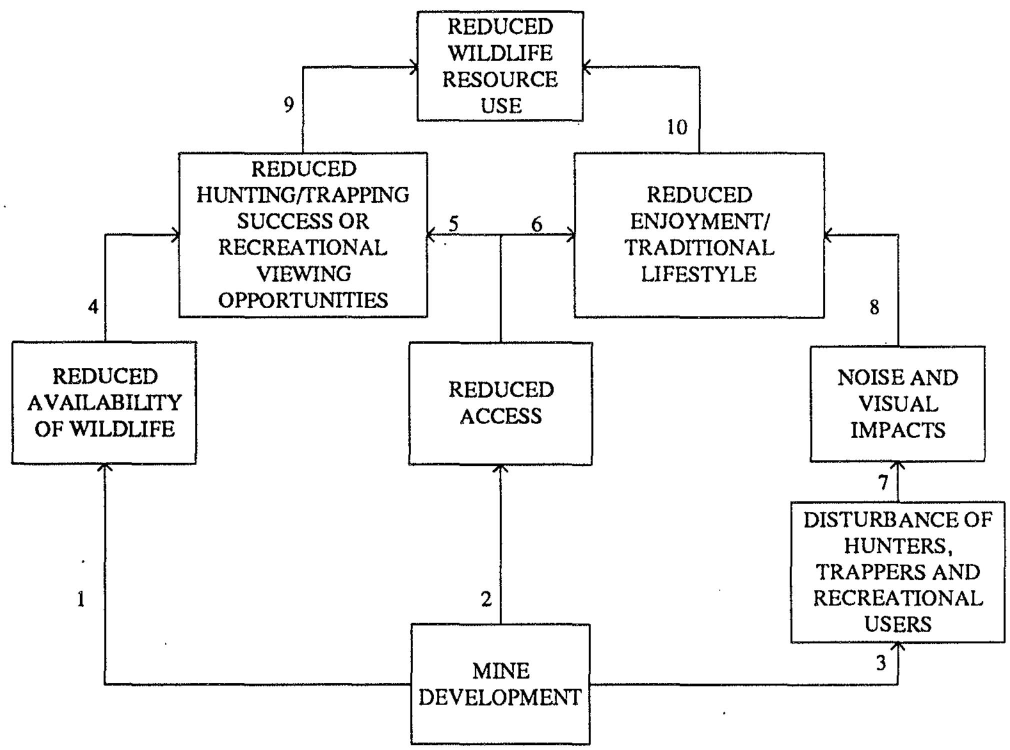



**Figure D4.0-16**
**HYPOTHESIS 22.** Mine development will cause a reduction in wildlife resource use (hunting, trapping, non-consumptive recreational use).

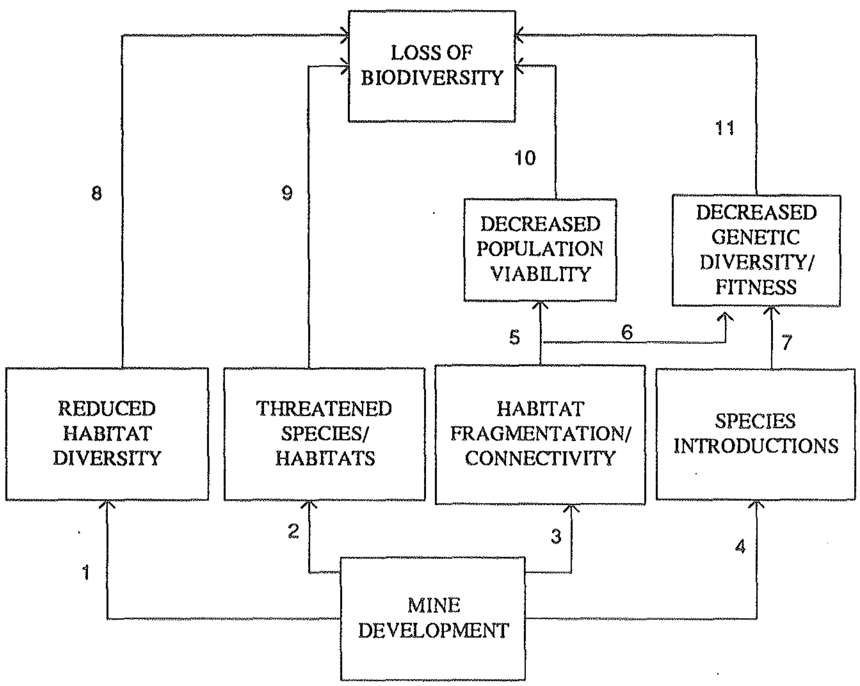



**Figure D4.0-17**
**HYPOTHESIS 23.** Development of the Steepbank Mine will contribute to a loss of natural biodiversity.

# APPENDIX I

# CALCULATIONS OF HABITAT CHANGES DURING MINE ADVANCE

Calculations of wildlife habitat losses and gains were based on net vegetation balances by terrain class developed for the Terrestrial Resources Component of the Steepbank Mine EIA prepared by Golder Associated (Table I-1). For purposes of the wildlife impact assessment, Table I-1 (which was originally comprises of eight terrain and 25 vegetation classes) was recombined into three broad terrain classes (Table I-2). For example, vegetation class areas within the Riparian Floodplain and River Terrace terrain classes were added together to create a single Riparian terrain class. Similarly, vegetation class areas within the Midland, Midland Drainage, Upland and Highland terrain classes were added to create a single Upland terrain class. No changes were made to the Riparian Escarpment terrain class.

In addition to recombining the terrain classes, adjustments to the areal extent of some vegetation types within each terrain class were made to account for habitat alienation associated with facilities and pit areas. Based on this approach, and additional 302 ha associated with facilites construction and 1,121 ha associated with mine operations were subtracted to account for habitat alienation (Table I-3).

Habitat suitability ratings developed for breeding birds, terrestrial furbearers and moose were then assigned to vegetation types within each terrain class (Table I-2). Vegetation types with the same habitat suitability ratings were added together to generate habitat suitability balances (Table I-4) for breeding birds, terrestrial furbearers and moose for the 1995 baseline and three project phases (2001, 2020, and Long-term). Habitat losses and gains were calculated by subtracting the number of ha of each vegetation type for the three project phases from the 1995 Baseline totals (refer to Tables D4.0-1 to D4.0-6).

Table I-1. Suncor ELC terrain/vegetation mine advancement summary for the local study area.

