APPENDIX 3.7

Wildlife Modelling

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1.0 HABITAT SUITABILITY MODELS

1.1 Introduction

The Joint Review Panel (JRP) Supplemental Information Requests (SIRs) for the Jackpine Mine Expansion (JME) dated January 30, 2012 included, among others, the following requests:

- an updated Environmental Impact Assessment (EIA) Application Case, excluding the Pierre River Mine (PRM), for specific Key Indicator Resources (KIRs; JRP SIR 8);
- information on pre-industrial conditions to allow the JRP to take into account effects that may have already been experienced prior to JME (JRP SIR 11); and
- an updated EIA Planned Development Case (PDC) based on planned projects disclosed as of September 2011 (JRP SIR 11).

To address these requests, the EIA Base Case, EIA Application Case and EIA PDC wildlife model predictions were updated. The EIA Base Case and EIA PDC wildlife model predictions were updated to be current to September 2011, and are referred to as the 2012 Base Case and 2012 PDC, respectively. The EIA Base Case information was updated to allow a reasonable comparison between assessment cases. The EIA Application Case was updated to remove PRM. This updated EIA Application Case is referred to as the 2012 JME Application Case. The results of these updated assessments are included in this submission, as follows:

- Appendix 1 of this submission presents the 2012 JME Application Case assessment for specific KIRs requested by JRP SIR 8, which includes a wildlife assessment that compares 2012 Base Case and 2012 JME Application Case predictions.
- Appendix 2 of this submission presents the 2012 Pre-Industrial Case (PIC) and Planned Development Case (PDC) assessment requested by JRP SIR 11. The PIC section discusses 2012 Base Case predictions. The 2012 PDC assessment includes a wildlife assessment that compares the 2012 JME Application Case and 2012 PDC predictions.

This appendix provides technical information on updated wildlife model results supporting the updated wildlife assessment information presented in Appendices 1 and 2 of this submission. The information in this appendix replaces the corresponding information in the EIA, Volume 5, Appendix 5-4. Habitat Suitability (HS) models quantify the measurable habitat preferences of wildlife and have been used extensively to predict the potential impacts of habitat alteration (Marzluff et al. 2002). These models facilitate an assessment that applies technology, scientific knowledge and available data for producing scientifically defensible, site-specific estimates of effects to wildlife habitat. Predictive output from HS models are used to inform the assessment of direct and indirect effects to wildlife habitat due to the JME, along with existing, approved, and planned developments.

1.2 Assessment Methods

Habitat modelling was conducted for all wildlife Key Indicator Resources (KIRs) and federally listed wildlife Species At Risk (SAR) likely to occur in the Local Study Area (LSA) (Table 1.2-1). The structure of the HS models used was detailed in the EIA, Volume 5, Appendix 5-4, Section 1.2 for wildlife KIRs and in the *May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Federally Listed Species at Risk Assessment, Appendix B. In addition, habitat modelling was conducted for wood bison and woodland caribou in accordance with JRP SIR 21. However, wood bison and woodland caribou are not likely to occur in the LSA, and are therefore unlikely to be affected by JME. Wood bison do not occur east of the Athabasca River, and woodland caribou are virtually absent from the LSA. The structure of the wood bison HS model was detailed in the wildlife SAR assessment as described in the *May 2011, Submission of Information to the Joint Review Panel* (Appendix 2, Federally Listed Species at Risk Assessment, Appendix B), and the woodland caribou HS model structure is detailed below in Section 1.2.1.

Table 1.2-1 Wildlife Key Indicator Resources and Federally Listed Species At Risk That May Be Affected By Habitat Loss in the Local Study Area

Common Name	COSEWIC[a]	SARA[a]	Alberta Provincial Status[b]
barred owl	not listed	not listed	Sensitive
beaver	not listed	not listed	Secure
black bear	Not At Risk	not listed	Secure
black-throated green warbler	not listed	not listed	Sensitive
Canada lynx	Not At Risk	not listed	Sensitive
Canadian toad	Not At Risk	not listed	May be at risk
fisher	not listed	not listed	Sensitive
moose	not listed	not listed	Secure
Canada warbler	Threatened	Schedule 1: Threatened	Sensitive
common nighthawk	Threatened	Schedule 1, Threatened	Sensitive
horned grebe	Special Concern	No Schedule, No Status	Sensitive
olive-sided flycatcher	Threatened	Schedule 1: Threatened	May Be At Risk
rusty blackbird	Special Concern	Schedule 1: Special Concern	Sensitive
short-eared owl	Special Concern	Schedule 3: Special Concern	May be at risk
western (boreal) toad	Special Concern	Schedule 1: Special Concern	Sensitive
wolverine (western population)	Special Concern	No Schedule: No Status	May be at risk
yellow rail	Special Concern	Schedule 1: Special Concern	Undetermined

(a) Species At Risk Public Registry 2011.

(b) ASRD 2011.

Forest stands at closure are considered to be 80 years old (December 2007 Jackpine Mine Expansion, Volume 5, Section 7.2.3 and *May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Federally Listed Species at Risk Assessment, Appendix B). Eighty years represents the estimated time required for the development of mature forest on the reclaimed landscape, and is a more appropriate time frame upon which to compare vegetation, wildlife and biodiversity values in the reclaimed landscape against the EIA Base Case values (EIA, Volume 5, Section 7.2.3). However, this represents a change from the EIA (EIA, Volume 5, Section 7.2.3) for habitat suitability modelling, in which stand ages of original wildlife KIRs were assigned using mine progression diagrams to represent stand ages at the point in time at which closure occurs (i.e., 2070), and therefore resulted in closure landscape much younger than that used for habitat suitability modelling here. The assumptions regarding stand age at closure were changed from those used in the EIA because mature forest stands at closure represent a more appropriate time frame for the assessment of long-term JME effects. Robust ecological communities and processes will take time to develop on the closure landscape. This approach is also consistent with assumptions underlying the vegetation and biodiversity assessments.

1.2.1 Woodland Caribou Habitat Suitability Index Model

The woodland caribou Habitat Suitability Index (HSI) model was created by Golder Associates Ltd. (Golder) specifically for populations that inhabit northeastern Alberta (Suncor 2000). The model was developed with reference to studies of woodland caribou behaviour and existing caribou models from other areas. The final model structure reflects the outcome of a review of the woodland caribou model conducted by Golder and Mr. Robert Anderson of Applied Ecosystem Management Ltd. (Anderson 2001, pers. comm.).

Woodland caribou are not likely to occur in the JME LSA and would typically be excluded from an assessment of this location. This modelling has been conducted to meet the requirements of JRP SIR 21.

1.2.1.1 Habitat Requirements

Within the boreal region of Alberta, winter habitat selection by woodland caribou is strongly associated with peatland habitats (Anderson 1999; Bradshaw et al. 1995; Edmonds and Bloomfield 1984; Fuller and Keith 1981; Stuart-Smith et al. 1997). Habitat selection is hierarchical (Johnson 1980) and woodland caribou may select habitats at a number of spatial scales (Anderson 1999; Bradshaw et al. 1995; Dyer et al. 1999; Stuart-Smith et al. 1997). As a result, a multi-scale assessment of habitat suitability is recommended to provide a better understanding of woodland caribou ecology (Anderson 1999).

On a regional scale, woodland caribou may select home ranges that encompass large peatland complexes to reduce their risk of predation (Anderson 2001, pers. comm.; Bergerud et al. 1984). Predation is an important limiting factor for woodland caribou populations (Dyer et al. 2001; Dzus 2001; Fuller and Keith 1981; Stuart-Smith et al. 1997). Woodland caribou avoid predators by separating themselves spatially from other ungulate prey (Bergerud et al. 1984; James 1999; Stuart-Smith et al. 1997). Calf survival is higher in landscapes with larger fens, a lower proportion of uplands, and landscapes that have the capability to support larger home ranges (Stuart-Smith et al. 1997). As a result, upland areas considered suitable habitat for ungulates such as moose are not considered suitable habitat for woodland caribou due to the higher concentrations of predators in upland habitats, while wetlands complexes provide refuge from predators (Latham 2009; Stuart-Smith et al. 1997). The majority of upland habitat use tends to be in patches found within large peatland complexes (Schneider et al. 2000).

An assessment of habitat suitability should include the identification of large peatland complexes on a regional scale. Within their home range, a finer scale of habitat selection may occur based on the availability of forage (Anderson 2001, pers. comm.). In the boreal region of Alberta, woodland caribou exhibit seasonal shifts in their diet. The most important winter food source for woodland caribou are terrestrial lichens (Edmonds and Bloomfield 1984; Fuller and Keith 1981; Manitoba Model Forest 1995), which are mostly found in peatlands, in particular treed fens and bogs (Anderson 1999; Beckingham and Archibald 1996). Preferred forage species include *Cladina* species, such as *C. mitis*, *C. uncialus and C. rangiferina; Centraria islandica* and *Stereocaulon* spp. (Manitoba Model Forest 1995). *Cladina* species were most commonly found in snow craters dug by woodland caribou in northeastern Alberta (Bradshaw et al. 1995). In years of high snow accumulation or when snow crust makes it difficult for caribou to access terrestrial lichens, there may be greater use of arboreal lichens (e.g., *Usnea* species, *Evernia mesomorpha*, *Alectoria* spp., *Bryoria trichoides*) (Manitoba Model Forest 1995; Simpson et al. 1985).

