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VIA EMAIL

July 27, 2010

Joslyn North Mine Joint Review Panel
Canadian Environmental Assessment Agency
160 Elgin Street, 22nd Floor
Place Bell Canada
Ottawa, ON, K1A 0H3

Energy Resources Conservation Board
Fort McMurray Regional Office
2nd Floor, Provincial Building
Fort McMurray, AB T9H 2K4

Attention: Gary Perkins
ERCB Legal Counsel

**Re: TOTAL E&P Joslyn Ltd. (TEPJ)
CEAR Reference No. 08-05-37519
ERCB Application No. 1445535**

Dear Sir:

Further to our letter dated June 24, 2010, as requested by the JRP, please find enclosed the Joslyn North Mine Project Additional Information prepared by TEPJ and dated July 27, 2010.

With respect to the responses to the JRP Additional Information Request (AIR) Questions 2 and 5, the responses are based on the best information currently available to TEPJ. A request for information relevant to Questions 2 and 5 was submitted to Alberta Sustainable Resource Development (ASRD), however, the information has yet to be provided.

Similarly, with respect to the response to AIR Question 6, the response is also based on the best information currently available to TEPJ. A request for the most recent and relevant data based on human-related mortality sources and rates was submitted to ASRD and Alberta Transportation for the VECs included in the Additional Information Project Update, however, the information has yet to be provided.

With respect to the responses to AIR Questions 20 to 26, as documented in our June 24, 2010 letter to the JRP:

- the assessment of project and cumulative effects as it pertains to the SARA-listed species will be completed by the end of August

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- the information on species listed as “Sensitive”, “At Risk” or “May Be At Risk” in the General Status of Alberta Wild Species 2005 will be submitted to ASRD subsequent to project approval.

Yours truly,

A handwritten signature in black ink, appearing to read 'M. Ignasiak', written in a cursive style.

Martin Ignasiak

cc: TOTAL E&P Joslyn Ltd.
Attn: Mr. Geoff Chow

**JOSLYN NORTH MINE PROJECT
ADDITIONAL INFORMATION**

**Submitted to
Government of Canada–Energy Resources Conservation Board
Joint Review Panel**

Total E&P Joslyn Ltd.

July 2010

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Abbreviations

%	percent
3D	three-dimensional
AAAQO	Alberta Ambient Air Quality Objectives
AAC	annual allowable cut
AADT	average annual daily traffic
ACCS	Alberta Culture and Community Spirit
ACFN	Athabasca Chipewyan First Nation
ADRP	Acid Deposition Research Program
AENV	Alberta Environment
AI	Additional Information
AI Project Update	2010 Additional Information Project Update
AIR	Additional Information Request
Al-Pac	Alberta-Pacific Forest Industries Inc.
AOSERP	Alberta Oil Sands Environmental Research Program
ASRD	Alberta Sustainable Resource Development
ARM	Athabasca River Model
bbbl	barrel, petroleum (42 U.S. gallons)
BWS	basal water sand
CALMET	Computer Aided Learning in Meteorology
CALPUFF	California Plume Dispersion Model
Canadian Natural	Canadian Natural Resources Limited
CCME	Canadian Council of Ministers of the Environment
CEAA	<i>Canadian Environmental Assessment Act</i>
CEB	chronic effects benchmark
CEMA	Cumulative Environmental Management Association

cm	centimetre
CNRL	Canadian Natural Resources Limited
CO	carbon monoxide
CONRAD	Canadian Oil Sands Network for Research and Development
CR	Consultant's Report
dBA	"A-weighted" decibels
EIA	environmental impact assessment
ERCB	Energy Resources Conservation Board
FEARO	Federal Environmental Assessment and Review Office
FMA	FMA Heritage Resources Consultants Inc.
FMFN	Fort McKay First Nation
FMU	forest management unit
GPLM	Golder Pit Lake Model
h	hour
ha	hectares
HHRA	Human Health Risk Assessment
HRIA	historical resources impact assessment
HSI	Habitat Suitability Index
HSPF	Hydrological Simulation Program FORTRAN
IFN	instream flow needs
Integrated Application	2006 Integrated Application
ISO	International Organization for Standardization
JCR	Joslyn Creek Realignment
JRP	Joint Review Panel
km	kilometre
km ²	square kilometres

LFH	litter, fermented, humus
LSA	local study area
m	metre
MCFN	Mikisew Cree First Nation
MFT	mature fine tailings
MPOI	Maximum Point Of Impingement
N/A	not applicable
NO _x	oxides of nitrogen
NO ₂	nitrogen dioxide
NRBS	Northern River Basins Study
NSMWG	NO _x /SO _x Management Working Group
PAH	polycyclic aromatic hydrocarbon
PAI	potential acid input
PDA	project development area
PDA	project development area
PM _{2.5}	particulate matter with a mean aerodynamic diameter of 2.5 microns (µm) or smaller
project	Joslyn North Mine Project
PSL	permissible sound level
RAMP	Regional Aquatics Monitoring Program
RMA	Resource Management Area
RSA	regional study area
SAGD	steam-assisted gravity drainage
SARA	<i>Species at Risk Act</i>
Shell	Shell Canada Limited
SI	Supplemental Information

SI Project Update	2007 Supplemental Information Project Update
SIR	Supplemental Information Request
SO ₂	sulphur dioxide
Suncor	Suncor Energy Inc.
Syncrude	Syncrude Canada Ltd.
TEPJ	Total E&P Joslyn Ltd.
TEK–TLU	traditional ecological knowledge and traditional land use
TRS	total reduced sulphur
U.S. EPA	United States Environmental Protection Agency
U.S. NRC	United States National Resource Council
VEC	valued ecosystem component
VOC	volatile organic compound
µg/m ³	micrograms per cubic metre

1.0 Accidents and Malfunctions

Question 1

Provide further information on the probability, potential consequences and environmental effects related to each of the potential accidents and malfunctions listed in the Joslyn North Mine Project Update, 2010, AIR Responses Section 4.0, and Appendix B, including tailings structure failure. More specifically, provide further information regarding the estimated likelihood of each accident or malfunction type, the estimated frequency of occurrence, the duration, magnitude and spatial extent of the effects, and whether or not the effects are reversible.

Response:

For accidents and malfunctions identified in the February 2010 Additional Information Project Update (AI Project Update), Section 4 and Appendix B, see Table 1-1. For each accident or malfunction type, information is presented regarding the probability of occurrence and the potential consequences to public safety and the environment. Specifically, in response to the request for additional information, the table summarizes the likelihood and frequency of occurrence of each event, and the spatial extent, magnitude, duration and reversibility of the effects.

The information in Table 1-1 was derived from TEPJ's internal risk management and evaluation process. Since this process is ongoing, the probabilities and potential consequences for the majority of cases have been assessed on a qualitative or semi-quantitative basis only, consistent with the present preliminary level of project design. It is anticipated that these estimates will be refined in conjunction with detailed design. A brief explanation of the main considerations and terminology used under each heading in Table 1-1 follows. The estimates of likelihood and potential consequences take into account the implementation of any planned protection or mitigation measures.

Frequency of Occurrence

Frequency of occurrence is expressed as a quantitative annual frequency or range of frequencies. For estimated frequencies, categorized based on historical data or expert judgement, see Table 1-2. Frequency refers to the occurrence of the central critical event (i.e., the accident or malfunction).

Likelihood of Occurrence

Likelihood of occurrence is expressed qualitatively and ranges from "likely" to "remote."

Spatial Extent of Effects

Spatial extent of effects is categorized as "internal" (internal to the operational areas of the project), "local" (occurring mainly within or near the project development area) or "regional" (occurring outside the project boundary within the regional surroundings). Effects categorized as internal and occurring during operation of the facility are not considered further as they are not expected to have consequences to public safety and the environment. Specific information regarding spatial extent is provided where available (i.e., as a result of modelling).

Magnitude of Effects

Magnitude of effects is expressed qualitatively and ranges from "moderate" to "disastrous" according to the definitions in Table 1-3a and Table 1-3b. Magnitude is categorized with respect to potential effects on public safety and the environment external to the operational areas of the project.

Duration of Effects

Duration of effects is categorized qualitatively as “short term” (occurring or persisting over hours to days), “medium term” (occurring or persisting over weeks to years, but for less than the operational life of the facility), “long term” (occurring or persisting over the operation life of the facility) or “residual” (extending beyond the operational life of the facility). Duration refers to human and environmental effects rather than the central critical event.

Reversibility of Effects

Effects are categorized with respect to reversibility and the timeframe over which reversal of effects is expected to occur. Reversibility is related to duration of effects. Effects are considered “reversible in the short term” if they cease or can be rectified within the timeframe of short-term effects, or reversible in the long term if they persist beyond the life of the project but will diminish with time.

Table 1-1 Probability and Consequences of Potential Accidents and Malfunctions

Accident or Malfunction	PROBABILITY		CONSEQUENCE (Worst Case)			
	Frequency of Occurrence	Likelihood of Consequence (Worst Case)	Spatial Extent of Effects	Magnitude of Effects	Duration of Effects	Reversibility of Effects
Instability of mine pit slopes Permanent Temporary	10^{-3} to 10^{-4} /year	Remote	Internal (mine pit); local (CNRL road, CNRL lease)	Catastrophic (environmental); major (human)	Medium term	Reversible in short term
	Likely	Remote	Internal (mine pit)	Serious	Short term	Reversible in short term
Failure of tailings pond dykes	6×10^{-4} /pond.year	Very unlikely to remote	Internal (infrastructure); local (JCR and Ells River); regional (mouth of Ells River, Athabasca River)	Disastrous (human and environmental) in local area; major in regional area	Medium term	Reversible in long term
Instability of external disposal areas	10^{-4} to 10^{-5} /year	Remote	Local (CNRL road, CNRL lease)	Catastrophic	Medium term	Reversible in short term
Overtopping of tailings dykes	Remote	Remote	Internal (perimeter ditch system); local (JCR and potentially Ells River)	Serious to major	Medium term	Reversible in long term
Seepage through tailings dykes and ponds	1.3×10^{-4} /pond.year	Very unlikely	Internal (perimeter ditch system); local (soil and groundwater)	Moderate to serious	Medium to long term	Reversible in long term
Release of runoff and process-affected water to surface water	Very unlikely	Very unlikely	Internal (perimeter ditch system); local (JCR and potentially Ells River)	Major	Medium term	Reversible in long term
Erosion of pit lakeshore	Unlikely	Very unlikely	Local (Ells River); regional (Athabasca River)	Moderate	Short term	Reversible in short term
Erosion or failure of closure landforms	Very unlikely	Very unlikely	Local (JCR and Ells River); regional (Athabasca River)	Moderate	Short term	Reversible in short term
Tailings water spill to surface water	Extremely unlikely	Remote	Internal (infrastructure); local (JCR and Ells River); regional (mouth of Ells River, Athabasca River)	Major	Medium term	Reversible in long term
Failure of Joslyn Creek Realignment (JCR) system	Extremely unlikely	Extremely unlikely	Local (JCR and Ells River); regional (Athabasca River)	Major	Medium term	Reversible in short term
Failure of offstream storage pond dam	Unlikely	Unlikely to very unlikely	Local (Ells River); regional (Athabasca River)	Moderate	Short term	Reversible in short term
Failure/plugging of water intake screens	Very unlikely	Very unlikely to remote	Local (Athabasca River adjacent to intake)	Moderate	Short term	Reversible in short term
Spill or release from onsite landfill or waste storage/transfer facility	Very unlikely	Remote	Internal (EDA-B area); local (CNRL road)	Moderate to serious	Short term	Reversible in short term

Table 1-1 Probability and Consequences of Potential Accidents and Malfunctions (cont'd)

Accident or Malfunction	PROBABILITY		CONSEQUENCE			
	Frequency of Occurrence	Likelihood of Consequence (Worst Case)	Spatial Extent of Effects	Magnitude of Effects	Duration of Effects	Reversibility of Effects
Accidental spill/release of hazardous materials during normal operations: hydrocarbon tanks/pipelines	8.23 x 10 ⁻⁴ /tank.year	Extremely unlikely to remote	Internal (facilities and infrastructure); local (CNRL road)	Moderate to major	Short term	Reversible in short term
Accidental Spill or Release of Hazardous Materials during normal operations: solvent storage	7.6 x 10 ⁻³ (worst case)	Very unlikely to remote	Internal (facilities and infrastructure); local (CNRL road)	Serious to major	Short term	Reversible in short term
Accidental spill or release of hazardous materials during normal operations: tailings line	Likely	Unlikely	Internal (facilities and infrastructure); local (soil and groundwater, if perimeter ditch capacity exceeded)	Moderate to major	Short term	Reversible in short term
Accidental spill or release of hazardous materials during normal operations: other chemicals	Likely	Unlikely	Internal (facilities and infrastructure)	Moderate to serious	Short term	Reversible in short term
Emissions during emergency flaring	Likely	Unlikely	Internal; local	Moderate	Short term	Reversible in short term
Failure of vapour recovery systems	Unlikely	Extremely unlikely to remote	Internal; local	Moderate [Note: this event would trigger flaring]	Short term	Reversible in short term
Traffic accident caused by increased traffic volume	Likely to unlikely (local/regional)	Unlikely to very unlikely (local/regional)	Internal; local (CNRL road); regional (Highway 63)	Moderate to serious	Short term	Irreversible (human); reversible in short term (environmental)
Excess release of solvent to tailings pond	Likely	Very unlikely	Internal (tailings pond)	Moderate to serious	Short term	Reversible in short term
Waterfowl interaction with tailings ponds	Likely	Likely	Local; regional	Serious to major	Short term	Irreversible (individual basis); reversible in short term (population basis)
Impact of Joslyn SAGD area on project [effects on tailings dyke stability]	Extremely unlikely	Remote	Internal; local; regional [see tailings dyke failure]	Disastrous (human and environmental) in local area; major in regional area	Medium term	Reversible in long term

Table 1-2 Incident Frequency Categories

Frequency Category	Definition for Qualitative Assessment	Frequency Range (occurrence/yr)
Likely	Could occur several times over plant lifetime.	Above 10 ⁻²
Unlikely	Could occur once for every 10 to 20 similar plants over 20 to 30 years of plant lifetime.	10 ⁻² – 10 ⁻³
Very unlikely	One time per year for at least 1000 units. One time for every 100 to 200 similar plants in the world over 20 to 30 years of plant lifetime.	10 ⁻³ – 10 ⁻⁴
Extremely unlikely	Has already occurred in the industry but corrective action has been taken.	10 ⁻⁴ – 10 ⁻⁵
Remote	Event physically possible but has never or seldom occurred over a period of 20 to 30 years for a large number of sites (above few thousands, e.g., process vessels, storage).	Below 10 ⁻⁵

Table 1-3a Incident Severity Category for Physical Injury Levels

Severity Level	Parameter	Number of Offsite People Exposed
Moderate	IEZ ²	–
Serious	IEZ	1 to 9
Major ¹	IEZ	10 to 99
	LE1% ²	1 to 9
	Fatality	–
Catastrophic ¹	IEZ	100 to 999
	LE1%	10 to 99
	Fatality	1
Disastrous ¹	IEZ	Above 999
	LE1%	Above 99
	Fatality	Above 2

NOTES:

¹ Worst-case combination should be considered for establishing the damage severity level for Major, Catastrophic and Disastrous.

² The damage severity associated with physical injury to offsite people is determined based on the following hazard intensity levels:

- number of people exposed within the irreversible effects zone (IEZ) of a hazard intensity level. The irreversible effect threshold corresponds to the value below which significant effects are not observed for the majority of individuals.
- number of people exposed within 1% lethality zone of a hazard intensity level – the LE1% zone. LE1% stands for lethal effect threshold; it corresponds to the value below which more than 1% of deaths among the exposed population is not observed.
- number of people exposed within fatal exposure zone of a hazard intensity level – the Fatality zone

Table 1-3b Spill Intensity Levels for Environmental Incident Category

Severity Level	Spill Event, Intensity Levels	Intensity Expressed As Oil Spill Volume
Moderate	Spill or release requiring notification to authorities, but without environmental consequences.	Below 0.1 bbl
Serious	Moderate spill within site limits.	0.1 – 10 bbl
Major	Significant spill external to the site. Evacuation of personnel.	10 – 200 bbl
Catastrophic	Spill with reversible environmental consequences external to the site.	200 – 2000 bbl
Disastrous	Major and sustained spill external to the site and extensive loss of aquatic life.	Above 2000 bbl

Question 2

Provide historical data on past instances of wildlife/tailings ponds interaction in the Oil Sands region after 1965. Include information on the numbers of birds involved in each incident, mortality rates, and the deterrent systems in place at the time.

Response:

Specific information on instances of wildlife/tailings pond interactions in the Athabasca oil sands region is available from operators of tailings ponds since the time when they either developed operational ponds, or since they started reporting to regulatory agencies on such interactions. No information is available before 1976. Summaries of recoveries of birds or wildlife from tailings ponds have been reported monthly/annually to federal and provincial regulatory agencies as a requirement of regulatory permits or approval. Reporting on specific incidents is not available except in rare events.

Similar bird-deterrent systems are operated by each of the oil sands companies, consisting primarily of human or falcon effigies and noise scare-cannons, with other system additions depending on the operator or site. These deterrent systems are typically deployed in early spring (April) and kept in place until autumn (October), with this timing influenced by the typical annual presence of migratory birds. Following is a summary of bird-deterrent systems at oil sands operations.

Bird-Deterrent Systems

The development of deterrent systems, and alternative deterrent devices or techniques considered, were documented in a 2000 report for the Oil Sands Bird Protection Committee (Golder 2000). As noted in that report, "Suncor and Syncrude have conducted a variety of scientific studies to determine ways to minimize bird contact with tailings ponds. This research has led to the development of deterrent systems that are maintained during the open-water periods of the year. Both operating companies have also completed studies to assess the effectiveness of their bird-deterrent systems. The primary focus of the studies as well as the deterrent systems has been on tailing ponds, although efforts to deter birds from other pond areas, buildings, other structures and equipment have also been undertaken by the oil sands operators."

The Oil Sands Bird Protection Committee was formed in 1978 to monitor bird/tailings pond interactions in the oil sands area. The committee, which originally consisted of representatives from Suncor, Syncrude, Canadian Wildlife Service and Alberta Fish and Wildlife, held semi-annual meetings until 1994, when regular meetings were discontinued because the deterrent programs at Suncor and Syncrude were deemed comprehensive and consistent. The committee was reactivated in 1999 so oil sands companies and regulators could continue to share information and review and possibly enhance the current successful strategies for bird protection.

The bird-deterrent programs developed for the oil sands mining operations stemmed from research completed in the 1970s. Initial research included work by Boag and Lewin (1979), research for an M.S. thesis (Gulley 1980) at Suncor, and studies at Syncrude by Christiansen and Yonge (1979), Smith and Yonge (1980a, 1980b) and Van Meer and Arner (1985a,b). These initial studies indicated that the most effective deterrent systems included a combination of human effigies designed to be mounted on floating platforms on the tailings pond surfaces, or to be placed along pond shorelines, combined with some form of noise scare-cannons. Other deterrent devices were tested and used in specialty situations (e.g., Phoenix Wailer along shorelines). The Phoenix Wailer produces random variations of irritating electronic sounds that alternate between speakers and at varying speeds, resulting in a stress environment meant to unsettle birds.

Operator-Specific Deterrent Systems

Following is a summary of the deterrent systems deployed by three oil sands operators, Suncor Energy Inc. (Suncor), Syncrude Canada Ltd. (Syncrude) and Shell Canada Ltd. (Shell), each of which have active oil sands tailings ponds. The information was either provided directly by the operators (Suncor and Shell), or taken from publicly available documentation (Syncrude). As Canadian Natural has not provided information to TEPJ, details for that operator are not included in the summary. As well, only Suncor and Shell provided to TEPJ detailed year by year information on recoveries of birds from tailings ponds.

Suncor Energy Inc. Lease 86/17, Millennium/Steepbank/South Tailings Pond Areas

Suncor began implementing regular avifauna surveys in 1976 concurrent with research on the effectiveness of bird-deterrent systems on tailings ponds. Suncor established that a combination of human effigies and propane noise scare-cannons were key elements of a deterrent system.

Suncor currently uses a variety of deterrent techniques to prevent birds from landing on the tailings ponds. Techniques include:

- human effigies
- propane scare-cannons
- Phoenix Wailer sound system

Suncor's annual surveys of its tailings ponds include monitoring of bird interactions with tailings ponds as well as the status of deterrent systems. The operational efficiency of the deterrent systems has been monitored by tracking the numbers of effigies and the number of cannons firing, as well as by monitoring the number of birds that interact with tailings ponds.

Syncrude Canada Ltd., Mildred Lake and Aurora North Tailings Pond Areas

Information on the Syncrude bird-deterrent programs is based on the Syncrude Southwest Sand Storage Area Conversion application (Syncrude 2008, Appendix I2), as follows:

Various techniques are used to deter waterfowl from Syncrude process ponds, including:

- *electronically triggered, propane-fired noise scare-cannons along the shoreline perimeter (which deter waterfowl by emitting a loud bang noise,*
- *effigies (scarecrows) along the shoreline perimeters,*
- *rafts with scare-cannons and effigies that are anchored in the water, and/or*
- *booming around the process pond inlets.*

The scare-cannons are the primary deterrent mechanism. The firing frequency of the units can be varied from 20 to 180 seconds. During peak migratory times, the cannons fire at higher frequencies. The frequency is lowered for other times of the season.

Shell Canada, Albian Sands Muskeg Rive Mine Tailings Pond Area

Bird-deterrent systems were evaluated for the Albian Sands Muskeg River Mine through a University of Alberta M.Sc. program that considered an alternative system to activate the propane scare-cannons, described in Ronconi and St. Clair (2003, 2005). Research on the Muskeg River Mine site led to development of a modified deterrent system. The fundamental bird-deterrent system includes propane scare-cannons, human effigies and other on-pond systems consisting of multiple pieces of equipment on a floating platform: propane-fired cannon, strobe light, mechanical peregrine falcon effigy and speaker that emits aggressive calls from predatory birds such as falcons or hawks.

The external tailings facility acts as primary containment for tailings produced by Albion's Muskeg River Mine. For up to eight months of the year (late March to late October), a bird-deterrent system that uses BirdAvert™ technology, a marine RADAR system operated with radio telecommunications through customized computer software, monitors the airspace over the tailings pond for presence of waterfowl and other avian species. Once the system has detected the presence of waterfowl or other avian species, it activates the bird-deterrent equipment "on-demand."

Within the network of floating platforms, certain floats are chosen to contain repeaters, which re-broadcast the radio signal to deterrents that are out of range or are purposely connected to increase coverage of a given zone. In most cases these are land-based platforms that use only propane-fired cannons along the shoreline of the tailings pond. These cannons are designed to have receivers, which activate the cannon upon receipt of repeated signals from specific floating deterrents.