| | | Coverage Area (ha) | | | | |
|---|---|---|---|---|---|---|
| **ELC Terrain Class** | **ELC Vegetation Class** | **1995** | **2001** | **2010** | **2020** | **Longterm** |
| **Riparian Flood Plain** | | 1474 | 1474 | 1474 | 1474 | 1474 |
| | Closed Jack Pine | 26 | 25 | 25 | 25 | 25 |
| | Closed White Spruce | 177 | 177 | 137 | 136 | 136 |
| | Closed Deciduous Forest | 372 | 370 | 351 | 351 | 453 |
| | Closed Mixedwood | | | | | 0 |
| | Closed Mixed Coniferous, Black Spruce Dominant | | | | | |
| | Peatland:Closed Black Spruce Bog | | | | | |
| | Peatland: Black Spruce-Tamarack Fen | | | | | |
| | Closed Mixedwood, White Spruce Dominant | 255 | 252 | 250 | 250 | 250 |
| | Closed Lodgepole Pine (Reclaimed) | | | | | |
| | Peatland: Open Black Spruce Bog | | | | | |
| | Peatland: Open Tamarack Fen | | | | | |
| | Wetland Shrub Complex | 560 | 554 | 521 | 522 | 520 |
| | Disturbed/Herb, Grasses | 1 | 1 | 88 | 89 | 1 |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 41 | 41 | 41 | 41 | 41 |
| | Industrial Open Water | 44 | 43 | 43 | 43 | 43 |
| | Lease 97 Mine Infrastructure (Sparsely-Vegetated) | | 7 | 6 | 6 | |
| | Lease 97 Pit 7/A,B (Sparsely-Vegetated) | | | | | |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Sparsely-Vegetated) | | | | | |
| | Lease 97 Active Mine Area | | | 5 | | |
| | Lease 97 Dyke 11(Sparsely-Vegetated) | | | 1 | | |
| | Lease 97 East Gravel Pit (Sparsely-Vegetated) | | | | | |
| | Lease 97 North Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 South Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 West Overburden Storage (Sparsely-Vegetated) | | | | 6 | |
| | Lease 97 East Overburden Storage (Sparsely-Vegetated) | | | | | |
| | **Subtotal Area** | 1474 | 1469 | 1469 | 1469 | 1470 |
| | **Subtotal Cumulative Rounding & Interpolation Error** | 0 | 5 | 5 | 5 | 4 |
| **Riparian River Terraces** | | 2228 | 2228 | 2228 | 2228 | 2228 |
| | Closed Jack Pine | 130 | 110 | 104 | 104 | 103 |
| | Closed White Spruce | 665 | 646 | 592 | 580 | 578 |
| | Closed Deciduous Forest | 937 | 866 | 710 | 700 | 1057 |
| | Closed Mixedwood | | | | | 21 |
| | Closed Mixed Coniferous, Black Spruce Dominant | | | | | |
| | Peatland:Closed Black Spruce Bog | | | | | |
| | Peatland: Black Spruce-Tamarack Fen | | | | | |
| | Closed Mixedwood, White Spruce Dominant | 308 | 296 | 288 | 287 | 285 |
| | Closed Lodgepole Pine (Reclaimed) | | | | | |
| | Peatland: Open Black Spruce Bog | | | | | |
| | Peatland: Open Tamarack Fen | | | | | |
| | Wetland Shrub Complex | 124 | 122 | 116 | 116 | 116 |
| | Disturbed/Herb, Grasses | 57 | 57 | 151 | 200 | 52 |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 7 | 7 | 7 | 7 | 7 |
| | Industrial Open Water | 1 | 1 | 1 | 1 | 1 |
| | Lease 97 Mine Infrastructure (Sparsely-Vegetated) | | 88 | 135 | 159 | |
| | Lease 97 Pit 7/A,B (Sparsely-Vegetated) | | | 3 | 2 | |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Sparsely-Vegetated) | | | | 40 | |
| | Lease 97 Active Mine Area | | | 38 | | |
| | Lease 97 Dyke 11(Sparsely-Vegetated) | | | 60 | | |
| | Lease 97 East Gravel Pit (Sparsely-Vegetated) | | | | | |
| | Lease 97 North Overburden Storage (Sparsely-Vegetated) | | 28 | 14 | | |
| | Lease 97 South Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 West Overburden Storage (Sparsely-Vegetated) | | | | 17 | 17 |
| | Lease 97 East Overburden Storage (Sparsely-Vegetated) | | | | | |
| | **Subtotal Area** | 2227 | 2219 | 2219 | 2212 | 2236 |
| | **Subtotal Cumulative Rounding & Interpolation Error** | 0 | 9 | 9 | 15 | -9 |
| **Riparian Escarpment** | | 4024 | 4024 | 4024 | 4024 | 4024 |
| | Closed Jack Pine | 465 | 440 | 346 | 325 | 323 |
| | Closed White Spruce | 365 | 363 | 324 | 290 | 289 |
| | Closed Deciduous Forest | 1647 | 1616 | 1350 | 1265 | 1784 |
| | Closed Mixedwood | 63 | 61 | 52 | 50 | 623 |
| | Closed Mixed Coniferous, Black Spruce Dominant | 241 | 225 | 160 | 148 | 147 |
| | Peatland:Closed Black Spruce Bog | 283 | 273 | 228 | 177 | 175 |
| | Peatland: Open Tamarack Fen | 518 | 504 | 371 | 255 | 250 |
| | Closed Mixedwood, White Spruce Dominant | 91 | 90 | 88 | 87 | 110 |
| | Closed Lodgepole Pine (Reclaimed) | | | | | |
| | Peatland: Open Black Spruce Bog | 16 | 15 | 15 | 11 | 11 |
| | Peatland: Black Spruce-Tamarack Fen | 28 | 25 | 25 | 22 | 22 |
| | Wetland Shrub Complex | 192 | 189 | 154 | 149 | 178 |
| | Disturbed/Herb, Grasses | 110 | 110 | 199 | 328 | 73 |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 5 | 5 | 5 | 5 | 5 |
| | Industrial Open Water | 0 | 0 | 0 | 0 | 6 |
| | Lease 97 Mine Infrastructure (Sparsely-Vegetated) | | 22 | 14 | 99 | |
| | Lease 97 Pit 7/A,B (Sparsely-Vegetated) | | | 432 | 436 | |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Sparsely-Vegetated) | | | | 353 | |
| | Lease 97 Active Mine Area | | 45 | 132 | 0 | |
| | Lease 97 Dyke 11(Sparsely-Vegetated) | | | 5 | | |
| | Lease 97 East Gravel Pit (Sparsely-Vegetated) | | 3 | | | |
| | Lease 97 North Overburden Storage (Sparsely-Vegetated) | | 10 | 97 | | |
| | Lease 97 South Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 West Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 East Overburden Storage (Sparsely-Vegetated) | | | | | |
| | **Subtotal Area** | 4023 | 3996 | 3997 | 4000 | 3996 |
| | **Subtotal Cumulative Rounding & Interpolation Error** | 0 | 27 | 26 | 24 | 27 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Midland** | | 5665 | 5665 | 5665 | 5665 | 5665 |
| | Closed Jack Pine | 332 | 331 | 331 | 331 | 331 |
| | Closed White Spruce | 364 | 363 | 363 | 363 | 363 |
| | Closed Deciduous Forest | 946 | 945 | 945 | 945 | 945 |
| | Closed Mixedwood | 141 | 139 | 139 | 139 | 139 |
| | Closed Mixed Coniferous, Black Spruce Dominant | 395 | 394 | 394 | 394 | 394 |
| | Peatland:Closed Black Spruce Bog | 905 | 901 | 901 | 901 | 901 |
| | Peatland: Open Tamarack Fen | 1197 | 1194 | 1194 | 1194 | 1194 |
| | Closed Mixedwood, White Spruce Dominant | 10 | 10 | 10 | 10 | 10 |
| | Closed Lodgepole Pine (Reclaimed) | | | | | |
| | Peatland: Open Black Spruce Bog | 131 | 130 | 130 | 130 | 130 |
| | Peatland: Black Spruce-Tamarack Fen | 94 | 94 | 94 | 94 | 94 |
| | Wetland Shrub Complex | 578 | 575 | 575 | 575 | 575 |
| | Disturbed/Herb, Grasses | 479 | 478 | 478 | 478 | 478 |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 93 | 92 | 92 | 92 | 92 |
| | Wetland Open Water - Emergent Vegetation Zone | | | | | |
| | Lease 97 Mine Infrastructure (Sparsely-Vegetated) | | | | | |
| | Lease 97 Pit 7/A,B (Sparsely-Vegetated) | | | | | |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Sparsely-Vegetated) | | | | | |
| | Lease 97 Active Mine Area | | | | | |
| | Lease 97 Dyke 11(Sparsely-Vegetated) | | | | | |
| | Lease 97 East Gravel Pit (Sparsely-Vegetated) | | | | | |
| | Lease 97 North Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 South Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 West Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 East Overburden Storage (Sparsely-Vegetated) | | | | | |