Other food sources that are more frequently consumed in spring and summer are: sedges, cotton-grass, fungi, grasses, ericaceous shrubs (e.g., Labrador tea, blueberry, bearberry), twinflower, mosses and woody browse (e.g., willows, birch and aspen). Knowledge of the relative importance of these forage species in the spring and summer seasons is limited (Anderson 2001, pers. comm.).

Woodland caribou are considered sensitive to numerous forms of human disturbances (Bradshaw et al. 1995). These disturbances include any activities generating loud noise (e.g., blasting, heavy equipment operation, traffic, airstrip use), activities that alter habitat (e.g., road development, logging, well pad construction, linear corridor clearing, human-caused fires, loss of lichens as a result of atmospheric pollution) and activities that directly interfere with woodland caribou (e.g., human access to wilderness areas, especially on all-terrain vehicles [ATVs] and snowmobiles, vehicle collisions, hunting, peat harvest operations) (Magnusson and Wasel 1999; Manitoba Model Forest 1995). Habitat alteration or fragmentation may also affect woodland caribou by creating suitable conditions for moose and deer. Healthy moose and deer populations attract and support a greater number of predators (e.g., wolves, black bear), which may result in increased woodland caribou predation and possible population decline (Latham et al. 2011).

In northeastern Alberta, Dyer et al. (1999) found that woodland caribou in open coniferous wetlands (i.e., peatland) used areas adjacent to roads less than other areas during all time periods (i.e., late winter, calving, summer and rut). The maximum avoidance distance for roads that was statistically significant was 250 m. Road avoidance was generally less when woodland caribou were in closed coniferous forest that provided effective security cover (Dyer et al. 1999).

Woodland caribou also avoided habitat within 250 to 1,000 m of new well sites. Avoidance of well sites was generally greatest during late winter when human activity was highest and during calving when female woodland caribou are most sensitive to disturbance. Dyer et al. (1999) reported that woodland caribou temporarily avoided industrial developments until related activities stopped. Bradshaw et al. (1995) also noted that noise disturbance led to increased rates of movement of woodland caribou, but not complete displacement. Overall, development activities may result in habitat avoidance, lower habitat productivity or direct mortality of woodland caribou.

1.2.1.2 Model Development

Assumptions

The assumptions for the woodland caribou HSI model are that:

- woodland caribou habitat selection is largely affected by two factors: predation risk and forage availability;
- woodland caribou select areas of predominantly peatland habitat (i.e., bogs and fens) to avoid predation risk on a regional scale;
- woodland caribou select peatlands and some upland habitats (e.g., pine-dominant stands) on a local scale that provide suitable opportunities to forage on terrestrial lichens, the main winter food source for woodland caribou;
- woodland caribou avoid areas with a high density of human use; and
- woodland caribou use habitat adjacent to roads, oil and gas developments, and forestry operations less than expected by chance.

Habitat Effectiveness

Wildlife species may reduce their use of habitat adjacent to areas of human activity. These indirect effects are related to sensory disturbance and reduce the effectiveness of habitat in supporting wildlife needs. Effects that result from sensory disturbance are greater if the adjacent habitat is of high quality and if the total supply of habitat in the area is limiting.

The approach used in estimating the amount of habitat affected by sensory disturbance (i.e., habitat effectiveness) was to create a displacement model that assumes disturbance Zones of Influence (ZOI) and Disturbance Coefficients (DC). A ZOI is the maximum distance to which a disturbance (e.g., traffic noise) influences wildlife use of habitat. The DC is the effectiveness of the habitat within the ZOI in fulfilling the requirements of a particular species. For example, a habitat with a DC of 0.9 represents 90% habitat effectiveness. Different ZOI and DC are applied for each KIR and each human activity type.

For most wildlife species, data on the degree of habitat avoidance due to sensory disturbance are limited. As a result, most displacement models rely heavily on professional judgement when quantifying the degree of sensory disturbance a development produces and how it affects the behaviour of a given species. Research on woodland caribou has provided some indication of the degree to which woodland caribou reduce their use of habitats adjacent to human development (Dyer 1999; Table 1.2-2).

Table 1.2-2 Mean Woodland Caribou Use of Habitat Within the Zones of Influence Surrounding Industrial Developments

Type of Development	Zone of Influence [m]	Effectiveness of Habitat Use[a] (percentage of expected use)
roads[b]	0 to 100	3.65 (late winter) to 33.93 (summer)
	100 to 250	22.7 (summer) to 25.18 (calving)
	250 to 500	31.55 (summer) to 57.52 (calving)
facilities (new wellpads)	0 to 250	45.31 (late winter) to 117.84 (summer)
	250 to 500	70.57 (calving) to 108.15 (late winter)
seismic lines[c]	0 to 100	47.64 (calving) to 75.66 (rut)
	100 to 250	85.43 (late winter) to 113.78 (calving)

(a) Summarized from Dyer (1999).

(b) These figures are related to woodland caribou use of road development buffers in open conifer forest.

(c) There is no distinction between seismic lines with different levels of human activity.

These research results were used to derive DC and ZOI for woodland caribou (Table 1.2-3). As disturbance avoidance patterns vary between seasons, professional judgment was used to interpret the results of Dyer (1999) to select disturbance coefficients. Also, although Dyer et al. (1999) did not find statistically significant avoidance of areas beyond 250 m from roads, professional judgment was used to interpret results and infer that reduced habitat use may occur out to 1,000 m. Selection of DCs and representing avoidance out to 1,000 m was done to be a conservative interpretation of Dyer's (1999) results and to contribute to a more conservative EIA.

Table 1.2-3 Woodland Caribou Zones of Influence and Disturbance Coefficients by Disturbance Type

KIR	Disturbance Type					
	Roads		Facilities and Developments[b]		Utility Corridors[c]	
	ZOI	DC[a]	ZOI	DC	ZOI	DC
woodland caribou	100	0.0	250[b]	0.5	100[c]	0.5
	250	0.25	>250	1.0	>100	1.0
	500	0.50	n/a	n/a	n/a	n/a
	1,000	0.75	n/a	n/a	n/a	n/a
	>1,000	1.0	n/a	n/a	n/a	n/a

[a] DCs are roughly based on the mean woodland caribou use of ZOI presented as a percentage of expected use (Dyer 1999).

[b] Value based on woodland caribou avoidance of new wellpads.

[c] Value based on woodland caribou avoidance of seismic lines (applied to power lines, pipelines and seismic lines).

n/a = Not applicable.

Research completed by Dyer (1999) is limited in terms of providing a distinction between different types of linear disturbance features, (i.e., roads, utility corridors, seismic lines), and the relative influence of these types on wildlife use of habitat. In particular, Dyer (1999) was not able to determine relative use or avoidance of habitat adjacent to seismic lines with different levels of human activity. Factors such as the type, season and intensity of human use will affect woodland caribou use of habitat adjacent to these and other linear disturbance features. Despite these limitations, Dyer's (1999) research provides the best indication to date of woodland caribou behaviour in response to human disturbance.

Regional Component to Habitat Suitability Index

Peatland Area

Regional level habitat selection by woodland caribou involves selection of areas with a high coverage of peatlands. Schneider et al. (2000) assessed woodland caribou habitat on a regional scale by applying a digital version of the *Peatland Inventory of Alberta* (Vitt et al. 1997). Schneider et al. (2000) used this inventory to determine the habitat composition of ecodistricts across the Province of Alberta. Ecodistricts are landscape units delineated based on similar geology, landforms and vegetation characteristics. Based on an assessment of 11,000 telemetry locations, Schneider et al. (2000) concluded that areas with greater than 50% uplands were not considered suitable habitat for woodland caribou.

The previous woodland caribou HSI model (Suncor 2000) assessed regional habitat suitability using township blocks as landscape units. Townships, however, do not represent ecologically meaningful boundaries for caribou. Ecodistricts, as originally delineated by Strong (1992), were modified based on the regional vegetation classes derived from satellite imagery and surficial geology maps (Bayrock 1969, 1970; Bayrock and Reimchen 1973).