Summary of Bird Recovery Data

For a summary of annual bird recoveries between 1975 and 2009 for oil sands projects with active tailings ponds in operation during each of those years, see Table 2-1. Data are shown only where information was provided directly to TEPJ by the respective operators – Suncor and Shell. Table 2-1 shows the number of annual bird recoveries by operator throughout the reporting period, as well as an average per year for the operators.

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Table 2-1 Summary of Oil Sands Bird-Deterrent Systems and Bird Recoveries

Parameters	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Suncor Energy													
System in Place	n	e	e	e	f	f	f	f	f	f	f	f	f
Annual Recoveries	87	77	120	110	303	233	141	58	57	45	50	84	75
Shell (Muskeg River Mine)													
System in Place	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Annual Recoveries	0	0	0	0	0	0	0	0	0	0	0	0	0
NOTE: n/a = Not applicable (no operating tailings ponds); n = no deterrents; e = effigies only; f = effigies and scare-cannons.													

Parameters	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Suncor Energy													
System in Place	f	f	f	f	f	f	f	f	f	f	f	f	f
Annual Recoveries	52	137	105	97	197	139	88	43	76	77	83	48	205
Shell (Muskeg River Mine)													
System in Place	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Annual Recoveries	0	0	0	0	0	0	0	0	0	0	0	0	0
NOTE: n/a = Not applicable (no operating tailings ponds); e = effigies only; f = effigies and scare-cannons.													

Parameters	2001	2002	2003	2004	2005	2006	2007	2008	2009	TOTAL	AVERAGE PER YEAR
Suncor Energy											
System in Place	f	f	f	f	f	f	f	f	f		
Annual Recoveries	24	20	20	16	7	12	18	39	45	2,988	85.4
Shell (Muskeg River Mine)											
System in Place	N/A	N/A	f	f	f	f	f	f	f		
Annual Recoveries	0	0	12	2	7	3	26	7	12	69	9.9
NOTE: N/A = Not applicable (no operating tailings ponds); e = effigies only; f = effigies and scare-cannons.											

2.0 Cumulative Effects – Air Quality

Question 3

In addition to the information provided in Total’s response to the September 2008 Question 2 from the Panel, provide

- a. a comparison of the preindustrial (1965) conditions with the baseline assessment case presented in Total’s February 2010 Additional Information Project Update,

Response:

Table 3-1 lists concentrations of emissions included in the pre-industrial case (see the response to February 2010 AIR Question 2) as well as concentrations estimated from baseline modelling (see the AI Project Update, Section 14.3.2.1 and Appendix C).

Table 3-1 Pre-Industrial and 2010 Baseline Concentrations (Annual Average Predictions)

	NO ₂ (µg/m ³)	SO ₂ (µg/m ³)	CO (µg/m ³)	Aromatics (µg/m ³)
Pre-industrial Background	0.2 to 0.6	1.2	115 to 230	0.38
AI Project Update Baseline – Fort McKay	31	3.9	777 ^(a)	0.52
AI Project Update Baseline – Fort Chipewyan	5	0.6	139 ¹	0.007
Alberta Air Quality Objective (annual)	60	30	6000 (8 h)	n/a
NOTES: ¹ maximum 8 h average. N/A = not applicable.				

- b. an analysis of the effects that may have already been experienced prior to the proposed project using the comparison of results from (a) above,

Response:

Table 3-1 includes baseline predictions (see AI Project Update) at Fort McKay, in the heart of oil sands development, and Fort Chipewyan, relatively distant from development and subject to local emission sources. These values represent the effects predicted for the area before the project.

Predicted concentrations at Fort McKay are higher than at Fort Chipewyan, largely reflecting differences in the amount of industrial activity near the two locations. The changes at Fort McKay do reflect the influence of the existing oil sands developments in the area, as evident from the changes in concentrations. However, as noted in Table 3-1, the predicted concentrations remain well below guideline values.

The analyses of air quality indicators detailed for the project in the AI Project Update, Section 14, Table 14.2-11 provided an indication of the effects of industrial activity experienced before the project, as well as including the project. The project’s contributions to changes in air quality are very small, as detailed in Section 14.2.

- c. an assessment of the significance of effects, and clearly indicate what threshold or definition is used to determine the significance of the cumulative effects.**

Response:

For the cumulative effects of the proposed project to be considered significant in the air quality assessment, all the following should apply (see the response to Question 19):

- effects should be negative
- effects should be more than local in extent
- effects should be irreversible
- magnitude of effect should be above Ambient Air Quality Objectives (AAQOs) or standards where applicable (see the AI Project Update, Section 14, Table 14.2-2 to Table 14.2-6), or greater than a 10% increase where no objectives or standards exist

The AI Project Update, Section 14, Table 14.2-11 listed significance ratings for air quality indicators, as a change from Baseline to project, including effects of all projects contributing to the Baseline Case. The following relate to project effect ratings:

- project air quality effects were considered to be local in extent, continuously occurring (emissions are continuous and upset cases are considered separately), long lasting (for the life of the project) but reversible after project operations cease, and negative in direction
- the project does not create new exceedances of AAQOs at the maximum point of impingement (MPOI) or at any community receptor
- the magnitude of most project-only effects was low, except for:
 - CO concentrations, which were considered to be high magnitude as concentrations at the nearest community increased by more than 10% (although concentrations were much less than AAQOs)
 - benzene and b(a)p concentrations as concentrations at the nearest community increased by more than 10% (although concentrations were less than AAQOs)
 - deposition of potential acid input (PAI) and nitrogen (increases greater than 5% above baseline)
 - metals where the project contribution was rated as nil because of the high (Baseline) background
- confidence ratings were generally high for project contribution predictions except for deposition of PAI and nitrogen, which are considered to have higher modelling uncertainties, and for emissions of VOCs and PAHs where additional emission uncertainties exist

Overall, potential effects of the project on all air quality indicators are considered insignificant.

3.0 Cumulative Effects – Wildlife

Question 4

Provide a map of Forest Management Units of the Resource Management Area (RMA) relative to the Regional Study Area (RSA):

- a. Provide a chart listing the annual allowable cut for each of the Forest Management Units within the RSA.**

Response:

There is only one forest management unit (FMA) – FMU A15 – in the RSA (see Figure 4-1). The annual allowable cut (AAC) for FMU A15 is:

- for total deciduous AAC – 478,036 m³/a
- for FMU coniferous ACC – 306,912 m³/a

References

ASRD (Alberta Sustainable Resource Development). 2008. *Approval – Alberta Pacific's Forest Management Plan Revision Annual Allowable Cuts*. Accessed July 14, 2010. Available at: http://srd.alberta.ca/ManagingPrograms/ForestManagement/ForestManagementPlanning/ForestManagementPlans/documents/AlbertaPacificForestProducts/ALPAC_amended_allowable_cuts_Nov_2008.pdf.

- b. List the volume and area harvested in each of the last 5 years, and the next 25 years of projected harvests, broken down by areas harvested for oil sand projects, and normal harvest areas.**
- c. Include a breakdown for the coniferous and deciduous resources.**

Response to 4b and 4c:

Al-Pac has no plans to harvest timber from FMU A15 in areas outside the planned oil sand development areas; all future harvesting will take place within development footprints (Pope 2010, pers. comm.). Coniferous harvesting is also done within areas of planned oil sands developments.

Total harvest volumes and areas in FMU A15 for the years 2005 to 2009 (see Table 4-1) were provided by Al-Pac in a July 14, 2010 email from Don Pope. The breakdown for coniferous and deciduous resources harvested was not provided in this email since Al-Pac does not harvest coniferous trees nor are they provided with the harvest information since the permit holders submit this information directly to the provincial Government (Pope 2010, pers. comm.).

The harvesting details for the next 25 years are not available since the current harvesting plan (spatial harvest plan) does not go beyond 2016. The spatial harvest plan for FMU A15, illustrating the areas that will be harvested between 2001 and 2016, can be found on the ASRD website at:

http://www.srd.alberta.ca/ManagingPrograms/ForestManagement/ForestManagementPlanning/ForestManagementPlans/documents/AlbertaPacificForestProducts/A15_SHS.pdf.

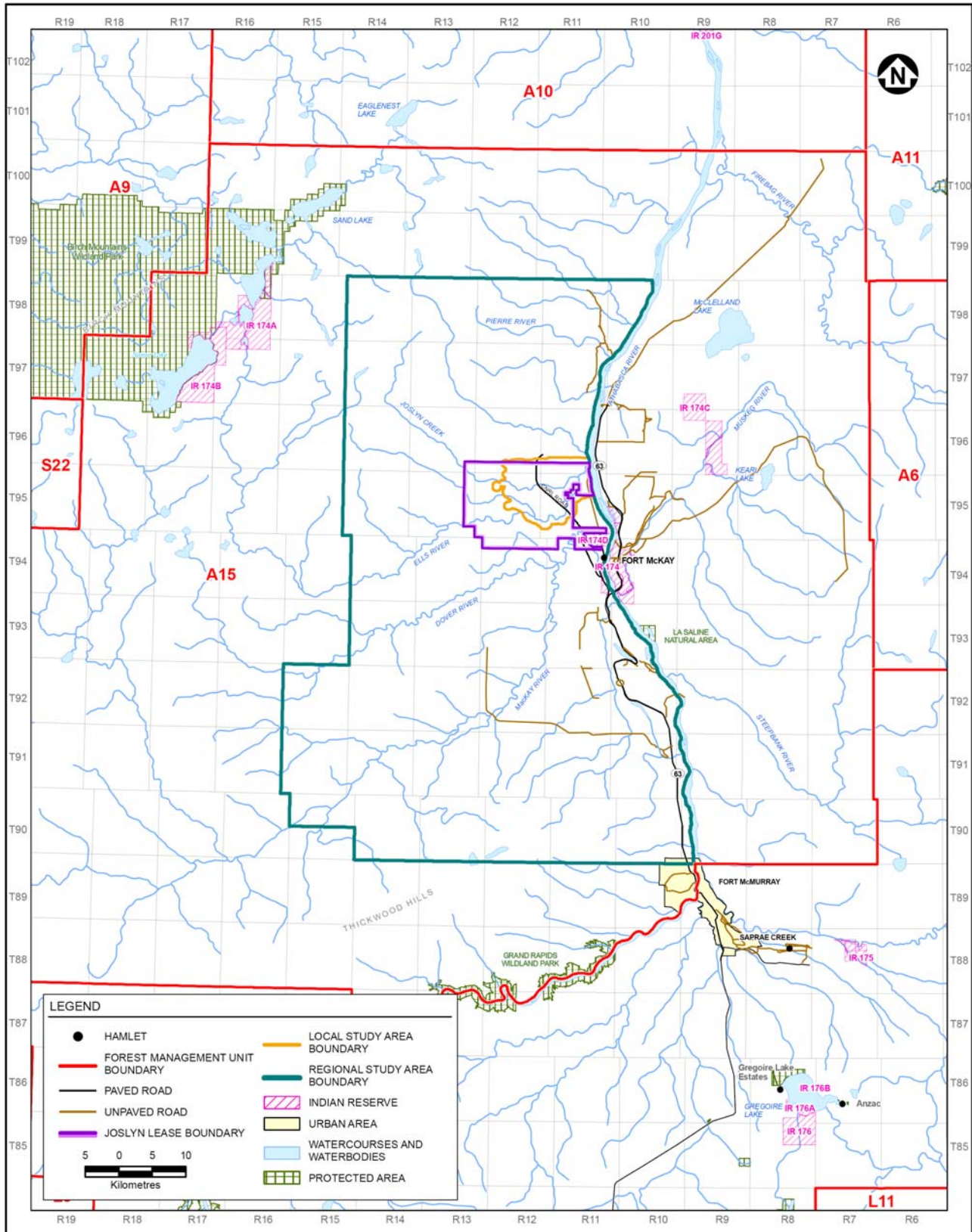


Figure 4-1 Forest Management Units in the Regional Study Area

Table 4-1 Harvest Areas and Volumes from 2005 to 2009 in FMU A15 (the RSA)

Year	Harvest Area (ha)	Total Harvest Volume – Actual (m ³ /a)
2005	10,100	539,922
2006	9,300	434,690
2007	7,700	902,827
2008	6,250	682,773
2009	8,000	520,476

References

- ASRD (Alberta Sustainable Resource Development). 2008. *Approval – Alberta-Pacific’s Forest Management Plan Revision Annual Allowable Cuts*. Accessed July 14, 2010.
http://srd.alberta.ca/ManagingPrograms/ForestManagement/ForestManagementPlanning/ForestManagementPlans/documents/AlbertaPacificForestProducts/ALPAC_amended_allowable_cuts_Nov_2008.pdf.
- Pope, D. 2010. Integrated Land Management Specialist. Alberta-Pacific Forest Industries. Edmonton, Alberta. Telephone conversations and email. July 14, 19 and 20, 2010.

Question 5

For each of the wildlife species that were identified as valued environmental components (VECs), provide regional wildlife population estimates for the following time periods: predisturbance (1965), project start up and 2037.

Response:**Background**

The following response provides population estimates for wildlife species identified as valued ecosystem components (VECs) in the AI Project Update. Estimates are provided for the temporal scenarios considered in the AI Project Update:

- pre-industrial disturbance (1965)
- Baseline Case (existing and approved projects at full buildout) to address project start-up
- Application Case (2037, existing and approved projects, including the Joslyn North Mine Project, all at full buildout with no reclamation)
- Planned Development Case (existing, approved projects and disclosed projects (including Joslyn) at full buildout with no reclamation)

As three of the VECs addressed in the AI Project Update represent either a species group (waterfowl) or species communities (mixedwood forest and old-growth bird communities), no “population” estimates have been provided for these species associations. The response to Question 20 provides population estimates for several SARA-listed species that fall within these groups and that are likely to occur in the regional study area (RSA).

The analysis assumes that the term “regional wildlife population estimate” in Question 5 refers to the estimated number of animals in the RSA defined in the AI Project Update. Because of a lack of information, it is not possible to estimate numbers for genetically or ecologically defined population boundaries. Moreover, such boundaries would likely represent a geographic area far greater than the RSA, which could trivialize project-related effects for some if not all the VECs.

Assessment Methods: Estimating Wildlife Populations in the RSA

Wildlife populations in the RSA were estimated based on best available information. Sources of information were used in the following priority sequence (depending on availability):

1. data from the RSA
2. data from the oil sands region
3. data from northern Alberta
4. data from boreal forest ecosystems
5. data from other forested ecosystems

There is little provincial information on regional wildlife populations for the pre-disturbance (1965) case and traditional knowledge does not provide the quantitative information necessary for such calculations. Therefore, pre-disturbance population estimates were based on the current capability of the land to support wildlife without human-related disturbance. Existing disturbances were “removed” from the RSA and replaced with natural vegetation anticipated in the absence of such disturbances. This was done considering adjacent vegetation characteristics, pre-disturbance airphotos (where available) and known ecological relationships. Population estimates were developed based on known habitat/density relationships for the region or relevant literature, including 1970s sources.

Population estimates were developed in one of two ways, depending on the information available:

- Where density estimates were available, the population size was calculated as density multiplied by the area of available habitat in the RSA. Where possible, density estimates were estimated for high-, moderate- and low-quality habitat, based on the range of densities reported. These densities were then applied across the RSA, based on the availability of these habitat classes presented in the AI Project Update.
- Where density estimates were not available for a species, the RSA population was estimated based on the best available information on its home range or territory size. This analysis assumed that territories do not vary in size between sexes. The population size was estimated by dividing the total available habitat (identified by the wildlife models) by the home range of the species (as estimated in the literature), assuming no overlap of territories to accommodate breeding activities. To accommodate habitat differences across the landscape, smaller territory sizes (and higher animal densities) were assigned to higher-quality habitat, and larger territory sizes were assigned to poorer-quality habitats.

No estimates of population density or home range were found for Canadian toads, which made it impossible to calculate a population estimate for that species. For information on yellow rail, see the response to Question 20.

Results

Moose

Most moose population information is based on density estimates generated from mid-winter aerial surveys in the oil sands region by the province and oil sands developers. As moose tend to prefer more open, upland forests and wetlands at this time of the year, aerial counts capture a relatively high proportion of the animals in the survey area. However, the majority of the surveys were not stratified by habitat type and, as a result, did not provide density estimates by habitat quality.

Moose densities presented in the literature range from 0.54 moose/km² to less than 0.1 moose/km², including an observed density of only 0.09 moose/km² in the local study area (LSA) for the project (Wiacek et al. 2002; Golder 2009). The great majority of densities reported for the oil sands area are less than 0.3 moose/km².

For RSA population estimates, densities of 0.5, 0.3 and 0.1 moose/km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the range of densities presented in the literature. The high value of 0.5 moose/km² reflects provincial data from the 1970s, before the major increase in industrial activity occurred in the area. The mid-value of 0.3 moose/km² represents the high end of the majority of densities reported over the last 20 years, and the low value of 0.1 moose/km² represents the lower end of the range of densities reported at both the scale of the wildlife management unit (WMU) and the LSA.

Black Bear

Population information for black bear was largely derived from Alberta Oil Sands Environmental Research Program (AOSERP) research in the late-1970s and early 1980s. Fuller and Keith (1980) estimated densities of 0.25 to 0.50 bears/km² in the AOSERP area, based on territory size of cubless females, while Young (1978) estimated densities of 0.18 to 0.25 bears/km², based on Cold Lake data and habitat comparisons between areas (in Wiacek et al. 2002).

For RSA population estimates, densities of 0.5, 0.3 and 0.18 bears/km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the range of densities presented in the literature. As the high value of 0.5 bears/km² reflects AOSERP data from the 1970s, before the major increase in industrial activity occurred in the area, it is likely a fair representation of bear densities from undisturbed, higher-quality upland habitats (i.e., Fort Hills complex).

Fisher

Most data for fisher in the oil sands region originates from winter track count surveys completed as part of EIAs (Wiacek et al. 2002). However, track count survey data must be interpreted with caution as they are susceptible to environmental and behavioural variation (Wiacek et al. 2002). Although they can provide a reasonable index of the relative abundance and distribution of fisher (Thompson et al. 1981), they cannot be easily used to estimate populations.

Research in North America examining home range size of fishers can be used to estimate population size. Overall, North American home range areas for fisher range from 4 to 32 km² for females and 19 to 79 km² for males (Badry 2004), with mean home range sizes of 38 km² for males and 15 km² for females (Powell 1994 in Badry 2004). In Alberta, Badry et al. 1997 (in Badry 2004) found that translocated fishers had home ranges of 24.3 km² and 14.9 km² for males and females respectively, which were similar to home range sizes of fishers in eastern North America.

For RSA population estimates, home range sizes of 19 km², 24 km² and 38 km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the variation in home ranges presented in the literature. It was assumed that each home range is occupied by two fishers to account for the anticipated overlap of male and female territories. As the high value of 19 km² reflects the small end of the range of male home ranges for North America, which in turn would provide a high population estimate, it likely represents the upper end of fisher densities from undisturbed, higher-quality habitats in the oil sands region and the project RSA.

Canada Lynx and Snowshoe Hare

Determining population estimates for Canada lynx and snowshoe hare is problematic because of the linked population cycles between these two species, as lynx are obligate predators of snowshoe hare. Overall, hare populations in the northern boreal forest reach peaks approximately every 10 years, with population densities changing 2- to 200-fold (Brand and Keith 1979; Boutin et al. 1995 in Wiacek et al. 2002). Based on this, population densities of snowshoe hares between high and low years range from 800 to 1200 hares/km² to <50 hares/km² (Keith 1974 in Wolff 1980).

Lynx populations exhibit a delayed density-dependent cycle, lagging 1-2 years behind that of hares, with population densities changing 3- to 17-fold during one cycle (Mowat et al. 1999; Krebs et al. 2001 in Wiacek et al. 2002). Overall, reported lynx population densities range from < 2 lynx/100 km² at population lows to 37.2 lynx/100 km² during peak densities (Koehler and Aubry 1994). In the northern boreal forest, Mowat et al. (1999) found that peak lynx densities can vary substantially based on habitat with densities in recent burns (30 to 45/100 km²) being higher than in mature forests (8 to 20 /100 km²). Lows in lynx population densities are typically < 3 lynx/100 km² (Mowat et al. 1999).

To better represent the variation on population dynamics in the RSA, a density estimate for both population peaks and lows is provided for both VECs. For peak lynx populations, densities of 0.4, 0.25 and 0.1 lynx/km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the range of densities presented in the literature. For low lynx population cycles, densities of 0.03, 0.02 and 0.01 lynx/km² were assigned to high-, moderate- and low-quality habitat, respectively.

For peak hare populations, densities of 1200, 1000 and 800 hare/km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the range of densities reported in the literature. For low hare population cycles, densities of 50, 30 and 10 hare/km² were assigned to high-, moderate- and low-quality habitat, respectively.

American Beaver

The majority of population-related information for beaver in the oil sands region was derived from density estimates generated from aerial surveys focused on counting lodges along watercourses. Surveys in the LSA documented an active lodge density of 0.75 lodges/km of watercourse (Golder 2009). This falls within the range of densities recorded in previous surveys in the oil sands region (Golder 2009). In other regional surveys, active lodge density has varied from 1.17 lodges/km for the CNRL Horizon Project (Canadian Natural 2002), 0.69 lodges/km for the Shell Jackpine Mine – Phase 1 Project (Shell 2002) and 0.62 lodges/km for the Shell Jackpine Mine Expansion (Shell 2007). Densities derived from research undertaken by the AOSERP in the late 1970s were much lower; ranging from 0.32 lodges/km of stream (Searing 1979 in Wiacek et al. 2002) to 0.40 lodges/km of stream (Gilbert 1979 in Wiacek et al. 2002). This possibly reflects the higher trapping pressures exerted on beaver at that time.

Typically, beaver abundance is best measured by the density of food caches in an area because each colony constructs only one food cache, but might use more than one lodge (Fuller 1953; Gunson 1970; Salter and Duncan 1986, all cited in Wiacek et al. 2002). As data on beavers in the oil sands region are typically recorded as lodge density, it was assumed that one colony had two lodges associated with it. On average, beaver colony size is approximately 6.3 animals (Searing 1979 in Wiacek et al. 2002).

For RSA population estimates, densities of 1.17, 0.72 and 0.4 beaver lodges/km of watercourse were assigned to high-, moderate- and low-quality habitat. These values conservatively capture the range of densities presented in the literature, with a focus on the estimates adjacent to the Joslyn Lease.

To calculate the beaver population estimate, lodge density was multiplied by stream length, divided by two (assuming two lodges per colony) and then multiplied by 6.3 (average beaver colony size after Searing 1979 in Wiacek et al. 2002). The value of 1.17 lodges/km of watercourse was used to best represent high-quality habitat as it is one of the highest-recorded densities in the region.