| | **Subtotal Area** | **5665** | **5645** | **5645** | **5645** | **5645** |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **0** | **21** | **21** | **21** | **21** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Midland Drainage** | | 2700 | 2700 | 2700 | 2700 | 2700 |
| | Closed Jack Pine | 328 | 327 | 327 | 327 | 327 |
| | Closed White Spruce | 165 | 165 | 165 | 165 | 165 |
| | Closed Deciduous Forest | 570 | 569 | 569 | 569 | 569 |
| | Closed Mixedwood | 28 | 28 | 28 | 28 | 28 |
| | Closed Mixed Coniferous, Black Spruce Dominant | 81 | 81 | 81 | 81 | 81 |
| | Peatland:Closed Black Spruce Bog | 57 | 55 | 55 | 55 | 55 |
| | Peatland: Open Tamarack Fen | 341 | 341 | 341 | 341 | 341 |
| | Closed Mixedwood, White Spruce Dominant | 47 | 46 | 46 | 46 | 46 |
| | Closed Lodgepole Pine (Reclaimed) | | | | | |
| | Peatland: Open Black Spruce Bog | | | | | |
| | Peatland: Black Spruce-Tamarack Fen | 53 | 53 | 53 | 53 | 53 |
| | Wetland Shrub Complex | 603 | 599 | 599 | 599 | 599 |
| | Disturbed/Herb, Grasses | 387 | 385 | 385 | 385 | 385 |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 26 | 25 | 25 | 26 | 25 |
| | Industrial Open Water | 16 | 16 | 16 | 16 | 16 |
| | Lease 97 Mine Infrastructure (Sparsely-Vegetated) | | | | | |
| | Lease 97 Pit 7/A,B (Sparsely-Vegetated) | | | | | |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Sparsely-Vegetated) | | | | | |
| | Lease 97 Active Mine Area | | | | | |
| | Lease 97 Dyke 11(Sparsely-Vegetated) | | | | | |
| | Lease 97 East Gravel Pit (Sparsely-Vegetated) | | | | | |
| | Lease 97 North Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 South Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 West Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 East Overburden Storage (Sparsely-Vegetated) | | | | | |
| | **Subtotal Area** | **2700** | **2689** | **2689** | **2689** | **2689** |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **0** | **12** | **12** | **12** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Upland** | | 16792 | 16792 | 16792 | 16792 | 16792 |
| | Closed Jack Pine | 1180 | 1171 | 1151 | 1127 | 1127 |
| | Closed White Spruce | 1363 | 1352 | 1351 | 1340 | 1340 |
| | Closed Deciduous Forest | 1206 | 1179 | 1160 | 1144 | 1243 |
| | Closed Mixedwood | 1721 | 1700 | 1689 | 1676 | 2025 |
| | Closed Mixed Coniferous, Black Spruce Dominant | 723 | 720 | 719 | 705 | 705 |
| | Peatland:Closed Black Spruce Bog | 1490 | 1469 | 1427 | 1299 | 1295 |
| | Peatland: Black Spruce-Tamarack Fen | 1394 | 1388 | 1256 | 832 | 827 |
| | Closed Mixedwood, White Spruce Dominant | 26 | 26 | 25 | 25 | 854 |
| | Closed Lodgepole Pine (Reclaimed) | | | | | |
| | Peatland: Open Black Spruce Bog | 5886 | 5862 | 5727 | 5136 | 5122 |
| | Peatland: Open Tamarack Fen | 1309 | 1303 | 1303 | 1294 | 1294 |
| | Wetland Shrub Complex | 399 | 391 | 388 | 377 | 546 |
| | Disturbed/Herb, Grasses | 91 | 88 | 241 | 838 | 81 |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 3 | 3 | 3 | 3 | 3 |
| | Industrial Open Water | | | | | 229 |
| | Lease 97 Mine Infrastructure (Sparsely-Vegetated) | | 1 | 5 | 112 | |
| | Lease 97 Pit 7/A,B (Sparsely-Vegetated) | | | | 233 | |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Sparsely-Vegetated) | | | 235 | 377 | |
| | Lease 97 Active Mine Area | | | | 163 | |
| | Lease 97 Dyke 11(Sparsely-Vegetated) | | | | | |
| | Lease 97 East Gravel Pit (Sparsely-Vegetated) | | 29 | | | |
| | Lease 97 North Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 South Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 West Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 East Overburden Storage (Sparsely-Vegetated) | | | | | |
| | **Subtotal Area** | **16791** | **16681** | **16680** | **16681** | **16691** |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **1** | **111** | **111** | **111** | **101** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Highland** | | 2030 | 2030 | 2030 | 2030 | 2030 |
| | Closed Jack Pine | 287 | 286 | 286 | 286 | 286 |
| | Closed White Spruce | 334 | 333 | 333 | 333 | 333 |
| | Closed Deciduous Forest | 51 | 51 | 51 | 51 | 51 |
| | Closed Mixedwood | 657 | 655 | 655 | 655 | 655 |
| | Closed Mixed Coniferous, Black Spruce Dominant | 48 | 47 | 47 | 47 | 47 |
| | Peatland:Closed Black Spruce Bog | | | | | |
| | Peatland: Open Tamarack Fen | | | | | |
| | Closed Mixedwood, White Spruce Dominant | | | | | |
| | Closed Lodgepole Pine (Reclaimed) | | | | | |
| | Peatland: Open Black Spruce Bog | | | | | |
| | Peatland: Black Spruce-Tamarack Fen | 612 | 609 | 609 | 609 | 609 |
| | Wetland Shrub Complex | 43 | 43 | 43 | 43 | 43 |
| | Disturbed/Herb, Grasses | | | | | |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | | | | | |
| | Wetland Open Water - Emergent Vegetation Zone | | | | | |
| | Lease 97 Mine Infrastructure (Sparsely-Vegetated) | | | | | |
| | Lease 97 Pit 7/A,B (Sparsely-Vegetated) | | | | | |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Sparsely-Vegetated) | | | | | |
| | Lease 97 Active Mine Area | | | | | |
| | Lease 97 Dyke 11(Sparsely-Vegetated) | | | | | |
| | Lease 97 East Gravel Pit (Sparsely-Vegetated) | | | | | |
| | Lease 97 North Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 South Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 West Overburden Storage (Sparsely-Vegetated) | | | | | |
| | Lease 97 East Overburden Storage (Sparsely-Vegetated) | | | | | |
| | **Subtotal Area** | **2030** | **2024** | **2024** | **2024** | **2024** |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **0** | **6** | **6** | **6** | **6** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Suncor Lease 86/17** | | 3876 | 3876 | 3876 | 3876 | 3876 |
| | Closed Jack Pine | 4 | 4 | 4 | 4 | 4 |
| | Closed White Spruce | | | 20 | 48 | 46 |
| | Closed Deciduous Forest | 31 | 31 | 31 | 65 | 65 |
| | Closed Mixedwood | 2 | 2 | 70 | 386 | 1528 |
| | Closed Mixed Coniferous, Black Spruce Dominant | | | | | |
| | Peatland:Closed Black Spruce Bog | 258 | 255 | 197 | 171 | 170 |
| | Peatland: Black Spruce-Tamarack Fen | 3 | 3 | 3 | 3 | 3 |
| | Closed Mixedwood, White Spruce Dominant | 56 | 56 | 253 | 433 | 1198 |
| | Closed Lodgepole Pine (Reclaimed) | | | | 25 | 25 |
| | Peatland: Open Black Spruce Bog | | | | | |
| | Peatland: Open Tamarack Fen | 1 | 1 | 1 | 1 | 1 |
| | Wetland Shrub Complex | 173 | 164 | 140 | 193 | 301 |
| | Disturbed/Herb, Grasses | 941 | 1206 | 1202 | 1547 | 273 |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 1860 | 1607 | 1504 | 495 | 160 |
| | Industrial Open Water | 546 | 546 | 450 | 504 | 0 |
| | Wetland OpenWater - Emergent | 0 | 0 | 0 | 0 | 101 |
| | **Subtotal Area** | **3875** | **3875** | **3875** | **3875** | **3875** |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **1** | **1** | **1** | **1** | **1** |
| | **Total Area *** | **38785** | **38597** | **38598** | **38594** | **38524** |
| | **Total Cumulative Rounding & Spatial Interpolation Error** | **3** | **191** | **191** | **195** | **163** |