The habitat composition of ecodistricts within the Regional Study Area (RSA) was assessed to determine the relative proportion of peatlands available for woodland caribou. The area of peatlands within each ecodistrict was then used to rank the habitat at the landscape scale and determine SI(1), which ranges from 0.0 to 1.0 (Figure 1.2-1). Based on research conducted by Schneider et al. (2000), areas with greater than 50% peatland were considered highly suitable habitat for woodland caribou (SI(1) = 1.0). The minimum peatland patch size or habitat configuration that will support woodland caribou (Anderson 2001, pers. comm.) is unknown. As a result, the Regional Suitability Index (SI(1)) is set on a scale that gradually increases from 0.0 to 1.0 as peatland area expands from 0% to 50% for a given ecodistrict. At this regional scale, areas with greater than 50% peatland are considered highly suitable habitat for woodland caribou.

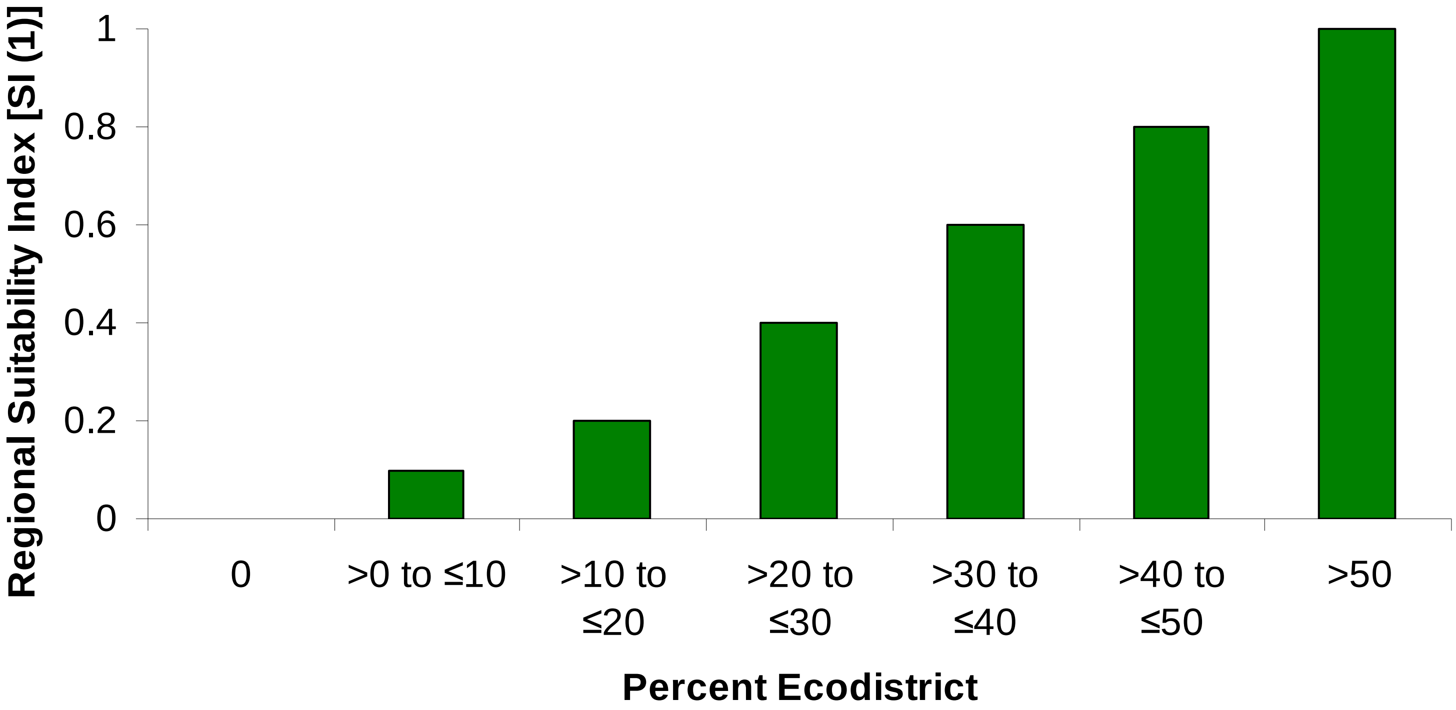
Local Component to Habitat Suitability Index

Food Availability

Local-level habitat selection by woodland caribou is likely affected by several factors. In particular, it involves the selection of certain vegetation types that provide the opportunity for woodland caribou to forage on terrestrial lichens. To date, field research has not revealed whether the relative abundance of terrestrial lichen affects site-specific habitat selection by woodland caribou (Anderson 2001, pers. comm.). As a result, food availability was assessed based on the presence or absence of lichens.

The mean percent lichen cover (*Cladina* spp.) for each ecosite phase and wetlands type was generated with data collected during summer vegetation surveys on sites near or within the RSA (Table 1.2-4). The mean lichen percent cover was used to calculate the suitability index SI(2) (Figure 1.2-2). Vegetation types without terrestrial lichens were assumed to be unsuitable habitat for woodland caribou (SI(2) = 0.0). Vegetation types with less than 5% lichens were assumed to provide limited forage opportunity for woodland caribou and were assigned a value of 0.1. All vegetation types with greater than 5% cover of terrestrial lichens were assigned a value of 1.0 to indicate that these habitats were suitable for woodland caribou.

This local component (SI(2)) is used in the model's predictions of habitat suitability within both the RSA and LSA. SI(2) scores were generalized for expression at the RSA scale using correspondence between ecosite phases and regional land cover classes (Table 1.2-5). In circumstances where ecosite phases and wetlands types with different SI(2) scores translated to the same regional land cover class, a weighted mean SI(2) was calculated. Weights were calculated based on proportional representation of competing ecosite phases and wetlands types within the extent of the Alberta Vegetation Inventory (AVI) data available for the RSA.



PROJECT

JACKPINE MINE EXPANSION

TITLE

RELATIONSHIP BETWEEN PEATLAND COVER AND THE REGIONAL SUITABILITY INDEX SI(1) FOR WOODLAND CARIBOU

Shell Canada Limited

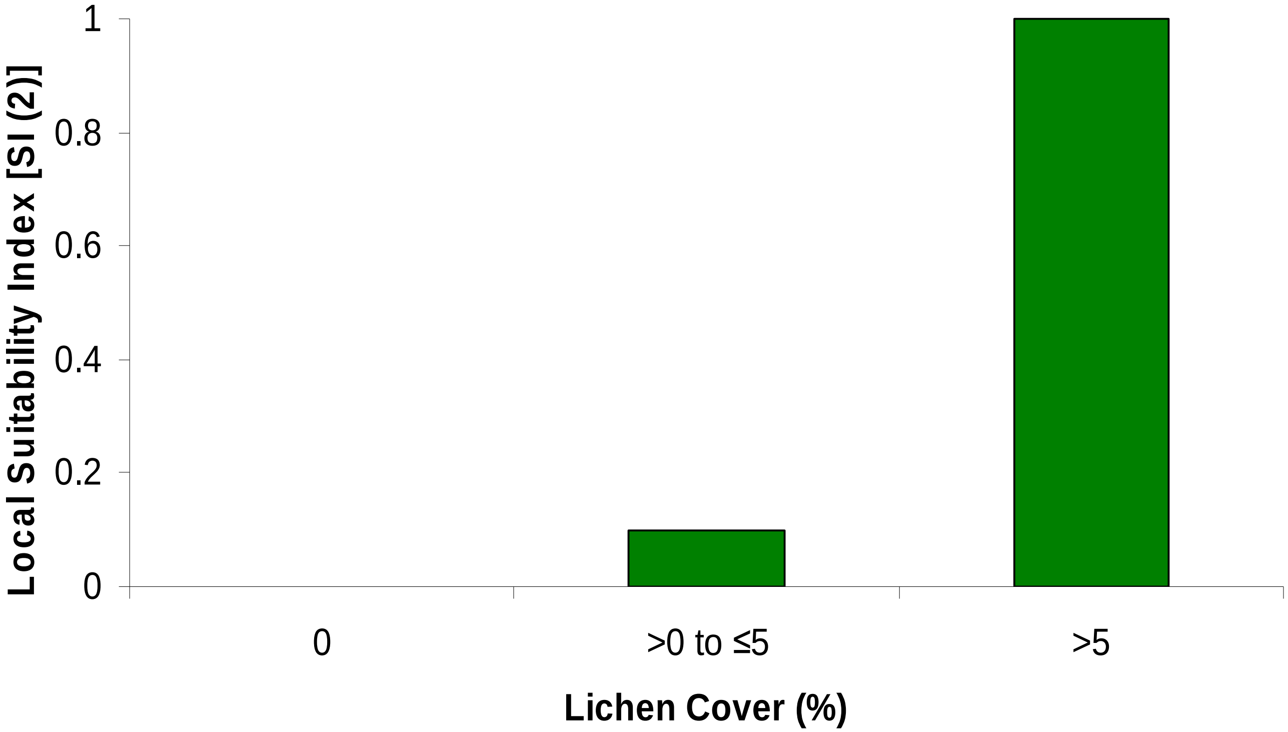
PROJECT	10.1346.0001.6100		FILE No.	10134600016100A001
DESIGN	JG	16 Apr. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	24 Apr. 2012		
CHECK	MB	11 May 2012		
REVIEW	WES	11 May 2012		