Ruffed Grouse

Population information for ruffed grouse has largely been derived from AOSERP research in the late 1970s (e.g., Hennan et al. 1977; Francis and Lumbis 1979, both cited in Wiacek et al. 2002). Hennan et al. 1977 (in Wiacek et al. 2002) estimated densities of grouse for a variety of habitat types in the AOSERP area ranging from 0.03 to 0.08 male grouse/ha, while Collister and Kansas 1997 (in Wiacek et al. 2002) reported 0.03 to 0.04 breeding pairs/ha in the Kearl Lake area. Overall, densities of territorial males/breeding pairs in the oil sands region is generally <0.1/ha (Wiacek et al. 2002). This value is lower than that reported for the southern boreal forest of central Alberta (densities 0.12 to 0.22 males/ha in aspen forest; Rusch and Keith 1971).

For RSA population estimates, densities of 8, 5 and 2 male grouse/km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the range of densities presented in the literature. These estimates were then multiplied by two to account for one female to be associated with each male. As the high value of 8 male grouse/km² reflects AOSERP data from the 1970s, before the major increase in industrial activity occurred in the area, it is likely a fair representation of grouse densities from undisturbed, higher-quality upland habitats in the RSA.

Northern Goshawk

Most western populations of goshawks at mid-latitudes support nesting densities of approximately 3.6 to 10.7 pairs/100 km² (Squires and Reynolds 1997). Density information for northern goshawks in boreal ecosystems is limited. Studies in Alaska found densities of 0.3 to 2.4 pairs/100 km² (McGowan 1975 in Squires and Reynolds 1997) while studies in the Yukon Territory found 5 pairs/100 km² (Doyle and Smith 1994). Mahon (1999) found 4 to 6 pairs/100 km² in west-central British Columbia, a range that also falls in the middle of most North American estimates.

For RSA population estimates, densities of 0.07, 0.05 and 0.03 pairs/km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the range of densities reported in the literature. As the high value of 0.07 pairs/km² falls at the higher end of western North American estimates, it is likely the most accurate representation of goshawk densities from undisturbed, higher-quality upland habitats available in the RSA.

Great Gray Owl

Great gray owl densities can vary greatly in response to food supply and/or nest site availability (Bull and Duncan 1993). In North America, relatively high nesting densities have been reported in Oregon (0.74 pairs/km² and 1.72 pairs/km² [Bull and Henjum 1990]); 1.88 pairs/km² were reported in Manitoba and Minnesota (Duncan 1987 in Bull and Duncan 1993); 0.66 pairs/km² were reported in California (Winter 1986 in Bull and Duncan 1993).

For RSA population estimates, densities of 1.88, 1.38 and 0.88 pairs/km² were assigned to high-, moderate- and low-quality habitat, respectively, to conservatively capture the range of densities presented in the literature. As the high value of 1.88 pairs/km² reflects relatively undisturbed forested ecosystems in the boreal zone (Manitoba), it was used to best represent owl densities in higher-quality upland habitats available in the RSA.

Summary

For population estimates for all VECs, except for Canadian toad, for pre-industrial (pre-development), Baseline Case, Application Case and Planned Development Case, see Table 5-1.

The analysis concludes that wildlife populations in the RSA have already declined an average of 19% relative to pre-industrial conditions (ranging from a loss of 9% for beaver to 37% for moose). These declines are based solely on estimated changes in wildlife habitat of VECs, including direct losses from industrial footprints and indirect losses in adjacent zones of influence from sensory disturbance. In other words, at baseline wildlife populations in the RSA average 81% of their pre-industrial levels (ranging from 63% to 91%).

The project would result in an additional 1% reduction in wildlife populations in the RSA population, relative to the pre-industrial case. Wildlife populations in the application case are 10% to 38% lower than the pre-industrial case. Or put another way, in the Application Case, wildlife populations in the RSA average 80% of their pre-industrial levels (ranging from 62% to 90%).

Compared with the Application Case, the Planned Development Case would result in additional reductions in wildlife populations, ranging from 6% to 9% of the pre-industrial population. Thus, the cumulative effects of all existing, approved and disclosed projects (including the Joslyn North Mine Project) assuming full buildout and no reclamation, would result in reductions in wildlife populations ranging from 19% (beaver) to 44% (moose), relative to pre-industrial conditions. In other words, in the Project Development (Application) Case, wildlife populations in the RSA average 72% of their pre-industrial levels (ranging from 56% to 81%).

The estimated declines are considered to be conservatively high for a number of reasons. Habitat loss does not necessarily equate to animal losses from the population, as animals displaced from disturbances could successfully relocate to adjacent areas. This is particularly true for harvested species as such species seldom occupy the land at maximum carrying capacity. In addition, estimates of habitat loss assume simultaneous full buildout of all known and planned developments for the RSA, without the benefits of reclamation. This greatly overestimates the percentage of the RSA that would have active industrial development and associated effects on wildlife.

Table 5-1 Wildlife Population Estimates in the RSA

VEC	Habitat Quality/Class	Density Estimate (individuals/km ²) or Home Range Size (km ²) ¹		Pre-Industrial (1965)		Baseline Case		Application Case (2037)		Planned Development Case	
		Value	Units / Calculation	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate
Moose	Low	0.10	Density (individuals/km ²) Calculation: individuals/km ² * habitat area	414	41	688	69	669	67	609	61
	Moderate	0.30		1,596	479	1845	554	1,823	547	1,634	490
	High	0.50		1,570	785	392	196	391	196	370	185
	Total			3,580	1,305	2,925	818	2,883	809	2,613	736
Black bear	Low	0.18	Density (individuals/km ²) Calculation: individuals/km ² * habitat area	139	25	195	35	189	34	177	32
	Moderate	0.30		1,809	543	1,870	561	1,839	552	1,653	496
	High	0.50		1,632	816	989	495	981	491	902	451
	Total			3,580	1,384	3,054	1091	3,009	1,076	2,732	979
Fisher	Low	38	Home range size for a pair of fishers (km ²) Calculation: (habitat area / home range size) * 2 individuals per home range	348	18	806	42	774	41	682	36
	Moderate	24		2,783	232	1,966	164	1,955	163	1,799	150
	High	19		449	47	282	30	280	29	251	26
	Total			3,580	297	3,054	236	3,009	233	2,732	212
Canada lynx (Peak)	Low	0.10	Density (individuals/km ²) Calculation: individuals/km ² * habitat area	0	0	33	3	29	3	25	3
	Moderate	0.25		1,744	436	1,608	402	1,589	397	1,454	364
	High	0.40		1,679	672	1,285	514	1,265	506	1,134	454
	Total			3,423	1,108	2,926	919	2,883	906	2,613	820

Table 5-1 Wildlife Population Estimates in the RSA (cont'd)

VEC	Habitat Quality/Class	Density Estimate (individuals/km ²) or Home Range Size (km ²) ¹		Pre-Industrial (1965)		Baseline Case		Application Case (2037)		Planned Development Case	
		Value	Units / Calculation	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate
Canada lynx (Low)	Low	0.01	Density (individuals/km ²) Calculation: individuals/km ² * habitat area	0	0	33	0	29	0	25	0
	Moderate	0.02		1,744	35	1,608	32	1,589	32	1,454	29
	High	0.03		1,679	50	1,285	39	1,265	38	1,134	34
	Total			3,423	85	2,926	71	2,883	70	2,613	63
Snowshoe hare (Peak)	Low	800	Density (individuals/km ²) Calculation: individuals/km ² * habitat area	0	0	0	0	0	0	0	0
	Moderate	1,000		1,720	1,720,000	1,499	1,499,000	1,479	1,479,000	1,339	1,339,000
	High	1,200		1,703	2,043,600	1,414	1,696,800	1,392	1,670,400	1,264	1,516,800
	Total			3,423	3,763,600	2,913	3,195,800	2,871	3,149,400	2,603	2,855,800
Snowshoe hare (Low)	Low	10	Density (individuals/km ²) Calculation: individuals/km ² * habitat area	0	0	0	0	0	0	0	0
	Moderate	30		1,720	51,600	1,499	44,970	1,479	44,370	1,339	40,170
	High	50		1,703	85,150	1,414	70,700	1,392	69,600	1,264	63,200
	Total			3,423	136,750	2,913	115,670	2,871	113,970	2,603	103,370
American beaver ²	Low	0.40	Density (lodges/km of watercourse) Calculation: [(lodge density * length of watercourse)/2 lodges per colony] * 6.3 individuals per colony	435	548	384	484	380	479	347	437
	Moderate	0.75		758	1,791	700	1,654	694	1,640	619	1,462
	High	1.17		2,945	10,854	2,674	9,855	2,637	9,719	2,372	8,742
	Total			4,338	13,193	3,989	11,993	3,934	11,837	3,541	10,642

Table 5-1 Wildlife Population Estimates in the RSA (cont'd)

VEC	Habitat Quality/Class	Density Estimate (individuals/km ²) or Home Range Size (km ²) ¹		Pre-Industrial (1965)		Baseline Case		Application Case (2037)		Planned Development Case	
		Value	Units / Calculation	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate	Habitat Available (km ²)	Population Estimate
Ruffed grouse	Low	2	Density (individuals/km ²) Calculation: (pairs/km ² * habitat area) * 2 individuals per pair	46	184	42	168	42	168	39	156
	Moderate	5		559	5,590	489	4,890	486	4,860	438	4,380
	High	8		1,416	22,656	1,154	18,464	1,136	18,176	1,019	16,304
	Total			2,021	28,430	1,685	23,522	1,664	23,204	1,496	20,840
Northern goshawk	Low	0.03	Density (pairs/km ²) Calculation: (pairs/km ² * habitat area) * 2 individuals per pair	129	8	172	10	167	10	149	9
	Moderate	0.05		880	88	690	69	685	69	625	63
	High	0.07		1,166	163	867	121	856	120	740	104
	Total			2,175	259	1,729	201	1,708	198	1,514	175
Great gray owl	Low	0.88	Density (pairs/km ²) Calculation: (pairs/km ² * habitat area) * 2 individuals per pair	206	363	227	400	224	394	218	384
	Moderate	1.38		2,335	6,445	1,945	5,368	1,920	5,299	1,707	4,711
	High	1.88		287	1,079	223	838	217	816	194	729
	Total			2,828	7,886	2,395	6,606	2,361	6,509	2,119	5,824

NOTES:

¹ Refer to species descriptions for the literature sources of the density and home range estimates.

² Total available habitat for beavers is based on length of watercourse (streams) in the RSA.

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Question 6

In its response to the September 2008 Questions 2, 3 and 4 from the Panel, Total has assessed separately the significance of the effects of past projects, of recently proposed projects and of ongoing and future activities on VECs, without combining all of these sources of effects together to provide an overall assessment of how valued wildlife have been cumulatively affected:

- a. **Provide an overall assessment of the likely cumulative effects for each wildlife VEC identified. This assessment should include the combined effects of past, current, future activities and projects that have affected and may affect wildlife. In its assessment, Total is requested to consider:**
 - **habitat loss caused by the project, by forest harvesting, and by other past, existing exploration and development such as oil and gas, in-situ and oil sands mining;**
 - **direct mortality (hunting, poaching, road collision); and**
 - **reduction in habitat suitability (noise, edge effect and fragmentation).**
- b. **Provide a determination of the significance of these combined effects on each valued wildlife species and clearly indicate what threshold or definition were used to determine the significance of the cumulative effects.**
- c. **Provide a determination of the significance of these combined effects on each valued wildlife species and clearly indicate what threshold or definition were used to determine the significance of the cumulative effects.**

Response to 6a, 6b and 6c:

The statement in Question 6 that “TOTAL has assessed separately the significance of the effects of past projects, of recently proposed projects and of ongoing and future activities on VECs, without

combining all of these sources of effects together ...” is inaccurate. The assessment considered cumulative effects on wildlife for three distinct assessment scenarios (periods), where the combined effects from all known, relevant human-related disturbances on the landscape were considered. These assessment scenarios included:

- Baseline Case, which included the combined effects of all existing and approved developments in the RSA
- Application Case, which included the combined effects of all existing and approved developments on the landscape, plus effects of the project
- Planned Development Case, which included the combined effects of all existing and approved developments in the RSA, plus effects of the project, plus effects of all future disclosed projects in the RSA

Therefore, this latter case combined the effects of all known relevant human disturbances in the RSA. In addition, to err on the side of caution, all assessment cases, including the latter, assumed that all identified projects in the RSA were at full buildout, and that no reclamation had occurred.

The Joint Review Panel (JRP) also requested that the effects of habitat loss, direct mortality and reduced habitat suitability be assessed as combined effects, rather than as individual effects. In fact, in the above assessment cases provided in the AI Project Update, the effects of habitat loss and reduced habitat suitability have already been combined. To accommodate the uncertainties of noise and other sensory disturbance effects on wildlife, habitat modelling done to track cumulative losses of habitat availability in the RSA recognized buffers of reduced habitat values around the actual footprints of disturbance on the landscape. Although these zones of influence contain intact native vegetation conditions, lower habitat values were assigned to these zones to reflect the level of sensory disturbance in these areas, and to reflect their lower potential suitability/attractiveness for wildlife. Consequently, the assessment accounted for the effects of both direct habitat alteration from disturbance footprints and indirect habitat loss from sensory disturbance adjacent to footprints.

Combining the effects of reduced habitat availability with direct mortalities to estimate overall effects is problematic, as the two effects represent very different cumulative issues pertaining to wildlife. A change in habitat availability does not equate to direct animal mortalities, as it is possible that some animals can successfully relocate to other less disturbed portions of their range. Until the reclaimed landscape has matured, reduced habitat availability does represent a reduction in the capability of the land to support wildlife, and fewer numbers of animals can be expected to occupy the same unit of land after disturbance in some situations. If the information is available, an evaluation of whether cumulative mortality rates can be sustained by the estimated population levels for various land use development scenarios would be the most effective way to consider the combined effects of habitat loss and mortality.

This response is based on the best information currently available to TEPJ. TEPJ has requested from Alberta Sustainable Resource Development (ASRD) and Alberta Transportation the most recent and relevant databases on human-related mortality sources and rates for the VECs included in the AI Project Update but the information has not yet been provided.

4.0 Human Health – Noise

Question 7

For the Joslyn North Mine Project Additional Information, AI Project Update, (2010 Project Update) with respect to the 1.5 km boundary from the project as per ERCB Directive 038: Noise Control (February 2007) revise

- a. Table 14.9-2 to include predicted cumulative levels for receptor points along the boundary,

Response:

Table 14.9-2 from the Additional Information Project Update has been modified in Table 7-1 to include the two points along the 1.5 km criteria boundary that represent the locations of highest predicted noise contributions from the project. These locations are west and southeast of the project development area (PDA), as shown in Figure 7-1 and Figure 7-2.

Table 7-1 Application Case Sound Levels Including 1.5 km Criteria Boundary

Snapshot	Receptor		1.5 km Criteria Boundary	
	R1 (dBA)	R2 (dBA)	West Maximum	Southeast Maximum
2020 Snapshot				
Baseline Case Cumulative Sound Predictions	35.0 ¹	38.1 ¹	35.0	35.2 ¹
Project Contribution	42.8	25.3	35.9	37.5
Application Case Cumulative Sound Predictions	43.5 ²	38.3 ²	38.5 ²	39.6 ²
2033 Snapshot				
Baseline Case Cumulative Sound Predictions	35.0 ¹	38.0 ¹	35.0	35.0 ¹
Project Contribution	37.8	23.5	32.5	35.6
Application Case Cumulative Sound Predictions	39.6 ²	38.3 ²	36.9 ²	38.3 ²
Nighttime Permissible Sound Level (PSL)	40 ³	43 ³	40 ³	40 ³
NOTES:				
¹ This value is the logarithmic sum of sound level contributions from the ERCB-mandated ambient sound level and the highest expected sound emissions from the Shell Canada Limited Muskeg Rive Mine Expansion operation for the timeframe assessed.				
² The value is the logarithmic sum of sound level contribution from the Baseline Case and the project.				
³ ERCB 2007.				

- b. Figures H-1 and H-2 to include the receptor points along the boundary,

Response:

Figure H-1 and Figure H-2 from the AI Project Update have been modified as requested to include the two locations that represent the highest predicted noise levels along the 1.5 km criteria boundary (see Figure 7-1 and Figure 7-2).

- c. Table 14.9-3 to include receptor points along the boundary.

Response:

Table 14.9-3 from the AI Project Update has been modified in Table 7-2 to include the two points along the 1.5-km criteria boundary that represent the locations of highest predicted noise contributions from the project.

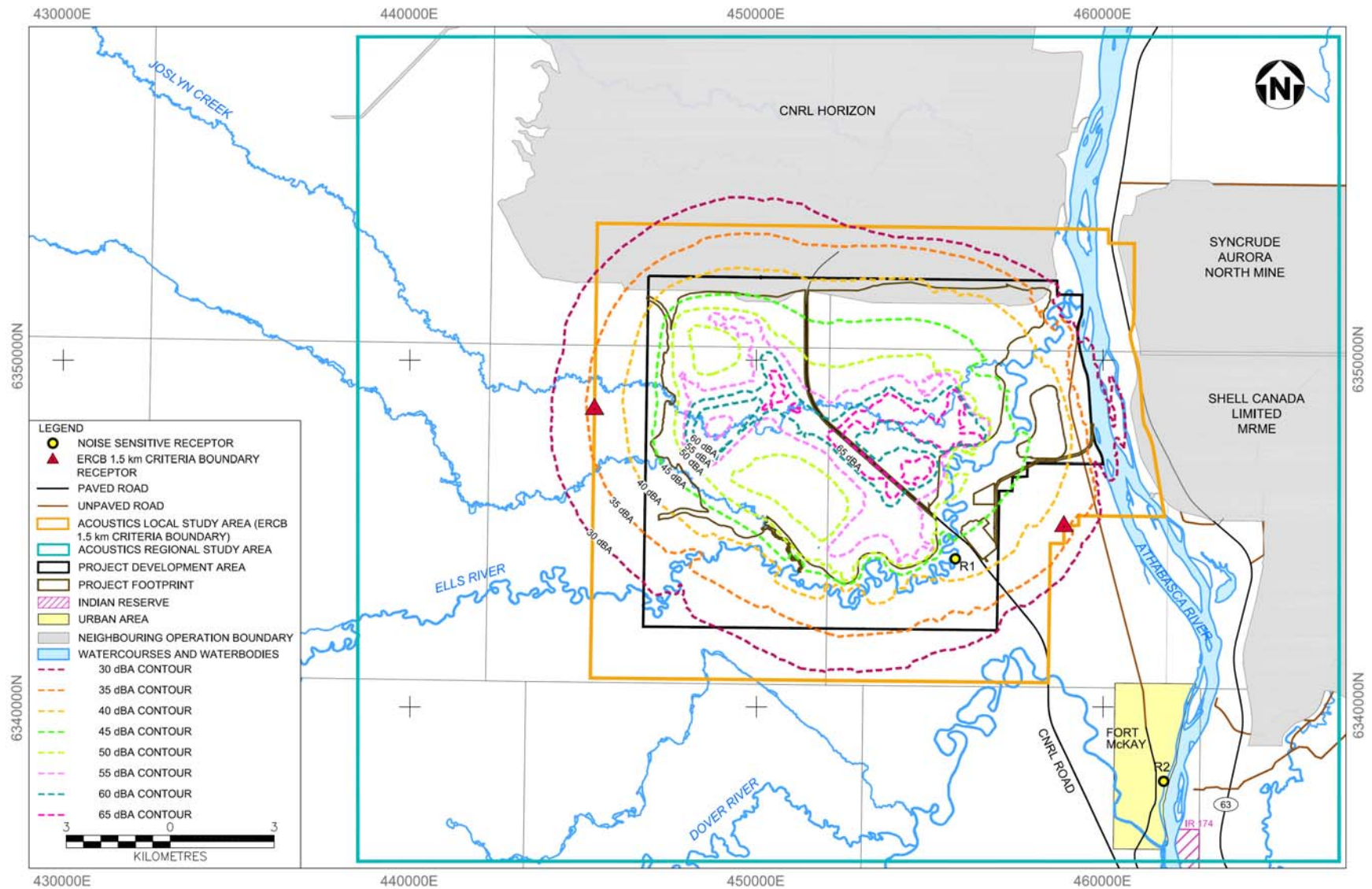


Figure 7-1 2020 Snapshot Sound Prediction Including 1.5-km Criteria Boundary Receptors

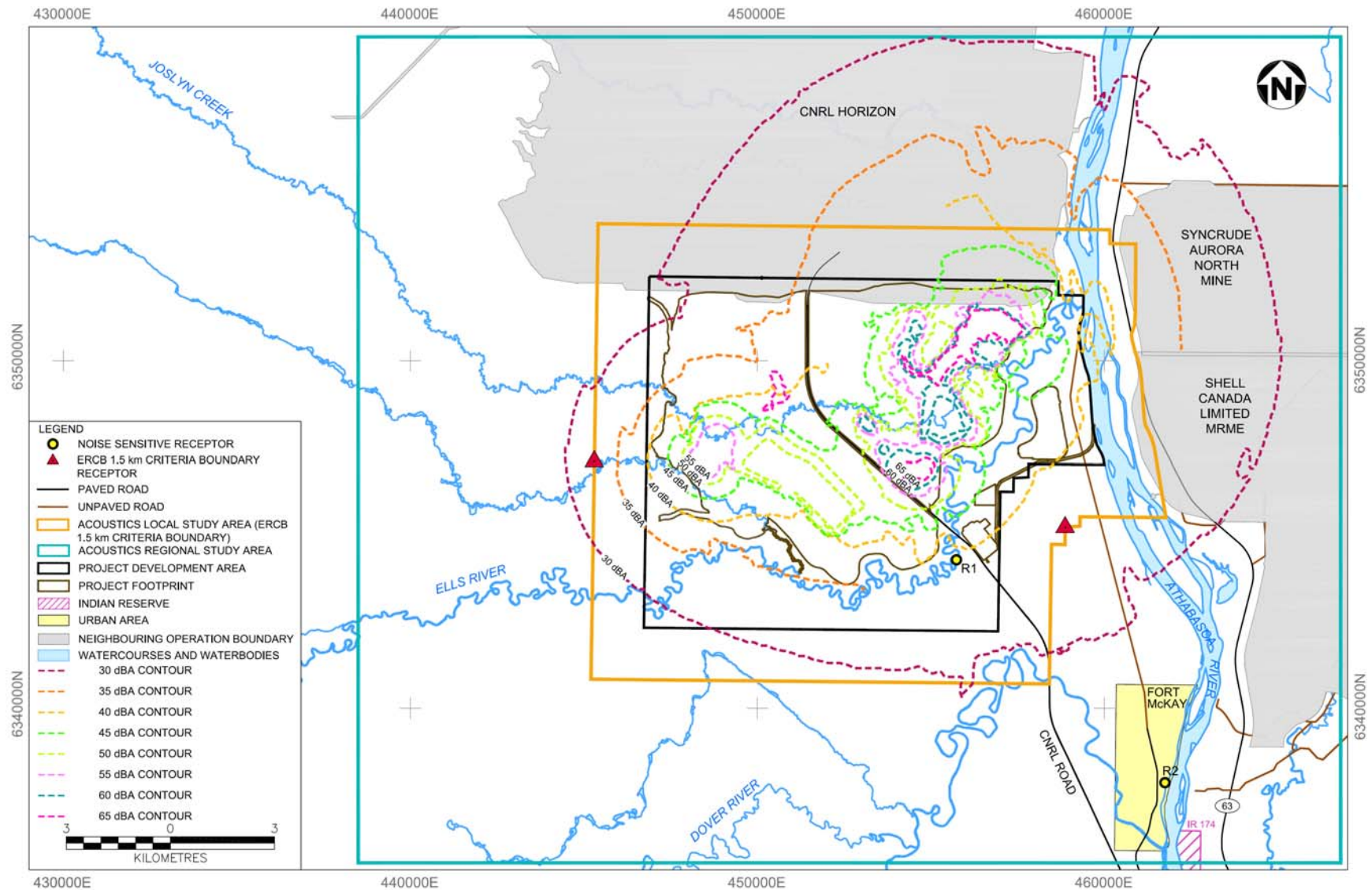


Figure 7-2 2033 Snapshot Sound Prediction Including 1.5-km Criteria Boundary Receptors

Table 7-2 Cumulative Nighttime Sound Level Comparison Including the 1.5 km Criteria Boundary

Location	ERCB Nighttime Criteria	2020 Snapshot (dBA)		2033 Snapshot (dBA)	
		AI Project Update	SI Project Update	AI Project Update	SI Project Update
R1	40	43.5	44.5	39.6	43.4
R2	43	38.3	38.9	38.3	38.4
1.5 km Boundary, West	40	38.5	NA	36.9	NA
1.5 km Boundary, Southeast	40	39.6	NA	38.3	NA

NOTE:
NA = not available; values along the 1.5 km criteria boundary were not determined in the SI Project Update and are therefore not compared.