Table I-2. Summary of net vegetation balances by terrain class and habitat suitability ratings for moose, terrestrial furbearers and breeding birds in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | | RATINGS | | |
|---|---|---|---|---|---|---|---|---|
| **ELC Terrain Class** | **ELC Vegetation Class** | **1995** | **2001** | **2020** | **Longterm** | **Birds** | **Furbearers** | **Moose** |
| **Riparian** | | 3701 | 3701 | 3702 | 3701 | | | |
| | Closed Jack Pine * | 156 | 109 | 129 | 128 | G*** | M | P |
| | Closed White Spruce *,** | 843 | 785 | 552 | 714 | E | G | P |
| | Closed Deciduous Forest *,** | 1308 | 1097 | 590 | 1510 | E | E | E |
| | Closed Mixedwood | 0 | 0 | 0 | 21 | M | M | G |
| | Closed Mixed Coniferous, Black Spruce Dominant | 0 | 0 | 0 | 0 | G | E | P |
| | Peatland: Closed Black Spruce Bog | 0 | 0 | 0 | 0 | G | G | P |
| | Peatland: Black Spruce-Tamarack Fen | 0 | 0 | 0 | 0 | G | G | M |
| | Closed Mixedwood, White Spruce Dominant* | 563 | 489 | 537 | 535 | G | G | P |
| | Closed Lodgepole Pine (Reclaimed) | 0 | 0 | 0 | 0 | M | M | M |
| | Peatland: Open Black Spruce Bog | 0 | 0 | 0 | 0 | G | G | P |
| | Peatland: Open Tamarack Fen | 0 | 0 | 0 | 0 | M | G | P |
| | Wetland Shrub Complex*,** | 683 | 635 | 523 | 636 | E | P | M |
| | Disturbed/Herb, Grasses** | 58 | 57 | 288 | 52 | M | G | P |
| | Industrial/Non-Vegetated (Primarily Lease 86/17) | 47 | 47 | 47 | 47 | VP | VP | VP |
| | Industrial Open Water | 44 | 44 | 44 | 44 | VP | VP | VP |
| | Lease 97 Mine Infrastructure (Non-vegetated) | 0 | 95 | 164 | 0 | VP | VP | VP |
| | Lease 97 Pit 7/A,B (Non-vegetated) | 0 | 0 | 2 | 0 | VP | VP | VP |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Non-vegetated) | 0 | 0 | 40 | 0 | VP | VP | VP |
| | Lease 97 Active Mine Area | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 Dyke 11(Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 East Gravel Pit (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 North Overburden Storage (Non-vegetated) | 0 | 28 | 0 | 0 | VP | VP | VP |
| | Lease 97 South Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 West Overburden Storage (Non-vegetated) | 0 | 0 | 23 | 17 | VP | VP | VP |
| | Lease 97 East Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | **Subtotal Area** | **3701** | **3386** | **2940** | **3706** | | | |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **0** | **316** | **761** | **-4** | | | |
| **Escarpment** | | 4024 | 4024 | 4024 | 4024 | | | |
| | Closed Jack Pine | 465 | 440 | 325 | 323 | G | M | P |
| | Closed White Spruce | 365 | 363 | 290 | 289 | E | G | P |
| | Closed Deciduous Forest *,** | 1647 | 1613 | 1265 | 1784 | G | G | E |
| | Closed Mixedwood | 63 | 61 | 50 | 623 | M | M | G |
| | Closed Mixed Coniferous, Black Spruce Dominant | 241 | 225 | 148 | 147 | G | E | P |
| | Peatland: Closed Black Spruce Bog | 283 | 273 | 177 | 175 | G | G | P |
| | Peatland: Black Spruce-Tamarack Fen | 518 | 504 | 255 | 250 | G | G | M |
| | Closed Mixedwood, White Spruce Dominant | 91 | 90 | 87 | 110 | G | G | P |
| | Closed Lodgepole Pine (Reclaimed) | 0 | 0 | 0 | 0 | M | M | M |
| | Peatland: Open Black Spruce Bog | 16 | 15 | 11 | 11 | G | G | P |
| | Peatland: Open Tamarack Fen | 28 | 25 | 22 | 22 | M | G | P |
| | Wetland Shrub Complex | 192 | 189 | 149 | 178 | E | P | M |
| | Disturbed/Herb, Grasses | 110 | 110 | 328 | 73 | M | G | P |
| | Industrial/Non-Vegetated (Primarily Lease 86/17) | 5 | 5 | 5 | 5 | VP | VP | VP |
| | Industrial Open Water | 0 | 0 | 0 | 6 | VP | VP | VP |
| | Lease 97 Mine Infrastructure (Non-vegetated) | 0 | 22 | 99 | 0 | VP | VP | VP |
| | Lease 97 Pit 7/A,B (Non-vegetated) | 0 | 0 | 436 | 0 | VP | VP | VP |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Non-vegetated) | 0 | 0 | 353 | 0 | VP | VP | VP |
| | Lease 97 Active Mine Area | 0 | 45 | 0 | 0 | VP | VP | VP |
| | Lease 97 Dyke 11(Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 East Gravel Pit (Non-vegetated) | 0 | 3 | 0 | 0 | VP | VP | VP |
| | Lease 97 North Overburden Storage (Non-vegetated) | 0 | 10 | 0 | 0 | VP | VP | VP |
| | Lease 97 South Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 West Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 East Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | **Subtotal Area** | **4023** | **3993** | **4000** | **3996** | | | |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **0** | **30** | **24** | **27** | | | |
| **Upland** | | 27188 | 27188 | 27188 | 27188 | | | |
| | Closed Jack Pine ** | 2127 | 2114 | 2042 | 2071 | G | M | P |
| | Closed White Spruce | 2225 | 2212 | 2200 | 2200 | E | G | P |
| | Closed Deciduous Forest *,** | 2772 | 2743 | 2708 | 2807 | G | M | E |
| | Closed Mixedwood** | 2546 | 2522 | 2486 | 2847 | M | M | G |
| | Closed Mixed Coniferous, Black Spruce Dominant** | 1245 | 1241 | 1205 | 1227 | G | E | P |
| | Peatland: Closed Black Spruce Bog ** | 2452 | 2424 | 2234 | 2250 | G | G | P |
| | Peatland: Black Spruce-Tamarack Fen ** | 2932 | 2923 | 2308 | 2362 | G | G | M |
| | Closed Mixedwood, White Spruce Dominant** | 83 | 81 | 26 | 910 | G | G | P |
| | Closed Lodgepole Pine (Reclaimed) | 0 | 0 | 0 | 0 | M | M | P |
| | Peatland: Open Black Spruce Bog ** | 6016 | 5992 | 5086 | 5252 | G | G | P |
| | Peatland Open Tamarack Fen | 2068 | 2059 | 2050 | 2050 | M | G | M |
| | Wetland Shrub Complex | 1623 | 1608 | 1594 | 1763 | E | P | M |
| | Disturbed/Herb, Grasses** | 957 | 951 | 1685 | 944 | M | G | P |
| | Industrial/Non-Vegetated (Primarily Lease 86/17) | 122 | 121 | 121 | 121 | VP | VP | VP |
| | Industrial Open Water | 16 | 16 | 16 | 245 | VP | VP | VP |
| | Lease 97 Mine Infrastructure (Non-vegetated) | 0 | 1 | 112 | 0 | VP | VP | VP |
| | Lease 97 Pit 7/A,B (Non-vegetated) | 0 | 0 | 233 | 0 | VP | VP | VP |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Non-vegetated) | 0 | 0 | 377 | 0 | VP | VP | VP |
| | Lease 97 Active Mine Area | 0 | 0 | 163 | 0 | VP | VP | VP |
| | Lease 97 Dyke 11(Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 East Gravel Pit (Non-vegetated) | 0 | 29 | 0 | 0 | VP | VP | VP |
| | Lease 97 North Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 South Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 West Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | Lease 97 East Overburden Storage (Non-vegetated) | 0 | 0 | 0 | 0 | VP | VP | VP |
| | **Subtotal Area** | **27186** | **27037** | **26646** | **27048** | | | |
| | **Subtotal Cumulative Rounding & Interpolation Error** | **2** | **150** | **541** | **139** | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Suncor Lease 86/17** | | 3876 | 3876 | 3876 | 3876 | | | |
| | Closed Jack Pine | 4 | 4 | 4 | 4 | G | M | P |
| | Closed White Spruce | 0 | 0 | 48 | 46 | E | G | P |
| | Closed Deciduous Forest | 31 | 31 | 65 | 65 | G | M | E |
| | Closed Mixedwood | 2 | 2 | 386 | 1528 | M | M | G |
| | Closed Mixed Coniferous, Black Spruce Dominant | 0 | 0 | 0 | 0 | G | E | P |
| | Peatland:Closed Black Spruce Bog | 258 | 255 | 171 | 170 | G | G | P |
| | Peatland: Black Spruce-Tamarack Fen | 3 | 3 | 3 | 3 | G | G | M |
| | Closed Mixedwood, White Spruce Dominant | 56 | 56 | 433 | 1198 | G | G | P |
| | Closed Lodgepole Pine (Reclaimed) | 0 | 0 | 25 | 25 | M | M | P |
| | Peatland: Open Black Spruce Bog | 0 | 0 | 0 | 0 | G | G | P |
| | Peatland: Open Tamarack Fen | 1 | 1 | 1 | 1 | M | G | M |
| | Wetland Shrub Complex | 173 | 164 | 193 | 301 | E | P | M |
| | Disturbed/Herb, Grasses | 941 | 1206 | 1547 | 273 | M | G | P |
| | Industrial/Sparsely-Vegetated (Primarily Lease 86/17) | 1860 | 1607 | 495 | 160 | VP | VP | VP |
| | Industrial Open Water | 546 | 546 | 504 | 0 | VP | VP | VP |
| | Wetland OpenWater - Emergent | 0 | 0 | 0 | 101 | G | M | M |
| | **Subtotal Area** | 3875 | 3875 | 3875 | 3875 | | | |
| | **Subtotal Cumulative Rounding & Interpolation Error** | 1 | 1 | 1 | 1 | | | |
| | **Total Area** | 38785 | 38292 | 37461 | 38625 | | | |
| | **Total Cumulative Rounding & Spatial Interpolation Error** | 3 | 497 | 1328 | 163 | | | |