FIGURE: 1.2-1

Table 1.2-4 Food Index Value SI(2) for Each Vegetation Type in the Local Study Area

Map Code	Ecosite Phase/Wetlands Type	Terrestrial Lichens [%]	SI(2)
BFNN	forested bog	5.6[(a)]	1.0
BONN	open bog	5.6[(a)]	1.0
BTNI	wooded bog with internal lawns	7.0	1.0
BTNN	wooded bog	7.0	1.0
BUu	burn uplands	0.5	0.1
BUw	burn wetlands	0.5	0.1
CC	cutblock	< 0.1	0.1
DIS	disturbance	0.0	0.0
FFNN	forested fen	3.3[(a)]	0.1
FONG	graminoid fen	0.5	0.1
FONS	shrubby fen	0.8	0.1
FOPN	open patterned fen	<1.0[(a)]	0.1
FTNI	wooded fen with internal lawns	2.9	0.1
FTNN	wooded fen	2.9	0.1
FTNR	wooded fen with internal lawns and islands of forested peat plateau	0.5	0.1
FTPN	wooded patterned fen	2.9	0.1
Lake	lake	0.0	0.0
MONG	marsh	0.0[(a)]	0.0
SONS	shrubby swamp	0.2	0.1
STNN	wooded swamp	3.5	0.1
WONN	shallow open water	0.0	0.0
a1	lichen jack pine	18.2	1.0
b1	blueberry jack pine-aspen	5.0	0.1
b2	blueberry aspen (white birch)	4.5	0.1
b3	blueberry aspen-white spruce	15.3	1.0
b4	blueberry white spruce-jack pine	4.0	0.1
c1	Labrador tea-mesic jack pine-black spruce	9.7	1.0
d1	low-bush cranberry aspen	0.5	0.1
d2	low-bush cranberry aspen-white spruce	0.6	0.1
d3	low-bush cranberry white spruce	2.5	0.1
e1	dogwood balsam poplar-aspen	<1.0[(a)]	0.0
e2	dogwood balsam poplar-white spruce	<1.0[(a)]	0.0
e3	dogwood white spruce	< 0.1	0.1
f3	horsetail white spruce	<1.0[(a)]	0.0
g1	Labrador tea-subhygric black spruce-jack pine	6.0	1.0
h1	Labrador tea/horsetail white spruce-black spruce	3.5	0.1

(a) Due to data deficiencies, some terrestrial lichen percentages were estimated based on a combination of professional judgment and comparisons to similar ecosite phases and wetlands types.



PROJECT

JACKPINE MINE EXPANSION

TITLE

LOCAL SUSTAINABILITY INDEX FOR MEAN LICHEN COVER SI(2) FOR WOODLAND CARIBOU

Shell Canada Limited

PROJECT	10.1346.0001.6100		FILE No.	10134600016100A002
DESIGN	JG	16 Apr. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	24 Apr. 2012	FIGURE: 1.2-2	
CHECK	MB	11 May 2012		
REVIEW	WES	11 May 2012		

Table 1.2-5 Food Index Value SI(2) for Regional Land Cover Classes

Regional Land Cover Class	SI(2)
treed poor fen/bog	1.0
burn	0.1
cutblock	0.1
agriculture	0.0
non-treed wetlands	0.1
treed fen	0.1
water	0.0
coniferous jack pine	1.0
mixedwood aspen−jack pine	0.1
deciduous aspen−balsam poplar	0.1
mixedwood aspen−white spruce	0.3
coniferous jack pine−black spruce	0.7
coniferous white spruce	0.1

Combined Regional Model

The regional and local habitat suitability indices are assumed to be equal in importance to woodland caribou habitat. The two are added together and the average obtained. Habitat suitability is then reduced by the disturbance coefficient within zones of influence of disturbances:

$$HSI = [SI(1) + SI\ (2)\ ]/2\ x\ DC$$

1.2.1.3 Validation

The woodland caribou model was validated using available caribou observations, as well as RSA-scale baseline model output produced for previous oil sands EIAs. Observations were first split into separate data sources to maximize ease of direct comparison. Observations were derived from the Very High Frequency (VHF) collar data collected from 130 animals and from Global Positional System (GPS) collar data collected from one animal (ACC 2004). The VHF collar data ranged from 2 to 376 observations per individual (491 observation points total), meaning the behaviour of more frequently observed individuals had a greater effect on validation results than less frequently observed individuals. The GPS collar data consisted of 3,576 observations, averaging about 10 GPS locations per day. To remove some of the spatial autocorrelation between observations, the GPS collar dataset was reduced by randomly selecting one observation per day. For each model output extent, only observations that were taken within one year of the GIS disturbance layer creation date were considered, so that observations remained relevant to model output.

Manly's standardized selection ratio (Manly et al. 1972, 2002) was used to quantify habitat preference (i.e., low, moderate and high classes), and a G-test was performed to detect statistically significant differences ($\alpha = 0.05$) between classes. Validation results using VHF and GPS collar data suggested that caribou habitat preference increased with increasing predicted habitat quality classes, indicating a good model (Table 1.2-6).

Table 1.2-6 Validation Results for the Woodland Caribou Habitat Suitability Index Model

Data Source	HSI Class	Manly's Selection Ratio[a]	G-Test
VHF collar data	high	0.515	significant
	moderate	0.326	
	low	0.159	
GPS collar data	high	0.627	significant
	moderate	0.265	
	low	0.107	

(a) Manly et al. 1972, 2002

Overall, collar data are likely to be a more reliable indicator of habitat preference than track transect data. First, transect data can only be collected in winter, and is therefore representative only of winter habitat selection. Also, field identification of caribou tracks can be difficult, and observer error may occasionally result in moose tracks misidentified as caribou. In contrast, collar data represent habitat selection year-round, and overall risks of error are greatly reduced. The favourable results found, when validating with VHF and GPS collars, suggests that, more often than not, model predictions of woodland caribou habitat quality class are reliable.

1.2.2 Habitat Suitability Model Evaluation

The assumptions and structure of the RSA-scale HSI model for black-throated green warbler are stated in the EIA, Volume 5, Appendix 5-4, Section 1.2.2. The assumptions and structures of the LSA and RSA-scale HSI models for Canada warbler, olive-sided flycatcher and rusty blackbird are discussed in the SAR assessment (May 2011, Submission of Information to the Joint Review Panel, Appendix 2, Federally Listed Species at Risk Assessment, Appendix B). Although data for formal statistical validation of these models are not available, model structures and predictive outputs conform to the current state of knowledge regarding the ecology and habitat preferences of this species. Therefore, based on professional judgement, the RSA- and LSA-scale models provide reasonable assessments of the effects of JME and planned developments on habitat for these species.

Although data for statistical model validation are not available, a further evaluation of the predictive strength of these HSI models is possible using Alberta Biodiversity Monitoring Institute (ABMI) data. The ABMI breeding bird survey data were analyzed to calculate habitat associations based on estimates of relative population densities per plot, and compared to assumptions regarding habitat associations underlying the HSI model structures.

For the black-throated green warbler RSA HSI model, the results of the analysis of the ABMI data are fairly consistent with expectations. Habitat types with the highest observed relative densities of black-throated green warblers coincided with those habitat types classified as high and moderate suitability. Validation of the empirically derived LSA-scale resource selection function for black-throated green warbler was discussed in the EIA, Volume 5, Appendix 5-4, Section 1.2.2.

The ABMI data were also generally consistent with the LSA-scale Canada warbler HSI model, with the highest relative densities observed in those ecosite phases identified as high suitability habitat for the species. However, numerous Canada warbler observations were collected in Labrador tea/horsetail white spruce-black spruce (h1) stands, which were identified in the HSI model as nil suitability. These observations are unusual, given that Canada warbler is a bird of deciduous, and to a lesser degree mixedwood stands, but is generally absent from conifer-dominated stands (Campbell et al. 2001, Campbell et al. 2007). Avoidance of coniferous stands is due to the lesser shrub development they exhibit. It is likely that these observations are due to the proximity of mature deciduous stands to ABMI plots in Labrador tea/horsetail white spruce-black spruce (h1) stands. Due to the well known habitat associations of Canada warbler, the model was not adjusted as a result of this analysis. At the RSA scale, the highest relative densities of Canada warbler were observed within habitat types that correlate with the deciduous aspen-balsam poplar regional land cover class, which was classified as high suitability habitat in the HSI model.