Question 8

According to Section 14.9.3.3 Table 14.9-3 Application Case Predicted Sound Levels – 2007 and 2010 Updates Page 14-92 “the predicted 2020 snapshot sound level at R1 continues to exceed the ERCB nighttime PSL [permissible sound level] criteria.” Describe how Total will comply with the requirements of Section 3.6 19) b) Compliance Determination/Attenuation Measures Page 17 of Directive 038: Noise Control (February 2007) which states “If the predicted sound level indicates noncompliance with this directive, identify attenuation measures that the licensee is committing to and implementing for compliance.”

Response:

Section 3.6 19) b) of ERCB Directive 038 requires identification of attenuation measures and commitments to meet compliance. To verify and, if needed, achieve compliance, TEPJ will carry out the plan for management of noise from the project as outlined in the AI Project Update, Appendix H. The first step would be to monitor noise at the project site and at the R1 trapper cabin during representative operating conditions to verify the model predictions. Should the measurement program verify that the permissible sound level (PSL) might be exceeded, TEPJ will discuss solutions, including relocating the cabin as per an existing agreement with the cabin owner.

Question 9

In Section 14.9.4, page 14-92 of the 2010 Project Update Total states, “consultation will continue with the trapper cabin owner at R1 to move the cabin at the cabin owner’s request. The sound predictions at receptor R1 will be verified by monitoring once construction begins.”

- a. Clarify whether or not the monitoring program Total is committing to will include the construction and operating phases of the project,

Response:

The noise monitoring program planned by TEPJ will include both construction and operation phases.

- b. Describe how Total will verify sound predictions at receptor R1 through monitoring during the construction and operational phases of the project.**

Response:

The monitoring program TEPJ has committed to is intended to verify compliance with ERCB Directive 038. TEPJ will develop an annual noise monitoring program that will measure sound levels at Receptor R1 and at the project site using Directive 038 monitoring requirements. Ongoing monitoring will verify compliance and measurements near the site will be used to determine the amount of attenuation occurring between the project and Receptor R1. The program will continue until the year 2020 or the time when the maximum sound levels at Receptor R1 are expected.

5.0 Mining

Question 10

To facilitate the review of the Project Update, with respect to resource conservation, provide the entire drilling database, used in the Feb 2010 Project Update, in NAD 1983 coordinates in an Excel or CSV format.

Response:

The drilling database has been provided to the ERCB under separate cover.

6.0 Reclamation – End Pit Lakes

Question 11

In the Section 11.2, Page 11-6 of the 2010 Project Update Total states “There will be one pit lake in the closure landscape.” It also states that “There is no plan to transfer [mature fine tailings] MFT into the pit lake.”

- a. **Provide plans and timelines for demonstrating the efficacy of Total’s proposed MFT free end-pit lake.**

Response:

The proposed MFT-free pit lake will be effective and sustainable because TEPJ has:

- applied fundamental, sound and proven principles of hydrology, limnology and water treatment
- modelled predicted water quality using accepted and peer-reviewed models and applied conservative assumptions to predict their performance and refine their design
- incorporated key findings from CONRAD and CEMA research on pit lakes, experimental ponds and wetlands in the analysis

Project pit lake filling is to start in 2037 and water is planned to be released from 2044 onward. This plan will provide adequate time to progressively apply and incorporate key findings from prior and ongoing research and modelling to resolve uncertainties with the project pit lake before approval to release water into the Ells River. Data, which are also expected to be available for the pit lakes of currently operating projects, will also be considered in refinement of the project pit lake design.

- b. **What is Total’s commitment to demonstrate success in research and development with respect to efficacy of end-pit lakes?**

Response:

TEPJ’s commitment to success in research and development of pit lakes is demonstrated through support and participation in multi-stakeholder organizations such as CEMA and CONRAD.

7.0 Reclamation – Terrestrial

Question 12

Identify and provide relevant research papers from the Cumulative Environmental Management Association (CEMA) and peer reviewed literature on strategies and results regarding ecosystem development and the time required for the ingress of native species establishment into reclamation. Specify the species expected in the timeframes stated.

Response:

Most reclamation research and development that has resulted in recommended strategies for ecosystem development on the closure landscape has been captured in:

- *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010)
- *Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)* (AENV 2008)

The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010) represents an update to the original version of the guideline, with incorporation of over 10-years of CONRAD and CEMA research.

Recent research on various soil amendments, including the use of LFH and incorporation of coarse woody debris, is also now being factored into reclamation strategies. Results indicate:

- LFH transplants assist in creating diverse ecosystems on reclaimed upland landscapes by providing a source of propagules for revegetating upland forest communities, and might be more beneficial for early plant establishment after germination (MacKenzie and Naeth 2009). Species differences between treatments are numerous and are provided in MacKenzie (2007).
- Addition of coarse woody debris did not affect initial vegetation emergence, but increased species richness and decreased introduced species cover. Post-winter assessments found that woody debris cover aided in the survival of planted seedlings by providing protected microsites; woody debris cover also promoted the accumulation of naturally regenerated woody plants. The study also found that the soil under woody debris had a lower temperature range and higher soil volumetric water content (Brown 2010). Detailed species data are provided in Brown (2010).

In addition to research on upland site types, techniques for improving reclamation of wetland ecosystems have and are being investigated. While there are differences in species composition between reclaimed and typical naturally occurring wetlands in the region (see Wong et al. 2008), seed bank studies have shown that older reclaimed wetland seed banks were more similar to natural wetlands than newly reclaimed wetlands. This suggests that while salinity exerts an overriding control on species presence, species replacement sequences for plant communities in reclaimed oil sands wetlands might parallel those of naturally occurring systems (see Cooper 2004).

A number of recent trials and studies have been completed to enhance colonization rates and increase diversity including:

- rhizome divisions with leafy stems of select species, including *Acorus calamus*, *Eleocharis arcicularis*, *Eleocharis palustris* and *Mentha arvensis*, have proven effective, surviving and spreading throughout plots (Smureciu et al. 2006)
- soil transfers from reference wetlands that accelerated plant colonization rates (see Cooper 2004 for a discussion as well as detailed species lists)

- addition of phosphate and gypsum to consolidated tailings water allows for a benthic community similar to those found in reference wetlands (as discussed in Macyk and Drozdowski 2008)
- relationships between water quality and wetland species, specifically saline communities (Purdy et al. 2005; Trites and Bayley 2010)

With respect to time required for ingress of native species, higher forest site indices have been measured in reclaimed sites compared with natural areas, suggesting that reclamation efforts have been successful in providing equivalent capability for forest production. The reclamation areas are young, however, and the long-term sustainability of the growth is currently unknown. Also, factors such as fertilization, vegetation control and initial plant spacing could be having an effect on measured site indices (Timberline Natural Resource Group Ltd. 2008). The long-term monitoring that is underway at operational oil sands projects is collecting data that will be used to determine the sustainability of tree growth on the reclaimed sites. Should tree growth on reclaimed sites continue to match natural growth rates in the area, then older structural stages of forests would become available on the closure landscape 100+ years after initial plantings or LFH transplants.

Results of long-term vegetation monitoring on reclaimed sites completed by CEMA have noted that plant communities present on natural and reclaimed sites show differences in species composition and cover (see Stantec 2009). In general, reclaimed sites have more bare ground, grass and forbs, with less cover of moss, lichen, shrubs, trees and woody debris, although there is considerable variability within and among site types, treatments and age classes.

While there are differences, Rowland et al. (2009) note that irrespective of treatment, older reclaimed sites (21 to 25 years) were more similar to natural forests and less similar to younger reclaimed sites, with the exception of treatments that included a subsoil component over tailings sand (both with and without peat–mineral mix). Such treatments that included a subsoil component over tailings sand appear to be moving to a novel community, likely because of reduced moisture retention. Sites with peat–mineral mix directly over tailings sand shifted toward more natural community structure at the 21 to 25 year point (see Rowland et al. 2009).

Older reclaimed sites (31 to 35 years) subsequently diverge from natural stands as understorey plant diversity declines with canopy closure (Stantec 2009; Rowland et al. 2009). Such a decline has been noted in other reclaimed areas (Frouz et al. 2008) as well as from chronosequences associated with natural disturbances such as fire (see De Grandpré et al. 1993; Roberts 2004; Hart and Chen 2006, 2008). It has been recommended that a number of young forest stands recovering from natural disturbances (i.e., fires) should be included as part of the long-term soil and vegetation reclamation monitoring plots to assist in the understanding of reclamation ecosystem trajectories (Stantec 2009; Rowland et al. 2009).

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- Rowland, S.M., C.E. Prescott, S.J. Grayston, S.A. Quideau and G. Bradfield. 2009. Recreating a functioning forest soil in reclaimed oil sands in northern Alberta: An approach for measuring success in ecological restoration. *Journal of Environmental Quality* 38: 1580–1590.
- Stantec 2009. *Results from Long-Term Soil and Vegetation Plots Established in the Oil Sands Region (2009)*. Prepared for Cumulative Environmental Management Association. Fort McMurray, Alberta.
- Timberline Natural Resource Group Ltd. 2008. *Analyzing and Relationship Between LCCS Ratings and Site Productivity*. Cumulative Environmental Management Association. Fort McMurray, Alberta.
- Trites, M. and S. Bayley. 2010. Importance of water quality to wetland establishment. Presentation at *Reclamation and Restoration of Boreal Peatland and Forest Ecosystems: Towards a Sustainable Future*. March 25–27, 2010. Edmonton, Alberta.
- Wong, A., C. Greenway and S. Bayley. 2008. *An Analyses of Existing Information of Wetland Vegetation in the Oil Sands Region – Marshes*. Prepared for the Cumulative Environmental Management Association. Fort McMurray, Alberta.

Question 13

Discuss the recommendations of CEMA research regarding the success of strategies for the establishment of specific ecosite phases for reclaimed areas and how it would be incorporated into operational management strategies.

Response:

CEMA and CONRAD research on strategies for the establishment of specific ecosite phases for reclaimed areas has been recently summarized in the:

- *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010)
- *Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)* (AENV 2008)

The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010) represents an update to the original version of the guideline, with incorporation of over 10 years of CONRAD and CEMA research. One of the major modifications between editions has been the introduction of the site type concept. Site type is introduced as the primary revegetation target to:

- reflect species overlap between ecosite phases
- allow for greater flexibility in revegetation in recognition of uncertainty in edaphic conditions on new reclaimed landscapes

The five upland site types include:

- Dry Site Type – a and b ecosites
- Moist Poor Site Type – c ecosite
- Moist Rich Site Type – d and e ecosites
- Wet Rich Site Type – f and some h ecosites
- Wet Poor Site Type – g and some h ecosites

In addition to providing recommendations for species out-planting and planting densities by site type, the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* recommends the following strategies to improve reclamation success:

- Using the LFH layer and upper 10 to 30 cm of upland forest soils as a source of propagules as it enhances the abundance and diversity of wooded plants on reclaimed landscapes when directly placed or stored, preferably in small stockpiles, for a year or less (MacKenzie 2007; MacKenzie and Naeth 2007). The project will be reclaimed using topsoil (including the LFH horizon) and subsoil from upland areas and TEPJ has provided reclamation plans that indicate direct placement of 44% of salvaged reclamation materials (by volume) (see AI Project Update, Section 11, Table 11.3-2).
- Targeting different plant communities for surface soils where conductivities or anticipated conductivities might exceed 4 dS/cm following the work of Purdy et al. (2005), Close (2007) and Close et al. (2007). The project Conservation, Closure and Reclamation Plan identifies the Sh3 (salt-tolerant riparian shrubland) that includes planting species identified as appropriate for areas where surface salts are likely to be present (see AI Project Update, Section 11, Table 11.3-6).

Recently published research (Brown 2010) available after completion of the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010) supports the use of coarse woody debris as a favourable amendment as it increases native vegetation

cover and species richness and decreases introduced species cover. TEPJ has incorporated the use of coarse woody debris in the Closure, Conservation and Reclamation Plan where site-specific conditions are appropriate.

The revised edition of the *Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)* (AENV 2008) provides numerous recommendations for the construction of marshes (Ecosite Phase 11) along with associated ponds that include such aspects as basin morphology, sediment and substrate properties, hydrology, water chemistry, vegetation and phytoplankton, invertebrates and habitat for vertebrates. Numerous marsh wetlands have been constructed in the oil sands region and elsewhere (see Macyk and Drozdowski 2008 for a summary) and knowledge gained is extensive.

Strategies for the generation of Ecosites i, j and k (i.e., fens and bogs) have not been tested in the oil sands region, though it has been concluded that hydrological conditions suitable for their establishment are feasible (see Price et al. 2009). Currently, both Syncrude (Wytrkykush 2010) and Suncor (Daly 2010) are testing the viability of fen reclamation. As with other research programs occurring in the oil sands region, TEPJ will evaluate results and incorporate recommendations in their reclamation planning as appropriate.

The distribution and occurrence of ecosite phases in the project's conceptual Closure, Conservation and Reclamation Plan are aligned with the recommendations provided in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010) and the *Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)* (AENV 2008). Reclamation research that has, for the most part, been included in these guidelines will be included in continuing project planning, as will results of future research efforts. For additional information, see Question 15.

References

- AENV (Alberta Environment). 2008. *Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)*. Prepared by Harris, M.L. of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, Alberta. Edmonton, Alberta. December 2007. 330 p. ISBN: 978-0-7785-7697-6.
- AENV. 2010. *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition*. Prepared by the Terrestrial Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. Fort McMurray, Alberta. December 2009.
- Close, E.B. 2007. *Forest Productivity in Naturally Saline Landscape of Alberta's Boreal Forest*. M.Sc. Thesis. Department of Renewable Resources, University of Alberta, Edmonton, Alberta.
- Close, E.B., B.G. Purdy, S.E. Macdonald and S.X. Chang. 2007. *Forest Productivity in Naturally Saline Landscapes of Alberta's Boreal Forest*. Prepared for the Cumulative Environmental Management Association. Fort McMurray, Alberta.
- Daly, C. 2010. Innovative Wetland reclamation design case studies: The Suncor Fen and Pond 1 Marsh. Presented at *Reclamation and Restoration of Boreal Peatland and Forest Ecosystems: Toward a Sustainable Future*. Edmonton, Alberta. March 25–27, 2010.
- MacKenzie, D.D. 2007. *Assisted Natural Recovery Using a Forest Soil Propagule Bank in the Athabasca Oil Sands*. MSc Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.

- MacKenzie, D.D. and M.A. Naeth. 2009. The role of the forest soil propagule bank in assisted natural recovery after oil sands mining. *Restoration Ecology* 17: 1061–2971.
- Macyk, T.M. and B.L. Kwiatkowski. 2008. *Comprehensive Report on Operational Reclamation Techniques in the Mineable Oil Sands Region*. Cumulative Environmental Management Association. Fort McMurray, Alberta.
- Price, J.S., R.G. McLaren and D.L. Rudolph. 2009. Landscape restoration after oil sands mining: conceptual design and hydrological modelling for fen reconstruction. *International Journal of Mining, Reclamation and Environment* 24: 109–123.
- Purdy, B.G., S.E. Macdonald and V. Lieffers. 2005. Naturally saline boreal communities as models for reclamation of saline oil sand tailings. *Restoration Ecology* 13: 667–677.
- Wytrkykush, C. 2010. Fen wetland landform design and reclamation. Presented at *Reclamation and Restoration of Boreal Peatland and Forest Ecosystems: Toward a Sustainable Future*. Edmonton, Alberta. March 25–27, 2010.

Question 14

Provide any relevant studies of monitoring and research regarding reclamation conducted by CEMA. Include a summary of the studies' conclusions.

Response:

For a list and abbreviated summary of recent relevant reclamation studies, recommendations and results from studies funded by CEMA, CONRAD and others, see Table 14-1. For a more extensive list of reclamation literature of relevance to the oil sands, see the CEMA Reclamation Research Database available at: <http://www.cemaonline.ca/index.php/tools/reclamation-research> and in the numerous literature reviews and bibliographies commissioned by CEMA (see Table 14-1).