Note: All balances include an adjustment in area to account for habitat alienation (250 m width)
* Habitat alienation associated with facilities construction
** Habitat alienation associates with operations
*** E-Excellent, G-Good, M-Moderate, P-Poor, VP-Very Poor

Table I-3. Summary of adjustments to vegetation class areas (ha) to account for habitat alienation during facilities construction and mine operations in the Steepbank Mine study area.

| ELC Terrain Class | ELC Vegetation Class | Area (ha) Construction | Area (ha) Operation |
|---|---|---|---|
| **Riparian** | | | |
| | Closed Jack Pine * | 26 | 0 |
| | Closed White Spruce *,** | 37 | 164 |
| | Closed Deciduous Forest *,** | 139 | 0 |
| | Closed Mixedwood | 0 | 0 |
| | Closed Mixed Coniferous, Black Spruce Dominant | 0 | 0 |
| | Peatland: Closed Black Spruce Bog | 0 | 0 |
| | Peatland: Black Spruce-Tamarack Fen | 0 | 0 |
| | Closed Mixedwood, White Spruce Dominant* | 59 | 0 |
| | Closed Lodgepole Pine (Reclaimed) | 0 | 0 |
| | Peatland: Open Black Spruce Bog | 0 | 0 |
| | Peatland: Open Tamarack Fen | 0 | 0 |
| | Wetland Shrub Complex*,** | 41 | 116 |
| | Disturbed/Herb, Grasses** | 0 | 1 |
| | Industrial/Non-Vegetated (Primarily Lease 86/17) | 0 | 0 |
| | Industrial Open Water | 0 | 0 |
| | Lease 97 Mine Infrastructure (Non-vegetated) | 0 | 0 |
| | Lease 97 Pit 7/A,B (Non-vegetated) | 0 | 0 |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Non-vegetated) | 0 | 0 |
| | Lease 97 Active Mine Area | 0 | 0 |
| | Lease 97 Dyke 11(Non-vegetated) | 0 | 0 |
| | Lease 97 East Gravel Pit (Non-vegetated) | 0 | 0 |
| | Lease 97 North Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 South Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 West Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 East Overburden Storage (Non-vegetated) | 0 | 0 |
| | **Subtotal Area** | **302** | **281** |
| **Escarpment** | | | |
| | Closed Jack Pine | 0 | 0 |
| | Closed White Spruce | 0 | 0 |
| | Closed Deciduous Forest *,** | 3 | 461 |
| | Closed Mixedwood | 0 | 0 |
| | Closed Mixed Coniferous, Black Spruce Dominant | 0 | 0 |
| | Peatland: Closed Black Spruce Bog | 0 | 0 |
| | Peatland: Black Spruce-Tamarack Fen | 0 | 0 |
| | Closed Mixedwood, White Spruce Dominant | 0 | 0 |
| | Closed Lodgepole Pine (Reclaimed) | 0 | 0 |
| | Peatland: Open Black Spruce Bog | 0 | 0 |
| | Peatland: Open Tamarack Fen | 0 | 0 |
| | Wetland Shrub Complex | 0 | 0 |
| | Disturbed/Herb, Grasses | 0 | 0 |
| | Industrial/Non-Vegetated (Primarily Lease 86/17) | 0 | 0 |
| | Industrial Open Water | 0 | 0 |
| | Lease 97 Mine Infrastructure (Non-vegetated) | 0 | 0 |
| | Lease 97 Pit 7/A,B (Non-vegetated) | 0 | 0 |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Non-vegetated) | 0 | 0 |
| | Lease 97 Active Mine Area | 0 | 0 |
| | Lease 97 Dyke 11(Non-vegetated) | 0 | 0 |
| | Lease 97 East Gravel Pit (Non-vegetated) | 0 | 0 |
| | Lease 97 North Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 South Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 West Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 East Overburden Storage (Non-vegetated) | 0 | 0 |
| | **Subtotal Area** | **3** | **461** |
| **Upland** | | | |
| | Closed Jack Pine ** | 0 | 29 |
| | Closed White Spruce | 0 | 0 |
| | Closed Deciduous Forest *,** | 0 | 0 |
| | Closed Mixedwood** | 0 | 12 |
| | Closed Mixed Coniferous, Black Spruce Dominant** | 0 | 21 |
| | Peatland: Closed Black Spruce Bog ** | 0 | 20 |
| | Peatland: Black Spruce-Tamarack Fen ** | 0 | 58 |
| | Closed Mixedwood, White Spruce Dominant** | 0 | 55 |
| | Closed Lodgepole Pine (Reclaimed) | 0 | 0 |
| | Peatland: Open Black Spruce Bog ** | 0 | 180 |
| | Peatland Open Tamarack Fen | 0 | 0 |
| | Wetland Shrub Complex | 0 | 0 |
| | Disturbed/Herb, Grasses** | 0 | 15 |
| | Industrial/Non-Vegetated (Primarily Lease 86/17) | 0 | 0 |
| | Industrial Open Water | 0 | 0 |
| | Lease 97 Mine Infrastructure (Non-vegetated) | 0 | 0 |
| | Lease 97 Pit 7/A,B (Non-vegetated) | 0 | 0 |
| | Lease 97 Pit 8/A,B, Dyke 11B, Dyke 12 (Non-vegetated) | 0 | 0 |
| | Lease 97 Active Mine Area | 0 | 0 |
| | Lease 97 Dyke 11(Non-vegetated) | 0 | 0 |
| | Lease 97 East Gravel Pit (Non-vegetated) | 0 | 0 |
| | Lease 97 North Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 South Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 West Overburden Storage (Non-vegetated) | 0 | 0 |
| | Lease 97 East Overburden Storage (Non-vegetated) | 0 | 0 |
| | **Subtotal Area** | **0** | **390** |
| **TOTAL HABITAT AREA ALIENATED** | | **305** | **1132** |

Table I-4. Habitat suitability balances for breeding birds in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| **ELC Terrain Class** | **Suitability Classes** | **1995** | **2001** | **2020** | **Longterm** |
| **Riparian** | | 3701 | 3701 | 3702 | 3701 |
| | Class 1 - Excellent | 2834 | 2517 | 1665 | 2860 |
| | Class 2 - Good | 718 | 598 | 667 | 664 |
| | Class 3 - Moderate | 58 | 57 | 288 | 73 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 91 | 213 | 321 | 108 |
| | **Subtotal Area** | **3701** | **3386** | **2940** | **3706** |
| **Escarpment** | | 4024 | 4024 | 4024 | 4024 |
| | Class 1 - Excellent | 557 | 552 | 440 | 467 |
| | Class 2 - Good | 3261 | 3160 | 2267 | 2800 |
| | Class 3 - Moderate | 201 | 196 | 399 | 718 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 5 | 84 | 893 | 11 |
| | **Subtotal Area** | **4023** | **3993** | **4000** | **3996** |
| **Upland** | | 27188 | 27188 | 27188 | 27188 |
| | Class 1 - Excellent | 3848 | 3821 | 3794 | 3963 |
| | Class 2 - Good | 17628 | 17518 | 15609 | 16878 |
| | Class 3 - Moderate | 5571 | 5532 | 6221 | 5841 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 139 | 166 | 1022 | 366 |
| | **Subtotal Area** | **27186** | **27037** | **26646** | **27048** |
| **Suncor Leases 86/17** | | 3876 | 3876 | 3876 | 3876 |
| | Class 1 - Excellent | 173 | 164 | 241 | 347 |
| | Class 2 - Good | 352 | 349 | 676 | 1541 |
| | Class 3 - Moderate | 944 | 1209 | 1959 | 1827 |
| | Class 4 - Poor | 0 | 0 | 0 | 0 |
| | Class 5 - Very Poor | 2406 | 2153 | 999 | 160 |
| | **Subtotal Area** | **3875** | **3875** | **3875** | **3875** |