Relative densities of olive-sided flycatcher from ABMI data also coincided well with the habitat rankings of the LSA-scale HSI model, with the highest relative densities occurring in the ecosite phases and wetlands types identified as being of high suitability due to canopy compositions that exceeded 70% coniferous species. However, the RSA-scale model showed more variability in the relationship between habitat suitability and relative densities obtained from ABMI data. Olive-sided flycatchers are often found close to forest edges, taking advantage of standing snags in forest openings for effective foraging (Altman and Sallabanks 2000). The LSA-scale model is able to represent this complexity well due to the higher resolution vegetation data available at that scale. At the RSA scale, these details are more difficult to represent, and as a result the relationship between observed relative density and habitat suitability is weaker. However, this does not necessarily mean that the RSA-scale olive-sided flycatcher model is unreliable. Rather, it is likely that the scale at which ABMI habitat types are classified, and the manner in which they are classified by dominant habitat type rather than occurring within contiguous habitats, may make ABMI breeding bird survey data inappropriate for evaluating olive-sided flycatcher habitat suitability predictions at the RSA scale for olive-sided flycatcher.

For rusty blackbird, the highest relative densities calculated from ABMI data occurred in wetlands types classified as high suitability at the LSA and RSA-scales. Again, the ABMI breeding bird survey data provide evidence that the models are consistent with empirical data collected in the region.

1.3 Results

Habitat suitability modelling results for the LSA at the 2012 Base Case, 2012 JME Application Case and Closure scenario are presented in Table 1.3-1. Direct habitat change refers to habitat loss due to the JME footprint. Indirect habitat change refers to a reduction in habitat quality outside of the JME footprint due to the effects of sensory disturbance and surficial aquifer drawdown. Results at the RSA scale for the PIC and 2012 Base Case are presented in Table 1.3-2, while results regarding habitat suitability at 2012 Base Case, 2012 JME Application Case and 2012 PDC relative to the 2012 Base Case are presented in Table 1.3-3.

Table 1.3-1 Change in Wildlife Habitat Due to the Jackpine Mine Expansion Within the Local Study Area: 2012 JME Application Case

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	2012 Base Case Habitat		Direct Habitat Change From 2012 Base Case Due to Site Clearing of JME		Indirect Habitat Change From 2012 Base Case Due to JME		Net Habitat Change From 2012 Base Case Due to JME		Net Habitat Change From 2012 Base Case After Closure	
		Area [ha]	% of LSA	Area [ha]	%	Area [ha]	%	Area [ha]	%	Area [ha]	%
barred owl	high	1,093	5	-598	-55	4	<1	-595	-54	-710	-65
	moderate	0	0	0	0	0	0	0	0	0	0
	low	23,718	80	-18,369	-77	-3	>-1	-18,372	-77	-906	-4
	nil	4,813	16	18,967	394	0	>-1	18,967	394	1,616	34
beaver	high	5,023	17	-3,275	-65	35	<1	-3,240	-65	2,236	45
	moderate	816	3	-565	-69	-21	-3	-586	-72	-560	-69
	low	1,222	4	-919	-75	-69	-6	-988	-81	934	76
	nil	22,563	76	4,759	21	55	<1	4,814	21	-2,610	-12
black bear	high	6,096	21	-5,067	-83	-992	-16	-6,059	-99	1,707	28
	moderate	5,939	20	-4,743	-80	-344	-6	-5,087	-86	4,273	72
	low	12,776	43	-9,157	-72	1,336	10	-7,821	-61	-7,597	-59
	nil	4,813	16	18,967	394	0	>-1	18,967	394	1,616	34
black-throated green warbler	high	863	3	-551	-64	-96	-11	-647	-75	-622	-72
	moderate high	666	2	-421	-63	46	7	-375	-56	-462	-69
	moderate	722	2	-486	-67	9	1	-477	-66	-512	-71
	moderate low	939	3	-672	-72	-1	>-1	-672	-72	-706	-75
	low	21,621	73	-16,837	-78	42	<1	-16,795	-78	686	3
	nil	4,813	16	18,967	394	0	>-1	18,967	394	1,616	34
Canada lynx	high	7,338	25	-5,266	-72	-95	-1	-5,362	-73	3,324	45
	moderate high	6,051	20	-4,905	-81	-80	-1	-4,985	-82	1,600	26
	moderate	5,452	18	-4,311	-79	-528	-10	-4,839	-89	-2,814	-52
	moderate low	3,704	13	-3,010	-81	-195	-5	-3,205	-87	-2,114	-57
	low	2,267	8	-1,475	-65	899	40	-576	-25	-1,612	-71
	nil	4,813	16	18,967	394	0	>-1	18,967	394	1,616	34
Canadian toad	high	2,542	9	-1,474	-58	-42	-2	-1,516	-60	2,123	84
	moderate	6,762	23	-4,221	-62	526	8	-3,695	-55	12,846	190
	low	2,924	10	-2,368	-81	1,006	34	-1,363	-47	-1,732	-59
	nil	17,397	59	8,063	46	-1,489	-9	6,573	38	-13,237	-76

Table 1.3-1 Change in Wildlife Habitat Due to the Jackpine Mine Expansion Within the Local Study Area: 2012 JME Application Case (continued)

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	2012 Base Case Habitat		Direct Habitat Change From 2012 Base Case Due to Site Clearing of JME		Indirect Habitat Change From 2012 Base Case Due to JME		Net Habitat Change From 2012 Base Case Due to JME		Net Habitat Change From 2012 Base Case After Closure	
		Area [ha]	% of LSA	Area [ha]	%	Area [ha]	%	Area [ha]	%	Area [ha]	%
fisher / marten	high	7,001	24	-5,249	-75	-6	>-1	-5,255	-75	-1,472	-21
	moderate high	6,620	22	-4,845	-73	-63	>-1	-4,907	-74	836	13
	moderate	4,627	16	-3,335	-72	-6	>-1	-3,341	-72	3,869	84
	moderate low	3,332	11	-2,447	-73	-73	-2	-2,519	-76	-1,716	-52
	low	3,231	11	-3,091	-96	147	5	-2,944	-91	-3,133	-97
	nil	4,813	16	18,967	394	0	>-1	18,967	394	1,616	34
moose	high	2,974	10	-2,769	-93	-22	>-1	-2,791	-94	-1,933	-65
	moderate high	4,719	16	-4,138	-88	8	<1	-4,130	-88	552	12
	moderate	5,958	20	-4,405	-74	-669	-11	-5,074	-85	1,535	26
	moderate low	6,544	22	-4,827	-74	189	3	-4,638	-71	-333	-5
	low	4,617	16	-2,827	-61	493	11	-2,334	-51	-1,437	-31
	nil	4,813	16	18,967	394	0	>-1	18,967	394	1,616	34
Canada warbler	high	570	2	-242	-42	-122	-21	-364	-64	1,207	212
	moderate	2,426	8	-2,007	-83	-96	-4	-2,103	-87	-32	-1
	low	974	3	-418	-43	215	22	-203	-21	1,780	183
	nil	25,654	87	2,667	10	3	<1	2,670	10	-2,955	-12
common nighthawk	high	2,788	9	-2,503	-90	-129	-5	-2,632	-94	-411	-15
	moderate	15,936	54	-12,062	-76	-627	-4	-12,690	-80	-7,191	-45
	low	7,035	24	-4,854	-69	758	11	-4,096	-58	7,349	104
	nil	3,865	13	19,420	502	-2	>-1	19,417	502	253	7
horned grebe	high	680	2	-652	-96	-21	-3	-672	-99	-507	-75
	moderate	35	<1	-10	-29	18	52	8	23	-4	-12
	low	0	0	0	0	0	0	0	0	0	0
	nil	28,909	98	662	2	2	<1	664	2	511	2
olive-sided flycatcher	high	4,362	15	-3,639	-83	-239	-5	-3,878	-89	1,341	31
	moderate	2,584	9	-1,622	-63	42	2	-1,579	-61	4,161	161
	low	2,925	10	-1,593	-54	194	7	-1,400	-48	1,951	67
	nil	19,754	67	6,854	35	3	<1	6,857	35	-7,453	-38

Table 1.3-1 Change in Wildlife Habitat Due to the Jackpine Mine Expansion Within the Local Study Area: 2012 JME Application Case (continued)