Table 14-1 Summary of Recent Reclamation Work Relevant to the Oil Sands Region

Study	Abbreviated Summary
Landscapes and Landscape Planning	
Alberta Environmental Protection. 1997. <i>Oil Sands Mining End Land Use Committee Report and Recommendations</i> . Edmonton, Alberta.	Lists desired/allowable end land use targets for closure planning and landscape design.
ASRD (Alberta Sustainable Resource Development). 2002. <i>Fort McMurray–Athabasca Oil Sands Subregional Integrated Resource Plan</i> . Edmonton, Alberta.	Lists objectives and guidelines for reclamation including forest protection, water and ecological resources and wildlife habitat.
Campbell, G. 2009. <i>Process and Considerations for Mine Planning</i> . Presentation, <i>Meeting the Expectation of a Continuous Functional Closure Landscape in the Oil Sands Region</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Presents Syncrude's mining/reclamation/closure sequences including information of surface drainage, geotechnical stability and soil capture.
CEMA (Cumulative Environmental Management Association). 2005. <i>Landscape Design Checklist</i> . Revised RSDS Government Regulator Version. Reclamation Working Group, Cumulative Environmental Management Association. Fort McMurray, Alberta.	Recommendations for landform design.
DMS Consulting. 2006. <i>Review of Legislation and Policy Related to Reclamation Landform Design in the Athabasca Oil Sands Region of Alberta</i> . Reclamation Working Group, Cumulative Environmental Management Association. Fort McMurray, Alberta.	Identifies key documents that provide guidance on wetland, soil, vegetation and forestry reclamation requirements.
Johnson, E.A. and K. Miyanishi. 2008. Creating new landscapes and ecosystems. <i>Annals of the New York Academy of Science</i> 1134: 120–145.	Closure landscapes recreate landforms and ecosystems and require a reasonable understanding of geophysical and ecological process that operate over many scales. Recommends a focus on hydrological landscapes.
Komex (Komex International Ltd.). 2003. <i>A Literature Review of Vegetation, Soils, Landforms, Watershed Integrity and Biodiversity</i> . Prepared for Cumulative Environmental Management Association. Fort McMurray, Alberta.	Literature review of ecological interactions between development and land use disturbance with a discussion of the relative importance of some disturbance effects of relevance to the oil sands region.
Lanoue, A. 2009. <i>Process and Considerations for Mine Closure Planning</i> . Presentation, <i>Meeting the Expectation of a Continuous Functional Closure Landscape in the Oil Sands Region</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Outlines linear closure plan including integration, between leases. Also discuss liability, responsibility, cost and technology.
Macyk, T.M. and B.L. Kwiatkowski. 2008. <i>Comprehensive Report on Operational Reclamation Techniques in the Mineable Oil Sands Region</i> . Cumulative Environmental Management Association, Fort McMurray, Alberta.	Historical and current operational reclamation management practices in the oil sands region as well as for other mining activities (coal) in Alberta.
Millennium EMS Solutions. 2010. <i>Guide to the Landscape Design Checklist in the Athabasca Oil Sands Region</i> . Reclamation Working Group, Cumulative Environmental Management Association. Fort McMurray, Alberta.	Reference document to support the Landscape Design Checklist.
Reid, J. 2009. <i>Synthesis of the 2009 Reclamation Working Group Workshop: Meeting the Expectation of a Continuous Functional Closure Landscape in the Oil Sands Region</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta	Workshop focus included: <ul style="list-style-type: none"> • Within-lease (landform-landscape) coordination. Closure/reclamation planning is conducted and implemented within the footprint. • Lease boundary coordination – landscapes and landscape features transition from one lease to another or from one lease to adjacent undisturbed habitats in an integrated fashion. • Regional coordination – to ensure that closure/reclamation planning is functioning
Richens, T. 2009. <i>Regulatory Expectations for Closure Planning</i> . Presentation, <i>Meeting the Expectation of a Continuous Functional Closure Landscape in the Oil Sands Region</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Informs industry of the new expectations (2011) for reclamation and closure plans as guided by AENV/ASRD.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Soil Salvage	
Alberta Agriculture. 1987. <i>Soil Criteria Relative to Disturbance and Reclamation</i> . Alberta Agricultural, Food and Rural Development. Edmonton, Alberta.	Identification of suitability of cover soil.
Beckingham, J.D. and J.H. Archibald. 1996. <i>Field Guide to Ecosites of Northern Alberta</i> . Natural Resources Canada, Canadian Forest Service, Alberta. Spec. Rec. 5. Edmonton, Alberta.	Topsoil depth criteria.
Soil and Soil Amendments	
Carey, S. 2008. Growing season energy and water exchange from an oil sands overburden reclamation soil cover, Fort McMurray, Alberta, Canada. <i>Hydrological Processes</i> 22: 2847–2857.	Documents changes in dominant vegetation from initial planting of foxtail barley, to sweet clover in 2004 and a low-density species mix in 2005 (aspen and white spruce). Also documented weather, soil moisture, vegetation (and growth stage).
Hemstock, S.S. 2008. <i>Plant Productivity, Soil Microorganisms and Soil Nitrogen Cycling In Peat Amendments Used For Oil Sands Reclamation</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Mesic and humic peats provide better substrates for early successional species than fibric peat. Acidic peat mixes should include pH amendments or acid tolerant species should be used for sites reclaimed with fibric peat. Amendments with greater mineralization rates have greater plant cover and total number of species.
Hemstock, S.S., S.A. Quideau and D.S. Chanasyk. 2010. <i>Nitrogen availability from peat amendments used in boreal oil sands reclamation</i> . <i>Canadian Journal of Soil Science</i> 90: 165-175.	Nitrification and not mineralization might dominate nitrogen availability in peat–mineral mixes.
Khasa, D.P., M. Fung and B. Logan. 2005. Early growth response of container-grown selected woody boreal seedlings in amended composite tailings and tailings sand. <i>Bioresource Technology</i> 7: 857–864.	Beneficial amendments and salt tolerant hybrid poplar were planted to a reclaimed site. Peat and pulp waste were the best amendments for vegetative growth. Agribost and a mixture of pulp waste and fly ash were the worst for vegetative growth.
McMillan, R., S.A. Quideua, M.D. MacKenzie and O. Biryukova. 2007. Nitrogen mineralization and microbial activity in Oil Sands reclaimed boreal forest soils. <i>Journal of Environmental Quality</i> 36: 1470–1478.	Experiment examining microbial activity on reclaimed sites using a peat–mineral mix, LFH and a combination of the two. The LFH material had the highest gross and net nitrification rates and respiration rates.
Moskal, T.D. 1999. <i>Moisture Characteristics of Coarse-Textured Soils and Peat–Mineral Mixes</i> . M.Sc. Thesis. Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Peat–mineral mixes had an increase in available water-holding capacity in tailings sand. Increasing the depth of the peat–mineral mix increased total soil moisture as did increasing the mix ratio from 1:1 to 3:1 (but not significantly).
Moskal, T.D., L. Leskiw, M.A. Naeth and D.S. Chanasyk. 2001. Effect of organic carbon (peat) on moisture retention of peat–mineral mixes. <i>Canadian Journal of Soil Science</i> 81: 205–211.	Water retention parameters of in situ samples on a gravimetric basis were significantly related to % organic carbon, but those on a volume basis were not. Trends in volumetric water-holding capacity for in situ, coarse-textured samples were similar to those for gravimetric water-holding capacity, because of similar bulk densities. For peaty soils, trends in volumetric water retention were not the same as the gravimetric basis because of low and irregular bulk densities. For laboratory-constructed peat–mineral mixes, field capacity and water-holding capacity significantly affected by % organic carbon though wilting point was not. Addition of peat material resulted in minor textural changes for sand and loamy sand, hence the change in texture could not be responsible for the increases in WHC as the result of peat additions. The results for sandy loam were variable.
Paragon Soil and Environmental Consulting Inc. 2009. <i>Results From Long-Term Soil and Vegetation Plots Established in the Oil Sands Region (2009): Soils Component</i> . Prepared for Cumulative Environmental Management Association. Fort McMurray, Alberta.	Nutrients are higher in reclaimed coarse soils than natural coarse soils. Nutrients in reclaimed fine-textured soils are within natural range. No significant changes in bulk density. Minor changes in pH, salinity and SAR (they are not limiting). C:N ratios improved in some prescriptions. In some prescriptions, boron was above Alberta Tier 1 guidelines. No metals were above CCME guidelines. Hydrocarbons present in one prescription.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Rowland, S.M., C.E. Prescott, S.J. Grayston, S.A. Quideau and G. Bradfield. 2009. Recreating a functioning forest soil in reclaimed oil sands in northern Alberta: An approach for measuring success in ecological restoration. <i>Journal of Environmental Quality</i> 38: 580–1590.	Compared with natural ecosystems, reclaimed treatments had more bare ground, grasses and forbs but less moss, lichen, shrubs, trees and woody debris. Shrubs appear to facilitate development of an organic layer.
Yarmuch, M. 2003. <i>Measurement of Soil Physical Parameters to Evaluate Soil Structure Quality in Reclaimed Oil Sands Soils, Alberta, Canada</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Compared soil structure in reclaimed soil with undisturbed soil and found soil structure was similar.
LFH	
MacKenzie, D.D. 2007. <i>Assisted Natural Recovery Using a Forest Soil Propagule Bank in the Athabasca Oil Sands</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Studied peat and LFH propagule sources. LFH-enhanced plant community diversity, species richness, plant abundance and nutrients.
MacKenzie, D.D. and M.A. Naeth. 2009. The role of the forest soil propagule bank in assisted natural recovery after oil sands mining. <i>Restoration Ecology</i> 17: 1061–2971.	More plant species from propagules in donor LFH than in peat.
McMillan, R. 2005. <i>Forest Floor as a Prescription in Oil Sands Reclamation</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	No significant differences in net mineralization between reclaimed sites and undisturbed forest. Microbial biomass differences between the two were related to moisture.
Hydrology	
Eishorbagy, A., A. Jutla, L. Barbour and J. Kells. 2005. System dynamics approach to assess the sustainability of reclamation of disturbed watersheds. <i>Canadian Journal of Civil Engineering</i> 32: 144–158.	Watershed modelling critical for assessing hydrologic performance of reconstructed watersheds.
Eishorbagy, A. and S.L. Barbour. 2007. Probabilistic approach for design and hydrologic performance assessment of reconstructed watersheds. <i>Journal of Geotechnical and Geoenvironmental Engineering</i> : 133: 1110–1118.	Attempts to create a simulation tool to assess reclamation cover's moisture content under various climactic conditions and various cover design types.
Kelln, C., S.L. Barbour and C. Qualizza. 2008. Controls on the spatial distribution of soil moisture and solute transport in a sloping reclamation cover. <i>Canadian Geotechnical Journal</i> 45: 351–366.	Upward salt transport from buried shale increases because of soil moisture conditions and lateral groundwater flux.
Mapfumo, E., D.S. Chanasyk and C.L.A. Chaikowsky. 2006. Stochastic simulation of soil water status on reclaimed land in northern Alberta. <i>Journal of Spatial Hydrology</i> 6: 52–63.	Evaluating stochastic simulation for soil water and evaluating its use at unsampled locations. Great uncertainty in estimation on wet and dry days.
Meiers, G.P. L.S. Barbour and C.V. Qualizza. 2006. The use of in situ field measurement of hydraulic conductivity to provide an understanding of cover system performance over time. In: R.I. Barnhisel (ed.). <i>Seventh International Conference on Acid Rock Drainage (ICARD), March 26–30, 2006</i> . American Society of Mining and Reclamation. St. Louis, Missouri.	Interflow volumes, which are critical for flushing salt from reclamation covers, dependent on hydraulic conductivity of the cover, cover thickness and yearly climatic variability.
Revegetation Practices	
Brown, R.L. 2010. <i>Use of Woody Debris as an Amendment for Reclamation After Oil Sands Mining</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta	Woody debris increased species diversity and decreased introduced species cover. As time went on, there were more saplings and woody plant abundance on woody debris. Negatively, woody debris decreased nitrogen availability and had higher phosphorus leachate. Soil had a lower temperature and higher soil moisture with coarse woody debris present.
Burgers, T.D. 2005. <i>Reclamation of an Oil Sand Tailings Storage Facility: Vegetation and Soil Interactions</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Two areas studied. In one area, sodicity and nutrient deficiencies affected revegetation. In the other area, sodicity, nutrient deficiencies and shallow soil affected revegetation.
Crowe, A.U., B. Han, A.R. Kermod, L.I. Bendell-Young and A.L. Plant. 2001. Effects of oil sands effluent on cattail and clover: photosynthesis and the level of stress proteins. <i>Environmental Pollution</i> 113: 311–322.	Cattails and clover have elevated photosynthesis when in effluent-seepage produced wetlands. Cause unknown, but RuBisCo enzyme levels ruled out. Cattails and clover are well-adapted to oil sand effluent wetlands, but their long-term survival is unknown.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Crowe, A.U., A.L. Plant and A.R. Kermod. 2002. Effects of an industrial effluent on plant colonization and on the germination and post-germinative growth of seeds of terrestrial and aquatic plant species. <i>Environmental Pollution</i> 117: 179–189.	Oil sand effluent inhibited germination. Fresh weights were reduced in some plants as well.
AENV (Alberta Environment). 2010. <i>Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition</i> . Prepared by the Terrestrial Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. Fort McMurray, Alberta. December 2009.	Recommendations for revegetation of forest vegetation by site type. Site types reflect general edaphic conditions including: <ul style="list-style-type: none"> • Dry Site Type – a and b ecosites • Moist Poor Site Type – c ecosite • Moist Rich Site Type – d and e ecosites • Wet Rich Site Type – f and some h ecosites • Wet Poor Site Type – g and some h ecosites
Geographic Dynamics Corp. 2002. <i>Shrub Species Review for Boreal Ecosite Re-establishment in the Oil Sands Region</i> . Prepared for Oil Sands Soil and Vegetation Working Group, Cumulative Environmental Management Association. Fort McMurray, Alberta.	Synthesis of shrub species for ecosite re-establishment including synecological and autecological information.
Geographic Dynamics Corp and FORRx Consulting Inc. 2008. <i>Vegetation Data Synthesis in the Athabasca Oil Sands Region</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Data summaries for upland forest ecosites, including characteristic species typical of Ecosites a to h. Summaries meant to represent natural ranges of variability for each ecosite users try to create.
Geographic Dynamics Corp. 2009. <i>Characteristic Species Thresholds: Ecosites f, g and h: A Supplemental Report to the Vegetation Data Synthesis in the Athabasca Oil Sands Region</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Report looked at the number of characteristic species typical of Ecosites a to h. Two thresholds are required, one for young stands and one for older stands because of the impact of trees on understorey vegetation as the stands mature.
Redfield, E., C. Croser, J.J. Zwiazek, M.D. MacKinnon and C. Qualizza. 2003. Responses of red-osier dogwood to oil sands tailings treated with gypsum or alum. <i>Journal of Environmental Quality</i> 32: 1008–1014.	NaCl salts cause greater needle damage than Na ₂ SO ₄ salts, but Na ₂ SO ₄ salts have more negative osmotic potential (plant stress). Drought-tolerance parameters might be more helpful in predicting salt tolerance in plants treated with Na ₂ SO ₄ salts than NaCl salts.
Renault, S., J.J. Zwiazek, M. Fung and S. Tuttle. 2000. Germination, growth and gas exchange of selected boreal forest seedlings in soil containing oil sands tailings. <i>Environmental Pollution</i> 107: 357–365.	Final germination was unaffected in fine tailings (initial delayed germination in some species). Differences in germination sensitivity could be the result of different osmotic tolerances or sensitivity to enzymes and hormones. Phytotoxic effects were the result of altered soil chemistry, texture and structure.
Renault, S., M. MacKinnon and C. Qualizza. 2004. Suitability of alтай wildrye (<i>Elymus angustus</i>) and slender wheatgrass (<i>Agropyron trachycaulum</i>) for initial reclamation of saline composite tailings of oil sands. <i>Environmental Pollution</i> 128: 339–349.	Greenhouse study to examine growth of grasses in gypsum and alum tailings (alum tailings are less salty, but Al ³⁺ could be toxic) with and without peat amendments. Wildrye and slender wheatgrass have potential for early reclamation of soft oil sand tailings.
Smreciu, A. and K. Gould. 2010. <i>Priority Shrub Species: Propagation and Establishment Final Report – 2009</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Evaluation of five shrub species considered a priority for use in reclamation with recommendations on propagation and establishment.
Stantec (Stantec Inc.). 2009. <i>Results from Long-Term Soil and Vegetation Plots Established in the Oil Sands Region (2009)</i> . Prepared for Cumulative Environmental Management Association. Fort McMurray, Alberta.	Plant communities of natural and reclaimed sites continue to show marked differences in species composition and cover, which was attributed to site age and treatment variability. Gaps between reclaimed and natural sites still exist, making the connection of pathways between reclaimed vegetation communities to target ecosite phases difficult. Reclaimed sites are younger in age (less than 40-years-old) and have vegetation reflective of young seral stages whereas natural sites are older (more than 40-years-old) and have vegetation characteristic of more established vegetation at equilibrium with site conditions.
TECO Natural Resource Group Limited. 2009. <i>Installation and Remeasurement of Permanent Sample Plots on Reclaimed Sites: 2009 Year-End Report</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Field report on tree metrics from permanent sample plots. No data analysis provided.
Wetlands	
Bacon, L. 2006. <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Discusses problems to date with wetland restoration – particularly salts. Examines research goals for wetlands and strengths and weaknesses in the field and current recommendations.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Bendell-Young, L.I., K.E. Bennett, A. Crowe, C.J. Kennedy, A.R. Kermode, M.M Moore, A.L. Plant and A. Wood. 2000. Ecological characteristics of wetlands receiving an industrial effluent. <i>Ecological Applications</i> 10: 310–322.	Fish and macroinvertebrates were the most sensitive ecological indicators in the wetlands receiving oil sands effluent. Cattails had higher photosynthesis.
Butterworth, E. 2006. Marshes and wetland ecology. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Originally, Ducks Unlimited used a structure-oriented rather than process-oriented wetland restoration. Reclaimed wetlands on the prairie are measured by waterfowl production, algae, vegetation and invertebrates.
Ciborowski, J. 2006. Invertebrate community development, secondary productions and export in young reference and treatment wetlands. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Question: Will they find a natural benthic column developing in the reclaimed wetland and how do they compare with the column found in other wetlands in the area?
AENV (Alberta Environment). 2008. <i>Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)</i> . Prepared by Harris, M.L. of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, Alberta. Edmonton, Alberta. December 2007. 330 p.	Describes integrated approach to planning, design, construction, monitoring and adaptive management of reclaimed wetlands. Focus is on nonpeat-accumulating marshes but recommendations for peatland reclamation are provided and a commitment to evaluate peatland reclamation by the industry is acknowledged.
Circle T Consulting Inc. 2009. <i>A Gap Analysis of Knowledge and Practices for Reclaiming Disturbances Associated With In Situ Oil Sands and Conventional Oil and Gas Exploration on Wetlands in Northern Alberta</i> . Prepared for the Cumulative Environmental Management Association. Fort McMurray, Alberta.	Examines gaps in reclamation knowledge for reclamation of disturbances associated with in situ oil sands and conventional oil and gas.
Cooper, D. 2006. Fen restoration. In <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Cooper's experience is in mountain ranges where fens contain a lot of sodium chloride and sodium sulphate (which creates a very unusual acid fen) and are in a very arid region (connected to large watersheds, but groundwater is quite saline). Interested in creating groundwater–land surface interactions that produce perennial saturated and anaerobic soils; work on establishing peat-forming plants. Using monitoring wells to understand how to reshape the landscape so it functions in connection with the groundwater system. Trying to recreate vegetation mosaics to understand the water table relationships of a variety of community types and studying propagation.
Cooper, N.J. 2004. <i>Vegetation Community Development of Reclaimed Oil Sands Wetlands</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Soil transfers from reference wetlands increased plant colonization rates in composite tailing wetlands. Primary successional species have a competitive advantage over mid-late seral stage species. Suggests that species replacement sequences for plant communities in reclaimed wetlands might be parallel to natural wetlands.
DeVito, K and C. Mendoza. 2006. Natural and reconstructed wetlands in the boreal plains region. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Focus is on determining linkages between hydrology, groundwater recharge/discharge, precipitation, perch systems, runoff, evapotranspiration and vegetation cover. Complications include effects of salts on these various components of the water balance and the impact of salts in these forms of water. Includes recognition that vegetation affects hydrology (i.e., uptake).
Fitzpatrick, C. 2006. Traditional use of boreal wetlands. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Muskeg is the heart. Mountains are the brain. Creeks and rivers are blood vessels. Moose and berries on the muskeg are a major source of food. Muskeg is a natural refrigerator, a water source, diapers and toilet paper, insulation, mattress material and a source of medicine.
Foote, L. 2006. Wildlife and oil sands: Disturbance in a cold spot of biodiversity. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Species to consider for wetlands include waterfowl, buffalo, moose, woodland caribou, tree swallows and fish. Nature itself has a lot of variation – keep variation built into the system. Focus should be on limiting wild fluctuations.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Garibaldi, A. 2006. Bridging ethnobotany, autecology and restoration: The study of Wapato (<i>Sagittaria latifolia Willd.</i>) in interior British Columbia and research implications for other areas. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Recommended focusing on keystone species (species that exert influence on the ecosystem disproportionate to their biomass). Keystone species can provide a starting point to restoration.
Golder Associates Ltd. 2006. <i>Predicted Water Quality of Oil Sands Reclamation Wetlands: Impact of Physical Design and Hydrology</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Model and sensitivity results indicate that wetland volume and associated residence time along with watershed characteristics drive water quality.
Howat, D. 2000. <i>Acceptable Salinity, Sodidity and pH Values for Boreal Forest Reclamation</i> . Alberta Environment, Environmental Sciences Division. Edmonton, Alberta. Report ESD/LM/00-2.	Identifies salinity, sodicity and pH tolerances for a variety of possible reclamation species.
Jacques-Whitford AXYS. 2007. <i>An Analysis of Existing Information on Peatland Vegetation in the Regional Municipality of Wood Buffalo: Phase 1 Peatland Data Compilation and Summarization</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Examines natural vegetation communities and environment conditions in peatlands.
Price, J.S., R.G. McLaren and D.L. Rudolph. 2009. Landscape restoration after oil sands mining: conceptual design and hydrological modelling for fen reconstruction. <i>International Journal of Mining, Reclamation and Environment</i> 24: 109–123.	Modelling paper that documents peatland reclamation is hydrologically possible under current climatic conditions.
Quinty, F. 2006. The Canadian approach to peat bog restoration. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Canadian approach to restoring harvested peatlands includes: reshape peat fields and flatten the surface, identify water chemistry, harvest plants appropriate for water chemistry and plant/spread diaspores on surface. Plants are covered with straw mulch and fertilized.
Tedder, W. 2006. CT research. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Focus on developing an understanding of the nature, acceptability and sustainability of ecosystems with CT-reclaimed landscape, to have capability of defining end land uses for landscapes and ensure that water discharges are environmentally acceptable.
Vitt, D. 2006. Boreal wetlands and groundwater. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Recommends requirements for peatland reclamation, including a positive regional water balance, saturated soils, stabilized water table, decreased salinity and moss layer. Once these criteria are met, nutrients become sequestered and peatland characteristics develop. Fens are the first seral stage in peatland succession.
Watson, D. 2006. Advancing reclamation and its certification in the Athabasca Oilsands: Landform design subgroup and reclamation certification subgroup. In: <i>Creating Wetlands in the Oil Sands Reclamation Workshop</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Work of the reclamation certification subgroup is to review existing regulatory documents, streamline regulations so there are no conflicts and ensure process to receive a reclamation certificate is efficient and effective.
Wong, A., C. Greenway and S. Bayley. 2008. <i>An Analysis of Existing Information of Wetland Vegetation in the Oil Sands Region – Marshes</i> . Prepared for the Cumulative Environmental Management Association. Fort McMurray, Alberta	Examines natural vegetation communities and environment conditions in marshes.
Salinity, Sodidity and pH	
Chaikowsky, C.L.A. 2003. <i>Soil Moisture Regime and Salinity on a Tailings Sand Storage Facility</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Because of a textural discontinuity between topsoil and tailings sand, there was a barrier to natural water flow. Topsoil continued to increase in moisture. Increased moisture content coincided with increased salinity. At the time of the study, the root zone was not inhibited by saturation or salinity/sodidity.
Croser, C., S. Renault, J. Franklin and J. Zwiazek. 2001. The effect of salinity on the emergence and seedling growth of <i>Picea mariana</i> , <i>Picea glauca</i> and <i>Pinus banksiana</i> . <i>Environmental Pollution</i> 115: 9–16.	Emergence of jack pine seedlings were least affected by salinity. White spruce was the most sensitive.
Crowe, A. 1999. <i>Physiological Effects of Oil Sands Effluent on Selected Aquatic and Terrestrial Plant Species</i> . M.Sc. Thesis, Simon Fraser University. Burnaby, B.C.	Offsite and onsite wetland vegetation was similar. Highest diversity was in wetlands with effluent seeping from dikes. Lowest wetland diversity was in areas of effluent treated with gypsum.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Franklin, J., S. Renault, S., Croser, J.J Zwiazek and M. MacKinnon. 2002. Jack pine growth and elemental composition are affected by saline tailings water. <i>Journal of Environmental Quality</i> 31: 648–653.	Needle necrosis caused by Na and Cl ion toxicity.
Franklin, J, J.J. Zwiazek, S. Renault and C. Croser. 2002. Growth and elemental composition of jack pine (<i>Pinus banksiana</i>) seedlings treated with sodium chloride and sodium sulfate. <i>Trees – Structure and Function</i> 16: 325–330.	Decreased jack pine growth because of NaCl toxicity, not nutrient deficiency (grown in sand culture).
Khasa, D.P., B. Hambling, G. Kernaghan, M. Fung and E. Ngimbi. 2002. Genetic variability in salt tolerance of selected boreal woody seedlings. <i>Forest Ecology and Management</i> 165: 257–269.	Highest percent survival: jack pine, white spruce, red alder and lodgepole pine.
Leung, S.S., M. MacKinnon and R.E.H. Smith. 2001. Aquatic reclamation in the Athabasca, Canada, oil sands: Naphthenate and salt effects on phytoplankton communities. <i>Environmental Toxicology and Chemistry</i> 20: 1532–1543.	Naphthenate concentration correlated with community structure. Salinity correlates with naphthenate concentration. This in turn affects phytoplankton communities.
Purdy, B.G., S.E. Macdonald and V. Lieffers. 2005. Naturally saline boreal communities as models for reclamation of saline oil sand tailings. <i>Restoration Ecology</i> 13: 667–677.	Upland boreal forest vegetation was similar in species composition to that found in nonsaline habitats. There were some upland saline habitats in which forest vegetation were growing well. In shrub zones at similar topography, in nonsaline areas, shrub or forest vegetation developed, whereas in the saline areas limited growth of boreal forest species. Species richness was lower in the reclaimed landscape compared with natural landscape.
Redfield, E.B. 2000. <i>Tolerance Mechanisms of Black Spruce (Picea mariana) Seedlings Exposed to Saline Oil Sands Tailings</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta. Edmonton, Alberta.	Black spruce seedlings were visibly more sensitive to NaCl than to Na ₂ SO ₄ . Excluding lethal amounts of Cl, the drought tolerance of spruce contributes to its ability to cope with salt-induced water deficits. Na can be more toxic under poorly aerated conditions.
Redfield, E.B. and J.J. Zwiazek. 2002. Drought tolerance characteristics of black spruce (<i>Picea mariana</i>) seedlings in relation to sodium sulfate and sodium chloride injury. <i>Canadian Journal of Botany</i> 80: 773–778.	Black spruce seedlings were visibly more sensitive to the Cl in NaCl than to Na ₂ SO ₄ . Injury by Na ₂ SO ₄ because of osmotic stress.
Renault, S. 2005. Tamarack response to salinity: Effects of sodium chloride on growth and ion, pigment and soluble carbohydrate levels. <i>Canadian Journal of Forest Research</i> 35: 2806–2812.	Tamarack seedlings can likely survive at low salinity levels.
Renault, S., C. Lait, J.J. Zwiazek and M.D. MacKinnon. 1998. Effect of high-salinity tailings waters produced from gypsum treatment of oil sand tailings on plants of the boreal forest. <i>Environmental Pollution</i> 102: 177–184.	Raspberry and strawberry seedlings were most susceptible to damage by Na ₂ SO ₄ salinity. Some preliminary damage to white spruce, black spruce and lodgepole pine seedlings. Willow and aspen first lost leaves, then grew new leaves. Dogwood and hybrid poplar were tolerant of Na ₂ SO ₄ salinity.
Renault, S., E. Paton, G. Nilsson and M.S. MacKinnon. 1999. Responses of boreal plants to high-salinity oil sands tailings water. <i>Journal of Environmental Quality</i> 28: 1957–1962.	Dogwood, hybrid poplar and buffalo-berry had high survival to saline CT water. Conifer seedlings developed necrosis and aspen lost foliage and produced new leaves.
Sinha, R. 2003. <i>Analysis of Salt Movement in Capped Composite Tailings and Its Effects on Plant Growth</i> . M.Sc. Thesis, Department of Renewable Resources, University of Alberta, Edmonton, Alberta.	Salt accumulation is related to amount and frequency of precipitation. Less precipitation increases soil salinity. Highlander grass can tolerate higher concentrations of salt than can dogwood.
Arbuscular and Ericoid Mycorrhizal Plants	
Bois, G., Y. Piché, M.Y.P Fung and D.P. Khasa. 2005. Mycorrhizal inoculum potentials of pure reclamation materials and revegetated tailing sands from the Canadian oil sand industry. <i>Mycorrhiza</i> 15: 149–158.	Composite tailings sand and common tailings sands had no active ectomycorrhizas (ECM). Native mycorrhiza in peat-enhanced ECM inoculums potentials, but all had low levels of diversity and percent colonization (composite tailings, common tailings, deep overburden and muskeg peat).
Danielson, R.M. 1991. Temporal changes and effects of amendments on the occurrence of sheathing (ecto-) mycorrhizas of conifers growing in oil sands tailings and coal spoil. <i>Agriculture, Ecosystems and Environment</i> 35: 261–281.	Mycorrhizas of white spruce developed quickly in coal mine spoil compared with those of jack pine in oil sands tailings. Adding sewage sludge increased growth of jack pine and sewage sludge and peat improved the growth of white spruce. Temporal changes in the fungi.
Kernaghan, G., B. Hambling, M. Fung and D.P. Khasa. 2002. In vitro selection of boreal ectomycorrhizal fungi for use in reclamation of saline-alkaline habitats. <i>Restoration Ecology</i> 10: 43–51.	Different fungi have different tolerances to saline situation. Wetland pH and degree of salinity also influence fungal growth and survival.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Reclamation Performance Assessment	
Eishoragy, A., M. Asce and S.L. Barbour. 2007. Probabilistic approach for design and hydrologic performance assessment of reconstructed watersheds. <i>Journal of Geotechnical and Geoenvironmental Engineering</i> 133: 1110–1118.	Recommendations for assessing available water-holding capacity of reclaimed soils to account for physical variability and uncertainty of parameters and allow for risk identification.
FOR _{rx} Consulting Inc. 2006. <i>Proposed Criteria and Indicators of Ecosystem Function for Reclaimed Oil Sands Sites</i> . Reclamation Working Group, Cumulative Environmental Management Association. Fort McMurray, Alberta.	Recommends and describes list of indicators of forest ecosystem function, including a description of how they might be used to assess reclamation success.
FOR _{rx} Consulting Inc. 2010. <i>Development and Evaluation of an Integrated Modelling Approach for Risk Analyses of Alternative Reclamation Strategies</i> . Reclamation Working Group, Cumulative Environmental Management Association. Fort McMurray, Alberta.	Provides a model-based system for projecting future performance in conjunction with empirical data including risk assessment associated with future climate change.
Geographic Dynamics Inc. 2006. <i>Development of Site Types; Classification Through the Groupings of Ecosites and Interpretations for Reclamation</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Provides a site type classification system with an evaluation of the ecological conditions of each ecological unit through assessment of available plot data.
Leskiw, L. 2006. <i>Land Capability Classification for Forest Ecosystems in the Oil Sands Region</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Working document to facilitate evaluation of land capabilities for forest ecosystems on natural and reclaimed lands in the Athabasca oil sands region.
Opabin Environmental Consultants. 2009. <i>A Framework for Reclamation Certification Criteria and Indicators for Mineable Oil Sands</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Framework for reclamation certification criteria and indicators for mineable oil sands.
Timberline Natural Resource Group Ltd. 2008. <i>Analyzing and Relationship Between LCCS Ratings and Site Productivity</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Using data from CEMA's long-term monitoring reclaimed and natural plots, site index recalculations and LCCS were determined. Higher site indices in reclaimed sites suggest that reclamation efforts have been successful to date, however sustainability of growth is unknown. Longer-term monitoring is required.
Wildlife	
AXYS Environmental Consulting Ltd. 2003. <i>Literature Review of Reclamation Techniques for Wildlife Habitats in the Boreal Forest</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Research review of reclamation techniques at the stand and element level that might allow for restoration of habitat features needed for functional wildlife habitat at landscape levels.
Gentes, M-L, C. Waldner, Z. Papp and J. Smits. 2006. Effects of oil sands tailing compounds and harsh weather on mortality rates, growth and detoxification effort in nestling tree swallows (<i>Tachycineta bicolor</i>). <i>Environmental Pollution</i> 142: 24–33.	Nestling tree swallows on reclaimed wetlands weighed less than those on a reference site and had higher EROD (an enzyme) activity. Additional stress could decrease the bird's survival rate after fledging.
Gentes, M-L, A. McNabb, C. Waldner and J.E. Smits. 2007. Increased thyroid hormone levels in tree swallows (<i>Tachycineta bicolor</i>) on reclaimed wetlands of the Athabasca oil sand. <i>Archives of Environmental Contamination and Toxicology</i> 53: 287–292.	Tree swallows had elevated hormone synthesis as well as “increased deiodination of T ₄ into T ₃ in peripheral tissues.” Cause could be exposure to polycyclic aromatic hydrocarbons or from environmental factors such as food availability.
Gentes, M-L, C. Waldner, Z. Papp and J.E. Smits. 2007. Effects of exposure to naphthenic acids in tree swallows (<i>Tachycineta bicolor</i>) on the Athabasca oil sands, Alberta, Canada. <i>Journal of Toxicology and Environmental Health Part A</i> 70:1182–1190.	Tree swallows can tolerate short-term exposure to a 10-fold dose (0.075g/kg body mass) of naphthenic acids (byproduct of oil sands mining).
Gentes, M-L, T. Whitworth, C. Waldner, H. Fenton and J.E. Smits. 2007. Tree swallows (<i>Tachycineta bicolor</i>) nesting on wetlands impacted by oil sands mining are highly parasitized by the bird blow fly <i>Protocalliphora</i> spp. <i>Journal of Wildlife Diseases</i> 43: 167–178.	Reclaimed wetlands have 60 to 72% more blowfly larvae (a parasite to tree swallows) than on the reference site.
Gurney, K.E., T.D. Williams, T.D., J.E. Smits, M. Wayland and S. Trudeau. 2005. Impact of oil-sands based wetlands on the growth of mallard (<i>Anas platyrhynchos</i>) ducklings. <i>Environmental Toxicology and Chemistry</i> 24: 457–463.	If observed differences in growth and size translate into decreased survival of juvenile waterfowl inhabiting these wetlands, then populations of these birds in the area could be negatively affected.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Papp, Z. and J.E. Smits. 2007. Validation and novel applications of the whole blood chemiluminescence assay of innate immune function in wild vertebrates and domestic chickens. <i>Journal of Wildlife Diseases</i> 43: 623–634.	Tested whole-blood chemiluminescence assay in the field on wildlife. Compared samples that went directly to the lab and held other samples for four days to simulate actual field access. Little difference.
Pollet, I. and L.I. Bendell-Young. 2000. Amphibians as indicators of wetland quality in wetlands formed from oil sands effluent. <i>Environmental Toxicology and Chemistry</i> .	Determined that wetlands formed with/by oil sands effluent will not support viable amphibian populations.
Ronconi, R.A. and C.C. St. Clair. 2006. Efficacy of a radar-activated on-demand system for deterring waterfowl from oil sands tailings ponds. <i>Journal of Applied Ecology</i> 43: 111–119.	Results promote the use of on-demand systems for waterfowl deterrence and recommend cannons over effigies as stimuli. Deterrence efforts should be operational in early spring, when tailings ponds appear to be most attractive to migrating waterfowl. Should target low-flying waterfowl and shorebirds and be effective day and night.
Smits, J.E., M.E. Wayland, M.J. Miller, K. Liber and S. Trudeau. 2000. Reproductive, immune and physiological end points in tree swallows on reclaimed oil sands mine site. <i>Environmental Toxicology and Chemistry</i> 19: 2951–2960.	No differences between reproductive success, nestling growth rate and immune stress on wetlands receiving tailings versus a natural wetland. An increase in EROD (an enzyme) activity on the tailings wetlands.
Aquatic Web	
Baker, L. 2007. <i>The Effects of Petroleum Coke Amendments on Macrophytes and Aquatic Invertebrates in Northern Alberta, Canada Constructed Wetlands</i> . M.Sc. Thesis, University of Windsor. Windsor Ontario.	Results indicate that petroleum coke had no obvious effect on percent cover, biomass, shoot-root relationship or macrophyte species richness. Small amendments of coke didn't significantly affect abundance or richness of invertebrates. Greater differences in dominant species, development of plant cover and accumulation of biomass.
Barr, L. 2009. <i>Influence of Consolidated Mine Tailings and Oil Sands Process Water on Colonization Potential of Aquatic Invertebrates of Constructed Wetlands in the Athabasca Oil Sands, Alberta</i> . M.Sc. Thesis, University of Windsor, Ontario.	Generally, where there was sediment contamination, zoobenthic community decreased in number, taxonomic richness and abundance of dominant taxa.
Daly, C. 2007. <i>Carbon sources, Microbial Community Production and Respiration in Constructed Wetlands of the Alberta, Canada Oil Sands Mining Area</i> . M.Sc. Thesis, University of Windsor. Windsor, Ontario.	Microbial function is different from oil-sands-process-material-affected wetlands, from reference constructed wetlands and do not correspond to natural wetlands. Petroleum can be incorporated in microbial biomass using stable isotope analysis.
Del Rio, L.F., A.K.M. Hadwin, L.J. Pinto, M.D. MacKinnon and M.M. Moore. 2006. Degradation of naphthenic acids by sediment micro-organisms. <i>Journal of Applied Microbiology</i> 101: 1049–1061.	Some micro-organisms are better at degrading naphthenic acids. Selecting these communities would benefit tailings-influenced wetlands.
Hadwin, A.K.M., L.F. Del Rio, L.J. Pinto, M. Painter, R. Routledge and M.M. Moore. 2006. Microbial communities in wetlands of the Athabasca oil sands: genetic and metabolic characterization. <i>FEMS Microbiology Ecology</i> 55: 68–78.	Metabolic capacities are different between affected and offsite microbial communities.
Leonhardt, C.L. 2003. <i>Zoobenthic Succession in Constructed Wetlands of the Fort McMurray Oil Sands Region: Developing a Measure of Zoobenthic Recovery</i> . M.Sc. Thesis, University of Windsor, Ontario.	Sampled zoobenthic community of wetlands 0 to 30-years-old to study community sequence throughout wetland succession. It took 7 to 13 years for comparable richness. But, after 13 years, wetlands still don't have all the taxa that natural wetlands do.
Leung, S.S.-C., M.D. MacKinnon and R.E.H. Smith. 2003. The ecological effects of naphthenic acids and salts on phytoplankton from the Athabasca oil sands region. <i>Aquatic Toxicology</i> 62: 11–26.	Research suggests that wet landscape reclamation can result in waters that support plankton communities similar to reference wetlands.
Madill, R.E.A., M.T. Orzechowski, G. Chen, B.G. Brownlee and N.J. Bunce. 2001. Preliminary risk assessment of the wet landscape option for reclamation of oil sands mine tailings: Bioassays with mature fine tailings porewater. <i>Environmental Toxicology</i> 16: 197–208.	Polyaromatic compounds were decomposed in porewater by naturally occurring microflora. Any toxicity was the result of the acid in naphthenic acids. Research concluded that it should be possible to develop tailing slurries in biologically productive artificial lakes.
Videla, P.P. 2007. <i>Examining Oil Sands Dissolved Carbon and Microbial Degradation Using Stable Isotope Analysis</i> . M.Sc. Thesis, University of Waterloo. Waterloo, Ontario.	Followed path of microbial degradation (follows carbon) using isotopes.