Habitat suitability balances for terrestrial furbearers in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| **ELC Terrain Class** | **Suitability Classes** | **1995** | **2001** | **2020** | **Longterm** |
| **Riparian** | | 3701 | 3701 | 3702 | 3701 |
| | Class 1 - Excellent | 1308 | 1097 | 590 | 1510 |
| | Class 2 - Good | 1463 | 1331 | 1377 | 1302 |
| | Class 3 - Moderate | 156 | 109 | 129 | 149 |
| | Class 4 - Poor | 683 | 635 | 523 | 636 |
| | Class 5 - Very Poor | 91 | 213 | 321 | 108 |
| | **Subtotal Area** | **3701** | **3386** | **2940** | **3706** |
| **Escarpment** | | 4024 | 4024 | 4024 | 4024 |
| | Class 1 - Excellent | 241 | 225 | 148 | 147 |
| | Class 2 - Good | 3058 | 2994 | 2435 | 2714 |
| | Class 3 - Moderate | 528 | 501 | 374 | 946 |
| | Class 4 - Poor | 192 | 189 | 149 | 178 |
| | Class 5 - Very Poor | 5 | 84 | 893 | 11 |
| | **Subtotal Area** | **4023** | **3993** | **4000** | **3996** |
| **Upland** | | 27188 | 27188 | 27188 | 27188 |
| | Class 1 - Excellent | 1245 | 1241 | 1205 | 1227 |
| | Class 2 - Good | 16734 | 16642 | 15589 | 15968 |
| | Class 3 - Moderate | 7445 | 7379 | 7236 | 7725 |
| | Class 4 - Poor | 1623 | 1608 | 1594 | 1763 |
| | Class 5 - Very Poor | 139 | 166 | 1022 | 366 |
| | **Subtotal Area** | **27186** | **27037** | **26646** | **27048** |
| **Suncor Leases 86/17** | | 3876 | 3876 | 3876 | 3876 |
| | Class 1 - Excellent | 0 | 0 | 0 | 0 |
| | Class 2 - Good | 1259 | 1521 | 2203 | 1691 |
| | Class 3 - Moderate | 37 | 37 | 480 | 1723 |
| | Class 4 - Poor | 173 | 164 | 193 | 301 |
| | Class 5 - Very Poor | 2406 | 2153 | 999 | 160 |
| | **Subtotal Area** | **3875** | **3875** | **3875** | **3875** |

Habitat suitability balances for moose in the Steepbank Mine study area.

| | | Coverage Area (ha) | | | |
|---|---|---|---|---|---|
| **ELC Terrain Class** | **Suitability Classes** | **1995** | **2001** | **2020** | **Longterm** |
| **Riparian** | | 3701 | 3701 | 3702 | 3701 |
| | Class 1 - Excellent | 1308 | 1097 | 590 | 1510 |
| | Class 2 - Good | 0 | 0 | 0 | 21 |
| | Class 3 - Moderate | 683 | 635 | 523 | 636 |
| | Class 4 - Poor | 1618 | 1440 | 1507 | 1430 |
| | Class 5 - Very Poor | 91 | 213 | 321 | 108 |
| | **Subtotal Area** | **3701** | **3386** | **2940** | **3706** |
| **Escarpment** | | 4024 | 4024 | 4024 | 4024 |
| | Class 1 - Excellent | 1647 | 1613 | 1265 | 1784 |
| | Class 2 - Good | 63 | 61 | 50 | 623 |
| | Class 3 - Moderate | 709 | 693 | 404 | 428 |
| | Class 4 - Poor | 1599 | 1542 | 1387 | 1150 |
| | Class 5 - Very Poor | 5 | 84 | 893 | 11 |
| | **Subtotal Area** | **4023** | **3993** | **4000** | **3996** |
| **Upland** | | 27188 | 27188 | 27188 | 27188 |
| | Class 1 - Excellent | 2772 | 2743 | 2708 | 2807 |
| | Class 2 - Good | 2546 | 2522 | 2486 | 2847 |
| | Class 3 - Moderate | 6623 | 6590 | 5952 | 6175 |
| | Class 4 - Poor | 15105 | 15016 | 14478 | 14854 |
| | Class 5 - Very Poor | 139 | 166 | 1022 | 366 |
| | **Subtotal Area** | **27186** | **27037** | **26646** | **27048** |
| **Suncor Leases 86/17** | | 3876 | 3876 | 3876 | 3876 |
| | Class 1 - Excellent | 31 | 31 | 65 | 65 |
| | Class 2 - Good | 2 | 2 | 386 | 1528 |
| | Class 3 - Moderate | 177 | 168 | 197 | 406 |
| | Class 4 - Poor | 1259 | 1521 | 2228 | 1716 |
| | Class 5 - Very Poor | 2406 | 2153 | 999 | 160 |
| | **Subtotal Area** | **3875** | **3875** | **3875** | **3875** |

# APPENDIX II

# IMPACT RATINGS

Figure II-1

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Moose**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | V | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | M | L | NA |
| | *Duration* | M | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | + | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | L | NA | NA |

Figure II-1 cont'd

HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio

VALUED ECOSYSTEM COMPONENT: Black Bear

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | I | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | + | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | L | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Wolf**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | V | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | M | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Snowshoe Hare**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | I | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Red-backed Vole**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | V | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-1 cont'd

HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio

VALUED ECOSYSTEM COMPONENT: Lynx

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | I | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L-M | NA | NA |
| | *Duration* | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L-M | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Fisher**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | V | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | I | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | - | 0 | 0 |
| Severity | L | NA | NA |
| Duration | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | - | - | 0 |
| Severity | L-M | L | NA |
| Duration | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | 0 | 0 | 0 |
| Severity | NA | NA | NA |
| Duration | NA | NA | NA |

FigureII-1 cont'd

HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio

VALUED ECOSYSTEM COMPONENT: Marten

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | V |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | V |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | I | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | V |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | - | 0 |
| | Severity | L-M | L | NA |
| | Duration | L | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | + | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | L | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Wolverine**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | U | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | U | U | U |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | - | 0 |
| | Severity | O-L | O-L | NA |
| | Duration | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | - | 0 |
| | Severity | 0-L | 0-L | NA |
| | Duration | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

Figure II-1 cont'd

HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio

VALUED ECOSYSTEM COMPONENT: Beaver

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | I | I | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | V | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | I | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | + | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | L | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: River Otter**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | I | I | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | U | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | U | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | U | U | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | 0-L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Bald Eagle**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | I | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | 0-M | 0-L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | 0-M | 0-L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Great Gray Owl**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | I | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | U | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | V |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | 0-L | NA | NA |
| | *Duration* | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | 0-L | 0-L | NA |
| | *Duration* | L | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | 0-L | 0-L | NA |
| | *Duration* | L | L | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Ruffed Grouse**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | I | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | 0 |
| *Severity* | L | NA | NA |
| *Duration* | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | 0 |
| *Severity* | L-M | NA | NA |
| *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | + | 0 | 0 |
| *Severity* | L | NA | NA |
| *Duration* | L | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Songbirds**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | V | V | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | V | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | M | NA | NA |
| | Duration | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

Figure II-1 cont'd

**HYPOTHESIS 18: Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populatio**

**VALUED ECOSYSTEM COMPONENT: Waterfowl**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Construction of access roads, bridges, plant facilities, utilities, and other facilities will result in loss or alienation of wildlife habitat. | I | I | I |
| 2. Site clearing, overburden stripping, waste disposal and other activities associated with mining operations will result in loss or alienation of wildlife habitat. | I | V | I |
| 3. Drainage alteration resulting from mine dewatering and stream diversions will result in loss of wetland habitat or changes in community structure and composition. | I | V | I |
| 4. Emissions resulting from mining and fixed plant operations will result in changes in community structure and composition or will affect the quality of wildlife habitats. | I | I | I |
| 5. Loss or alienation of habitat resulting from mine development will result in reduced abundance of wildlife. | I | V | I |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | - | 0 |
| | Severity | L | L | NA |
| | Duration | M | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