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	2012 Base Case Habitat		Direct Habitat Change From 2012 Base Case Due to Site Clearing of JME		Indirect Habitat Change From 2012 Base Case Due to JME		Net Habitat Change From 2012 Base Case Due to JME		Net Habitat Change From 2012 Base Case After Closure	
		Area [ha]	% of LSA	Area [ha]	%	Area [ha]	%	Area [ha]	%	Area [ha]	%
rusty blackbird	high	9,446	32	-7,784	-82	-1,080	-11	-8,864	-94	-5,898	-62
	moderate	3,979	13	-2,196	-55	-1,123	-28	-3,319	-83	-2,170	-55
	low	893	3	-627	-70	-200	-22	-826	-93	-663	-74
	nil	15,307	52	10,606	69	2,403	16	13,009	85	8,731	57
short-eared owl	high	3,736	13	-2,839	-76	-249	-7	-3,088	-83	-2,839	-76
	moderate	8,458	29	-6,635	-78	-38	>-1	-6,674	-79	-6,665	-79
	low	4,092	14	-3,088	-75	213	5	-2,875	-70	-1,196	-29
	nil	13,338	45	12,563	94	74	<1	12,637	95	10,700	80
western (boreal) toad	high	7,707	26	-5,929	-77	-1,372	-18	-7,301	-95	-5,797	-75
	moderate	6,031	20	-4,816	-80	-512	-8	-5,327	-88	-4,858	-81
	low	2,495	8	-1,593	-64	-626	-25	-2,219	-89	-1,554	-62
	nil	13,392	45	12,338	92	2,510	19	14,848	111	12,209	91
wolverine	high	22,764	77	-18,427	-81	-1,900	-8	-20,327	-89	830	4
	moderate	0	0	0	0	0	0	0	0	0	0
	low	3,978	13	-1,823	-46	1,901	48	78	2	-355	-9
	nil	2,882	10	12,739	442	7,511	261	20,250	703	-474	-16
wood bison	high	3,564	12	-3,076	-86	-415	-12	-3,492	-98	-3,074	-86
	moderate	2,510	8	-1,646	-66	-112	-4	-1,758	-70	-12	>-1
	low	14,977	51	-11,488	-77	451	3	-11,037	-74	-6,452	-43
	nil	8,573	29	16,211	189	76	<1	16,287	190	9,538	111
woodland caribou	high	1,514	5	-1,049	-69	-358	-24	-1,406	-93	6,388	422
	moderate	1,049	4	-664	-63	358	34	-306	-29	1,647	157
	low	21,741	73	-16,895	-78	-75	>-1	-16,970	-78	-9,376	-43
	nil	5,321	18	18,608	350	74	1	18,682	351	1,341	25
yellow rail	high	3,913	13	-3,237	-83	-452	-12	-3,689	-94	-3,261	-83
	moderate	415	1	-91	-22	-116	-28	-207	-50	-128	-31
	low	0	0	0	0	0	0	0	0	0	0
	nil	25,297	85	3,328	13	-568	-2	3,896	15	3,390	13

Table 1.3-2 Habitat Change for Key Indicator Resources and Wildlife Species at Risk in the Regional Study Area: Pre-Industrial Case

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	Pre-Industrial Case		Change From Pre-Industrial Case to 2012 Base Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	%
barred owl	high	222,863	10	-75,962	-34
	moderate	186,478	8	-80,151	-43
	low	925,294	41	-133,739	-14
	nil	942,742	41	289,852	31
beaver	high	586,995	26	-69,790	-12
	moderate	0	0	0	0
	low	275,397	12	-25,149	-9
	nil	1,414,984	62	94,939	7
black bear	high	1,156,744	51	-119,327	-10
	moderate	519,334	23	-26,005	-5
	low	544,983	24	-30,731	-6
	nil	56,314	2	176,063	313
black-throated green warbler	high	240,349	11	-81,725	-34
	moderate	231,520	10	-93,751	-40
	low	862,807	38	75,717	9
	nil	942,701	41	99,760	11
Canada lynx	high	473,755	21	-97,923	-21
	moderate high	428,628	19	-55,965	-13
	moderate	435,964	19	-12,960	-3
	moderate low	447,484	20	-5,470	-1
	low	435,230	19	-3,745	>-1
	nil	56,314	2	176,063	313
Canadian toad	high	228,234	10	-23,262	-10
	moderate	803,361	35	-66,725	-8
	low	201,585	9	-15,304	-8
	nil	1,044,196	46	105,292	10
fisher / marten	high	547,806	24	-123,098	-22
	moderate high	463,711	20	-30,194	-7
	moderate	449,251	20	-12,454	-3
	moderate low	428,437	19	-8,798	-2
	low	331,857	15	-1,518	>-1
	nil	56,314	2	176,063	313
moose	high	474,607	21	-67,107	-14
	moderate high	457,165	20	-39,518	-9
	moderate	446,519	20	-32,955	-7
	moderate low	429,125	19	-24,051	-6
	low	413,645	18	-12,433	-3
	nil	56,314	2	176,063	313
Canada warbler	high	186,246	8	-91,110	-49
	moderate	177,765	8	-59,679	-34
	low	45,330	2	-5,324	-12
	nil	1,868,036	82	156,113	8

Table 1.3-2 Habitat Change for Key Indicator Resources and Wildlife Species at Risk in the Regional Study Area: Pre-Industrial Case (continued)

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	Pre-Industrial Case		Change From Pre-Industrial Case to 2012 Base Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	%
common nighthawk	high	353,022	16	-34,514	-10
	moderate	1,366,640	60	-108,173	-8
	low	321,427	14	17,009	5
	nil	236,287	10	125,678	53
horned grebe	high	287,315	13	-49,950	-17
	moderate	170	<1	17,053	10,013
	low	0	0	0	0
	nil	1,989,891	87	32,897	2
olive-sided flycatcher	high	440,399	19	-45,542	-10
	moderate	1,049,211	46	-162,806	-16
	low	248,712	11	136,312	55
	nil	539,055	24	72,036	13
rusty blackbird	high	587,732	26	-102,940	-18
	moderate	608,101	27	-45,931	-8
	low	137	<1	35,267	25,830
	nil	1,081,407	47	113,603	11
short-eared owl	high	392,447	17	1,645	<1
	moderate	312,601	14	-20,320	-7
	low	603,490	26	-35,814	-6
	nil	968,838	43	54,489	6
western (boreal) toad	high	287,274	13	-55,069	-19
	moderate	429,709	19	-56,960	-13
	low	686,295	30	-30,741	-4
	nil	874,097	38	142,769	16
wolverine	high	2,273,964	100	-406,761	-18
	moderate	0	0	0	0
	low	1,856	<1	208,830	11,253
	nil	1,557	<1	197,931	12,715
wood bison	high	275,067	12	-81,131	-29
	moderate	647,036	28	-52,870	-8
	low	519,110	23	47,273	9
	nil	836,163	37	86,728	10
woodland caribou	high	423,700	19	-170,431	-40
	moderate	1,794,282	79	-1,649,202	-92
	low	3,181	<1	1,363,554	42,860
	nil	56,213	2	456,079	811
yellow rail	high	275,245	12	-49,918	-18
	moderate	152	<1	20,254	13,318
	low	0	0	0	0
	nil	2,001,979	88	29,664	1

Note: Nil includes 717.81 ha of area classified as cloud in PIC vegetation data due to remote sensing limitations.

Table 1.3-3 Habitat Change for Key Indicator Resources and Wildlife Species at Risk in the Regional Study Area: 2012 Planned Development Case

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	2012 Base Case		Habitat Change From 2012 Base Case Due to JME		Habitat Change From 2012 Base Case Due to the 2012 Planned Development Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	%	Area [ha]	%
barred owl	high	146,900	6	-1,016	>-1	-20,626	-14
	moderate	106,327	5	-692	>-1	-22,618	-21
	low	791,555	35	-7,688	>-1	-66,501	-8
	nil	1,232,593	54	9,396	<1	109,745	9
beaver	high	517,205	23	-3,975	>-1	-35,163	-7
	moderate	0	0	0	0	0	0
	low	250,249	11	-4,709	-2	-21,171	-8
	nil	1,509,923	66	8,684	<1	56,335	4
black bear	high	1,037,418	46	-5,537	>-1	-79,466	-8
	moderate	493,329	22	-3,271	>-1	-19,043	-4
	low	514,252	23	-3,603	>-1	-32,724	-6
	nil	232,378	10	12,412	5	131,233	56
black-throated green warbler	high	158,624	7	-1,288	>-1	-24,016	-15
	moderate	137,769	6	-742	>-1	-24,976	-18
	low	938,524	41	-7,507	>-1	-62,065	-7
	nil	1,042,460	46	9,537	<1	111,057	11
Canada lynx	high	375,832	17	-12,078	-3	-54,010	-14
	moderate high	372,663	16	-3,856	-1	-22,663	-6
	moderate	423,004	19	-588	>-1	-22,535	-5
	moderate low	442,015	19	4,107	<1	-11,709	-3
	low	431,485	19	2	<1	-7,905	-2
	nil	232,378	10	12,412	5	118,821	51
Canadian toad	high	204,972	9	-3,123	-2	-12,883	-6
	moderate	736,636	32	-4,257	>-1	-32,699	-4
	low	186,281	8	-1,985	-1	-9,806	-5
	nil	1,149,488	50	9,365	<1	55,388	5
fisher / marten	high	424,708	19	-11,695	-3	-64,675	-15
	moderate high	433,517	19	-546	>-1	-29,048	-7
	moderate	436,796	19	-97	>-1	-19,152	-4
	moderate low	419,639	18	-78	>-1	-14,278	-3
	low	330,339	15	4	<1	-4,080	-1
	nil	232,378	10	12,412	5	131,233	56
moose	high	407,500	18	-6,742	-2	-49,059	-12
	moderate high	417,648	18	-2,720	>-1	-30,450	-7
	moderate	413,564	18	-2,579	>-1	-27,424	-7
	moderate low	405,075	18	-3,080	>-1	-19,822	-5
	low	401,212	18	2,710	<1	-4,478	-1
	nil	232,378	10	12,412	5	131,233	56
Canada warbler	high	95,136	4	-491	>-1	-22,481	-24
	moderate	118,086	5	-1,077	>-1	-21,129	-18
	low	40,005	2	-140	>-1	366	<1
	nil	2,024,149	89	1,708	<1	43,244	2