Table 14-1 Listing and Summary of Recent Reclamation Work Relevant to the Oil Sands Region (cont'd)

Study	Abbreviated Summary
Videla, P.P., A.J. Farwell, B.J. Butler and D.G. Dixon. 2009. Examining the microbial degradation of naphthenic acids using stable isotope analysis of carbon and nitrogen. <i>Water, Air and Soil Pollution</i> 197: 107–119.	Followed path of microbial degradation (follows carbon) using isotopes.
Biodiversity	
Dupuis, B. 2009. Mining and the importance of biodiversity reclamation. Presentation from <i>Biodiversity Reclamation in the Oil Sands Region: Current State and Next Steps</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Conceptual importance of biodiversity reclamation and development of best practices.
Grant, C. 2009. Monitoring the Return of Biodiversity to Rehabilitated Bauxite Mines in Western Australia. Alcoa. Presentation from <i>Biodiversity Reclamation in the Oil Sands Region: Current State and Next Steps</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Outline progressive reclamation reference ecosystems, landform design, soil stripping, source of plant species, topsoil and overburden return, seed stores, fauna habitats and seedling planting. Include completion criteria and monitoring program.
Nason, T. and G. Glappstein. 2009. Biodiversity: Government of Alberta Perspective. Presentation from <i>Biodiversity Reclamation in the Oil Sands Region: Current State and Next Steps</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Offers information on biodiversity goals, policy drivers, key strategic responses, land use framework overview and strategies, regional plans and Alberta Biodiversity Monitoring Program. Also includes a Biodiversity Action Plan, proposed actions and ASRD's expectations for mine reclamation.
Nichols, O. 2009. Linking Good Assessment and Good Practice Rehabilitation to Re-establish Biodiversity Following Mining. E Presentation from <i>Biodiversity Reclamation in the Oil Sands Region: Current State and Next Steps</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Offers key principles to strong assessments and practices to re-establish biodiversity. Includes several case studies.
Reid, J. 2009. <i>Synthesis of the 2009 Reclamation Working Group Workshop Biodiversity Reclamation in the Oil Sands Region: Current State and Next Steps</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Discusses monitoring – how to ensure that biodiversity planning is aligned with government regulations, select appropriate indicators and maintain retained habitat.
Schieck, J. and B. Eaton. 2009. Reclamation of Oil Sands Sites – Recommendations for Biodiversity Restoration and Monitoring. Presentation from <i>Biodiversity Reclamation in the Oil Sands Region: Current State and Next Steps</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	A multi-species approach with reference conditions. Biodiversity should be measured over time at multiple locations with a reference and to allow regional assessment. Flow chart of steps to implement multi-species monitoring in the oil sands.
Simmons, D. 2009. Renewing the Health of Our Forests; Biodiversity Traditional Knowledge Study. Presentation from <i>Biodiversity Reclamation in the Oil Sands Region: Current State and Next Steps</i> . Cumulative Environmental Management Association. Fort McMurray, Alberta.	Presents traditional knowledge vision for reclamation. Basic outline of traditional knowledge research and monitoring scope, participation and follow-up.

Question 15

Provide relevant studies conducted by CEMA, and the Canadian Oil Sands Network for Research and Development (CONRAD), which would influence Total's reclamation and monitoring protocols, including a discussion of the recommendations contained in these studies.

Response:

For a list of recent relevant studies, recommendations and results from studies funded by CEMA, CONRAD and others currently providing direction for development of reclamation and monitoring protocols, see the response to Question 14.

TEPJ has and will continue to participate in CEMA and CONRAD to contribute toward and remain current in emerging reclamation and monitoring protocols for the region. The Closure, Conservation and Reclamation Plan developed and provided as part of the Integrated Application, SI Project Update and AI Project Update has taken the majority of its direction from:

- *Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)* (AENV 2008)
- *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010)

Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition (AENV 2010) is an update to the original version of the guideline, with incorporation of over 10 years of CONRAD and CEMA research.

TEPJ acknowledges the importance of research and monitoring, as reclamation directions and strategies continue to evolve and improve as a result of findings from such research and monitoring. As such, evolving reclamation strategies, performance objectives and associated evaluations and, where necessary, corrective actions will be key components of TEPJ's ongoing plans and operational protocols.

Recent relevant reclamation research and monitoring has had a direct influence on the following components of project design:

- Salvage and direct placement of upland soils and associated LFH to enhance soil physical properties and improve nutrient cycling of reconstructed soils and promote recolonization by native species from propagules.
- Depth and amendment prescriptions for soils to be reconstructed from peat–mineral mix to replace the capability of the reclaimed landscape for forested ecosystems.
- Prescribed plantings of native vegetation for ecosite phase re-establishment.
- Use of coarse woody debris in the establishment of reclaimed land vegetation (Brown 2010).
- Introduction of mesotopography onto the landscape to increase site diversity, establish sustainable drainage patterns, manage salinity and enhance opportunities for wetlands re-establishment.

References

Brown, R. 2010. *Use of Woody Debris as an Amendment for Reclamation after Oil Sands Mining*. MSc. Department of Renewable Resources, University of Alberta. Edmonton, Alberta.

Question 16

Provide any CEMA studies and peer reviewed literature on the suitability of reclamation to establish, and/or the time required to evolve into, appropriate wildlife habitat for the chosen list of VECs and a summary of the studies' conclusions.

Response:

Guides, manuals and frameworks for reclamation specific to oil sands operations have been developed by multi-stakeholder groups and research on key reclamation challenges has been completed to assist and guide reclamation planning (see the response to Question 14). The project will result in terrain and soil disturbance in the LSA. The Closure, Conservation and Reclamation Plan developed for the project was designed with the goal of constructing sustainable terrain, soils and drainage features that would provide the opportunity for a diversity of vegetation communities and associated habitats adapted to the local climate to be re-established on the landscape.

Throughout much of the history of oil sands development, reclamation priorities focused on the establishment of a stabilizing cover of vegetation on the landscape, rather than the re-establishment of more natural ecosite conditions and native vegetation communities. For example, early reclamation efforts experimented with the development of large tracts of grasslands for bison propagation, and introduced a number of aggressive, non-native tree and shrub species as a means of groundcover establishment and soil stabilization.

It has only been in the last two decades that the reclamation focus has turned to the re-establishment of natural ecosites. As a result, monitoring information on initiatives designed to gauge the successional and temporal performance of reclamation efforts has only recently become available (see the response to Question 12) and data remain limited. From a site productivity perspective, preliminary measurements from older monitoring plots indicate that early tree growth on reconstructed soils is comparable to growth rates of trees on natural soils, although the long-term sustainability of this growth is still in question (Timberline Natural Resource Group 2008). From a community succession perspective, the diversity of plants on sites with reconstructed peat–mineral mix soils still remains well below natural site levels (see Stantec 2009). However, more recently established reclamation plots that received upland soil/LFH transplants have demonstrated native plant diversity levels much closer to natural conditions (MacKenzie 2007; MacKenzie and Naeth 2009).

Following principles identified in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010), it is anticipated that the re-establishment of vegetation and wildlife diversity in the area will eventually be obtained, particularly with the inclusion of natural disturbance processes (e.g., fire) on the reclaimed landscape. However, as old-growth stands are present in the project footprint, the timeframe for such re-establishment might be in the order of 100 years or more. In addition, as the conditions suitable for some vegetation types to establish might not be available in the closure landscape (i.e., certain wetland types) vegetation and wildlife species with a high fidelity to these vegetation types might not be re-established in the local area.

References

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Question 17

Provide evidence from scientific, peer-review literature to show the success rate and time required regarding reversibility of the number of vegetated patches.

Response:

Large anthropogenic disturbances such as mines are known to create homogeneous landscapes (Herzog et al. 2001). This is evident in conceptual oil sands mining closure landscapes, including the closure landscape for the project, where large patches with relatively smooth edges are initially anticipated. The distribution and size of patches through time is controlled by factors such as climate, physiography and hydrology as well as natural disturbances (Pickett and White 1985; Forman 1995; Turner et al. 2001; Johnson and Miyanishi 2008).

Patch configuration on the closure reclamation landscapes will be initially influenced by the mesotopography and associated moisture/nutrient regimes that will occur immediately after recontouring and revegetation. Additional unplanned heterogeneity is expected to occur naturally because of the dynamic and complex interaction of these factors (i.e., development of opportunistic wetlands). While there is evidence that the number of vegetation patches in reclaimed mined landscapes does increase through time, largely reflecting unplanned heterogeneity (see Ru-tian et al. 2007), overall success rates and time required for development of comparable heterogeneity has not been documented. Simulation modelling (Keane et al. 2001), measured landscape pattern changes resulting from large, infrequent natural disturbances (Foster et al. 1998) and observed forest patterns emerging from past anthropogenic activities (Josefsson et al. 2009) all suggest that recovery is a slow process (i.e., centuries).

The mesotopography and soil prescriptions proposed for the mine have been designed with the intent of restoring the landscape to an equivalent land capability, as per the requirements of the Alberta *Environmental Protection and Enhancement Act* Conservation and Reclamation Regulations (115/93). The increased topographic complexity of the closure landscape, relative to pre-disturbance conditions, will encourage the development of a more complex patch network with time, as natural processes continue to work on the landscape.