Figure II-2

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Moose**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | V | V | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | V | V | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | V | V | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | V | V | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | V | V | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | V | V | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | V | V | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | V | V | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | V | V | I |
| 12. Decreased reproduction will result in lowered population abundance. | V | V | I |
| | | | |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | 0 |
| *Severity* | L | NA | NA |
| *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | 0 |
| *Severity* | L | NA | NA |
| *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | 0 | 0 | 0 |
| *Severity* | NA | NA | NA |
| *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Black Bear**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | V | V | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | I | I | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | I | I | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | I | I | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | I | I | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | I | I | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | I | I | I |
| 12. Decreased reproduction will result in lowered population abundance. | V | V | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Wolf**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | V | V | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | V | V | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | V | V | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | V | V | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | V | V | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | V | V | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | V | V | I |
| 12. Decreased reproduction will result in lowered population abundance. | V | V | I |
| | | | |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L-M | L | NA |
| | *Duration* | S | S | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L-M | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | O | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Snowshoe Hare**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | I | I | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | I | I | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | I | I | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | I | I | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | I | I | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | I | I | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | I | I | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | I | I | I |
| 12. Decreased reproduction will result in lowered population abundance. | I | I | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Red-backed Vole**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | I | I | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | I | I | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | I | I | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | I | I | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | I | I | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | I | I | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | I | I | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | I | I | I |
| 12. Decreased reproduction will result in lowered population abundance. | I | I | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Lynx**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | V | V | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | V | V | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | U | U | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | U | U | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | U | U | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | U | U | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | V | V | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L-M | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L-M | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Fisher**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | U | U | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | U | U | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | U | U | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | U | U | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | U | U | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | U | U | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | U | U | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | U | U | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | U | 0 | 0 |
| *Severity* | U | NA | NA |
| *Duration* | U | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | U | 0 | 0 |
| *Severity* | U | NA | NA |
| *Duration* | U | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | 0 | 0 | 0 |
| *Severity* | NA | NA | NA |
| *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Marten**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | U | U | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | U | U | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | U | U | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | U | U | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | U | U | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | U | U | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | U | U | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | U | U | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | U | U | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | U | U | I |
| | | | |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | U | 0 | 0 |
| | Severity | U | NA | NA |
| | Duration | U | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | U | 0 | 0 |
| | Severity | U | NA | NA |
| | Duration | U | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Wolverine**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | U | U | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | V | V | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | U | U | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | I | I | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | I | I | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | I | I | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | U | U | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | 0-L | NA | NA |
| | Duration | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | - | 0 |
| | Severity | 0-M | 0-L | NA |
| | Duration | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Beaver**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | I | I | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | I | I | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | I | I | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | I | I | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | I | I | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | I | I | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | I | I | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | I | I | I |
| 12. Decreased reproduction will result in lowered population abundance. | I | I | I |
| | | | |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | O | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-6

**HYPOTHESIS 23: Development of the Steepbank Mine will contribute to a loss of natural biodiversity.**

**VALUED ECOSYSTEM COMPONENT: Biodiversity**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Mine development will reduce the diversity of habitat types in the study region. | V | V | V |
| 2. Mine development will have an adverse effect on rare, threatened or endangered species or habitats in the study region. | V | V | V |
| 3. Mine development will result in fragmentation or loss of connectivity between habitats in the study region. | V | V | I |
| 4. Mine development will result in the introduction of non-native species. | I | I | I |
| 5. Increased habitat fragmentation or loss of connectivity between habitats will threaten the viability of certain wildlife species in the study region. | I | I | I |
| 6. Increased habitat fragmentation or loss of connectivity between habitats will result in reduced genetic diversity or genetic fitness of wildlife populations. | V | V | I |
| 7. Introduction of non-native species will reduce the genetic diversity or genetic fitness of native species. | I | I | I |
| 8. Reduced habitat diversity caused by Steepbank Mine development will result in an overall loss of regional biodiversity. | V | V | V |
| 9. Adverse impacts on rare, threatened or endangered species or habitats will result in an overall loss of regional biodiversity. | V | V | V |
| 10. Decreases in population viability caused by Steepbank Mine development will result in an overall loss of regional biodiversity. | I | I | I |
| 11. Decreases in genetic diversity or genetic fitness caused by Steepbank Mine development will result in an overall loss of regional biodiversity. | I | I | I |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | 0 |
| *Severity* | L | NA | NA |
| *Duration* | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | - | 0 |
| *Severity* | L-M | L | L |
| *Duration* | L | L | L |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | - |
| *Severity* | 0-L | NA | L |
| *Duration* | L | NA | L |

Figure II-5

**HYPOTHESIS 22: Mine development will cause a reduction in wildlife resource use.**

**VALUED ECOSYSTEM COMPONENT: Wildlife Resource Use**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Mine development will result in loss of habitat for species of commercial, domestic, or recreational importance. | V | V | I |
| 2. Noise and human activity will cause behavioural disturbance of wildlife. | V | V | I |
| 3. Noise and other disturbances associated with mine development and operation will cause disturbance to hunters, trappers, and recreational users. | I | I | I |
| 4. Habitat loss resulting from mine development will reduce the availability of wildlife to hunters, trappers, and recreational users. | V | V | I |
| 5. Behavioural disturbance of wildlife will cause range abandonment, reduced survival, or changes in reproductive success that will affect the availability of wildlife. | V | V | I |
| 6. Mine development will result in reduced access to the land base for hunters, trappers, and recreational users.. | V | V | I |
| 7. Noise, dust, and visual impairment will cause disturbance to hunters, trappers, and recreational users. | V | V | I |
| 8. Changes in the availability of wildlife will affect hunting and trapping success. | I | I | I |
| 9. Reduced access to hunting and trapping areas will affect hunting and trapping success. | V | V | I |
| 10. Reduced access will affect the enjoyment or satisfaction of wildlife resource users and traditional lifestyles. | V | V | I |
| 11. Noise and visual impacts will affect the enjoyment or satisfaction of wildlife resource users and traditional lifestyles. | V | V | I |
| 12. Reduced hunting and trapping success will cause reductions in wildlife resource use. | V | V | I |
| 13. Reduced enjoyment will result in reduced wildlife resource use and loss of traditional lifestyles. | V | V | I |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | H | L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | H | L | NA |
| | *Duration* | M | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-4 cont'd

**HYPOTHESIS 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.**

**VALUED ECOSYSTEM COMPONENT: Wolverine**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area. | V | V | I |
| 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements. | V | V | I |
| 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources. | U | U | I |
| 4. Obstruction of movements due to the presence of physical facilities and sturctures will disrupt dispersal, reproductive activity, or other processes important in population regulation. | I | I | I |
| 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources. | U | U | I |
| 6. Sensory disturbance of wildlife will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation. | I | I | I |
| 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife. | U | U | I |
| 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced wildlife abundance. | I | I | I |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-4 cont'd

**HYPOTHESIS 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.**

**VALUED ECOSYSTEM COMPONENT: Marten**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area. | V | V | I |
| 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements. | U | U | I |
| 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources. | I | V | I |
| 4. Obstruction of movements due to the presence of physical facilities and sturctures will disrupt dispersal, reproductive activity, or other processes important in population regulation. | I | V | I |
| 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources. | U | U | I |
| 6. Sensory disturbance of wildlife will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation. | U | U | I |
| 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife. | I | I | I |
| 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced wildlife abundance. | U | U | I |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | L | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | L | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-4 cont'd

**HYPOTHESIS 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.**

**VALUED ECOSYSTEM COMPONENT: Fisher**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area. | V | V | I |
| 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements. | U | U | I |
| 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources. | I | V | I |
| 4. Obstruction of movements due to the presence of physical facilities and sturctures will disrupt dispersal, reproductive activity, or other processes important in population regulation. | I | V | I |
| 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources. | U | U | I |
| 6. Sensory disturbance of wildlife will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation. | U | U | I |
| 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife. | I | I | I |
| 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced wildlife abundance. | I | V | I |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | M | L | NA |
| | *Duration* | L | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | L | NA | NA |

Figure II-4 cont'd

**HYPOTHESIS 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.**

**VALUED ECOSYSTEM COMPONENT: Lynx**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area. | V | V | I |
| 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements. | V | V | I |
| 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources. | V | V | I |
| 4. Obstruction of movements due to the presence of physical facilities and sturctures will disrupt dispersal, reproductive activity, or other processes important in population regulation. | I | V | I |
| 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources. | V | V | I |
| 6. Sensory disturbance of wildlife will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation. | V | V | I |
| 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife. | V | V | I |
| 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced wildlife abundance. | I | V | I |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | M | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-4 cont'd

**HYPOTHESIS 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.**

**VALUED ECOSYSTEM COMPONENT: Wolf**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area. | V | V | I |
| 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements. | V | V | I |
| 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources. | V | V | I |
| 4. Obstruction of movements due to the presence of physical facilities and sturctures will disrupt dispersal, reproductive activity, or other processes important in population regulation. | I | I | I |
| 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources. | V | V | I |
| 6. Sensory disturbance of wildlife will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation. | I | I | I |
| 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife. | V | V | I |
| 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced wildlife abundance. | I | I | I |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | - | 0 |
| *Severity* | M | L | NA |
| *Duration* | S | S | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | - | 0 |
| *Severity* | M | L | NA |
| *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | 0 | 0 | 0 |
| *Severity* | NA | NA | NA |
| *Duration* | NA | NA | NA |