Table 1.3-3 Habitat Change for Key Indicator Resources and Wildlife Species at Risk in the Regional Study Area: 2012 Planned Development Case (continued)

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	2012 Base Case		Habitat Change From 2012 Base Case Due to JME		Habitat Change From 2012 Base Case Due to the 2012 Planned Development Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	%	Area [ha]	%
common nighthawk	high	318,508	14	-603	>-1	-9,760	-3
	moderate	1,258,468	55	-9,931	>-1	-100,159	-8
	low	338,435	15	-1,182	>-1	34	<1
	nil	361,965	16	11,717	3	109,886	30
horned grebe	high	237,365	10	-4,314	-2	-25,312	-11
	moderate	17,223	<1	-287	-2	4,567	27
	low	0	0	0	0	0	0
	nil	2,022,788	89	4,602	<1	20,745	1
olive-sided flycatcher	high	394,857	17	-23	>-1	-13,298	-3
	moderate	886,405	39	-7,471	>-1	-75,938	-9
	low	385,023	17	-1,395	>-1	-1,215	>-1
	nil	611,091	27	8,889	1	90,451	15
rusty blackbird	high	484,792	21	-8,495	-2	-63,087	-13
	moderate	562,170	25	-6,186	-1	-32,207	-6
	low	35,404	2	-536	-2	14,752	42
	nil	1,195,010	52	15,217	1	80,542	7
short-eared owl	high	394,091	17	-3,039	>-1	-26,940	-7
	moderate	292,281	13	-3,302	-1	-29,165	-10
	low	567,676	25	-3,357	>-1	-19,497	-3
	nil	1,023,327	45	9,699	<1	75,602	7
western (boreal) toad	high	232,206	10	-4,211	-2	-25,944	-11
	moderate	372,750	16	-4,572	-1	-38,658	-10
	low	655,554	29	-7,038	-1	-23,966	-4
	nil	1,016,866	45	15,820	2	88,568	9
wolverine	high	1,867,203	82	-11,499	>-1	-185,281	-10
	moderate	0	0	0	0	0	0
	low	210,686	9	-725	>-1	54,427	26
	nil	199,488	9	12,224	6	130,854	66
wood bison	high	193,936	9	-3,480	-2	-25,234	-13
	moderate	594,166	26	-909	>-1	-41,816	-7
	low	566,383	25	-3,643	>-1	-25,725	-5
	nil	922,891	41	8,032	<1	92,775	10
woodland caribou	high	253,268	11	-1,322	>-1	-29,557	-12
	moderate	145,080	6	-2,992	-2	-15,847	-11
	low	1,366,735	60	-7,764	>-1	-82,326	-6
	nil	512,292	22	12,077	2	127,730	25
yellow rail	high	225,328	10	-4,294	-2	-25,442	-11
	moderate	20,406	<1	-371	-2	4,290	21
	low	0	0	0	0	0	0
	nil	2,031,643	89	4,665	<1	21,152	1

2.0 HABITAT FRAGMENTATION ANALYSIS

2.1 Introduction

Habitat fragmentation is defined as the separation of contiguous areas of habitat into smaller and more isolated habitat patches (Morrison et al. 1998). Whether suitable habitat is available for use by wildlife depends on several factors including the degree to which suitable habitat is fragmented.

The effects of habitat fragmentation include reduction in the area of remaining habitat, increased isolation of the habitat fragments and increased disturbance of habitat from surrounding areas (e.g., edge effects) (Haila 1999). The effect of fragmentation on a particular species depends on the scale of the landscape, the amount of suitable habitat remaining, the species' life history and its colonization and dispersal capability (Fahrig 1997). The effect of habitat fragmentation also depends on home range size, relationships with edge and interior stand conditions, and whether the species is a habitat specialist or generalist (Andrén 1994; Fahrig 1997). Changes in the landscape may have substantial effects on ecological processes and the long-term viability of wildlife populations, across numerous spatial scales.

2.2 Assessment Methods

A detailed description of habitat fragmentation assessment methods was presented in the EIA, Volume 5, Appendix 5-4, Section 2.2.

2.3 Results

Results of the fragmentation analysis are presented in Table 2.3-1 for the change from the PIC to the 2012 Base Case, and in Table 2.3-2 for the change from the 2012 Base Case to the 2012 JME Application Case during construction and operations and to the 2012 PDC. Changes are expressed as percent change relative to the fragmentation metrics for each habitat suitability class in the 2012 Base Case. Positive percent changes represent an increase in that metric relative to the 2012 Base Case, while a negative percent change represents a decrease relative to the 2012 Base Case. Due to the raster approach, total area of linear disturbances had to be overestimated to ensure their representation on the landscape. This was necessary for the analysis of fragmentation, but does mean that total habitat loss and fragmentation will be overestimated as well.

Table 2.3-1 Predicted Wildlife Habitat Fragmentation Effects in the Regional Study Area: Pre-Industrial Case to the 2012 Base Case

Key Indicator Resource	Habitat Suitability Class	Pre-Industrial Case				Change from the Pre-Industrial Case to the 2012 Base Case			
		NP	MPS [ha]	TCA [ha]	ENN_MN [m]	NP [%]	MPS [%]	TCA [%]	ENN_MN [%]
black bear	high	7,499	150	733,757	127	96.0	-54.8	-21.2	-35.6
	moderate	11,424	43	218,550	168	86.1	-50.1	-24.0	-39.7
	low	7,932	75	252,234	215	19.1	-19.7	-18.1	-35.8
	nil	2,054	30	29,272	783	545.0	-37.1	491.1	-49.3
Canada lynx	high	693	681	424,383	165	144.6	-68.0	-32.7	-35.3
	moderate high	919	465	349,438	217	87.1	-53.9	-21.0	-34.2
	moderate	748	582	354,723	293	47.5	-34.5	-7.9	-27.5
	moderate low	641	697	383,918	322	39.6	-29.6	-6.8	-26.3
	low	269	1,613	401,564	719	60.2	-38.3	-4.7	-39.5
	nil	2,081	68	29,066	1,101	536.6	-72.3	495.2	-63.9
Canada warbler	high	5,064	32	79,266	358	-7.7	-47.9	-63.0	-3.5
	moderate	725	2,678	1,747,889	217	8.8	-1.3	10.6	-13.6
	low	8,609	16	47,144	295	3.3	-40.2	-52.2	-8.5
	nil	2,607	14	9,936	443	44.8	-44.5	-39.9	-16.6
fisher / marten	high	1,703	320	423,943	212	74.3	-56.1	-35.3	-32.1
	moderate high	5,367	86	219,473	223	20.6	-22.9	-9.2	-19.7
	moderate	4,758	94	202,605	267	47.7	-34.5	-8.1	-27.4
	moderate low	5,359	80	216,515	327	28.6	-24.2	-8.0	-20.5
	low	1,520	218	262,877	797	17.3	-15.4	-3.8	-20.6
	nil	2,081	68	29,066	1,101	536.6	-72.3	495.2	-63.9
moose	high	219	2,158	401,471	302	374.0	-82.1	-25.2	-58.8
	moderate high	280	1,630	341,165	360	243.9	-73.6	-15.4	-58.0
	moderate	282	1,580	339,435	604	243.6	-73.2	-13.7	-67.2
	moderate low	242	1,769	345,880	984	174.0	-65.7	-11.5	-67.4
	low	154	2,680	374,736	2,011	160.4	-62.9	-7.7	-64.5
	nil	2,081	68	29,066	1,101	536.6	-72.3	495.2	-63.9

Note: NP = Number of patches; MPS = mean patch size; TCA = total core area; ENN_MN = mean nearest neighbour distance.
Nil includes 669.52 ha of area classified as cloud in Pre-Industrial Case vegetation data due to remote sensing limitations.