References

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Question 18

Discuss whether or not Total has used the information included in studies identified in questions 12 to 17 above to determine cumulative effects based on the probable success of reclamation to mitigate the impact to vegetation communities, rare species, and wildlife habitat of the local study area (LSA), and regionally for other built, approved or disclosed oil sands mine development.

Response:

The Closure, Conservation and Reclamation Plan developed for the project follows the reclamation guides, manuals and frameworks developed along with integrating results of research as applicable. Many of the listed studies have provided input used in development of key regulatory guidelines, discussed below. The goals and principles of the Landscape Design Checklist (CEMA 2005) were integrated in the Closure, Conservation and Reclamation Plan for the project and include but are not limited to:

- design of geotechnically stable landforms that are integrated with their surroundings
- use of progressive reclamation whenever practical, including transfer and direct placement of upland soils and associated native seed banks and propagules
- seeding and planting native species appropriate to ecosystem conditions following recommendations in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition* (AENV 2010) and *Guideline for Wetlands Established on Reclaimed Oil Sands Leases (2nd Edition)* (AENV 2008)
- restoring equivalent landscape capability in accordance with the Alberta *Environmental Protection and Enhancement Act*

In conjunction with these goals and principals, the Closure, Conservation and Reclamation Plan for the project recognizes the importance of adaptive management, acknowledging the:

- unpredictability of future conditions
- dynamic and interconnected nature of ecosystems, which can have multiple trajectories
- potential for changes in future land management and end use strategies
- potential for new, effective reclamation techniques

The Closure, Conservation and Reclamation Plan is conceptual, and the nature and distribution of the vegetation communities and associated habitats that will become re-established on the landscape must also be considered conceptual. The portion of the environmental assessment that assessed the long-term effects of the project on vegetation and wildlife at the LSA level assumed that the re-establishment of the predicted ecosite phases on the closure landscape would be successful, based on the reclamation demonstrated with peat–mineral soil reconstruction, upland soil/LFH transplants and use of coarse woody debris (see MacKenzie and Naeth 2009; Brown 2010). The LSA-based assessment also included the predicted structural stage of the vegetation (i.e., height of tree cover) for the various periods selected for the assessment, based on the tree growth patterns demonstrated on reclamation plots. The assessment did recognize the low probability of re-establishing peat-forming wetlands on the landscape and, as a result, conservatively identified loss of peatlands as not reversible.

On the regional scale, the assessment took a worst-case position and assumed that all developments included in the cumulative effects assessment, including the project, were at full buildout with no reclamation. This resulted in an extremely conservative (i.e., overstated) estimate of cumulative effects at the RSA level.

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8.0 Significance of Effects

Question 19

Clarify how Total has used the method, definitions and criteria described in Section C, pages C-15 and C-16 of the 2006 Integrated Application to determine the significance of the project effects and cumulative effects on VECs.

- a. For each VEC identified in its environmental assessment, clarify the methods, criteria, definitions, thresholds, and if applicable, the algorithm, that was used to determine what would be considered a significant effect.

Response:

The following provides the requested information on the environmental assessment for the project, by major environmental component. The following abbreviations are used:

- **Integrated Application** – the Integrated Application submitted to the Alberta Energy and Utilities Board and Alberta Environment in February 2006
- **CR** – Consultant’s Reports included as part of the Integrated Application
- **SI Project Update** – the Supplemental Information Project Update submitted in June 2007
- **AI Project Update** – the Additional Information Project Update submitted in February 2010

The methods, criteria, definitions, thresholds and, where applicable, algorithms used to determine what would be significant are described in general for the EIA in the Integrated Application, Section C.2. Additional clarifications on methodology were described in the SI Project Update, Section 13 and the AI Project Update, Section 14.1.1.

As described in Section C.2 of the Integrated Application, the impact classification system was based on the Canadian Environmental Assessment Agency (CEAA) reference guide (FEARO 1994) to assist proponents and project reviewers in determining whether a project is likely to cause significant adverse environmental effects. The CEAA guide was used for the project EIA to assist in determining whether or not an environmental effect was deemed to be significant. Significance was determined only after assessing whether the effect can be mitigated and after considering the following criteria (FEARO 1994):

- What is the magnitude of the impact?
- What is the geographic extent of the impact?
- What is the duration and frequency of the impact?
- What is the degree to which the effects are reversible or irreversible?
- What is the ecological context of the impact?
- Are there any environmental standards, guidelines or objectives for assessing the impact?

The CEAA definitions for these criteria are as follows:

Magnitude of the Impact: “Magnitude refers to the severity of the adverse environmental effects. Minor or inconsequential effects may not be significant. On the other hand, if the effects are major or catastrophic, the adverse environmental effects will be significant. When using this criterion, it is important to consider the extent to which the project could trigger or contribute to any cumulative environmental effects.”

Geographic Effect: “Localized adverse environmental effects may not be significant. Alternatively, widespread effects may be significant. When considering this criterion, it will be important to take

into account the extent to which adverse environmental effects caused by the project may occur in areas far removed from it (e.g., acid rain and the long-range transportation of atmospheric pollutants), as well as contribute to any cumulative environmental effects.”

Duration and Frequency: “Long term and/or frequent adverse environmental effects may be significant. Future adverse environmental effects should also be taken into account. For example, many human cancers associated with exposure to ionizing radiation have long latency periods of up to 30 years. Obviously when considering future adverse environmental effects, the question of their likelihood becomes very important.”

Degree to Which the Effects are Reversible or Irreversible: “Reversible adverse environmental effects may be less significant than adverse environmental effects that are irreversible. In practice, it can be difficult to know whether the adverse environmental effects of a project will be irreversible or not. It will be important to consider any planned decommissioning activities that may influence the degree to which the adverse environmental effects are reversible or irreversible.”

Specific descriptions for each of the environmental components and the VECs identified for those components were provided in the CRs submitted as part of the Integrated Application, and updated in specific component sections of the SI Project Update and AI Project Update.

Key component-specific information follows.

AIR QUALITY

All determinations of significance for air quality were made with the aid of dispersion modelling using CALPUFF/CALMET. Details on the dispersion modelling approach are provided in Appendix 1 of CR1 in the Integrated Application. The model results were used directly for most parameters evaluated in the EIA; however, for ozone, model results for oxides of nitrogen (NO_x) and volatile organic carbons (VOCs) were used to estimate potential ozone effects.

The following information is taken in part from the Integrated Application, CR1. The approach was applied to the air quality valued ecosystem components (VECs) for the concentrations of nitrogen dioxide (NO₂), sulphur dioxide (SO₂), particulate matter less than 2.5 microns (PM_{2.5}), carbon monoxide (CO), benzene, b(a)p, other VOCs and other polycyclic aromatic hydrocarbons (PAHs) as well as for the deposition of PAI and nitrogen. Ozone was initially assessed in the Integrated Application using the same approach, but was not assessed in 2007 and 2010 as a number of assessments by Alberta Environment and the Cumulative Environmental Management Association (CEMA) were in progress. Metals and total reduced sulphurs (TRS) were added to the list of VECs in the SI Project Update.

Results of the modelling were compared with ambient air quality criteria as detailed in CR1, Section 2.4.2.

For the methods, definition and criteria of the assessment for the project, see the Integrated Application, CR1, Table 2.6. Impact ratings were based on effects on communities rather than the nearest habitations (i.e., they do not include work camps).

For an effect associated with the Application Case, to be considered significant in the air quality assessment, compared with Baseline Case effects, all the following should apply, based on professional judgement:

- effects should be more than local in extent; for air quality VECs other than ozone, effects are largest nearest the source and decrease with distance
- effects should be irreversible (in air quality, effects cease when emissions cease)

- effects should be negative (all emissions are assumed to decrease air quality and therefore this test of significance is always met)
- magnitude of effect should be above ambient air quality objectives or standards where applicable, or greater than a 10% increase where no objectives or standards exist

A number of modelling refinements were made for the AI Project Update, as described in Section 14.2.2.2. The refinements included:

- The 2002 Mesoscale Model (MM5) one-year dataset was used, instead of the 1995 dataset, for the initial estimate wind field determination in the California Meteorological Model (CALMET) runs and for upper air data readings.
- Modelled predictions were interpreted according to guidance from the recently published guidance document *Using Ambient Air Quality Objectives in Industrial Plume Dispersion Modelling and Individual Industrial Site Monitoring* (AENV 2009a).
- Surface data from an additional meteorological station (Fort Chipewyan) were used for the CALMET modelling, in addition to the two stations (Fort McMurray and Mannix 75 m) used in the SI Project Update modelling.
- Fenceline receptors were added to the receptor grid. The fenceline receptors were placed around the project footprint plus a buffer zone of 1 km. Receptors were placed 100 m apart along this fenceline. No fenceline receptors were placed on the northern side of the project since the Canadian Natural Resources Limited Horizon mine abuts the project directly to the north, and members of the public would not be expected to have access to nearby areas north of the project.
- Sigma Z values for mine fleet emissions were increased from 15.0 m to 16.0 m, as suggested by the report *NO_x Dispersion and Chemistry Assumptions in the CALPUFF Model* (CEMA 2005).

Cumulative effects in the Planned Development Case were assessed considering that all projects considered were operating at full capacity at the same time. This is a conservative approach because it is possible that not all the projects included in the assessment will be built. Additionally, it is unlikely that even if built, that all projects would be fully operational at the same time. The following comments refer to potential cumulative regional effects and the Planned Development Case:

- The magnitude of potential cumulative regional effects was generally considered to be high as increases in concentration or deposition were typically greater than 10% above Baseline Case. Exceptions were concentrations of NO₂.
- Potential effects were regional, although the highest effects are localized around individual operations, and lasted for the length of oil sands operations.
- Confidence was generally lower for cumulative effects because of uncertainties in emissions from approved (but not built) and planned facilities.
- All effects are considered to be reversible (emissions cease when operations cease).

Significance for the Planned Development Case was assessed considering that regional emissions cease when project operations cease, and that in the few cases where exceedances of AAAQOs are predicted during operations, they are very localized, infrequent and do not occur at residences or in communities.

The Planned Development Case was also assessed considering that regional issues of air quality are managed through multi-stakeholder working groups and monitoring programs (e.g., acid deposition management framework established in the region to manage potential effects of acidifying emissions).

The effects presented in the project EIA are also consistent with other recent air quality assessments in the region, and therefore present no new issues for multi-stakeholder groups to address.

FISH AND FISH HABITAT

The methods for assessment of effects and significance to fish and fish habitat were described in the Integrated Application, CR3, Section 7.5, and remained the same for the SI Project Update and AI Project Update.

Potential project effects on fish habitat and fish populations included changes to:

- physical habitat components
- water quality (sediment and other chemical contaminants)
- water quantity (i.e., flow regimes)
- aquatic temperature regimes
- use of fish resources

Project-specific effects relative to direct physical disruption or loss of habitat were determined as part of the fish and fish habitat component assessment using project development plans and descriptions. The plans were examined to determine if project development activities would directly disturb or otherwise affect fish habitat in watercourses in the LSA. Other project-specific effects related to surface water quality, surface water quantity, substances that could potentially enter the aquatic system and use of aquatic resources were assessed by other environmental assessment components. Results of those assessments were then used to evaluate the potential for those factors to affect fish habitat and fish populations generally, and to assess potential effects on VECs.

Cumulative effects were defined as those that were neither reversible nor could be mitigated, were medium to long-term in duration and operated cumulatively with similar effects resulting from existing or planned developments.

Potential project effects, and potential mitigation for those effects, were identified and the significance of project effects was determined using the criteria described in Table 19-3 (from Integrated Application, CR3, Table 7.5.3-1).

Project-specific effects on fish and fish habitat relating to direct physical habitat alteration will be fully mitigated by development of the fish habitat compensation works and compliance with Fisheries and Oceans Canada's policy on no net loss of fish habitat productive capacity. Therefore, there will be no residual effects on fish and fish habitat associated with direct physical habitat alterations.

Results of assessments by other components, with respect to water quality and water quantity, indicated that potential project effects on those factors were insignificant, and their potential effects on fish or fish habitat are, therefore, also insignificant. Potential effects because of flow alterations in the Athabasca River can be fully mitigated through compliance with the Phase 1 Instream Flow Needs (IFN) guidelines developed by CEMA and the Alberta government.

Therefore, development of thresholds for what would constitute or identify a significant effect on fish populations or fish habitats was deemed unnecessary. As the potential effects on all factors that could potentially affect fish and fish habitat can be fully mitigated, no residual effects on fish or fish habitat are anticipated, and all potential effects on fish and fish habitat are insignificant.

GROUNDWATER

The VECs considered for groundwater, as detailed in Table 5.2 of CR4 of the Integrated Application, were refined in the SI Project update to include:

- head reduction in basal water sands (BWS)
- removal of surficial aquifer
- diversion of groundwater from surface water
- flow in BWS to and from the Athabasca and Ells Rivers
- BWS disposal
- interaction of BWS with end pit lake
- issues of salt dissolution and karst features
- groundwater contamination
- waste management practices
- operations water management

The methods used to evaluate potential effects on groundwater resources were detailed in the Integrated Application, CR4, Section 4. Assessment of the interaction of BWS flow with the Athabasca and Ells Rivers was documented in CR4, Section 5.2.4. Flows in the Athabasca River were provided (including the threshold low flow rate) and were compared with quantitative values for groundwater inflow/outflow derived using a MODFLOW-based 3D computer model, as described in CR4, Section 4.1. Additional modelling was completed for the project using the FEFLOW Finite Element Model, as detailed in the AI Project Update, Appendix E. The criteria used, as well as thresholds considered for assessing the significance of effects on groundwater, were detailed in the Integrated Application, CR4, Table 5.1. The criteria considered in the assessment of the groundwater VECs are provided in the AI Project Update, Table 14.5.3.

Confidence in the assessment of effects on groundwater quantity and quality increased from moderate in 2006 to high in 2010, as a result of additional fieldwork. In addition, detailed modelling was done to incorporate the new fieldwork results.

HISTORICAL RESOURCES

The assessment parameters outlined in the Integrated Application, Section C were not used for historical resources as these definitions are not considered relevant because of the discrete and finite (i.e., irreplaceable) nature of historic resources. Rather, Integrated Application CR5 provided alternative definitions for direction of effect, geographic extent, duration, magnitude, probability of occurrence, confidence, permanence and cumulative effects relevant to historical resources. These criteria were used to assess significance of effects.

Methods for assessing significance to historical resources have changed since the Integrated Application. The historical resources section of the AI Project Update used Alberta Culture and Community Spirit (ACCS) approvals to reflect significance. Historical resources are protected under the Alberta *Historical Resources Act*. Any effects on historical resources sites must be approved by the Minister of ACCS. Although recommendations for mitigation or *Historical Resources Act* clearance for the project (or both) are formulated by the senior archaeologist in the historical resources impact assessment (HRIA) permit report submitted to Historical Resources Management Branch of ACCS, requirements for site mitigation measures are determined by ACCS. Consequently, the threshold for determining significance is identified by ACCS during the approval process.

Although project effects can occur on historical resources sites, ACCS regulates effects on sites through the *Historical Resources Act*. It independently assesses the significance of individual sites and determines the need for, and the scope of, mitigation measures. ACCS issues requirements for mitigation of identified historical resources sites and issues *Historical Resources Act* clearance for the project to proceed relative to historical resources. Consequently, project-specific effects on archaeological resources are continually mitigated to the standards set by the regulators. In this context, after implementation of mitigation measures as issued by ACCS, effects on historical resources are not considered significant.

HUMAN AND WILDLIFE HEALTH

The approach used for the human and wildlife health risk assessment was detailed in the Integrated Application, Section 6. Updates to the approach and methods were made for the risk assessment completed for the SI Project Update, Section 13.6. Additional refinements in the AI Project Update, include the following:

- The method for selecting the most appropriate short-term and long-term toxicological reference values (or exposure limits) in the human health risk assessment (HHRA) was revised (see AI Project Update, Appendix F, Section F1).
- Assumptions (e.g., consumption rates) and methods used in the HHRA multiple pathway exposure assessment (see AI Project Update, Appendix F, Section F2) were changed to reflect assumptions used in recent applications for the oil sands region.
- Exposures to chemicals in the local environment or PDA were incorporated in the HHRA, or in other words, background exposures from the Joslyn Lease were incorporated in the HHRA (see AI Project Update, Appendix F, Section F3).
- New air quality information required a revised assessment of PM_{2.5} using Health Canada's SUM15 method (see AI Project Update, Appendix F, Section F4).

The developments considered in each of the cumulative assessment cases were updated in response to February 2010 AIR Question 3 (see AI Project Update, Section 14.1.1.3, Table 14.1-2 for the developments inclusion list).

Environmental impact assessment significance ratings were not applied to the HHRA. Instead, the potential health risks associated with the project and cumulative sources in the region were assessed on a chemical-by-chemical and case-by-case basis. The characterization of risks was based on a combination of guidelines offered by recognized regulatory agencies and professional judgment.

Human health risks documented in the Integrated Application and the AI Project Update were examined using a conventional risk assessment approach. This approach is consistent with those developed by Health Canada (1995, 2009), the Canadian Council of Ministers of the Environment (CCME 1996, 2006), the U.S. National Research Council (U.S. NRC 1983, 1994) and the U.S. Environmental Protection Agency (U.S. EPA 2005). The methods used in the HHRA, which have been endorsed by a number of provincial regulatory authorities in the past (e.g., Alberta Environment, Alberta Health and Wellness and the ERCB) do not lend themselves to an overall rating of environmental significance.

HYDROLOGY

The method suggested by CEAA (FEARO 1994) was used in the hydrology assessment to determine whether an effect on hydrology is significant or not, as described in the Integrated Application, Section C.6.4. Significance to hydrology was determined in consideration of the criteria including magnitude, geographic extent, duration, frequency and ability for recovery from the residual change after mitigation. The same method was used for the assessment in the SI Project Update and AI Project Update. The rationale for using this method is to follow the CEAA guidelines and to be consistent with other technical disciplines.

The definitions for these criteria are based on CEAA guidelines (see the Integrated Application, Section C.7). The same definitions apply for the SI Project Update and AI Project Update.

The continuous (dynamic) Hydrological Simulation Program FORTRAN (HSPF) model, developed by the United States Environmental Protection Agency (U.S. EPA), was used in this update for the Joslyn-Ells River watershed hydrologic modelling. The current regional HSPF model, calibrated and validated (Golder 2003) for the oil sands region, was recalibrated using local climate data to capture the local conditions in the Joslyn-Ells watershed. Details on the model and its calibration are provided in the AI Project Update, Appendix G.

The descriptive threshold values for rating the hydrology effects based on the criteria are provided in the Integrated Application, Section C.7. The same thresholds were used in the assessments documented in the SI Project Update and AI Project Update. These thresholds were applied in rating the effects based on the results of changes predicted in the various hydrologic parameter values and professional interpretation of these predicted changes.

This is a reasonable approach for hydrology assessment because the effects of changes in hydrology have been used as inputs for assessing effects on other environmental receptors such as fish and human health.

ACOUSTICS

The approach for the assessment of acoustics has focused on the potential for public complaint and regulatory compliance. As such, significance of effects on the acoustic environment was not determined for the project.

Effects assessment methods for Acoustics used the approach detailed in the Integrated Application, CR8, the SI Project Update, Section 13.8.2 and the AI Project Update, Section 14.9.2. The general approach included:

- determination of specific acoustic receptors
- determination of existing noise levels
- estimation of the sound emissions from the project
- use of predictive modelling to estimate sound levels at receptors
- comparison of the resulting cumulative sound levels to criteria

Specific methods for assessing project effects on acoustics have changed since the Integrated Application, based on changes in ERCB noise regulations. The Integrated Application met the assessment requirements of ERCB Interim Directive 99-08: Noise Control and Guide 038. In the Integrated Application, effects assessment (compliance) criteria for acoustics were identified in Volume 4, CR 8.

Modelling for the acoustics assessment evolved during the project, with the original models completed using an environmental noise propagation model, as described in the Integrated Application, CR8. The AI Project Update included the use of the Computer Aided Noise Attenuation (CadnaA) Model, which is based on internationally accepted algorithms for calculating outdoor noise propagation, International Organization for Standardization (ISO) 9613-2:1996 *Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation* (ISO 1996). The selected prediction methods, assumptions and limitations are described in the AI Project Update, Appendix H, Section H1.4.1.

Criteria for the acoustics assessment have changed between the Integrated Application and the AI Project Update. The assessments in the SI Project Update and AI Project Update followed the methods outlined in Directive 038: Noise Control, which superseded Interim Directive 99-08/ Guide 038. Directive 038 changed the design guideline at 1.5 km from a facility fenceline to a set criterion to be met at 1.5 km from a facility fenceline. The criteria were outlined in the SI Project Update, Section 13.8.2 and the AI Project Update, Section 14.9.2. Methods regarding consideration of cumulative effects for acoustics introduced in Directive 038 became more defined between 2007 and 2010, with the new methodology reflected in the AI Project Update.

TERRAIN AND SOILS

Determination of the significance of project effects on terrain and soils considered the soil resource and other key materials used to recreate the post-mining landforms, as well as the pre-development and closure land capability of the development area. The assessment also considered the potential effects associated with air emissions that could lead to acidification of soils.

The effects assessment methods for soils and terrain were outlined in the Integrated Application, Section 7 with updates in the SI Project Update, Section 13.10.2 and the AI Project Update, Section 14.10.2. The assessment methods used for the AI Project Update were consistent with those used for the SI Project Update, with the following exceptions:

- A slightly different LSA was used to be consistent with the vegetation and wildlife study areas (see Section 14.13.2 and Section 14.14.2). The LSA encompasses approximately 11,272 ha, an increase of 2,920 ha compared with the assessment in the SI Project Update, Section 13.10.3.1.
- Existing soil map units from the Canadian Natural Resources Limited (Canadian Natural) Horizon project were used for the northern area of the LSA adjacent to that project. Soil polygons along the Ells River valley were extrapolated based on adjacent information and aerial photo interpretation along the river valleys. In addition, some soil map units were renamed based on supplemental soil survey information.
- Soil map units for most of the RSA were derived from the existing Athabasca Oil Sands Environmental Research Project (AOSERP) mapping in the oil sands region (Turchenek and Lindsay 1982), which was updated for the CEMA NO_x/SO_x Management Working Group (NSMWG) (Golder 2004).
- Full buildout of development footprints during active mining periods, without any reclamation, was assumed for all cases in this assessment. This is a hypothetical, worst-case assumption.
- The soils assessment in the SI Project Update, Section 13.10.3.3, assessed the pit lake based on potential changes to land capability. This assessment considers the pit lake in the context of soils and terrain resources.