Figure II-4 cont'd

**HYPOTHESIS 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.**

**VALUED ECOSYSTEM COMPONENT: Black Bear**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area. | V | V | I |
| 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements. | I | I | I |
| 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources. | V | V | I |
| 4. Obstruction of movements due to the presence of physical facilities and sturctures will disrupt dispersal, reproductive activity, or other processes important in population regulation. | I | I | I |
| 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources. | I | I | I |
| 6. Sensory disturbance of wildlife will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation. | I | I | I |
| 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife. | I | V | I |
| 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced wildlife abundance. | I | I | I |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-4

**HYPOTHESIS 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.**

**VALUED ECOSYSTEM COMPONENT: Moose**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. The presence of physical facilities or structures will obstruct the movements of wildlife in the project area. | V | V | I |
| 2. Noise and human activity associated with various mine development activities will cause sensory disturbance of wildlife, which will affect wildlife movements. | V | V | I |
| 3. Obstruction of movements due to the presence of various physical facilities and structures will result in reduced access to important habitat or critical resources. | V | V | I |
| 4. Obstruction of movements due to the presence of physical facilities and sturctures will disrupt dispersal, reproductive activity, or other processes important in population regulation. | I | I | I |
| 5. Sensory disturbance of wildlife due to various development activities will result in reduced access to important habitat or critical resources. | V | V | I |
| 6. Sensory disturbance of wildlife will disrupt normal dispersal mechanisms, reproductive activity or other processes important in population regulation. | I | I | I |
| 7. Reduced access to important habitat or critical resources will result in reduced abundance of wildlife. | V | V | I |
| 8. Interference with normal dispersal mechanisms, reproductive activity or other processes important in population regulation will result in reduced wildlife abundance. | I | I | I |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | L | L | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | M | L | NA |
| | *Duration* | L | L | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Waterfowl**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | I | I | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Ruffed Grouse**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Raptors (Bald Eagle, Great Gray Owl)**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | V | V | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | - | 0 | 0 |
| Severity | L | NA | NA |
| Duration | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | - | 0 | 0 |
| Severity | L | NA | NA |
| Duration | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | 0 | 0 | 0 |
| Severity | NA | NA | NA |
| Duration | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: River Otter**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | I | I | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | V | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Beaver**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | V | V | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | I | I | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | V | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Marten and Fisher**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | I | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | - | 0 | 0 |
| | Severity | L | NA | NA |
| | Duration | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Lynx and Wolverine**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | I | I | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | I | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | - | 0 | 0 |
| Severity | L | NA | NA |
| Duration | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | - | 0 | 0 |
| Severity | L | NA | NA |
| Duration | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | 0 | 0 | 0 |
| Severity | NA | NA | NA |
| Duration | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Red-backed Vole & Snowshoe Hare**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | I | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | 0 |
| *Severity* | L | NA | NA |
| *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | 0 | 0 |
| *Severity* | L | NA | NA |
| *Duration* | S | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | 0 | 0 | 0 |
| *Severity* | NA | NA | NA |
| *Duration* | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Wolf**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | I | I | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | I | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | - | 0 |
| *Severity* | L | L | NA |
| *Duration* | S | S | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | - | - | 0 |
| *Severity* | L | L | NA |
| *Duration* | M | S | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | 0 | 0 | 0 |
| *Severity* | NA | NA | NA |
| *Duration* | NA | NA | NA |

Figure II-3 cont'd

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Black Bear**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | V | V | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | V | V | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | I | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | S | S | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-3

**HYPOTHESIS 20: Direct mortality of wildlife caused by mine development will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Moose**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Clearing, construction and other activities involving removal or damage to natural habitats will result in direct mortality of wildlife. | I | I | I |
| 2. Removal of nuisance or problem wildlife will result in reduced abundance of wildlife. | I | I | I |
| 3. Increased vehicular traffic associated with mine development will result in increased mortality of wildlife. | V | V | I |
| 4. Increased levels of hunting, trapping, and poaching due to increased accessibility will result in reduced populations of wildlife. | I | I | I |
| 5. Establishment of tailings ponds, transmission lines and other environmental hazards will result in direct mortality and reduced populations of wildlife. | I | I | I |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | S | S | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | - | 0 |
| | *Severity* | L | L | NA |
| | *Duration* | M | M | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Bald Eagle**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | V | V | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | V | V | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | V | V | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | I | I | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | V | V | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | I | I | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | V | V | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: River Otter**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | U | U | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | U | U | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | U | U | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | U | U | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | U | U | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | U | U | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | U | U | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | U | U | I |
| | | | |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | U | 0 | 0 |
| Severity | U | NA | NA |
| Duration | U | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | U | 0 | 0 |
| Severity | U | NA | NA |
| Duration | U | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | Local | Regional | Beyond Region |
|---|---|---|---|
| Direction | 0 | 0 | 0 |
| Severity | NA | NA | NA |
| Duration | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Waterfowl**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | V | V | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | I | I | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | V | V | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | I | I | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | I | I | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | I | I | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | V | V | I |
| 12. Decreased reproduction will result in lowered population abundance. | V | V | I |
| | | | |

* V - Hypothesis is valid

I - Hypothesis is invalid

U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Songbirds**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | V | V | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | U | U | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | V | V | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | V | V | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | V | V | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | V | V | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | V | V | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | V | V | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | V | V | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | U | U | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | S | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | - | 0 | 0 |
| | *Severity* | L | NA | NA |
| | *Duration* | M | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|---|
| | *Direction* | 0 | 0 | 0 |
| | *Severity* | NA | NA | NA |
| | *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Ruffed Grouse**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | U | U | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | U | U | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | U | U | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | U | U | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | U | U | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | U | U | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | U | U | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | U | U | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | U | U | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | U | U | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | U | 0 | 0 |
| *Severity* | U | NA | NA |
| *Duration* | U | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | U | 0 | 0 |
| *Severity* | U | NA | NA |
| *Duration* | U | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | *Local* | *Regional* | *Beyond Region* |
|---|---|---|---|
| *Direction* | 0 | 0 | 0 |
| *Severity* | NA | NA | NA |
| *Duration* | NA | NA | NA |

Figure II-2 cont'd

**HYPOTHESIS 19: Disturbance associated with mechanical noise and human activity will result in reduced abundance of wildlife.**

**VALUED ECOSYSTEM COMPONENT: Great Gray Owl**

| Linkages/Testable Hypotheses | Construction | Operation | Closure |
|---|---|---|---|
| 1. Noise and sensory disturbance associated with facility construction and mining operations will result in sensory disturbance of wildlife. | U | U | I |
| 2. Noise and sensory disturbance associated with increased human activity and vehicular traffic will result in sensory disturbance of wildlife. | I | I | I |
| 3. Sensory disturbance will result in decreased reproduction. | U | U | I |
| 4. Sensory disturbance of wildlife will result in avoidance or decreased use of traditionally used habitats. | U | U | I |
| 5. Sensory disturbance of wildlife will result in increased energy expenditure or stress. | U | U | I |
| 6. Avoidance of traditionally used habitats will result in overuse and deterioration of remaining ranges. | U | U | I |
| 7. Avoidance of traditionally used habitats will result in increased predation. | I | I | I |
| 8. Avoidance of traditionally used habitats will result in increased energy expenditure and reduced food availability. | U | U | I |
| 9. Overuse of remaining habitats will result in reduced carrying capacity and reduced abundance of wildlife. | U | U | I |
| 10. Increased predation of animals displaced from preferred habitats will result in reduced abundance of wildlife. | I | I | I |
| 11. Increased energy expenditure will affect productivity or survival, resulting in reduced abundance of wildlife. | U | U | I |
| 12. Decreased reproduction will result in lowered population abundance. | U | U | I |
| | | | |

* V - Hypothesis is valid
I - Hypothesis is invalid
U - Insufficient information to evaluate validity of hypothesis

**CONSTRUCTION PHASE (1997-2000)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | U | 0 | 0 |
| | Severity | U | NA | NA |
| | Duration | U | NA | NA |

**OPERATIONAL PHASE (2000-2020)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | U | 0 | 0 |
| | Severity | U | NA | NA |
| | Duration | U | NA | NA |

**CLOSURE(Long-term)**
**Geographic Extent**

| Impact Criteria | | Local | Regional | Beyond Region |
|---|---|---|---|---|
| | Direction | 0 | 0 | 0 |
| | Severity | NA | NA | NA |
| | Duration | NA | NA | NA |