Table 2.3-2 **Predicted Wildlife Habitat Fragmentation Effects in the Regional Study Area: 2012 JME Application Case (During Construction and Operations) and 2012 Planned Development Case**

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	Change from 2012 Base Case to 2012 JME Application Case				Change from 2012 Base Case to the 2012 Planned Development Case			
		NP [%]	MPS [%]	TCA [%]	ENN_MN [%]	NP [%]	MPS [%]	TCA [%]	ENN_MN [%]
black bear	high	-2	1	>-1	<1	-9	1	-7	9
	moderate	-2	1	<1	<1	<1	-4	-6	-2
	low	-1	<1	>-1	<1	3	-10	-9	-1
	nil	-5	10	8	2	-23	97	70	4
Canada lynx	high	<1	-4	-3	3	-5	-13	-17	9
	moderate high	>-1	>-1	>-1	<1	1	-8	-7	<1
	moderate	<1	>-1	>-1	3	23	-24	-7	-8
	moderate low	0	<1	<1	>-1	27	-23	-4	-15
	low	<1	>-1	0	9	21	-19	-3	-6
	nil	-5	10	8	2	-23	97	70	4
Canada warbler	high	>-1	<1	>-1	<1	-19	-8	-23	13
	moderate	>-1	<1	<1	<1	-52	113	3	-2
	low	-1	<1	>-1	<1	-13	-10	-23	10
	nil	>-1	<1	<1	<1	2	13	24	<1
fisher / marten	high	<1	-3	-3	<1	-4	-12	-16	5
	moderate high	>-1	<1	>-1	>-1	-3	-3	-8	>-1
	moderate	>-1	<1	>-1	>-1	13	-16	-7	-9
	moderate low	>-1	<1	>-1	>-1	7	-10	-4	-7
	low	<1	>-1	<1	>-1	6	-7	-2	-7
	nil	-5	10	8	2	-23	97	70	4
moose	high	1	-3	-1	7	5	-16	-12	20
	moderate high	>-1	>-1	>-1	-2	17	-21	-8	3
	moderate	>-1	<1	>-1	2	17	-20	-8	9
	moderate low	>-1	>-1	>-1	5	45	-35	-6	-22
	low	>-1	1	<1	3	63	-39	-2	-36
	nil	-5	10	8	2	-23	97	70	4

Note: NP = Number of patches; MPS = mean patch size; TCA = total core area; ENN_MN = mean nearest neighbour distance.

3.0 POPULATION VIABILITY ANALYSIS

3.1 Introduction

Population Viability Analysis (PVA) is a population modelling process that links changes in habitat with demographic parameters (i.e., birth and death rates) and environmental variation to calculate population trends and the probability of population extinction within a given period of time and space (Soulè 1987; Shaffer 1990). The PVA helps predict the potential effects of JME and other planned developments on wildlife populations in the RSA. In addition, the PVA can help identify those factors or variables that are driving the changes in population size and subsequently influencing the likelihood of population persistence.

3.2 Assessment Methods

For a detailed description of PVA assessment methods, refer to EIA, Volume 5, Appendix 5-4, Section 1.2. The geometric mean and standard deviations of survival and fecundity rates for moose and black bear were determined through a comprehensive review of the literature likely to be relevant to populations of these species in the RSA (Table 3.2-1).

Table 3.2-1 Literature Sources Used to Estimate Survival and Fecundity Rates for Black Bear and Moose

Species	Region	Reference
black bear	Alaska	Schwartz and Franzmann (1991)
	Alberta	Czetwertynski et al. (2007)
		Fuller and Keith (1977)
		Kemp (1970)
		Ruff (1978)
		Young (1978)
		Young and Ruff (1982)
	Colorado	Beck (1991)
	Montana	Jonkel and Cowan (1971)
	North America	Bunnell and Tait (1985)
	North Carolina	Sorensen and Powell (1998)
	Massachusetts	Elowe and Dodge (1989)
	Ontario	Samson and Hout (1998)
		Schenk et al. (1998)
	Tennessee	McLean and Pelton (1994)
moose	Alberta	Bibaud and Archer (1973)
		BOVAR Environmental Ltd. (1996)
		Brusnyk and Westworth (1986)
		Cook and Jacobsen (1978)
		Eccles and Duncan (1988)
		Hauge and Keith (1978, 1980, 1981)
		Penner (1976)
		Rolley and Keith (1980)
		Salter et al. (1986)
		Skinner (1996)
		Thompson et al. (1980)
		Westworth (1980)
		Westworth and Associates (1978)
		Westworth and Brusnyk (1982)

3.3 Results

3.3.1 Black Bear

Based on the survival and fecundity values in the stage matrix, the finite rate-of-increase (λ) for the black bear population was 1.01, assuming no density dependence or environmental variation. This suggests a relatively stable population, as a population that is replacing itself exactly would have a λ of 1.0 (Krebs 1994).

From the 2012 Base Case to the 2012 JME Application Case during construction and operations, the initial abundance, carrying capacity and population density of the RSA for black bear are predicted to decline by less than 1%. From the 2012 Base Case to the 2012 PDC, the initial abundance, carrying capacity and population density of the RSA for black bear are predicted to decline by about 7%; however, the probability of population extirpation remains less than 0.001% in all cases.

3.3.2 Moose

Based on the survival and fecundity values in the stage matrix, λ for the moose population was 1.05 assuming no density dependence or environmental variation. This suggests a stable and slightly increasing population, as a finite increase of 1.0 would represent a population that is replacing itself exactly (Krebs 1994).

From the 2012 Base Case to the 2012 JME Application Case during construction and operations, the initial abundance, carrying capacity and population density of the RSA for moose are predicted to decline by about 1%. From the 2012 Base Case to the 2012 PDC, the initial abundance, carrying capacity and population density of the RSA for moose are predicted to decline by about 9%; however, the probability of population extirpation remains less than 0.001% in all cases.

4.0 LINKAGE ZONE ANALYSIS

4.1 Introduction

Intact movement corridors are important for sustaining healthy wildlife populations. Movement corridors allow wildlife to move through and between suitable habitat patches and fulfill critical life requisites (Meitz 1994; Gibeau et al. 1996). A Linkage Zone Analysis (LZA) was completed to assess the impacts of JME on moose movement in the RSA. The LZA was produced through modifications to moose HS model output using information about habitat quality and the distribution of disturbance features on the landscape. The model identifies areas of suitable habitat for moose that allow the species to move through and between suitable habitats. Areas are otherwise considered fractured and act as barriers to movement. Barriers to movement may be natural (e.g., rivers) or man-made (e.g., above ground pipelines, roads).

4.2 Assessment Methods

A detailed description of LZA assessment methods can be found in the EIA, Volume 5, Appendix 5-4, Section 4.

4.3 Results

Results of the LZA for moose are expressed in terms of the percentage of fractured suitable habitat for the RSA as a whole, and within east-west rows and north-south columns of mapped habitat (Tables 4.3-1 and 4.3-2). The reported percentage of fractured habitat is higher than actually expected because the model assumes that man-made features and their zones of influence are completely avoided by moose. In reality, moose do use habitat in close proximity to human disturbance, although use relative to availability may decline, and areas near human use may present increased risk of mortality. The overall results highlight areas of the RSA that present challenges to the free movement of moose across the landscape.

Table 4.3-1 Habitat Unsuitable for Moose Movement in the Regional Study Area: Change From the Pre-Industrial Case

Corridor	Pre-Industrial Case [% unsuitable]	2012 Base Case	
		% of Corridors	Change From Pre-Industrial Case [%]
east-west A	0	3	3
east-west B	2	5	3
east-west C	5	18	14
east-west D	5	33	28
east-west E	2	47	45
east-west F	1	31	30
east-west G	1	29	28
east-west H	2	12	11
east-west I	4	17	13
north-south 1	0	19	19
north-south 2	3	20	17
north-south 3	4	15	11
north-south 4	2	13	12
north-south 5	1	36	34
north-south 6	5	55	50
north-south 7	2	45	43
north-south 8	2	21	19
north-south 9	2	8	6
north-south 10	3	5	1
Total Percentage of Habitat Unsuitable for Movement in the RSA	**2**	**26**	**23**

Table 4.3-2 Habitat Unsuitable for Moose Movement in the Regional Study Area: Change From 2012 Base Case

Corridor	2012 Base Case [% unsuitable]	2012 JME Application Case		2012 Planned Development Case	
		% of Corridors	Change From 2012 Base Case [%]	% of Corridors	Change From 2012 Base Case [%]
east-west A	3	3	0	3	0
east-west B	5	5	0	9	4
east-west C	18	18	0	25	7
east-west D	33	33	<1	34	2
east-west E	47	47	<1	51	4
east-west F	31	31	0	38	7
east-west G	29	29	0	37	8
east-west H	12	12	0	18	5
east-west I	17	17	0	17	<1
north-south 1	19	19	0	19	0
north-south 2	20	20	<1	29	9
north-south 3	15	15	<1	23	8
north-south 4	13	13	<1	19	6
north-south 5	36	36	<1	39	4
north-south 6	55	55	<1	66	12
north-south 7	45	45	<1	48	3
north-south 8	21	21	0	21	<1
north-south 9	8	8	0	10	2
north-south 10	5	5	0	5	<1
Total Percentage of Habitat Unsuitable for Movement in the RSA	**26**	**26**	**<1**	**31**	**5**

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