Effects assessment definitions for soils and terrain criteria, as outlined in the Integrated Application, Volume 2, Section 7.3 and Section 7.4, have not changed.

Thresholds (Soils Acidification)

Effects assessment thresholds for soils acidification were outlined in the Integrated Application, Section 7.4.2.4. Thresholds were also outlined in the SI Project Update, Section 13.10.3.6 and in the AI Project Update, Section 14.10.3.6. Threshold differences are indicated in the AI Project Update, Section 14.10.2.

WATER QUALITY

The water quality and aquatic health assessment was based on a multiple lines of evidence approach, considering water quality guidelines, chronic effects benchmarks, tissue benchmarks and whole effluent toxicity predictions, as described in Section 14.11.2 of the AI Project Update. For the criteria used to determine significance ratings for each category in Table 14.11-7, see the AI Project Update, Appendix J, Table J1-25.

For the significance ratings for water quality and aquatic health, see the AI Project Update, Section 14.11, Table 14.11-7.

The water quality modelling approach used for the assessment was defined in the SI Project Update (Section 13.11.2) and the following updates were used in the AI Project Update:

- The Hydrologic Simulation Program FORTRAN (HSPF) model was calibrated based on updated stream flow predictions (see Section 14.8.3.2) and additional background water quality data.
- Water quality in the pit lake was predicted using a combination of three models: inflow volume and chemistry from the reclaimed mine site were simulated using HSPF; hydrodynamics were simulated using a two dimensional hydrodynamic and water quality model (CE-QUAL-W2); and lake chemistry was simulated using the Golder Pit Lake Model (GPLM) (see Appendix J, Section J1.1).
- Daily water quality concentrations in the JCR and Ells River were simulated using HSPF.
- Daily water quality concentrations in the Athabasca River were simulated using the Athabasca River Model (ARM) (see Appendix J, Section J1.1).
- The list of water quality parameters differed slightly, mainly because of the grouping of polycyclic aromatic hydrocarbons (PAHs) and nutrients.

The assessment for aquatic health was mainly based on frequency of compliance with water quality guidelines, an approach that was based on the following multiple lines of evidence:

- comparison of predicted concentrations of individual constituents in water against background levels, water quality guidelines (AENV 1999; CCME 1999; U.S. EPA 2002) and chronic effects benchmarks (CEBs), as derived in Imperial Oil (2005) and Shell (2007)
- predicted levels of whole effluent chronic and acute toxicity predicted concentrations of constituents in fish tissue

Stream flows from the hydrology assessment (see Section 14.8.3.2 of the AI Project Update) and seepage rates from the groundwater assessment (see Section 14.5.3.4) were used as water quality model inputs. Water quality was assessed at four nodes in the LSA (see Section 14.8.3, Figure 14.8-1). The approach and methods for the acidification assessment of waterbodies was the same as those used in the SI Project Update, Section 13.11.3.2, except that PAI was calculated by including the uptake of nitrogen in terrestrial and aquatic ecosystems (AENV 2009; NSMWG 2007).

TRADITIONAL ECOLOGICAL KNOWLEDGE AND TRADITIONAL LAND USE

Significance ratings were not used for the Traditional Knowledge/Traditional Land Use studies completed for the project. Determination of significance is a regulatory concept and is considered to have little relevance with respect to the traditions, values and practices of Aboriginal peoples. It is not a term that Aboriginal peoples use when they conceive of and discuss how they use the land. Traditional land use practices of Aboriginal peoples take place within a holistic worldview and Aboriginal peoples are largely reluctant to rate the importance of plants and animals they use. For the *Traditional Ecological Knowledge and Traditional Land Use Report* (FMA 2005) and the *Traditional Ecological Knowledge and Land Use Report* (FMA 2006), both produced for Fort McKay First Nation (FMFN), FMFN members assessed perceived effects of the project on traditional lands, including the direct effects that any changes might have on the culture, practices and lifestyles of the Aboriginal peoples whose traditional land is being affected.

VEGETATION

Assessment of project effects on vegetation applied methodologies defined in the Integrated Application, CR13. The AI Project Update, Appendix K, Table K2-1 provided the effects assessment criteria used for vegetation. These criteria were tailored to be specific to vegetation. Criteria for determining the significance of project and cumulative effects are most appropriately based on accepted resource objectives or ecological thresholds associated with the resource in question. With such clear objectives or thresholds, the ability of the resource to accommodate the additional effects of a proposed project, in combination with other cumulative effects, can be assessed and a determination of significance can be made on that basis.

Although regional initiatives are progressing in the oil sands region to establish sustainable resource goals for biodiversity (ASRD 2008), resource objectives or thresholds for vegetation resources to date have focused primarily on forest harvesting activities and are not available for more general biodiversity issues.

In the absence of such objectives or relevant thresholds for vegetation at the species and community level, the AI Project Update defined significance based on the potential loss of species, community or landscape diversity for the long term at the RSA level. As described in the AI Project Update, Appendix K, Section K2.1, predicted effects were considered insignificant if they were of short- to medium-term duration, or if landscape, community and species (e.g., rare plant) diversity was not lost at the RSA scale. Conversely, predicted effects were considered significant if vegetation diversity at the species, community or landscape scale was lost in the RSA.

The vegetation assessment focused on vegetation and associated biodiversity indicators at multiple spatial scales that included landscape, community and species levels. This approach was guided by the assumption that vegetation species and assemblages of those species (i.e., vegetation types and larger landscape patches) differ as a function of such ecosystem variables as climate, landform, topography, soil type, water quality and water quantity. Characteristic assemblages of species in the landscape can be classified into vegetation types and patches that are generally recognizable at the community and landscape scale. As such, they can be mapped and changes in their occurrence resulting from human-related disturbances can be predicted and assessed.

Key assumptions in the assessment included:

- vegetation species and assemblages of those species that ultimately develop in the reclaimed landscape will continue to be a function of ecosystem variables and that known relationships and patterns will ultimately be reasonably similar but not identical to pre-disturbance conditions (see Bridge and Johnson 2000; Johnson and Miyanishi 2008)
- the revegetation pattern established on the closure landscape for the vegetation assessment was based on anticipated topographic positions, as well as soil, moisture and nutrient regimes. It is anticipated that the reclamation landscape will become more heterogeneous with time, as natural, stochastic processes such as fire and insect outbreaks as well as extreme climatic events (i.e., droughts, heavy run-off events, windstorms) continue to occur (see White 1979; Sousa 1984; Johnson and Miyanishi 2008)

The use of significance criteria related to the maintenance of diversity in the RSA is considered ecologically appropriate for this assessment, in the absence of established regional objectives for vegetation. As discussed above, the assessment approach characterized species, community and landscape patterns across the LSA and RSA, quantified changes in the relative abundance of these features for a variety of different land use development scenarios, and enabled those features particularly vulnerable to cumulative land use changes to be identified. Information provided by the assessment can be used by land and resource managers in their emerging decisions on conservation policies and protection practices for the region for vegetation resources.

By basing effects significance criteria on the potential loss of diversity, the assessment approach is consistent with key commitments made by Canada and Alberta related to maintenance of biodiversity, including the:

- *Convention on Biological Diversity* (United Nations 1992)
- *Canadian Biodiversity Strategy* (Government of Canada 1995)
- *Alberta Land Use Framework* (ASRD 2008) and associated pending *Biodiversity Action Plan*
- *Responsible Actions – A Plan for Alberta’s Oil Sands* (Alberta Treasury Board 2009)

Evaluating effects significance at the RSA rather than the LSA scale is also appropriate. To be effective, resource management and land use frameworks are implemented in broad regional areas such as the Lower Athabasca region, and management at this scale is fundamental to the TRIAD approach proposed by CEMA (2007). Covering an area of only 11,272 ha, the LSA used for the project assessment is not a representative unit of land within which broader ecological processes and resources are managed. As the proposed project footprint covers the majority of the LSA, biophysical conditions in this area will be modified. However, the relevance and significance of these effects can only be meaningfully evaluated in the context of the broader resource characteristics, industrial developments and management options in the RSA.

WILDLIFE

The environmental assessment focused on potential effects of the project on wildlife habitat, movement and mortality risk. The assessment methodology, as defined in the Integrated Application, CR14, is described in the AI Project Update, Appendix L, Section L1. The assessment concluded that the project will have small effects on wildlife mortality and movement. The most important potential effect of the project is on wildlife habitat.

Assessment criteria for wildlife (extent, duration, frequency and magnitude) were described in the AI Project Update, Appendix L, Table L1-1. They are used to characterize residual project effects on wildlife but do not, in themselves, determine whether a potential effects is significant (unacceptable).

Determining significance is best done in the context of accepted resource objectives or ecological thresholds for the resource in question. A project or cumulative effect is considered significant when it exceeds a threshold of what is considered acceptable. Several initiatives in the oils sands region are working to establish goals and thresholds for biodiversity (CEMA 2007; Carlson and Stelfox 2007). At this time, however, thresholds for wildlife habitat have not been developed for the region. The objectives and thresholds developed for wildlife have focused primarily on harvesting (e.g., hunting and trapping), which is not the effect of greatest concern for this project.

In the absence of established thresholds for wildlife habitat, the AI Project Update defines a significant effect as one that is likely to result in the long-term or irreversible loss of wildlife diversity in the RSA (see Section L1.2.6.4, Appendix L). This is described in further detail below.

The information provided in the Vegetation section describes why using a significance criteria based on regional biodiversity is consistent with key commitments made by the governments of both Canada and Alberta and the management of the Lower Athabasca Region. This rationale applies equally to wildlife as to vegetation.

Determining significance is a challenge when both local ecological and officially recognized thresholds are absent. In response to the questions on significance criteria, appropriate ecological thresholds for maintaining landscape diversity have been identified from the literature and selected for conservative (precautionary) values for comparison with assessment results.

Wildlife thresholds will vary depending on the underlying ecological processes, the species in question, the area and the type of development. As natural habits are converted, habitat is lost and what remains becomes more fragmented. Both phenomena can affect species persistence. Key factors that influence the maintenance of diversity are reproductive rate of the organism, mortality rates, the emigration rate, habitat pattern in the landscape (fragmentation) and matrix quality (survival rate of the organism in non-habitat areas) (Fahrig 2001). Fahrig (2002) concludes that for birds, at least, habitat loss has a much larger effect than fragmentation.

Evidence suggests that below certain thresholds of habitat cover levels, species may decline more rapidly than would be expected from habitat loss alone, potentially leading to their regional extirpation if population sizes become too small. Radford et al. (2005) found woodland bird diversity dropped rapidly when landscapes had <10% cover. When more than 10 to 30% of functional habitat remains in a region, species are affected by habitat loss, (Andr n 1994; Fahrig 1997; Swift and Hannon 2010), but are not necessarily regionally extirpated. Higher thresholds have been reported for amphibians (e.g., Gibbs 1998; Homan et al. 2004) that may reflect sensitivity to fragmentation after only moderate habitat loss. Some authors have found that, depending on the taxa and landscape, residual habitat thresholds may range from 10% to as high as 60% (Bennett and Ford 1997; Villard et al. 1999; Swift and Hannon 2002) to avoid rapid declines in population. A recent review by Swift and Hannon (2010), however, concluded that most empirical studies supported Andr n's (1994) proposed range of 10 to 30% habitat cover.

The majority of the evidence supports a 30% residual habitat threshold at a landscape level to avoid rapid declines that may lead to regional extirpation. To adopt a precautionary approach, based on the caveats described above, a significance threshold of 60% residual habitat has been used for comparison against assessment results. This threshold also encompasses some of the higher thresholds identified by some authors.

VISUAL AESTHETICS

Significance was assigned for visual aesthetics in the AI Project Update at each observer location, as was done in the Integrated Application. Visual effects were considered not significant at observer locations if the results were rated as negligible or none. The following criteria were used in the AI Project Update for the significance ratings for observer locations:

- **None** – No part of the development, work or activity associated with it is discernible.
- **Negligible** – Only a very small part of the project is discernible and they are such a distance that they are scarcely appreciated. Consequently they have very little effect on the scene.
- **Slight** – The project constitutes only a minor component of the wider view, which might be missed by the casual observer or receptor. Awareness of the project would not have a marked effect on the overall quality of the scene.
- **Moderate** – The project might form a visible and recognizable new element in the overall scene and might be readily noticed by the observer or receptor.
- **Substantial** – The project forms a significant and immediately apparent part of the scene that affects and changes its overall character.
- **Severe** – The project will become a dominant feature of the scene to which other elements become subordinate and they significantly affect and change its character.

Measurable parameters included the distance from the visible project feature to the observer location, the proportion of the entire project that was visible from that location and the results of the 3D model representation.

- b. **Provide the rationale employed by Total to conclude that the methods, criteria, definitions and threshold are reasonable.**

Response:

TEPJ concludes the methods, criteria, definitions and thresholds used for the EIA are reasonable because they are:

- adopted from several recognized sources, including Hegmann et al. (1995, 1999); FEARO (1990, 1994); Beanlands and Duinker (1983) and Roots (1994)
- in compliance with the EIA Terms of Reference, which established the framework for the environmental assessment, as described in the AI Project Update
- consistent with the ongoing nature of environmental assessment, wherein the assessment also addresses considerations subsequently expressed by government review agencies and the general public during collection of baseline environmental information and preparation of the environmental assessment

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9.0 Species at Risk

Question 20

For each species listed federally under SARA or listed as “sensitive”, “at risk”, or “may be at risk” in the General Status of Alberta Wild Species 2005 that may occur in the RSA (see Table L1-3 in Appendix L Wildlife Supporting Information 2010)1:

- a. **provide population estimates in the LSA (for preindustrial conditions and the baseline case), using existing data;**
- b. **quantify how the project is likely to affect the populations of these species at full build out.**

Response to 20a and 20b:

The additional information requested on four SARA-species listed in March 2010 potentially occurring in the LSA will be completed by the end of August 2010 and submitted to the JRP by the end of August, as per the June 24, 2010 letter sent to the JRP.

Progress to date on the SARA-listed species has included:

- a conference call with Environment Canada in late May to discuss their information needs and suitable survey methods for several SARA-listed bird species
- completion of field studies focused on determining the relative abundance, distribution and habitat selection of SARA-listed bird species were completed at the end of June
- further discussions with Environment Canada on existing federal databases on the species in question, and appropriate methods for estimating population levels in the absence of comprehensive existing data bases
- completion of data entry and initial evaluation of survey observations

As indicated in the letter dated June 24, 2010 sent to the JRP, additional information on species listed as Sensitive, At Risk, or May Be At Risk in the *General Status of Alberta Wildlife Species 2005* will be developed in consultation with ASRD subsequent to project approval.

Question 21

For each species listed federally under SARA or listed as “sensitive”, “at risk”, or “may be at risk” in the General Status of Alberta Wild Species 2005 that may occur in the RSA (see Table L1-3 in Appendix L Wildlife Supporting Information 2010):

- a. **provide the available habitat (relevant ecosite phases) in the LSA. Include maps of where this habitat occurs against any species at risk detections;**
- b. **quantify the expected area of occupancy for each ecosite phase used by each species;**
- c. **identify how much of this habitat will be affected by the project for each species.**

Response to 21a, 21b and 21c:

See the response to Question 20.

Question 22

For each species listed federally under SARA or listed as “sensitive”, “at risk”, or “may be at risk” in the General Status of Alberta Wild Species 2005 that may occur in the RSA (see Table L1-3 in Appendix L Wildlife Supporting Information 2010), indicate if reclamation will result in the same type of ecosite phases affected by the project and the approximate time it will take to reclaim these ecosite phases.

Response:

Once the habitat selection of SARA-listed species has been further refined based on survey observations, the potential to re-establish preferred habitats on the closure landscape and the timing required to do so will be discussed. This information will also be provided at the end of August.

Question 23

For each species listed federally under SARA or listed as “sensitive”, “at risk”, or “may be at risk” in the General Status of Alberta Wild Species 2005 that may occur in the RSA (see Table L1-3 in Appendix L Wildlife Supporting Information 2010), that did not have the Habitat Suitability Index (HSI) model applied:

- a. provide an update to Table L1-4;
- b. species, provide an update to Table L1-5 to show the potential habitat in the RSA.

Response to 23a and 23b:

See the response to Question 20.

Question 24

If additional surveys are to be conducted by Total for any of the above questions, include a summary of the survey methods, assumptions, sample sizes, and any other considerations that Total used to conduct the surveys.

Response:

Breeding bird point count surveys and common nighthawk nocturnal surveys were completed in the LSA in June and July 2010. Breeding bird point counts were undertaken from June 25 to July 2 while common nighthawk surveys were completed on June 23, 24 and 28. The purpose of the surveys was to gather local information on the occurrence, distribution and habitat selection of four SARA-listed bird species; Canada warbler, olive-sided flycatcher, rusty blackbird and common nighthawk. In addition, surveys were designed to facilitate verification of habitat suitability models for these species. As such, survey sites were placed in accessible areas of anticipated low, moderate and high suitability in the LSA to enable density comparisons to be made for the different habitat classes.

For the breeding bird survey, 80 fixed-radius point count stations were established in the LSA in a variety of ecosite phases considered to represent a range of suitable habitats for the target species. Sampling in higher-quality habitats for rusty blackbird (i.e., wetter sites with open water) was impeded because of access issues. Of the target species, only Canada warblers and olive-sided flycatchers were observed during the survey.

For the common nighthawk survey, 52 nocturnal listening stations were established in the LSA, with occurrences being recorded at numerous sites throughout the LSA.

Question 25

Total's response to Environment Canada's submission indicated that Total used surrogate species when assessing species at risk. Where relevant, indicate which wildlife VECs Total used as surrogate species for which species at risk and provide Total's rationale for this approach.

Response:

With the additional information being collected for SARA-listed species, TEPJ will not be using surrogate species to estimate the effects on SARA-listed species.

Question 26

For each species listed federally under SARA or listed as "sensitive", "at risk", or "may be at risk" in the General Status of Alberta Wild Species 2005 that may occur in the RSA (see Table L1-3 in Appendix L Wildlife Supporting Information 2010), indicate how the project is likely to affect these species:

- a. **include in your assessment the combined effects of habitat loss, direct mortality and reduction in habitat suitability (i.e. noise, edge effect and fragmentation of the habitat);**
- b. **provide any measures, other than habitat reclamation, that may be used specifically to mitigate effects on species at risk.**

SARA-Listed Species***Response to 26a and 26b:***

An assessment of the combined effects of habitat loss, direct mortality and reduced habitat suitability will be undertaken for SARA-listed species for the RSA and will be filed at the end of August 2010.

General Status of Alberta Wildlife Species***Response to 26a and 26b:***

As indicated in the June 24, 2010 letter sent to the JRP, additional information on species listed as Sensitive, At Risk, or May Be At Risk in the *General Status of Alberta Wildlife Species 2005* will be developed in consultation with ASRD subsequent to project approval.

10.0 Traditional Land Use

Question 27

In response to September 2008 Questions 1 and 2 from the Panel, Total notes that it has received or reviewed some Traditional Ecological Knowledge studies and Traditional Land Use studies. Total is asked to file the following reports:

- Fort McMurray 468 First Nation – TLU study published in 2006 titled *Nistawayaw: Where Three Rivers Meets*,
- Wood Buffalo Elders Interview Project,
- TEK-TLU study completed and published in May 2009 entitled ‘Fort McKay First Nation Traditional Knowledge Report’ in the context of the Shell Pierre River Mine Project, and
- The relevant sections of the Northern River Basins Study (NRBS 1996B).

Response:

For copies of the requested reports, see Appendix A. The sections of the *Northern River Basins Study Final Report* most relevant to the JRP are Section 3.4: Traditional Knowledge and Section 5.2: First Nations/Métis Issues: Recommendations to the NRBS Board.

References

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Question 28

Based on the information available, assess and determine the significance of the project effects, including the cumulative effects, on the current use of lands and resources for traditional purposes by aboriginal persons.

- In the assessment include a summary of the current use of land and resources by the Aboriginal people that may potentially be affected by the project, and provide clear conclusions and rationale about the significance of these effects.**

Response:

TEPJ funded TEK-TLU studies for the Joslyn Lease. The Fort McKay First Nations (FMFN) TEK-TLU studies (FMA 2005, 2006, 2008) discussed traditional land uses and land use features in the project area of importance to the community, as well as the resources that support those activities. The studies also identified a number of project-specific effects on traditional land users, and

summarized traditional ecological knowledge shared by community members. In the SI Project Update and AI Project Update, the potential effects of the revised project on TLU were revisited. As a result of the close proximity of Fort McKay, 10 km southwest of the proposed Joslyn North Mine, a portion of the Joslyn Lease area overlies lands identified by FMFN as a high-intensity Traditional Use Area (see FMA 2006, Figure 1-3). Some of this area will not be accessible by traditional land users during project construction and operations.

Using widely accepted assessment techniques, effects of the project were evaluated in combination with other disturbances and developments, on resources typically used by traditional land users, and it was concluded that the project can proceed without significant effects on those resources at the regional level. TEPJ recognizes that similar conclusions cannot, by extension, be applied to effects on individual traditional land users.

TEPJ has also provided funding to ACFN and offered funding to MCFN to conduct TEK–TLU studies. TEPJ approved scopes of work for both these studies in 2008 and the studies are ongoing. In the absence of these completed studies, TEPJ is not in a position to definitively comment on the level of effects on traditional land use for these First Nations.

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- FMA. 2008. *Fort McKay First Nation Traditional Knowledge Report for the Total E & P Canada Ltd. Joslyn North Mine Project Update*. Prepared for Fort McKay Industry Relations Corporation on behalf of Total E & P Canada Ltd. Calgary Alberta. (Copy attached in Appendix B.)

b. Clarify what measures will form part of the strategy to mitigate the effects on traditional land use.

Response:

TEPJ and Fort McKay have collaborated on development of an Environmental Agreement between the two parties for the project, a document that will continue to evolve through ongoing discussions and planning. A key objective of the agreement is to resolve, to the degree possible, project effects on traditional land use including:

- development of an access management plan that addresses the communities' interests
- a reclamation plan that includes the reestablishment of ecosites that support traditional pursuits
- development of a commercial native seedling facility

TEPJ intends to discuss offset options with representatives of Fort McKay, and is in discussions with ACFN and MCFN on the development of similar agreements with these communities.

Appendix A

Nistawayaw: Where Three Rivers Meet – Fort McMurray First Nation 468 Traditional Land Use Study

Fort McKay First Nation Traditional Knowledge Report – Jackpine Mine Expansion and Pierre River Mine Environmental Impact Assessment

A Report of Wisdom Synthesized from the Traditional Knowledge Component Studies

Final Report – Wood Buffalo Elder Interview

Appendix B

Fort McKay First Nation Traditional Knowledge Report – Total E & P Canada Ltd. Joslyn North Mine Project Update